

Collective Action in Governance Networks: Modelling and Assessing Organizational Behavior in Anti-Corruption Multi-Stakeholder Partnerships

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I, Jose Antonio Reyes-Gonzalez, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

For my beloved family, who supported me unconditionally through the ups and downs of this journey.

For all my friends and special ones.

Abstract

To achieve solutions across conflicting policy arenas, decisions are increasingly made within governance networks. While the narrative, promotion and growth of governance networks is indisputable to solve societal problems, the same enthusiasm has not fueled their disciplined study. Their potential to deliver on their promise of being effective, inclusive, and innovative collaborative platforms is far from established. This thesis identifies and explores neglected dimensions of governance networks in the literature. It tests hypotheses related to mechanisms that may affect governance networks' integration, composition and inner stability. It does so by collecting unique relational data from 116 organizational members of ten multi-stakeholder partnerships (MSPs) – associated with the Infrastructure Transparency Initiative (CoST) – in Latin America, Africa, and Eurasia. Drawing from this data, chapter 2 investigates whether actors' motivation to participate in governance networks can predict their level of influence. It finds that, contrary to widely held assumptions about MSPs, actors who are self-interested, rather than pro-socially motivated, exchange more information, expanding their ability to influence others. Chapter 3 examines when information exchange between network actors emerges. It indicates that once joint committee attendances are taken into account, the statistical effect of contact making based on participatory motivations diminishes, proving that actors prioritize opportunity structures that maximize contact-making outreach. Chapter 4 explores the extent to which the structure of networks reflects actors' efforts to cope with cooperation and coordination risks, and how this impacts functions for innovation. Evidence shows that self-organizing structures, such as bonding, when actors experience fear of partner defection, and bridging, when actors experience lack of direction, are not antagonistic. Actors can respond to these risks simultaneously at the cost of innovation. These findings challenge the normative claims of the governance network literature and contribute to the theories around governance systems of fragmented authority.

Impact statement

Contributions from this thesis are threefold: practical, methodological, and theoretical. In terms of practical application, one of the main takeaways of this thesis is that multi-stakeholder partnerships (MSPs), real-world examples of complex governance networks, do not moderate asymmetries between participants as it is widely assumed. On the contrary, partnerships may amplify disparities if due consideration is not given to actors' participatory motivations, perceptions of risks, and contextual factors for communication. This renders MSPs as one of the possible solutions for collective action problems that must be cautiously pondered against other collaborative arrangements.

This thesis has proved its real-world impact in three occasions. First, preliminary findings of social network analysis have served as input for the improvement of implementation protocols of the Infrastructure Transparency Initiative's (CoST). Having a potential impact in more than 20 countries and their ongoing processes for the implementation of transparency mechanisms. Analysis and conclusions of this thesis have supported CoST's International Secretariat to justify performance metrics in funding applications to multilateral organizations, setting a benchmark for innovative evaluations based on network analysis of multi-stakeholder spaces (see Appendix G7 and G8).

Second, the fourth chapter of this thesis has been selected in 2021 by the Innovation for Citizens Services Division (ICS) of the Inter-American Development Bank (IDB) to be further developed and rewritten as a working paper. This will include the support of IDB's senior consultants of the transparency and public infrastructure clusters of the Bank. The chapter is currently under revision and scheduled to be published as a working paper by mid-2023. This will mark the flagship publication of my research in the practitioner realm.

In addition, the design of this research project was awarded in 2019 best paper in the category of "Partnerships for Development" presented by Jeffrey Sachs at the United Nations' International Conference on the Sustainable Development Goals in New York. In the same year, my research was presented at the Yale Institute for Network Science, obtaining valuable feedback from Nicholas Christakis (Director of the Human Nature Lab) for research's practical application and possibilities to extend it to support health partnerships in developing countries.

Theoretically, the thesis contributes to the fields of governance networks and collective action, all characterized by governance systems of fragmented authority. It showcases a research approach that can enrich these fields as it draws on theoretical premises from political science (influence and power), psychology (motivations and perceptions) and new institutional economics (transactional costs). It evaluates and offers fresh insights related to popular claims about theories related to collaborative risks (Berardo & Scholz, 2010), innovation diffusion (Rogers, 2003), the Advocacy Coalition Framework (Sabatier & Weible, 2007), social capital (Putnam, 1993; Coleman, 1988), resource-dependence and social-exchange (Pfeffer & Salancik, 1978; Blau, 1964).

Methodologically, the thesis contributes to the literature on network data collection and treatment. Prior to the analysis, data collection took place thanks to the design of a distinctive online survey template developed by this thesis' author with the support of network experts and multi-stakeholder groups advisers. This allow an effective deployment of the survey across different national contexts, languages, and sector boundaries. The survey template can be employed in future research for network analysis, prioritizing confidentiality of participants in multi-stakeholder spaces (see Appendix G4).

Some of the concepts this thesis focuses on have been, until now, researched mostly in the context of single- and isolated-network analysis. This thesis presents methodological advances for complex network analysis, by stacking several network matrices diagonally as input files for network analysis techniques and simulations (see Appendixes G10 - G11). In particular, this data structuration enables the exploration of global patterns across a wide range of network datapoints simultaneously to draw inferences about underlying mechanisms that sustains network structuration (see Chapters 3 and 4).

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This work would not have been possible without the encouragement and contributions from Marc Esteve, as the first supervisor of this research project. Marc has been patient, kind and a consistent reviewer of my work throughout, for which I owe him a debt of gratitude. While not part of the beginning of my PhD program, Christian Schuster and Filip Agneessens, generously agreed to handle my project as the second and third (external) supervisor, respectively. Christian and Filip have provided valuable feedback of the thesis when requested and needed. I would like to express my appreciation for their never-ending patience during this time.

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ACRONYMS AND ABBREVIATIONS

Organizations

CoST	Infrastructure Transparency Initiative
EITI	Extractive Industries Transparency Initiative
GI Hub	Global Infrastructure Hub
GIFT	The Global Initiative for Fiscal Transparency
IDB	Inter-American Development Bank
OECD	Organization for Economic, Cooperation and Development
OGP	The Open Government Partnership
RSB	Round Table on Sustainable Biomaterials
UN	United Nations

Terms introduced

Aca	Academia
AT	Assurance Teams
CS	Civil Society
Med	Media
NS	National Secretariats
Obs	Observer Organization
PriS	Private Sector
PubS	Public Sector

CHAPTER 1: INTRODUCTION

Governance networks: an overview

We are in the age of the “network society” (Castells, 2022, p. 2). In today’s public affairs, governments are no longer able to delegate power to a single agency to solve a problem or provide a public service. Instead, there is a pervasive trend in which public, private and non-governmental organizations are called upon to come together in increasingly collaborative ways in order to solve challenges across policy areas, leverage experience and knowledge from multiple participants (Kilduff & Tsai 2003; Provan, Fish & Sydow, 2007). This is assumed to be a straightforward way “to get things done” (Imperial, 2005, p. 13), where solutions are available to tap into by placing the right actors around a table for discussion, coordination and cooperation (Huxham & Vangen, 2004).

These alliances take the form of *networks* (Klijn & Skelcher, 2007). They are integrated by groups of cross-sector individuals and/or organizations that work together to provide public goods, services, or value when single public sector agencies are unable to produce them (i.e., government failure). Or when private sector firms are unable or unwilling to provide them in the desired quantities (i.e., market failure) (Isett, Mergel, Leroux et al., 2011; Turrini, Cristofoli, Frosini, et al., 2010; Schäferhoff, Campe & Kaan, 2009).

Networks must be differentiated from multiple types of network-based platforms that are often used interchangeably in the literature (Lecy, Mergel & Schmitz, 2014; Kapucu, 2015). In *policy networks* a set of stakeholders have a common interest in public decisions, especially those about public resources allocation (Isett et al., 2011). *Cooperative networks* focus exclusively on information exchange among stakeholders, while in *coordination networks*, actors align their individual policies/practices to achieve beneficial results to everyone in a determined policy arena. On the other hand, *collaborative networks* focus on the production of goods and services by a set of interdependent organizational stakeholders (Lecy et al., 2014).

The term governance in *governance networks* refers to the replacement of hierarchical bureaucratic structures with more integrated and horizontal organizational arrangements (Kapucu, 2015). Governance networks fuse collaborative public goods and service provision with collective policymaking and information sharing (Isett et al., 2011). Thus, combining most of the characteristics of the different networks described above. Governance networks are the

main focus of this thesis, and they represent one of the highest levels of integration among multiple stakeholder actors (Lecy et al., 2014).

Governance networks are an emerging phenomenon. They have flourished since the late 1990s (Westerwinter, 2019), as the result of trends towards devolution and privatization in public services and goods. Governance networks are present in an increased number of countries, as signatures of participatory democracy.¹ This not only complements the limits of more traditional representative democracy (Rasche, 2012; Mena & Palazzo, 2010), but also it changes paradigms of markets as the only non-hierarchical efficient structure for public service delivery (Kapucu, 2015).

These governance arrangements are generally embedded in appealing narratives. They are mostly promoted by governments and multilateral organizations (Faul, 2016), emphasizing their capacity to create positive dynamics in complex arenas that require collective action. The benefits may include organizational flexibility, inclusiveness, efficiency, and innovation (Googins & Rochlin, 2000; Emerson, Nabatchi & Balogh, 2012). While this presumption seems intuitive for some scholars, policy makers, and practitioners, empirically there are several issues that make supporting this causal claim rather difficult.

Forming and maintaining these networks is far more complex than their definition implies. The formation and integration of all the required elements for governance networks often face resistance and misunderstanding from participants, condemning the outcome of the network before it has any actual benefit (Westerwinter, 2019). Thus, the argument that governance networks effectively address complex societal challenges, by integrating the interests, knowledge and skills of a number of participants, is still rather a normative idea than a methodologically sound and theoretically grounded empirical fact.

While the involvement of a diverse set of actors does enhance the capacity to address problems by integrating multiple perspectives in the solution of problems, it also brings about unintended and negative consequences (Hasnain, Sofaer, Bazzoli et al., 2013; Kapucu, 2015). The variety of actors and interests may cause psychological discomfort and uneasiness to work together (Bryson, 2004; Sørensen, 2006), and so it can also become a weakness likely to

¹ Klijn and Edelenbos (2013) noted that in North America, networks are focused on service delivery and policy implementation, while in Europe they are specialized in policy creation and decision-making.

produce failures in terms of partner defection, lack of coordination, and imbalances of influence (Huxham & Vangen, 2004; Berardo & Scholz, 2010).

It is due to these difficulties that the record of governance networks, in the form of partnerships and alliances, that have fallen short of expectations has been increasing over the years (Westerwinter, 2019). This unveils a much more complex reality than what is generally conceived by their supporters (Faul, 2016). The potential of governance networks to deliver on their promise of being effective, inclusive, and innovative collaborative platforms is far from established.

This thesis identifies and explores neglected dimensions of governance networks in the literature. It tests hypotheses related to mechanisms that may affect governance networks' integration, composition and inner stability. It does so by collecting unique relational data from 116 organizational members of ten multi-stakeholder partnerships (MSPs) in Latin America, Africa, and Eurasia. Drawing from this data, evidence shows that (i) contrary to widely held assumptions about MSPs, actors who are self-interested, rather than pro-socially motivated to participate in them, exchange more information, increasing their likeliness to shape influence on others, and change collective agendas; (ii) it finds that once joint committee attendance is taken into account, the statistical effect of contact making based on participatory motivations diminishes, proving that actors prioritize opportunity structures that maximize contact-making and outreach; and (iii) it shows that self-organizing structures, such as bonding, when actors experience fear of partner defection, and bridging, when actors experience lack of direction, are not antagonistic. Actors can respond to these risks simultaneously at the cost of innovation. These findings challenge the normative claims of the governance network literature and contribute to the theories around governance systems of fragmented authority.

Literature and theory

To date, the literature on networks has developed in a fragmented way. The literature has generally adopted an expansive form of research, considering multiple definitions, versions and contexts of networks. Scholars have published comprehensive reviews of network research and what make them to work better (see Provan & Milward, 1995; Isett et al., 2011; Lecy et al., 2014; Provan et al., 2007; Robinson, 2006; Berry, Brower, Choi et al., 2004; Turrini et al.,

2010). These reviews highlight unresolved questions in the current literature and some important research issues that provide clear directions for new investigations.

In this thesis, I build on frameworks for network evaluations from Provan & Milward (1995) and Turrini et al. (2010). Provan & Milward have placed great interest on network effectiveness based on services improvement for networks' services main beneficiaries. At the *client-level*, evaluations of network activities focus mainly on assessing the outcomes of the network in terms of the target population they intend to serve. These evaluations have been employed in a wide range of public administration and public policy studies in the literature, for instance in school districts (Meier & O'Toole, 2001), job and training networks (Jennings & Ewalt, 1998), and healthcare services (Provan & Milward, 1995).

An alternative venue of research has employed a wider criterion to assess networks. This has been focused on the overall benefit that networks bring to the community, city or country where they operate (Turrini et al., 2010). At the *community-level*, evaluations go beyond the client-level described above. Several authors have embraced this perspective of evaluation for policy and collaborative networks, including community health improvements (Conrad, Cave & Lucas, 2003), economic development, and successful policy implementation (Provan & Milward, 2001).

While both community- and client-level evaluations are primarily concerned with the external effects generated by networks, a third classification of evaluation has been suggested to complement these two, providing a more robust and encompassing framework for network assessment. The *network-level* type of evaluation refers to the sustainability, legitimacy, and maintenance of the network itself. According to Provan and Milward (2001) this evaluation criteria focuses on networks' internal capacity to become a viable interorganizational platform, capable of resilience and adaptation throughout time.

At the network-level, Turrini et al. (2009) have proposed a set of less explored study areas that not only expand Provan & Milward's evaluation framework, but also they intend to improve our understanding of the structure and functioning characteristics of networks. These areas of research opportunity refer to (i) networks' integration mechanisms, (ii) networks' composition, and (iii) networks' inner stability.

Integration mechanisms refers to the structural characteristics that provide cohesiveness to the network. Critical mechanisms for integration are the flow of common information among network actors, as well as the integration of internal network bodies that facilitate collaboration and coordination towards a collective goal (Berardo & Scholz, 2010; Henry, Lubell & McCoy, 2011; Berardo & Lubell, 2016).

Network composition focus on the level of heterogeneity in networks. This posits that the more heterogenous groups of actors participate in a network, the better the practices for learning and innovating (Turrini et al., 2010). The literature neither determines nor explains the direction or size of groups that may influence positively a network. In this regard, the work of Brown, O'Toole and Brudney (1998), and Hermans, Sartas, van Schagen et al. (2017) are relevant. Their contributions agree on the point that networks need diversity of inputs, manageable size of participants and incentives to innovate that cut-across administrative levels and sectoral silos.

Network inner stability reflects another relevant aspect of network evaluations and effectiveness. Turrini et al (2010) refers to the work of Junke (2005), Provan and Milward (2001) and Huxham, and Vangen (2004) and argue that social dynamics that can promote trust and reciprocity are essential for the stability of the network. These factors support the creation social capital buffering collective action (Putnam, 1993; Coleman, 1988). Increased reciprocity and trust are linked to positive outcomes. And the development of networks as they can foster multiple other network relationships, improving capacities for collaborative work.

Framework of analysis

This thesis integrates and builds on frameworks of network evaluation from Turrini et al. (2010) and Provan and Milward (1995). I have selected the three previous scopes above for inquiry and extension with empirical data from governance networks.

Table 1.1 shows the state of the current literature in the conceptualization of network evaluations, performance, and management. The table shows a transition from client-level to network-level performance literature, according to Provan and Milward (1995). It also highlights the research extensions emphasized by Turrini and colleagues (2010), and the three dimensions that this thesis contributes to the literature. These dimensions are (i) participatory

motivations and influence, (ii) opportunity structures and type of information, and (iii) collective action risks and innovation. In the reminder of this subsection, a description of each dimension is provided.

Table 1. 1 *Dimensions of inquiry in the thesis*

Evaluation scope (Provan & Milward, 1995)	Extension Framework (Turrini et al. 2010)	Proposed research dimensions (Thesis)	References
Client-level	-	-	Jennings & Ewalt, 1998; Provan & Milward, 1995; Meier & O'Toole, 2001
Community-level	-	-	Provan & Milward, 2001; Conrad et al., 2003
Network-level	-	-	Agranoff & McGuire, 2001; Howlett, 2002; Mandell, 1999; Faul, 2016; Hermans et al., 2017
Contributions	Network integration mechanisms	-	Berardo & Scholz, 2010; Henry, Lubell & McCoy, 2011; Berardo & Lubell, 2016
	-	Chapter 2. Participatory motivations & influence	Fischer & Maag, 2022; Fischer & Sciarini, 2015; Ryan & Decy, 2000; Le Grand, 2003
	Network composition	-	Brown, O'Toole & Brudney, 1998; Faul, 2016; Hermans et al., 2017
	-	Chapter 3. Opportunity structures & type of information	Ansel & Gash, 2008; Carpenter, et al., 2004; Leifeld & Schneider, 2012; Henry et al., 2011; North, 1990; Williamson, 1981
	Network inner stability	-	Junke, 2005; Provan & Milward, 2001; Huxham, and Vangen. 2004
	-	Chapter 4. collective action risks and innovation	Berardo & Scholz, 2010; Berardo & Lubell, 2016; Feiock, 2013; Hermans et al., 2017; Roger, 2003

Source: Author's own elaboration. Based on Provan and Milward (1995) and Turrini et al. (2010) frameworks for network effectiveness assessments.

Dimension 1: Motivations of participation & influence. Prior studies have investigated the impact of actors' motivations to become participants of an organization on the organizational outcomes, especially those from the public sector (see Besley & Ghatak, 2018; Esteve & Schuster, 2020). These studies, however, have failed to explain how motivations shape actors' perceptions such as influence and reputation. The importance of this dimension resides in the fact that it is challenging to motivate actors to perform tasks collaboratively, such as sharing information and solve problems collectively. This requires time, energy, and knowledge that must be shared strategically (Fischer & Maag, 2022). Actors define participatory motivations based on whether their contributions will be rewarded or not

(Davenport & Prusak, 1998; Steets, 2010; Fischer & Leifeld, 2015). Participatory motivations in networks can be roughly differentiated between extrinsically self-interest motivations or intrinsically pro-social motivations (Ryan & Decy, 2000; Le Grand, 2003).

This is a dimension of inquiry within the networks' integration mechanism scope, because motivations serve as components to help actors to integrate, interact and achieve collective goals (Le Grand, 2003; Fischer & Maag, 2022). For networks concerned with governance tasks, partner motivations are crucial given that motivational differences can derail collaborative arrangements (Selsky & Parker, 2005).

In this dimension, the thesis challenges general assumptions that pro-social motivations lie at the core of the rationale for governance network formation. This assumption is tested vis-a-vis more selfish participatory motivations. Some governance network actors are driven by an altruistic desire to protect or speak for vulnerable communities and/or constituencies when joining governance networks, while others seek reputational opportunities and access to lucrative opportunities (Steets, 2010). Thus, this work identifies an unresolved tension in governance-network actors, fueled by two seemingly contradictory rationales that may determine actors' perceptions of influence and the capacity to change collective agendas.

Dimension 2: Opportunity structures and types of information. As previously noted, the scope of networks' composition refers to the underlying conditions that support productive interactions between network actors. Their heterogeneity in demographics characteristics, group size, professional backgrounds, and interests have been widely studied in this regard. However, an aspect that has been overlooked in the literature is the type of resources that network actors share, and the conditions that facilitate or inhibit these transactions.

By employing a transaction cost-based approach (North, 1990; Williamson, 1981), I argue that establishing information relationships with others in governance networks is not incidental. Actors are likely to employ several opportunity structures at once that minimize costs and maximize the access of information (see also Leifeld & Schneider, 2012; Henry et al., 2011). Opportunity structures are situational opportunities available in social, organizational, and institutional contexts that provide various strategic possibilities for actors to achieve specific outcomes (Merton, 1995).

In exploring this dimension for network composition, I test to what extent endogenous and exogenous opportunities structures enable or hinder information exchange in governance

networks. These opportunity structures are further evaluated in networks of political and technical information, elucidating patterns of network formation for each type.

Dimension 3: Collaboration risks & innovation. Networks' inner stability is determined by how network actors self-organize themselves. This capacity of self-organization is likely to be influenced by the inherent uncertainties and ambiguousness of collaborative processes (Berardo & Lubell, 2016). Thus, governance networks are likely to create adaptative mechanisms to cope with these risks. In exploring this dimension, I follow premises from the collective-action literature that posit that collective-action problems affects the relational structure of governance networks differently (Ostrom, 1990; 2005; Olivier, 2019).

When actors experience cooperation risks and fear partner defection, they tend to self-organize in *bonding structures*, such as reciprocity and transitive closed triads, that facilitate the flow of redundant information to identify and/or penalize defectors (Berardo & Scholz, 2010; Putnam, 1993). While facing coordination risks, on the other hand, actors experience lower defection threats and so they tend to create links that facilitate the emergence of *bridging structures*, providing access to new information and collaborators to synchronize collective efforts (Berardo & Lubell, 2016). Both network structures allow actors to follow different partner-selection strategies and gain higher payoffs when coping with collective action risks imposed by fragmented authority settings (Feiock, 2013). The thesis explores these theoretical premises of risk in five Latin American case studies.

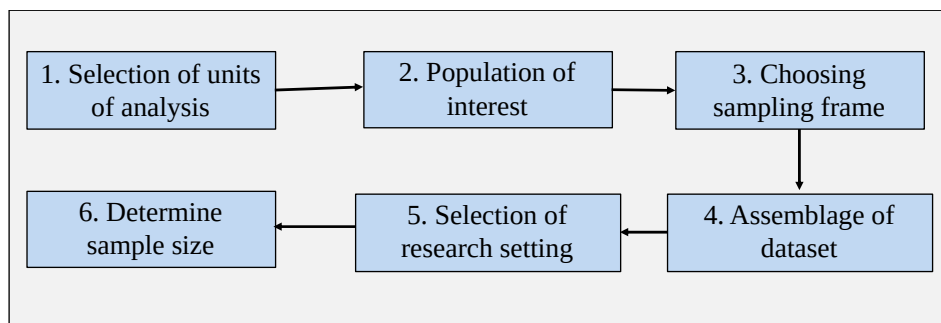
I further argue that innovation goes beyond the simple implementation of new technological tools. Instead, it requires the reordering of societal structures that enable the exchange of information and use of knowledge collaboratively. Extant research has not yet shown how bonding and bridging structures impact not only actors' self-organization capacity, but also how they facilitate or inhibit functions for innovation in governance networks (Hermans et al., 2017). The coupling of both research threads offers a fresh path of inquiry.

Research setting

I followed a six-step process for the selection of case studies (see Halperin & Heath, 2017; Callegaro, Manfredo & Vehovar, 2015). Figure 1.1 illustrates this sequence. Each step is contingent on others, and some may overlap during the research development. For sake of

parsimony, here they are presented in descriptive steps. For the *selection of units of analysis* (step 1, in Figure 1.1), I delineated the target population of governance networks of interest by focusing on the multi-stakeholder type of associations, in particular that of multi-stakeholder partnerships (MSPs). Then I chose a strategy for the *sampling frame* (step 3), described in the following subsection.

Figure 1. 1 *Research setting selection plan*



Source: Author's own elaboration.

Sampling frame

The sampling frame within the development of a research design, is a list of elements that enables the identification of eligible case studies of the population. The sampling frame is meant to include a complete (or as complete as possible) list of all cases in the population of interest (Halperin & Heath, 2017).

For this aim, I ensembled a dataset as a sampling frame by relying on previous data collection efforts that, to the best of my knowledge, represent the most comprehensive sources of information about MSPs. These sources included the Global Solution Network Database (GSN, 2017), the United Nations Environment Program (UNEP, 2017), the UN World Summit on Sustainable Development Partnership Database (WSSD, 2018), the Yearbook of International Organizations (YIO, 2017), and the Transnational Public-Private Governance Initiatives in World Politics dataset (Westerwinter, 2019).²

² I am grateful to Oliver Westerwinter for sharing the data prior to its public release in 2019.

This led to the identification of 375 MSPs at the national and international level, with foundational dates spanning from the decade of the 1990s. With a wide range of entities identified by the sampling frame, I selected only those that met a six-criteria established by the seminal work on collaborative governance from Ansell and Gash (2008).

Selection proceeded by choosing partnerships that (1) had a forum initiated or supported by public agency or institution; (2) that participation was based on a diverse set of actors, from private sector organizations to civil society organizations and/or academia. I further excluded public-public, public-civil, private-civil, or private-private partnerships. A third selection criterion was that participants must have engaged (and not simply consulted) directly in the decision making of the partnership; (4) that the forum was formally organized in an institutionalized way, with protocols and a calendar of official meetings; (5) that the forum aimed to make decisions by consensus; and (6) that the focus of the collaboration addressed issues related to public policies.

After this selection, the dataset was then reduced to 180 partnerships. From these, 23 percent of them (41 partnerships) were ineligible case studies because they were no longer active and/or ceased operations before 2017. Furthermore, 25 percent (45 partnerships) were deleted from the dataset given that their contact information was unavailable in official websites or did not reply to emails requesting information about their constitution.

The final number of cases in the dataset was further reduced to a total of 94 partnerships. A process of first engagement started in January of 2019, by sending a formal invitation to participate in the research project (see letter of invitation in Appendix G1). Table 1.2 contains the name of six MSPs who replied to the invitation.

In a second stage of engagement in 2019, I presented the details of the project, as well as the detailed requirements for participation. After this, three initiatives (IHA, ICTI and Bonsucro) dropped out from the pool of potential participants. Reasons varied, including (1) lack of time, (2) shortage of administrative resources, and (3) unusual turnover of participants in that year.

From the remaining set of MSPs, the EITI and the RSB conditioned their participation in the research by suggesting simplified strategies of data collection. This would have required a change in the research design planned considering only a very small number of participants. However, these suggestions were opposite to what is considered as good practices for data

collection for social network analysis. Good practices require the participation, as much as possible, of all the actors involved in a certain type of networks of interactions (Borgatti, Everett & Johnson, 2013; Agneessens & Labianca, 2022). Thus, these two cases were dropped.

Table 1. 2 *Pool of potential MSPs participants for research*

Name of organization	Responsible	Date of 1 st email response	Date of presentation of the project (Skype Call)
1. Round Table on Sustainable Biomaterials (RSB)	Tina Gyane, Finance & Administration Manager	21 October 2019	25 October 2019
2. Extractive Industries Transparency Initiative (EITI)	Sam Bartlett, Technical Director	01 September 2019	13 September 2019
3. The Infrastructure Transparency Initiative (CoST)	John Hawkins, Director of Programs	28 August 2019	30 August 2019
4. International Hydropower Association (IHA)	Eddie Rich, CEO	14 October 2019	18 October 2019
5. The ICTI Ethical Toy Program	Mark Robertson, Senior Vice President	08 November 2019	12 November 2019
6. Bonsucro	Rafael Seixas, Membership Manager	29 August 2019	06 September 2019

Source: Author's own elaboration.

The Infrastructure Transparency Initiative (CoST) showed great interest of participation after a customized presentation to the International Secretariat based in London (see presentation in Appendix G2). The initiative fully committed with the requirements for data collection, by granting access to eleven implementing countries in Latin America (Honduras, Guatemala, Costa Rica, El Salvador, and Panama), Southeast and West Africa (Malawi, Ethiopia, and Ghana), and Eurasia (Afghanistan, Ukraine, and Thailand). Therefore, the current thesis focusses on CoST as a single case study for research, justifying the case section primarily on practical grounds and feasibility.

As a token of gratitude and knowledge contribution for this research collaboration, two reports, containing special analysis of the results of the survey, were designed and written for CoST's International Secretariat. These reports were presented and discussed via Skype in September 2020 and January 2021 (see reports in Appendix G7 and G8).

The Infrastructure Transparency Initiative

The Infrastructure Transparency Initiative (CoST) is an anti-corruption multi-stakeholder initiative that operates like a hybrid between an accountability-based NGO and an audit agency (Truex & Søreide, 2010). The initiative entails members from governments, civil society, academia and the private sector to implement transparency programs in the infrastructure sector in more than 20 countries (CoST, 2019). The goal of CoST is to encourage the disclosure of information on a selection of public infrastructure projects, and to independently assess whether those projects are financially justified, by delivering value for money (Hawkins & Prado, 2019). The initiative operates on the principle that transparency can foster accountability, by relying on multi-stakeholder arrangements as social platforms for dialogue and consensus building. These are networks of actors expected to collaborate, generate and assess evidence-based information to inform citizens and public institutions, reducing corruption and the risks posed to the public from poor quality infrastructure (CoST, 2019).

With such broad objectives, the initiative has faced several challenges that have prevented successful implementation. These challenges unfold in four main fronts: (1) personal motivations of the stakeholders (i.e., poor participation due to time constraints or conflicts of interest), (2) organizational dynamics (problems in reaching consensus on key decisions, power imbalance and information bottlenecks), (3) risks of collaboration (poor participation from key stakeholders and free riding from others), and (4) funders' pressures on goal attainment (insufficient time to accomplish expected change) (Truex & Søreide, 2010).

CoST's institutional framework

CoST, the global anti-corruption initiative was implemented in more than 20 countries as for 2020.³ The implementation unfolds under four key mandates: (1) the program implementation is delivered and monitored by a *national multi-stakeholder partnership/group*; (2) the partnership agree upon criteria for selecting a subset of public-infrastructure sector projects for in-depth review, and participants select agencies or institutions to work with for this purpose; (3) they requests information from the relevant procuring public sector agencies, and in turn

³ Countries included Honduras, Thailand, Ukraine, Afghanistan, Malawi, Guatemala, Costa Rica, Ethiopia, El Salvador, Panama, Ghana, Uganda, Tanzania, Mexico, Ecuador, Argentina, Mozambique, Tanzania, Indonesia and Timor-Leste (CoST, 2019).

hires an *Assurance Team*⁴ to review the information, highlighting any discrepancies and reasons for concern (i.e., contractual and procedural red flags); (4) the partnership synthesizes this information into an annual report and communicates the findings to the public; lastly, (5) the partnership makes recommendations to governments in order to improve evaluated infrastructure projects and sector performance in general, while also following up the progress of governments in this regard during the subsequent years (Truex & Søreide, 2010; Hawkins & Prado, 2019; Hawkins & McKittrick, 2012).

Every multi-stakeholder partnership relies on a *National Secretariat* that serves as a full-time administrative body that is responsible for the day-to-day activities for the implementation of CoST.⁵ Some of these tasks entail the facilitation of communication between the *International Secretariat* and the MSPs, provision of technical support for stakeholders, and build capacity for the procuring entities to disclose data (CoST, 2019).

The role of the International Secretariat is largely to offer learning, support, and guidance to participating countries, and encourage additional countries to join (CoST, 2019). The International Secretariat monitors progress in the programs of implementation and informs the *Board of Directors*. The Board is the main decision-making body of CoST as it sets up the admission criteria and approves countries' applications to join the initiative. It also helps to raise funds and provide national-level support to CoST members (CoST, 2019).

Identification of networks of interest

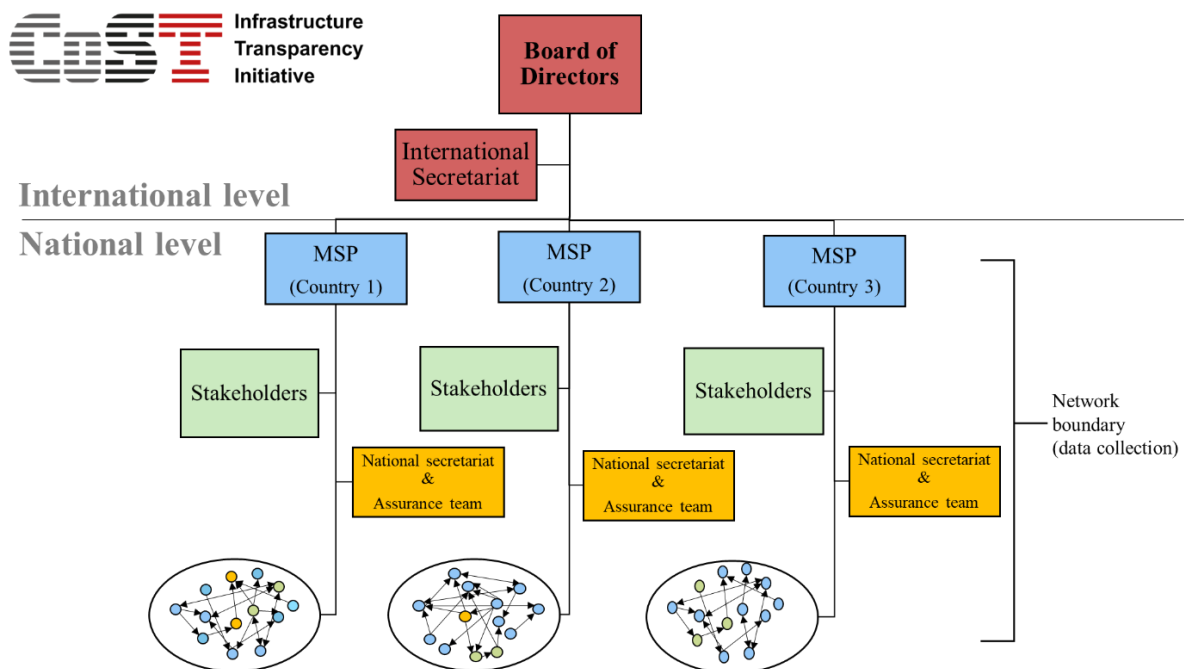
In order to proceed with a valid and useful network analysis, the properties of the organization have to be identified and accounted for (Borgatti & Molina, 2005). It is critical to identify which actors should be counted in as network actors. As mentioned above, the multi-stakeholder partnership is the organizational unit of CoST, where the phenomenon of interest for this thesis resides. The partnership shapes the space where multi-stakeholder interactions unfold for information exchange and collaboration.

⁴ These are independent groups of professionals: engineers, architects, scholars and other experts that collaborate with the multi-stakeholder partnerships.

⁵ National Secretariats operate as *network administrative organization* (Provan & Milward, 1991), aiming at organizing and coordinating activities for better outcomes.

Thus, for this thesis the network boundaries for data collection are delimited by the participant stakeholders that form partnerships at the national level, but also those internal bodies that provide technical assistance and/or administrative support to the partnership (see Figure 1.2). These additional actors, such as the National Secretariats and the Assurance Teams, although not stakeholders *per se*, entail the formal structure of the networks of interest given their close collaborative relationship with the stakeholders.

Figure 1. 2 Organizational structure of CoST



Source: Author's own elaboration.

Data collection

Relational data was collected through an online survey. The survey was designed based on the literature of network data-collection for organizational settings (Agneessens & Labianca, 2022; Borgatti et al., 2013). The questionnaire included 15 items and was translated into five languages (see the English version of the survey in Appendix G4). The International Secretariat endorsed the distribution of the survey in eleven implementing countries during the second quarter of 2020.

The survey was built and distributed using the online platform Qualtrics (Qualtrics, Provo, UT). I followed a detailed calendarized protocol. I sent survey invitations, distribution of surveys, and reminders to private email addresses of active members of the partnerships. For that, I followed official organograms and stakeholder maps facilitated by the International Secretariat.⁶ This allowed the identification and inclusion of relevant stakeholder organizations in the sample.

The Research Ethics Committee from University College London (UCL) approved the study, and the guidelines of data collection and confidentiality of participants. Before the survey, participants were briefed on its purpose and voluntary nature. Most participants completed the survey in a single session of 20 minutes. Additional invitations were sent to participants who did not respond in the first round, and half-completed surveys were followed-up by telephone to gather as much complete data as possible. Two half-completed surveys were removed, ensuring that all data were drawn from completed questionnaires.

The survey recorded responses from partnerships located in Latin America (El Salvador, Costa Rica, Guatemala, Panama, and Honduras), Africa (Ethiopia, Malawi and Ghana) and Eurasia (Ukraine and Afghanistan). The global response rate for the ten partnerships was 93%, and at the country level response rates surpassed the 80% threshold in all the cases. Table 1.3 shows the composition of the ten partnerships in the sample, including foundation years, number of respondents per country, organizations, and sector affiliations.

Across all the cases, the largest sectoral representation came from the civil society (31), followed by public-sector (28) and private-sector (25) organizations. The smallest representation comprised academic institutions, media outlets, and observer organizations (i.e., the World Bank, British embassies, and the Inter-American Development Bank). Apart from Panama, due to its recent formation shortly before the data-collection period, every partnership had an administrative National Secretariat and a technical Assurance Team in action.

This research setting captured a diverse range of actors and sectoral representation. Most importantly, the boundaries of network participants were clearly defined, with no important actor left out of the survey.

⁶ Publicly available information on partnerships' official websites was also employed to retrieve lists of active stakeholders.

Table 1. 3 *Composition of MSPs*

Country	Response	Respondents	Orgs	PubS	PriS	CS	Aca	Med	Obs	NS	AT
El Salvador (2018)	100%	13	10	2	2	2	2	0	0	1	1
Costa Rica (2017)	93%	27	13	3	2	2	0	0	4	1	1
Guatemala (2010)	92%	24	13	3	2	4	0	0	2	1	1
Panama (2019)	100%	17	12	5	2	3	0	0	1	1	0
Honduras (2014)	81%	25	11	3	3	3	0	0	0	1	1
Malawi (2009)	88%	15	15	4	2	4	0	1	2	1	1
Ghana (2019)	92%	12	9	1	3	2	0	1	0	1	1
Ethiopia (2009)	100%	14	10	3	3	2	0	0	0	1	1
Ukraine (2015)	88%	14	11	1	3	5	0	0	0	1	1
Afghanistan (2017)	94%	16	12	3	3	4	0	0	0	1	1
Total*	93%	177	116	28	25	31	2	2	9	10	9

* Total survey participants and organizations by country as for 2020. Acronyms: public sector (PubS), private sector (PriS), civil society (CS), academia (Aca), media (Med), observer organization (Obs), national secretariats (NS), and Assurance Teams (AT).

Contributions of the study

Previously mentioned in the Impact Statement section above, this thesis' contributions are threefold: methodological, theoretical, and practical. Methodologically, this thesis contributes to the literature on relational data collection and treatment. Successful data collection took place thanks to the design of a distinctive online survey template used for data collection across different national contexts, languages, and sector boundaries (see Appendix G4). The survey template can be used in future research for network analysis, prioritizing confidentiality of participants.

Some of the concepts this thesis focuses on, have been, until now, researched mostly in the context of single- and isolated-network analysis. The thesis advances methodologically with special network data treatment by stacking several network matrices diagonally as input files for advanced network analysis techniques. This data structuration has enabled the

identification and exploration of global patterns across a wide range of relational datapoints from different networks at the same time (see statistical analysis in Chapters 3 and 4).

Another methodological contribution is that network analysis is typically applied as a quantitative method, which has significant limitations. Quantitative methods can capture the form of relationships, but they are less suitable for capturing the content of relationships. Chapter 4 of this thesis fills this gap, by offering mixed methods through semi-structured interviews and quantitative social network analysis approaches, with interview data substantiating and complementing statistical analyses.

From a theoretical perspective, the thesis contributes to the fields of governance networks, multi-stakeholder partnerships and collective action, all characterized by governance systems of fragmented authority. It showcases research approach that can enrich these fields as it draws on theoretical premises from political science (influence and power), psychology (motivations and perceptions) and new institutional economics (transactional costs). Further, it evaluates and offers fresh insights related to popular claims about theories related to collaborative risks (Berardo & Scholz, 2010), innovation diffusion (Rogers, 2003), the Advocacy Coalition Framework (Sabatier & Weible, 2007), social capital (Putnam, 1993; Coleman, 1988), resource-dependence and social-exchange (Pfeffer & Salancik, 1978; Blau, 1964).

In terms of practical application, this thesis explores inner-functioning mechanisms of governance networks while working together in collective action endeavors. These mechanisms can be usefully taken into account by network conveners, practitioners, and policy makers to improve engagement of stakeholders and representation of different interests. One of the main takeaways is that multi-stakeholder partnerships, as real-world examples of complex governance systems managed collaboratively, do not moderate asymmetries between participants, as it is widely assumed. On the contrary, partnerships may amplify these disparities if due consideration is not given to actors' motivations, perceptions of risks, and contextual factors for communication. This renders these platforms as one of the possible solutions for collective action problems that has to be cautiously pondered against other collaborative arrangements.

For this thesis, real-world impact has been shown in two occasions. First, preliminary findings of social network analysis in 2020 have serve as input to revise and improve the

Infrastructure Transparency Initiative's (CoST) protocols for the implementation of transparency and accountability mechanisms through the use of multi-stakeholder partnerships. Analysis and conclusions of this thesis have supported CoST's International Secretariat to justify performance metrics in funding applications to multilateral organizations, setting a benchmark for innovative evaluations of networks of multi-stakeholder spaces (see reports to CoST in Appendix G7 and G8).

Second, the fourth chapter of this thesis has been selected in 2022 by the Transparency and Integrity Cluster from the Innovation for Citizens Services Division (ICS) of the Inter-American Development Bank (IDB) to be developed as a collaboratively working paper with participation of senior consultants in transparency and public infrastructure. The paper is under revision and scheduled to be published in 2023, becoming the flagship publication for this research in the practitioner realm.

In United States, this research project was awarded best paper in 2019 in the category of "Partnerships for Development" presented by Jeffrey Sachs at the United Nations' International Conference on the Sustainable Development (ICSD) in New York. In the same year, presented at the Yale Institute for Network Science, the thesis also received valuable feedback from Nicholas Christakis, director of the Human Nature Lab, for its practical application and possibilities to extend it further to support governments in developing countries.

Overview of thesis

The following chapters in this thesis are based on versions of studies that are currently under review in academic journals. One consequence is that some of the issues discussed throughout these chapters contain similar sections, such as research setting, data collection and operationalization of main network variables. The use of the first person of plural "we" is appropriate for studies that have multiple authors. Thus, for the core section of the thesis, comprising chapters 2, 3 and 4, this characteristic is prevalent.

Table 1.4 above shows the names of those scholars who have contributed to these the main chapters of the thesis.⁷ While co-authors have given important feedback at different stages

⁷ I followed Elsevier's categorization for Contributor Roles Taxonomy (CRediT) to highlight contributions to the chapters. For more information see <https://www.elsevier.com/authors/policies-and-guidelines/credit-author-statement>.

of the development and writing of the chapters, the origin of the ideas, discussion and arguments have been developed by the main author of this thesis.

Table 1. 4 Authors contributions

<i>Chapter</i>	<i>Authors</i>	<i>Affiliation</i>	<i>Contributions</i>	<i>Publication</i>
2	Antonio Reyes Main author	School of Public Policy, UCL	Conceptualization, Methodology, Data Collection, Data Curation, Formal Analysis, Writing (1 st Draft), Visualizations, and Project Administration.	Public Administration Journal (PADM-22-07-00263.R1) Conditionally accepted December 2022
	Marc Esteve Co-author	School of Public Policy, UCL	Writing, Review & Editing, Supervision	
	Filip Agneessens Co-author	Sociology and Social Research, University of Trento	Review & Editing, Supervision	
3	Antonio Reyes Main author	School of Public Policy, UCL	Conceptualization, Methodology, Data Collection, Data Curation, Formal Analysis, Writing (1 st Draft), Visualizations, and Project Administration.	Policy Studies Journal (PSJ-22-RIP-0282) Under peer-review process December 2022
	Marc Esteve Co-author	School of Public Policy, UCL	Writing, Review & Editing, Supervision	
	Filip Agneessens Co-author	Sociology and Social Research, University of Trento	Review & Editing, Supervision	
4	Antonio Reyes Main author	School of Public Policy, UCL	Conceptualization, Methodology, Data Collection, Semi-structured interviews, Data Curation and coding, Formal Analysis, Writing (1 st Draft), Visualizations, and Project Administration.	Journal of Public Administration Research and Theory (MS 2022534) Under peer-review process January 2023
	Marc Esteve Co-author	School of Public Policy, UCL	Writing, Review & Editing, Supervision	
	Guillermo Lagarda Co-author	Research Coordinator Transparency & Integrity Cluster at the Inter-American Development Bank (IDB)	Feedback, Review & Editing	IDB Working paper

Source: Author's own elaboration. Based on Elsevier's CRediT framework.

In *Chapter 2*, I depart from the assumption that in any collaborative setting, some actors have a disproportionate influence on collective decision-making. I assess the causes of influence disparities and whether differences in motivations can account for them. In this chapter, I investigate whether actors' motivation to participate in MSPs can predict their level of influence. I further posit that information exchange can be used as a mediator to assess this

relationship, because it increases actors' exposure among other participants, regardless of motivation. By evaluating a relational dataset collected from 10 MSPs, encompassing 116 public and non-public organizations located across three different regions of the world, I show that actors who are self-interested, rather than pro-socially motivated, are more likely to engage in information-exchange activities in MSPs. I also show that these information-exchange activities shape perceived influence by other actors. At present, perceived influence is a kind of reward that may accrue to actors who proactively exchange information, causing MSPs to undermine their own formal institutional narratives, amplifying rather than moderating influence disparities.

In *Chapter 3*, I show that stakeholders may take transaction costs into account when deciding when and with whom they will establish information relationships. I initially build a model that shows that preference similarity based on motivations to participate in MSP are important to explain the formation of information ties. Once adding opportunity structures which reduce transaction costs of exchange, such as issue committees, serve as opportunity structures for contact-making processes that outweigh preference similarity. Results are consistent across networks of political and technical information. The chapter makes an important contribution to the literature of governance networks by providing evidence on specific opportunity structures that maximize outreach and access to new information in MSPs.

In *Chapter 4*, I used mix methods to explore the relational nature of the five Latin American MSPs in the sample. Statistical network methods showed that bonding and bridging structures to cope with perceptions of collective action risks operate simultaneously in these partnerships. Bonding and bridging structures are not antagonistic. The findings cast new light on the phenomenon referred to as "small-world networks" that incorporates both structures to address fears of defection and lack of coordination. While bonding and bridging support conflict resolution within networks, they may also have unintended consequences, favoring homophily type of association in collaborative relationships. Collaboration in these MSPs does not cut across boundaries of sector affiliation or administrative level, limiting functions of innovation. A set of 13 semi-structured interviews provide stakeholders' anecdotal evidence supporting inferences derived from the quantitative analysis.

Finally, in *Chapter 5*, I discuss the contributions of this thesis. This chapter addresses issues that remain open and provide an outlook for future research that advance theories and analytical practices for governance networks.

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CHAPTER 2. SHAPING INFLUENCE IN GOVERNANCE NETWORKS: THE ROLE OF MOTIVATIONS AND INFORMATION EXCHANGE

ABSTRACT

In governance networks, some actors have unequal influence on collective decision-making, challenging networks' normative assumptions. This paper investigates whether actors' motivation to participate in a governance network can predict their level of influence. Information exchange is used as a mediator to assess this relationship, because it increases actors' exposure among other participants, regardless of motivation. A unique relational dataset from ten anti-corruption multi-stakeholder partnerships (MSPs) in Latin America, Africa and Eurasia provides support for this argument. Logistic regression path analysis reveals that actors who are self-interested, rather than pro-socially motivated, take the lead in information-exchange activities. Self-centered actors can therefore shape their perceived influence on others, expanding their capacity to determine or change MSPs' agendas that may end up departing from agreed-upon collective objectives. This paper concludes that self-interested motivations impact the way in which actors are perceived and their ability to engage with others.

Keywords: governance networks, multi-stakeholder partnerships, motivations, information exchange, influence, mediation, path analysis

Ethics and integrity statements

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Introduction

To achieve solutions across conflicting policy arenas, decisions are increasingly made within governance networks. These are collaborative forums that build solutions based on knowledge, consensus and legitimacy from multiple actors. These actors are brought together for negotiation and deliberation (Murray, Haynes & Hudson, 2010; Huxham & Vangen, 2004). They harness the strengths and the interests of the public and non-public sectors, formalizing spaces for cross-sectoral collaboration, information exchange and decision making (Ansell & Gash, 2008).

Governance networks, however, find it challenging to motivate actors to share information and solve problems collectively (Faul, 2016). It requires time, energy, and knowledge that must be shared strategically and patiently (Fischer & Maag, 2022). Actors predefine their motivations based on the opportunity costs to participate in these networks (Fischer & Leifeld, 2015), and whether they believe their contributions will be rewarded or not (Davenport & Prusak, 1998; Steets, 2010; Fischer & Leifeld, 2015). Participatory motivations in networks can be roughly differentiated between extrinsically self-interest motivations (i.e., improve one's reputation, profit maximization, etc.) or intrinsically pro-social motivations (i.e., philanthropy, altruism, etc.) (Ryan & Decy, 2000; Le Grand, 2003).

The present study identifies an unresolved tension in governance-network partners, fueled by these two seemingly contradictory rationales about participatory motivations. We argue that understanding these types of motivations is critical to unveil how actors not only structure relationships within governance networks, but also how they shape perceptions about influence. Although networks are purposefully designed to flatten differences between participants, they may also be subject of “hidden” organizational dynamics that lead some actors to become more influential than others, conditioning the direction of the collective decision-making process (Bryson, 2004; Faul, 2016).

In the public administration field, prior studies have investigated the impact of actor's motivations on organizational outcomes (Besley & Ghatak, 2018; Esteve & Schuster, 2020). These studies, however, have failed to explain how motivations shape influence within groups. There has been, however, no systematic examination of why actors consider other actors as influential through the lenses of participatory motivations. This paper integrates and explores

both analytical perspectives, considering participatory motivation an important, and yet unexplored, element to explain influence in governance networks.

We address this tension in multi-stakeholder partnerships (MSPs) tasked with the implementation of anti-corruption governance mechanisms in the public-infrastructure sector of ten countries in Latin America, Africa, and Eurasia. MSPs offer a real-world example of complex governance systems managed collaboratively by diverse organizational stakeholders (Hermans, Sartas, & Van Schagen et al., 2017). Some MSP actors are driven by an altruistic desire to protect or speak for infrastructure vulnerable communities and protect quality of public services, while others seek business and reputational opportunities (Steets, 2010; Richter, 2001). For MSPs concerned with transparency and accountability, participatory motivations is a critical subject of investigation in order to understand collaborative asymmetries that can derail collaborative efforts (Truex & Søreide, 2011; Brockmyer & Fox, 2015).

The present study investigates whether pro-social or self-interested motivations attenuate or augment asymmetries of influence. Relational data was analyzed via logistic regression path analysis, revealing that information in governance networks is generally exchanged by self-interested, rather than pro-social, actors. Self-centered stakeholders employ this mechanism to gain group exposure among others and build influence on their behalf, expanding their capacity to determine or change agendas beyond agreed-upon objectives.

This paper focuses on the understudied field of motivations that expands our understanding of why actors participate in collaborative efforts, which, in turn, is crucial for understanding how networks, polycentric and collaborative governance systems operate in practice (Fischer & Maag, 2022). Our findings can help practitioners and conveners of networks to recognize factors that undermine collective action, as well as to design reward mechanisms that satisfy partners' more private objectives, while enabling them to contribute to collective goals.

Literature and theory

Governance networks: an overview

We are in the age of the “network society” (Castells, 2022, p. 2). In today’s public affairs, governments are no longer able to delegate power to a single agency to solve a problem or

provide a public service. Instead, there is a pervasive trend in which public, private and non-profit organizations are called upon to come together in increasingly collaborative ways, in order to solve challenges across policy areas, leveraging experience and knowledge from multiple participants (Kilduff & Tsai 2003; Provan, Fish & Sydow, 2007). This is assumed to be a straightforward way “to get things done” (Imperial, 2005, p. 13), where solutions are available to tap into by placing the right actors around a table for negotiation and deliberation (Huxham & Vangen, 2004).

These alliances take the form of *networks* (Klijn & Skelcher, 2007). They are integrated by groups of cross-sectoral actors that work together to provide public goods, services, or value when single public sector agencies are unable to produce them (i.e., government failure) or when private sector firms are unable or unwilling to provide them in the desired quantities (i.e., market failure) (Isett, Mergel, Leroux et al., 2011; Turrini, Cristofoli, Frosini, et al., 2010; Schäferhoff, Campe & Kaan, 2009).

Networks must be differentiated from multiple types of network-based platforms that are often used interchangeably in the literature (Lecy, Mergel & Schmitz, 2014; Kapucu, 2015). In *policy networks* a set of stakeholders have a common interest in public decisions, especially those about public resources allocation (Isett et al., 2011). *Cooperative networks* focus exclusively on information exchange among stakeholders, while in *coordination networks* actors align their individual policies/practices to achieve results that may turn out beneficial to everyone in a determined policy arena. On the other hand, *collaborative networks* focus on the production of goods and services by a set of interdependent organizational stakeholders (Lecy et al., 2014).

The term governance in *governance networks* refers to the replacement of hierarchical bureaucratic structures with more integrated and horizontal organizational arrangements (Kapucu, 2015). Governance networks fuse collaborative public goods and service provision with collective policymaking and information sharing (Isett et al., 2011), combining most of the characteristics of the different networks described above. Governance networks are the main focus of this paper, and they represent one of the highest levels of integration among multiple stakeholder actors (Lecy et al., 2014).

Scholars, policy makers, and practitioners broadly agree that governance networks bring positive benefits. By integrating actors into voluntarily, non-hierarchical structures, they

create forums for inclusiveness, flexibility, and innovation for policy solutions and delivery of public goods (Googins & Rochlin, 2000; Emerson, Nabatchi & Balogh, 2011). Such networks showcase the diverse interests, needs, and objectives of different stakeholders; their critical interdependencies; and the importance of concerted action (Hermans et al., 2017).

Contrary to the normative expectations of networks and their distinctive benevolent main objective to solve societal problems, actors may have also different incentives to advance private interests. That is, actors may form strategic relationships with others, gain structural advantages, and/or exert control through objective/subjective -authority attributes, such as influence (Smith, Halgin, Kidwell-Lopez et al., 2014).

Influence

Disputes of influence and control over resources and outcomes are ubiquitous in organizations, political parties and partnerships (Bunderson & Reagans, 2011; Smith et al., 2014). Influence is one of the most fundamental but also most controversial concepts in public administration research as it infers the act of exerting control on actors or policy decisions (Dahl, 1961; Henry, 2011).

Influence is generally understood as the perceived importance of actors involved in group dynamics when evaluated by their peers (Ingold & Leifeld, 2016; De Klepper, Labianca, Sleenbos & Agneessens, 2017). As an inherently subjective authority attribute that is based on the mutual evaluation among political actors (Fischer & Sciarini, 2015), influence is a competence-based status differentiator (De Klepper et al., 2017), socially constructed and consolidated by group perceptions (Bustos, 2021). Thus, actors involved in a decision-making process within groups have the most accurate view of how influence is allocated among other participants (Fischer & Sciarini, 2015).

For long time, influence has been linked with reputation and power in the literature of political science and political sociology (Dahl, 1961; Emerson, 1962). Several studies have been used reputational power in policy analysis to disentangle sources of influence in organizations (Fernandez & Gould, 1994; Henry, 2011).

The political elite stream of research, for example, has explored theoretical approaches to explain influence differentials (Parry, 2005). These studies posit that influence can be

explained as the result of actors' reputation, formal authority, and structural positions (Parry, 2005; Hunter, 1953; Mills, 1956). Although the present study considers the merits of each of these approaches, we argue that they fail to recognize an underlying, more endogenous, determinant of influence, which is manifested in the direction of actors' actions (Ingold & Leifeld, 2016; De Klepper et al., 2017).

Actors' motivations determine intention and direction of actions within collective decision-making processes (Brandenberger, Ingold, Fischer et al., 2020). Motivations can impact perceptions of others, increasing or diminishing perceived influence, but also the number of allies or adversaries an actor holds. Although several authors have proposed theoretical arguments and lists of participatory goals that actors can obtain from participating and working in networks (Fischer & Sciarini, 2015; Ansell & Gash 2008; Lecy et al., 2014), the empirical literature on which of these motivations are important to determine actors' expected behavior within networks is currently rather limited. The present study posits that actors' participatory motivations complements previous approaches in explaining influence differentials in the literature.

Motivations

Motivation comes from *movere* in Latin. To be motivated is to be moved to do something (Ryan & Deci, 2000). Motivation explains a physiological process that leads to actors to behave in a particular way, depending on incentives and contexts (Esteve & Schuster, 2020). When it comes to organizational settings, motivation is often seen as the "degree to which an individual wants and tries hard to do well at a particular task" (Mitchell, 1982, p. 81). However, as a multidimensional concept (Esteve & Schuster, 2020), motivation can also be conceptualized not only by actors' intensity or persistence of doing something in a work setting, but also by the direction of that action.

According to the self-determination theory (Ryan & Decy, 2000), motivations can be distinguished in two camps that determines direction of actions. Ryan and Decy (2000) posit that the *intrinsic motivation* is defined as "doing of an activity for its inherent satisfactions rather than for some separable [private] consequences" (p. 55). On the other hand, an *extrinsic motivation* refers to an activity that "is done in order to attain some separable [private]

outcome” (Ryan & Decy, 2000, p. 60). These types of motivators are, of course, not mutually exclusive. They lie on a continuum, rather than representing a dichotomy (Esteve & Schuster, 2020).

Much of the context of actor’s situation will determine whether an actor is driven by intrinsic or extrinsic motivations or both. However, we do believe that motivations can be roughly separated and studied through the lens of this basic differentiation, which echoes recent investigation about actors’ participatory benefits in networks (see Fischer & Maag, 2022).⁸

Studies of networks, emphasize that the role of participation in such forums is the creation of shared value and public goods (Steets, 2010). The *raison d’être* of governance networks is to contribute to finding substantive solutions to complex societal challenges collectively (Selsky & Parker, 2005). Some actors would join governance networks because they genuinely want to contribute to find collective solutions to tackle social problems at hand, reduce sectoral conflict, and provide benefits to the largest number of stakeholders possible (Fischer & Leifeld, 2015). This intrinsic motivation would be referred as “altruistic” or “pro-social” by social psychologists (Grant, 2008), because it creates value, independently of individual short-term goals.

Actors are then motivated to help others for no private rewards and may engage in collaborative activities to the possible detriment of their individual interests (see also Le Grand, 2003). Pro-socially motivated actors will direct efforts towards societal goals, which is the main assumption for governance networks to exist in the first place (Isett et al., 2011; Lecy et al., 2014). This rather normative assumption is also emphasized by the literature on collaborative institutions, collaborative governance, and collective action institutions (Ansell & Gash 2008; Lubell, Henry & McCoy, 2010).

This perspective has been criticized, nonetheless. Networks as collaborative platforms fall outside their partners’ norms, professional roles, and communities of practice (Carlile, 2004; Imperial, 2004). Actors work together aiming at the creation of collaborative advantage (Huxham & Vangen, 2004), while also trying to accomplish their more private objectives, maintaining their own influence and institutional identities (Bryson, 2004; Fischer & Leifeld,

⁸ Fischer and Maag (2002) differentiate four types of benefits that actors obtain from networks: (1) exchange (networking, knowledge, etc.), (2) policy (position papers, influence on forum decisions, etc), (3) individual (influence on forum decisions, visibility, etc.), and (4) collective (position papers, compromises etc.) benefits.

2015). According to the rational choice theory, these “self-interested” motivations seek to maximize private gains (Esteve & Schuster, 2015). Rewards may comprise benefits such as wealth, agenda setting power, reputation, or even personal development (Le Grand, 2003). By these means, actors may participate in networks because they want to lobby for their own preferred solution and achieve rewards independently of the objectives of others (Fischer & Leifeld, 2015).

Practitioners and conveners of governance networks often underestimate actors’ motivations to participate in them (Fischer & Leifeld, 2015). Although networks are formally designed to reduce inequalities, actors’ self-interested motivations may create asymmetrical relational structures that undermine normative discourses of equal partnering and participation (Faul, 2016). Studies have shown that self-interested actors are willing to exchange their time and resources as long as they can obtain a network output close to their expected goal (Fischer & Leifeld, 2015; Faul, 2016). Given that self-interest motivations depart from the original goals of governance networks, it is expected that actors in this camp would be less willing to collaborate and more likely to reduce participation and influence (Kell, 2003; Doh & Teegen, 2002).

Actors’ conflicting motivational preferences may affect not only their capacity to shape influence on others, but also how they behave within the network. It is then by the incentives of pro-social and self-interest goals obtained from governance networks that actors define their participatory motivations, leading to a collective rationality of network existence (Fischer & Leifeld, 2015).

Given these conflicting accounts, we hypothesize that pro-social actors are more likely to be perceived as more influential than self-interested actors, since altruistic goals are intrinsic to the formation and objectives of governance networks. The opposite is expected for those actors holding self-interested motivations. We split both types of motivations in two hypotheses, because doing so provides better analytical purchase on the effect of existing asymmetries of influence:

Hypothesis 1a. *Actors motivated to participate in governance networks for pro-social reasons are more likely to be perceived as influential by other actors in their networks.*

Hypothesis 1b. *Actors motivated to participate in governance networks for self-interested reasons are less likely to be perceived as influential by other actors in their networks.*

Information exchange

According to Weber and Khademian (2008), networks cannot work effectively unless they collectively integrate diverse sources of information and knowledge. Emerson et al. argue that knowledge and information-sharing are in practice the “currency of collaboration” (2011, p. 16). Governance-network participants cannot fully understand other network actor’ goals, strategies, or reasons for cooperating without such input. Thus, reducing this level of uncertainty benefits all participant actors (Berardo & Lubell, 2016; Roloff, 2008). Circulating more information in networks reduces transaction costs of collaboration, helping actors to identify and negotiate mutually beneficial solutions (Leifeld & Schneider, 2012; Brandenberger et al., 2020). However, not all actors feel comfortable exchanging information (Schrack & Whitford, 2011).

Actors are more likely to participate in collective action if they believe it will generate benefits to them (Mulema & Mazur, 2015). Groups of actors may withdraw from collective processes and limit their interactions with others if participation seems likely to produce more costs than benefits (Feiock, 2013). We therefore hypothesize that self-centered actors are less likely to exchange information with others than pro-social actors within governance networks (Faul, 2016; Leifeld & Schneider, 2012):

Hypothesis 2a. *Actors who are motivated to participate in governance networks for pro-social reasons are more likely to share information with others in their networks.*

Hypothesis 2b. *Actors who are motivated to participate in governance networks for self-interested reasons are less likely to share information with others in their networks.*

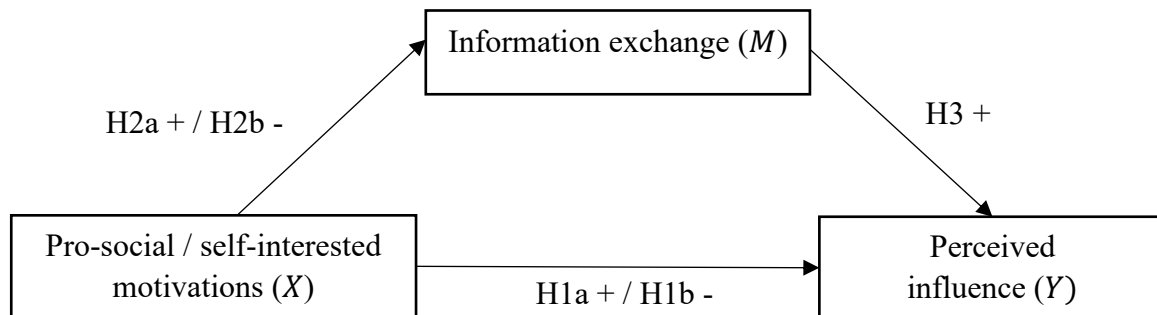
Whether governance networks consist of individuals, groups, or organizations, it is important to know which actors exert the most influence. Since being influential is in part a structural phenomenon, each actor's influence must be considered within a wider web of relationships (Greening & Gray, 1994). From a network perspective, the direct and indirect connections actors have, embedded within the network, sustain perceived levels of influence (Ingold & Leifeld, 2016). From this perspective, influence serves as dyadic attribution (Ingold & Leifeld, 2016). That is, influence can be also determined by process of sending and receiving valuable resources, such as information, ideas or knowledge within a network, rather than being the result of actors' individual attributes (i.e., wealth, job position, charisma, etc.).

Brass has noted the importance of "being in the right place" (1984, p. 518), a concept he developed by exploring how actors build networks and position themselves within structures that offer benefits, such as influence and popularity. Once established, information-exchange relationships become sources of influence (Rethemeyer & Hatmaker, 2008; Smith et al., 2014), which serve as an instrumental role, while substantiating status (Weiss, 1986; Sabatier, 1978). Actors who proactively exchange information tend to acquire higher social standing (Bunderson & Reagans, 2011) and social differentiation, a crucial antecedent variable to assess perceived influence within groups (Bustos, 2021; Smith et al., 2014; Leifeld & Schneider, 2012). Based on this rationale, we propose:

Hypothesis 3. *The more information an actor sends to others, the more likely he/she is to be perceived as influential in governance networks.*

A mediation model underpins our analysis of these hypotheses. Motivations (whether pro-social or self-interested) may affect perceived influence with or without the mediation of an intervening variable: information exchange. The model proposed contains two consequent (dependent) variables (M) and (Y) and two antecedent (independent) variables (X) and (M). In Figure 2.1, the pathway that leads from X to Y without passing through M is called the *direct effect* of X on Y . The second pathway from X to Y is the *indirect effect* of X on Y through M .

Figure 2. 1 *Conceptual model of the hypothesized process*



Source: Authors' own elaboration. The antecedent variable *X* represents here two separate independent variables that are evaluated in different models in the Appendix section (2B and 2C).

Research setting

This study investigates multi-stakeholder partnerships (MSPs), which implement anti-corruption mechanisms in the public-infrastructure sector. Focusing on MSPs in this sector is timely and relevant for several reasons. First, the UN Sustainable Development Goals (SDGs) have recently reaffirmed the significance of public infrastructure for economic development and social policy (UN, 2021). Second, the sector is characterized by large investments, discretion, and the need for significant regulatory intervention (Hawkins & McKittrick, 2012). Third, the sector has important cross-cutting effects on other priority areas, including transportation, education, and health for developing nations (GI Hub, 2018).

The MSPs in this study are tasked with implementing the global Infrastructure Transparency Initiative (CoST), which combines features of a consultancy agency and an accountability-based non-governmental organization (Truex & Søreide, 2011). Its main objective is to disclose relevant information about public infrastructure projects in different

countries, while independently assessing whether those projects deliver value for public money.⁹ Of the 20 plus countries implementing CoST, ten are included in the study sample.

Along with CoST, other well-established transparency initiatives, including The Extractive Industries Transparency Initiative (EITI), The Open Government Partnership (OGP), and The Global Initiative for Fiscal Transparency (GIFT) (Brockmyer & Fox, 2015), rely on formal and independent multi-stakeholder partnerships for the implementation of anti-corruption mechanisms (Fraser & Carbonnier, 2022). By this means, the shared characteristics of the MSPs in our sample with the aforementioned global initiatives, provide external validity for the findings of this study. Results of this study can be then replicated and understood in lights of these similar research settings.

Data collection

A unique dataset was collected through an online survey, designed to reflect the relational data-collection literature on organizational networks (Agneessens & Labianca, 2022; Borgatti et al., 2013). Our survey included 15 items and was translated into five languages. We collaborated closely with the CoST International Secretariat (Program Director and Senior Policy / Research Adviser), who endorsed the distribution of the survey in several CoST-implementing countries during the second quarter of 2020.

The survey was built and distributed using Qualtrics (Qualtrics, Provo, UT). We followed a detailed calendarized protocol, sending survey invitations, distributions, and reminders to the private email addresses of active members of the MSPs. We followed formal organograms and stakeholder maps facilitated by the International Secretariat.¹⁰ This allowed the identification and inclusion of relevant stakeholder organizations in the sample. We also considered network-boundary specifications (Berardo, Fischer & Hamilton, 2020), confirming the participation of all stakeholders that interacted with the MSPs during 2019 and 2020.

⁹ This includes technical infrastructure specifications, such as estimated costs (forecasted and actual), contractor companies, project deadlines, and differences between original and final infrastructure contracts (Truex & Søreide, 2011).

¹⁰ Publicly available information on MSP official websites was also employed to retrieve lists of active stakeholders.

The Research Ethics Committee of the main author's university approved the study and guidelines of data collection, ensuring confidentiality for participants. Before the survey, participants were briefed on its purpose and voluntary nature. Most participants completed the survey in a single 20-minute session. Additional invitations were sent to participants who did not respond, and half-completed surveys were followed-up by telephone to gather as much complete data as possible. We removed two half-completed surveys, ensuring that all data were drawn from completed questionnaires.

Table 2. 1 *Composition of MSPs*

Country	Response	Respondents	Orgs	PubS	PriS	CS	Aca	Med	Obs	NS	AT
El Salvador (2018)	100%	13	10	2	2	2	2	0	0	1	1
Costa Rica (2017)	93%	27	13	3	2	2	0	0	4	1	1
Guatemala (2010)	92%	24	13	3	2	4	0	0	2	1	1
Panama (2019)	100%	17	12	5	2	3	0	0	1	1	0
Honduras (2014)	81%	25	11	3	3	3	0	0	0	1	1
Malawi (2009)	88%	15	15	4	2	4	0	1	2	1	1
Ghana (2019)	92%	12	9	1	3	2	0	1	0	1	1
Ethiopia (2009)	100%	14	10	3	3	2	0	0	0	1	1
Ukraine (2015)	88%	14	11	1	3	5	0	0	0	1	1
Afghanistan (2017)	94%	16	12	3	3	4	0	0	0	1	1
Total*	93%	177	116	28	25	31	2	2	9	10	9

* Total survey participants and organizations by country as for 2020. Acronyms: public sector (PubS), private sector (PriS), civil society (CS), academia (Aca), media (Med), observer organization (Obs), national secretariats (NS), and Assurance Teams (AT).

The survey recorded responses from the MSPs located in Latin America (El Salvador, Costa Rica, Guatemala, Panama, and Honduras), Africa (Ethiopia, Malawi and Ghana) and Eurasia (Ukraine and Afghanistan). These are all developing countries with low-to-medium Human Development Index (HDI) scores and relatively new democracies in the global south (UNDP, 2019).

The global response rate for the ten MSPs was 93%; at country level, response rates surpassed the 80% threshold, which increases the confidence in this paper's findings. Table 2.1 shows the composition of the ten MSPs in the sample, including foundation years, number of respondents per country, organizations, and sector affiliations.

Across all cases, the largest sectoral representation comes from the civil society (31), followed by public-sector (28) and private-sector (25) organizations. The smallest sector comprised academic institutions, media outlets, and observer organizations such as the World Bank, British embassies, and the Inter-American Development Bank. Apart from Panama, due to its recent formation shortly before the data-collection period, every partnership had an administrative National Secretariat and a technical Assurance Team.¹¹

The research setting featured a diverse range of actors and sectoral representation. Most importantly, the boundaries of network participants were clearly defined, with no important actors left out of the survey (see Appendix 2A). Our research design provides then internal validity for this study's findings (Berardo et al., 2020).

Operationalization

Aggregated responses

The present study aggregates data at the organizational level. Individual survey responses were aggregated to obtain a single organizational response. Organization A is linked to Organization B if at least one survey respondent affiliated to Organization A names Organization B as a communication partner (an established practice in organizational and governance-network studies) (Agneessens & Labianca, 2022; Borgatti et al., 2013). Social-network analysis techniques are used to achieve the objectives of this study, and this aggregation procedure facilitates such analysis (Kapucu, 2015).

¹¹ MSPs request project information from procurement agencies and private companies by hiring an Assurance Team of professional infrastructure experts that reviews the technical information and highlight contract discrepancies. The MSPs, assisted by the National Secretariat, synthesize the Assurance Team's technical advice into an annual public report.

Network data

A social-network approach is used to operationalize the mediating variable (M , information exchange) and the dependent variable (Y , perceived influence). This method explains the relational preferences of actors empirically, establishing information-exchange relationships from an interpersonal and structural perspective (Borgatti et al., 2013). An information-exchange-network question is used to operationalize the mediating variable. Respondents were asked to:

*“Consider all your email, telephone interactions last year (January–December 2019) and face-to-face meetings with members of your multi-stakeholder group. In these interactions, how often did you provide information on public-infrastructure-related matters to people representing the following organizations and/or internal bodies that develop the work of the initiative, including the National Secretariat and Assurance Team?”*¹²

Respondents used a network checklist to identify organizations participating in their MSPs, indicating those they had relationships with. This *roster* of names reduced recall error from the respondents (Borgatti et al., 2013), and responses created a reliable network structure for each organization’s neighborhood of information-exchange collaborators.

Responses to the information-exchange network question were collected using a 4-point Likert scale. Which provides the strength of the information-exchange relationships (Borgatti et al., 2013; Agneessens & Labianca, 2022). To simulate networks and interpret network measures, we dichotomized these ties, disregarding their varying levels of intensity. This turned naturally valued ties into binary ones (present = 1 / absent = 0) (Borgatti & Quintane, 2018). To operationalize information exchange as the mediator variable (M), we counted the ties that every organization sent to others (outgoing ties, $A \rightarrow B$). The descriptive information about this network is available in Table 2.2 below.

¹² Key elements for information exchange included some or all of the following topics: infrastructure-project cost and time overruns, tender and contract awards, contract management, and the social and environmental impacts of infrastructure developments.

Table 2. 2 Descriptive information of networks

Descriptive	Information network	Influence network
No. of organizations	116	116
Total no. of ties	833	933
No. of senders	97	102
No. of receivers	116	116
Network density	0.06	0.07

To operationalize perceived influence (Y) as the dependent variable, we collected data using a second network question:

*“Consider situations last year (January–December 2019) when you participated (with or without the right to vote) in initiative-implementation decisions. How often were you influenced by the information or arguments of people representing the following organizations and/or internal bodies that develop work for the initiative, including the National Secretariat and Assurance Team?”*¹³

This is a straightforward and impersonal way to operationalize influence; the question condenses theoretical conceptualizations linked to perceptions of influence in governance networks discussed above. In addition, third-actor perceptions are more accurate than self-perceptions (Ingold & Leifeld, 2016). By using a separate network question for perceived influence, outside the information-exchange network, we also avoided common-source bias (Meier & O’Toole, 2013).

Responses were ranked using a Likert scale. The influence network was also dichotomized (1= the present tie; 0 = no ties), disregarding their varying intensities. These data allowed us to build a binary, directed network matrix with the row organization indicating what column organization is perceived as influential. We counted all influence nominations every organization received from survey respondents (incoming ties, $A < - B$). The more

¹³ These arguments may have included professional knowledge, political views, and/or expertise in the implementation of the initiative.

nominations an organization received, the stronger its assumed capacity to exert influence within an MSP (Ingold & Leifeld, 2016). See Table 2.2 above for more details.

Motivations: independent variable

The goals of most governance networks are based on the public good they are attempting to deliver (Steets, 2010; Huxham & Vangen, 1996). To operationalize the decisional approach as our main independent variable (X), we first selected four recurrent pro-social motivations in the partnership literature. We adapted these to the public-infrastructure sector. Respondents were asked to rate how much the following statements reflect their own motivation to participate in a MSP ¹⁴: (1) “*to contribute to the public debate about public infrastructure projects*” (Truex & Søreide, 2011); (2) “*to enhance government transparency*” (Brockmyer & Fox, 2015); (3) “*to co-produce public policies to tackle corruption*” (Rich & Moberg, 2015); and (4) “*to improve value for money in public-infrastructure projects*” (Brockmyer & Fox, 2015). Second, we also inquired opinions on common self-interested motivations for partnership participation: (1) “*to engage with key public and private stakeholders*” (Millar et al., 2004); (2) “*to obtain reputational benefits*” (Alsop, 2004); and (3) “*to secure sources of funding for my home organization*” (Richter, 2001).

Responses were rated using a Likert scale as well. To ensure one-dimensionality for each construct, an exploratory factorial analysis was carried out; two items in the pro-social construct failed the first validity evaluation, due to low loadings < 0.50 (Hair et al., 2014). Removing the first and fourth items in the pro-social construct produced an acceptable validity score. We obtained an adequate Cronbach’s alpha > 0.70 for each construct (Cronbach, 1951).

Controls

We considered three control variables for the model. *Job position* captures each respondent’s job position in their home organizations, with the actor’s formal authority based on his/her position within an organizational organigram. The positions included in the survey were (1)

¹⁴ Respondents were not informed of the classification of motivational items during the survey.

executive direction, (2) higher management, (3) intermediate management, (4) operative level, (5) junior, (6) representative, and (7) other.

Professional knowledge was the second control included. Respondents were asked how much they have contributed to various collective processes of the MSPs. Options to select from were: (1) “selecting indicators to evaluate infrastructure projects”; (2) “determining how to communicate results to the public”; (3) “selecting infrastructure projects for assurance reports”; (4) “advising on annual-report preparations”; (5) “interpreting technical findings for infrastructure projects”; and (6) “following up recommendations”.

The third control variable, *years of participation*, measured the role of seniority of respondents in their respective MSPs, and assessed whether perceived influence effects remained significant when this variable is controlled.

Methods

To test the conditional process illustrated in Figure 1, we used a mediation model to investigate and explain the formulated relationship. Mediation analysis is a statistical method that uses ordinary least squares and a logistic regression path analysis to evaluate research evidence, testing hypotheses to determine how an antecedent variable transmits its effects to a consequent or dependent variable. Since our model included two consequent variables, M and Y , two linear models are required, one for each consequent:

$$M = i_M + aX + e_M \quad (1)$$

$$Y = i_Y + c'X + bM + e_Y \quad (2)$$

where i_M and i_Y are regression constants, and e_M and e_Y are estimation errors in M and Y . The regression coefficients are represented by components a , b , and c' , given the antecedent variables used to estimate effects. The coefficients are estimates of the presumed influence of each variable on others in the system. The analytical goal is to estimate these coefficients, piece them together, and interpret them.

In the mediation model, the first component is the *direct effect*; the path then goes from X to Y . The *direct effect* is indicated by c' , which holds M constant. The second component is

the indirect path from X to Y , containing the conditional effect of M to Y , indicated by a and b . The total effect is the sum of the direct and indirect values indicated by c .

Before running the model, we revised basic correlations between the variables. Table 2.3 shows the means, standard deviations, and correlations. Based on the correlation coefficients reported below, the self-interested-motivation variable is positively related to perceived influence ($X_1 \rightarrow Y$) although the relationship is not significant ($0.032, p > .05$). This independent variable is, however, positive, and strongly correlated with the mediator variable of information exchange ($X_1 \rightarrow M$) ($0.317, p < .001$), which in turn is highly correlated with the dependent variable ($M \rightarrow Y$) ($0.374, p < .001$). Although pro-social motivations are positively correlated with Y , the coefficients are not significant ($X_2 \rightarrow Y$) ($0.022, p > .05$); the same is true for its correlation with information exchange ($X_2 \rightarrow M$) ($0.043, p > .05$).

The control variable of job position is negatively correlated with the dependent ($C_1 \rightarrow Y$) ($-0.088, p > .05$). This suggests that actors may not wield much influence within MSPs, despite high-level job positions in their home organizations. Interestingly, this variable is positively correlated with self-interested motivations and negatively correlated with pro-social motivations. For the control of years of participation, results show a positive correlation with influence, although the relationship is not significant ($C_2 \rightarrow Y$) ($0.128, p > .05$). In addition, results for this control (C_2) suggest that senior MSP actors are driven less by self-interested motivations than by altruistic ones. On the other hand, contributions of professional-knowledge, as the third and final control variable (C_3), is positively and significantly correlated with influence ($C_3 \rightarrow Y$) ($0.260, p < 0.001$).

Table 2. 3 *Descriptive statistics*

Variable	Mean	s. d.	1	2	3	4	5	6
1. Perceived influence (Y)	8.04	2.19						
2. Information exchange (M)	7.18	4.23	0.374***					
3. Self-interested motivations (X_1)	6.30	2.50	0.032	0.317***				
4. Pro-social motivations (X_2)	9.50	0.98	0.022	0.043	0.192*			
5. Job position (home org.) (C_1)	4.98	2.03	-0.088	0.205*	0.028	-0.018		
6. Years of participation (C_2)	2.96	1.52	0.128	-0.033	-0.251**	0.018	0.041	
7. Professional knowledge (C_3)	3.13	0.87	0.260**	0.142	0.231*	0.187*	-0.096	0.270**

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. $N = 116$ organizations.

The variance inflation factors (VIF) of the regression analysis shows that the largest VIF in the model is 1.32 for X_1 , which is significantly below the threshold level of 10 needed to avoid multicollinearity problems in a multivariate data analysis (Hair et al., 2014).

Despite the lack of statistical significance of the effect of both X_1 and X_2 on Y at this stage, it does not preclude whether different types of motivations affect perceived influence through an intervening process. No evidence of an association between X and Y is required as the precursor for a conditional process conducted through mediation (Edwards & Lambert, 2007).

Findings

Our results are discussed in three stages. The first stage reports the results of the model's direct effect, when information exchange M is controlled. The second stage describes the results of the indirect effect on components a (the effect of motivations on information exchange) and b (the effect of information exchange on perceived influence). Here, M is part of a conditional process that determines the effect of motivations X on perceived influence Y . The third stage combines these coefficients and interprets the mediation process via its total effect and statistical inferences (Edwards & Lambert, 2007).

We used mediation Model 4 (within path analysis PROCESS, version 3.5.3 for statistical computing environment R)¹⁵ to test the hypothesized mechanisms layout above.¹⁶ The antecedent variables of the model information exchange (M) and participatory motivation (X_1 and X_2), are not mean centered or standardized for this analysis.

We ran three versions of the proposed model (see Appendix 2B and 2C).¹⁷ From Table 2.3, we observed that self-interested motivations play a significant role in explaining the general model and the mediation effect. Thus, this section describes and discusses the results of the third version of the model, which employs self-interested motivations as the only independent variable, while controlling for pro-social motivations.

¹⁵ See R codes in Appendix G9.

¹⁶ We selected 90% confidence for the bias-corrected bootstrap confidence intervals (CIs), using 500 bootstrap sample estimates (Hayes, 2018).

¹⁷ The first version employs self-interest motivations without controlling for pro-social motivations. The second version does the opposite, while the third one, explained here, uses self-interest as the only independent variable, while controlling for pro-social motivations.

Table 2.4 shows that neither self-interested motivations nor pro-social motivations (as a control) have a significant effect on perceived influence directly. In fact, the effect is negative for both types of motivations, supporting only Hypothesis 1b (self-interested actors are less likely to be considered influential in MSPs), all things equal. The direct effect of the model (c') suggests that two organizations that differ by one unit in self-interested motivations but are equal in information exchange (M) will differ by $c' = -0.1087$ units lower on average ($p > 0.05$) in their likelihood of being perceived as influential stakeholders in their MSP.

Despite the normative narrative of multi-stakeholder partnerships (Steets, 2010), the results show that pro-social stakeholder organizations (C_1) have a negative relationship with perceived influence ($g_1 = -0.0295$, $p > 0.05$), offering no support for Hypothesis 1a. According to our data, in governance networks, actors do not gain influence through actions derived from altruistic motivations. On the contrary, they can actually undermine their role in the network. Thus, we can argue that those who pursue genuine transparency objectives and policy reforms in the public-infrastructure sector are seen as less influential by others.

Table 2. 4 Model coefficients for the mediation process

	<i>Antecedent</i>		<i>Information exchange (M)</i>					<i>Perceived influence (Y)</i>			
			<i>Coeff</i>	<i>SE</i>	<i>p</i>	<i>BootS CI</i>		<i>Coeff</i>	<i>SE</i>	<i>p</i>	<i>BootS CI</i>
Variables of interest	Self-interested motivations (X)	a	0.5023**	0.1653	0.0030	0.1748 0.8299	c'	-0.1087	0.0853	0.2053	-0.2779 0.0604
	Information exchange (M)		--	--	--	--	b	0.2170***	0.0473	0.0000	0.1233 0.3107
	Mediation effect		--	--	--	--	ab	0.1090	--	--	0.0274 0.2113
	Total effect		--	--	--	--	c	0.0003	0.0891	0.9976	-0.1763 0.1769
Control variables	Pro-social motivations (C_1)	f_1	-0.1233	0.3926	0.7541	-0.9014 0.6548	g_1	-0.0295	0.1948	0.8800	-0.4156 0.3566
	Position in home org. (C_2)	f_2	0.4291*	0.1858	0.0228	0.0609 0.7972	g_2	-0.1668	0.0943	0.0799	-0.3538 0.0202
	Years of participation (C_3)	f_3	0.0199	0.2706	0.9416	-0.5165 0.5562	g_3	0.0912	0.1342	0.4983	-0.1748 0.3572
	Professional knowledge (C_4)	f_4	0.4695	0.4769	0.3270	-0.4756 1.4147	g_4	0.5030*	0.2376	0.0365	0.0322 0.9739
Constant		i_M	1.5218	3.8743	0.6952	-6.1562 9.1997	i_Y	6.4369**	1.9227	0.0011	2.6262 10.2475

$R^2 = 0.14$

$F(5, 110) = 3.83, < .001$

$R^2 = 0.22$

$F(6, 109) = 5.30, < .001$

Source: PROCESS model outcome. Table design taken from Hayes (2018). Indirect effect (mediation) = ab ; Direct effect = c' ; Total effect = c .

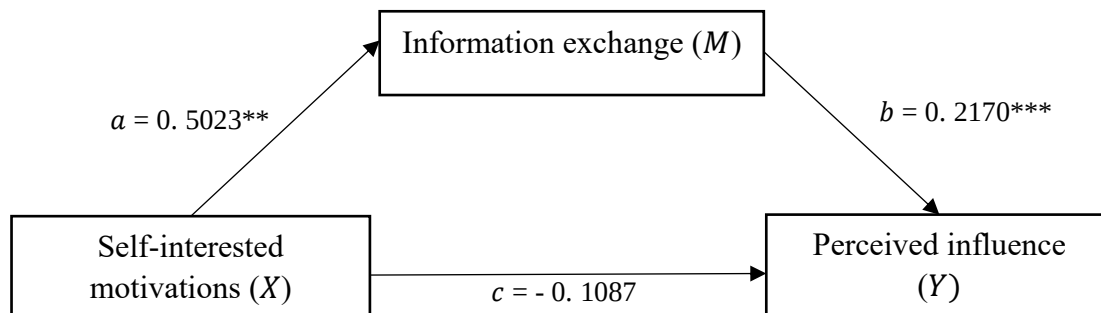
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

For the first component of the indirect effect (a) in Figure 2.2, the results show that self-centered actors are, on average, $a = 0.5023$ units higher (more likely) to exchange information

with other network actors. The coefficients show a positive and statistically significant relationship ($p < 0.01$), contrasting with the expected results for Hypothesis 2b that posits that self-interested actors are less likely to share information with others. In addition, Hypothesis 2a is not supported, as more altruistic actors seem far less likely to share information than their self-interested counterparts ($F_1 = -0.1233$, $p > 0.05$).

In the indirect-effect, results of the component b support Hypothesis 3, stating that actors who share more information are generally perceived as more influential. When two stakeholder organizations with equivalent motivations differ by one information-exchange unit (M), the organization that shares more information will be $b = 0.2170$ units higher on perceived influence ($p < 0.001$). In other words, when b is positive, organizations that exchange more information receive more influence nominations.

Figure 2. 2 Statistical diagram of the mediation model



Multiplying coefficients a and b yields the indirect effect of self-interested motivations on perceived influence through information exchange (see Hayes, 2018). Self-interested stakeholders receiving higher scores for information exchange, were on average $ab = 0.1090$ units higher for perceived importance. Thus, the mechanism of information exchange strengthens an actor's capacity to gain influence in MSP. Prior studies have treated information exchange as a competence-based status differentiator, exploring the impact of contributions to collaborative processes (Bunderson, 2003; Smith et al., 2014; Klepper et al., 2017). Information contributions may signal commitment and active participation, thus generating perceived reputation as being influence, even for those pursuing selfish interests.

We now describe the total effect of the model. We piece the individual coefficient effects described above together and interpret them in terms of the total effect. Adding together the direct and indirect effects produces the total model effect (c) (Aiken & West, 1991): $c' + ab = -0.1087 + 0.1090 = 0.0003$. Although information exchange may mediate and mitigate negative perceptions of influence, self-interested actors create more positive perceptions of their influence, although not to a significant degree.¹⁸

Having defined the main effects of the model, we now move on to discuss the control variables. As Table 2.4 shows, contributions of professional knowledge (C_4) makes a positive and statistically significant contribution to perceived influence ($g_4 = 0.5030$, $p < 0.05$). Given that knowledge can be embedded within general exchanges of information, caution is advice in the interpretation of this control variable, as it may have a confounding effect. However, the model shows that once controlling for professional knowledge contributions, information exchange still is a significant factor that explains increases in influence perceptions. Considering them separately, both serve as mechanisms that could be employed strategically by stakeholder organizations to increase their influence.

On the other hand, job position (C_2), here interpreted as part of the positional approach has also shown no significant results to explain influence ($g_2 = -0.1668$, $p > 0.05$). However, it contributes to explain information exchange, the mediator of the model ($f_2 = 0.4291$, $p < 0.05$). Those actors holding senior positions in their home organizations tend to share more information within MSPs, from which we speculate that more senior stakeholders exchange information more proactively, possibly as a means to improve their influence and bend collective goals.¹⁹

Discussion of results

Overall, participatory motivations have shown not to be that relevant as it was initially thought. At best, the integration of these participatory drivers has unveiled a new perspective on the direction between motivations, information exchange and influence that counterargues established postures about governance networks and multi-stakeholder collaborations (Steets, 2010; Ansell & Gas, 2008; Huxham & Vangen, 2004).

¹⁸ For an explanation about the inferences that support information exchange as a mediator in the model, taking into consideration bootstrapped confidence intervals (Wood, 2005), see Appendix 2D.

¹⁹ We are thankful to a reviewer, whose comments guided us to draw this conclusion.

We found that information exchange in networks offers a more robust explanation for perceived influence. This confirms that influence assessments can be relational in nature and that should be analyzed through the structural/relational characteristics of a network. Participants have the most accurate view of how influence is allocated among other actors in a web of relationships, as it has been previously highlighted by Fischer and Sciarini (2015) in the pursue to unpack reputational power.

Contrary to Ingold and Leifeld's (2016) evaluation of policy networks in Switzerland and Germany, this paper shows that stakeholders in MSPs are perceived as influential because of their structural position in the network of information exchange, but not necessarily because of their institutional roles nor their seniority level. It should be noted that influence seems to be related more to a cognitive approach. In other words, it is not about who an actor is, but about what this actor does or seems to do in a network to improve influence.

The results confirm that information exchange plays a key role in mediating the relationship between self-interest motivations and influence. Similar findings have been identified in research about Swiss networks/forums of natural habitat and hazard governance (see Fischer & Maag, 2022), where actors providing high input into the collaboration were those that were looking for individual rather than collective benefits, aiming at gaining influence over policy making and practice.

Along with our study, these more recent findings of influence patterns in networks, presents a problematic scenario because key collaborative inputs, such as information, is then shaped by conflicting motivational preferences among stakeholders. Such information may reflect stakeholders' biases, reducing the effectiveness and quality of governance in networks. Those who receive information only from a subset of like-minded peers can lose access to valuable sources of information and knowledge that are purportedly offered by governance platforms of multi-stakeholder participation. Polarized information exchanges within MSPs may cause stakeholders to reject decisions that fail to consider opposing views (Angst & Brandenberger, 2020). When forming coalitions, persuading adversarial partners, and controlling agendas, stakeholders may bypass or abandon agreed-to collective objectives (Leifeld & Schneider, 2012; Fischer & Maag, 2022).

It should not be assumed that participants of governance network are motivated entirely for the betterment of society (Fischer & Maag, 2022; Gustafson & Hertting, 2017). In doing so, one may fall in the trap of the *de facto* "participatory design" (Fung, 2006, p. 66), which is the

product of a top-down perspective of policy makers and practitioners' intentions. One should also consider the bottom-up expectations of participants (Gustafson & Hertting, 2017), that shape constantly governance dynamics within networks that tend to be rather vague and subject to ongoing interpretation and negotiation of collective objectives.

Conclusion

It has been very well established in various branches of the literature that actors with considerable influence are particularly able to clout decision making processes (Ingold & Leifeld, 2016; Fischer & Sciarini, 2015). Today, however, very little research exists in public administration and political science as to why some actors in governance networks are perceived as more important than others with an eye on their participatory motivations. Practitioners and conveners of governance networks need to know what motivates their most devoted stakeholders, that is, those who are more active than others.

This paper contributes to the extant literature, by emphasizing endogenous determinants of influence, other than the usual approaches to understand it based on actors' reputation, formal authority, and structural position (Parry, 2005; Brass, 1984). Disentangling the determinants of influence is crucial in order to assess the sustainability of governance networks and multi-stakeholder collaborations (Ingold & Leifeld, 2016). To that end, our analysis recognizes network actors' different goals, and the direction of their actions.

The presence of pro-socially motivated actors is central to many accounts of governance-network problems. Theoretical accounts see commitment to altruistic motivations as the *sine qua non* condition for collective action and effective governance relationships. This paper tests this argument, analyzing a unique relational dataset collected in 2020 from organizational stakeholders in ten anti-corruption partnerships across three regions in the world (Eurasia, Africa, and Latin America).

Logistic regression path analysis of the data reveals that self-interested actors achieve far more significant dynamism than pro-social actors when it comes to information exchange (a core collaborative activity). Findings are problematic, however, not only because they counterargue established theoretical postures about networks based on multi-stakeholder collaborations, but also, because information that is influenced by stakeholders' associated

biases to their more private interests, raises concerns about their real contributions to the decision-making process.

We find support to our claim that information exchange serves as a mediator; it helps to explain perceived influence among participants of governance networks. Actors providing high input are those that lend importance to network outputs that confer them influence, which can be used to gain control over networks' problem-solving power, agenda-setting, and decision-making. Exchanging information may enable self-interested actors to strengthen their influence over colleagues and peers, pursuing goals that may end up departing from collective objectives. We do not claim that motivations and information sharing fully determine perceived influence in networks, but we do make the claim that there are good reasons to think they have an influence. The broader significance of our findings is that we have explained how an important mediating variable comes about.

The present findings support theoretical arguments from the resource-dependence theory (Pfeffer & Salancik, 1978) and social-exchange theory (Blau, 1964), which posit that actors engage in collaborative interactions because they expect to be rewarded, either directly or indirectly. At present, perceived influence (a reward) may accrue to actors who proactively exchange information, causing networks to undermine their own formal institutional partnership narratives, amplifying rather than moderating influence disparities (Faul, 2016; Schrank & Whitford, 2011; Fischer & Maag, 2022).

While we believe that our results provide compelling evidence regarding some of the determinants of influence in governance networks, several limitations remain. First, mediation model is the most rudimentary and simple model available for statistical analysis (Hayes, 2018). It may greatly oversimplify the complex dynamics through which motivations impacts perceived influence in real-world processes. We believe that this study reveals a key piece of the puzzle. However, future scholarship should explore the role of motivations in more elaborated models and verify whether our findings provide a valid explanation for networks' distribution of influence when alternative mediating or moderating variables are considered such as actors' alternative ways of participation (e.g., meetings attendance), but also network size and network maturity.

Second, our research design only allowed us to evaluate the impact of participatory motivations in actors who collaborate in governance networks. It is true that future research

could be fruitfully undertaken by considering alternative types of networks as research settings (i.e., policy, collaborative, coordinative networks, etc.) from a wider range of countries and issue areas. At present, we have assumed that our findings may be generalizable given the cross-sectoral nature of many of these networks, but more research is needed in this respect. This would help to disentangle the conditions under which influence imbalances lead to fragmentation or disintegration of different types of networks that depends on the engagement of a myriad actors to find solutions collaboratively.

Third, due to the case selection, we only collected data on actors that have actually invested time and resources for the implementation of a transparency initiative at the country level. We did not collect data from the founders of the initiative, which are stakeholders by themselves. The distinction is important, as the latter have different set of incentives to participate in governance networks (Fischer & Leifeld, 2015) and may portray a different rationale for perceived influence. This is one further limitation that future scholarship may try to overcome, by comparing the effects of motivations among these different types of stakeholders, disentangling whether and to what extent influence perceptions change when types of motivations can be grouped by the nature of stakeholder participants on the one hand and stakeholder founders on the other.

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Appendix 2A: CoST institutional framework and network boundary

The implementation of CoST unfolds under four key mandates: (1) the program implementation is delivered and monitored by a *national multi-stakeholder partnership* (MSP); (2) the MSPs agree upon criteria for selecting a subset of public-infrastructure sector projects for in-depth review, and select agencies or institutions to work with, for this purpose; (3) they request information from the relevant public sector procuring agencies, and in turn hire an *Assurance Team*²⁰ to review the information and highlight any discrepancies and reasons for concern (i.e., red flags); (4) the MSPs synthesize this information into an annual report and communicate the findings through media outlets to the public; lastly, (5) the MSPs make recommendations to governments to improve infrastructure projects and sector performance, while also following up progress on this regard (Truex & Søreide, 2010; Hawkins & Prado, 2019; Hawkins & McKittrick, 2012).

Every MSP relies on a *National Secretariat* that serves as a full-time administrative body that is responsible for the day-to-day activities for the implementation of CoST.²¹ Some of these tasks entail the facilitation of communication between the *International Secretariat* and the MSPs, provision of technical support for stakeholders, and build capacity for the procuring entities to disclose data (CoST, 2019).

The role of the International Secretariat is largely to offer learning, support, and guidance to participating countries, and encourage additional countries to join (CoST, 2019). The international secretariat monitors progress of implementing countries and inform the *Board of Directors*. The board is the main decision-making body of CoST as it sets up the admission criteria and approves countries' applications to join the initiative. It also helps to raise funds and provide national-level support to CoST members (CoST, 2019).

In order to undertake analysis on social networks in an organizational setting, it is relevant to identify which actors should be counted in as members of the network, and thus be included in the data collection. The MSP is the organizational unit of CoST where the phenomenon of interest of this paper resides, because it is the space where multi-stakeholder interactions occur for information exchange and collaboration. That is, the MSPs represent the

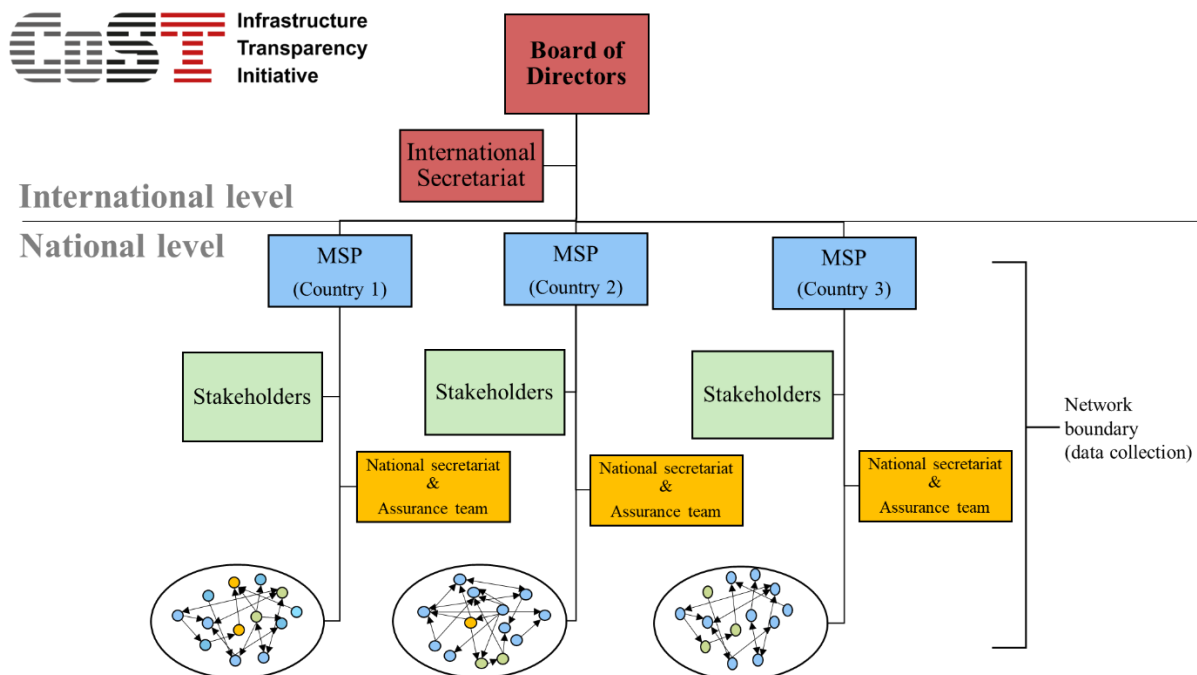
²⁰ These are independent groups of professionals: engineers, architects, scholars and other experts.

²¹ National Secretariats operate as *network administrative organization* (Provan & Milward, 1991), intending to organize and coordinate the activities of the participant stakeholders to produce better outcomes.

multi-stakeholder sphere where tasks of collective action unfold, and where influence asymmetries occur, given the presence of actors from different backgrounds and communities of practice.

The configurations of the MSPs within CoST's institutional framework represent an easily observed and recognized entity with "natural" boundaries of who participate and who does not: representatives of public and non-public constituency groups. Although not stakeholders *per se*, the National Secretariats and the Assurance Teams also are part of the MSPs and their networks of interactions. These defined our research design and data collection strategy. Figure 3 illustrates the demarcation of the networks of interests within the organigram of CoST as for 2020.

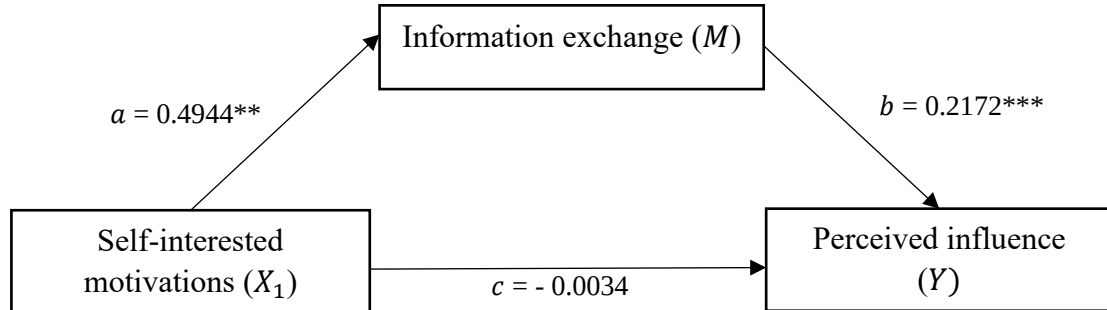
Figure 3 Organizational framework of CoST



Source: Author's own elaboration based on CoST's official website (2019).

Appendix 2B: Mediation model without pro-social motivations

Figure 3. Model 1 Self-interested motivations

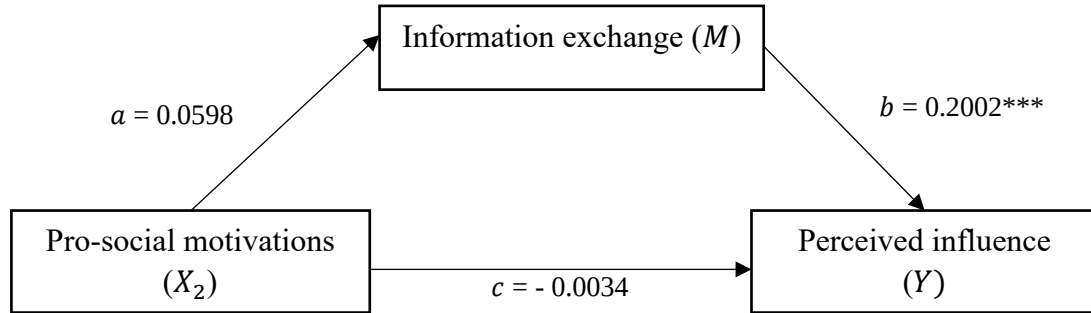


		Information exchange (M)				Influence (Y)			
		Antecedent	Coeff	p	BootS CI		Coeff	p	BootS CI
Variables of interest	Self-interested motivations (X ₁)	a	0.4944**	0.0030	0.1721 0.8167	c'	-0.1107	0.1897	-0.2770 0.0556
	Information exchange (M)		--	--	--	B	0.2172***	0.0000	0.1240 0.3105
Model effects	Mediation effect		--	--	--	Ab	0.1074		0.0270 0.2058
	Total effect		--	--	--	C	-0.0034	0.9695	-0.1771 0.1704
Control variables	Job position home org (C ₁)	f ₁	0.4296*	0.0221	0.0630 0.7962	g ₁	-0.1668	0.0786	-0.3529 0.0194
	Professional knowledge (C ₂)	f ₂	0.4498	0.3415	-0.4832 1.3829	g ₂	0.4982*	0.0358	0.0338 0.9627
	Years of participation (C ₃)	f ₃	0.0182	0.9462	-0.5158 0.5522	g ₃	0.0908	0.4982	-0.1740 0.3555
	Constant	i _m	0.4645	0.8081	-3.3170 4.2460	i _y	6.1839***	0.0000	4.3086 8.0591
			R ² = 0.14 F(4, 111) = 4.80, < .01				R ² = 0.22 F(6, 110) = 6.41, < .001		

Source: PROCESS model outcome. Table design taken from Hayes (2018). Indirect effect (mediation) = ab ; Direct effect = c' ; Total effect = c . *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Appendix 2C: Mediation model without self-interest motivations

Figure 3. Model 2 Pro-social motivations



		Information exchange (M)				Influence (Y)			
		Antecedent	Coeff	p	BootS CI		Coeff	p	BootS CI
Variables of interest	Pro-social motivations (X ₂)	a	0.0598	0.8821	-0.7370 0.8566	c'	-0.0681	0.7248	-0.4505 0.3143
	Information exchange (M)		--	--	--	B	0.2002***	0.0000	0.1100 0.2905
Model effects	Mediation effect		--	--	--	Ab	0.0120		-0.1198 0.1868
	Total effect		--	--	--	C	-0.0561	0.7880	-0.4688 0.3566
Control variables	Job position home org (C ₁)	f ₁	0.4744*	0.0150	0.0941 0.8547	g ₁	-0.1687	0.0774	-0.3561 0.0188
	Professional knowledge (C ₂)	f ₂	0.9052	0.3295	-0.7815 0.2645	g ₂	0.4239	0.0679	-0.0318 0.8796
	Years of participation (C ₃)	f ₃	-0.2585	0.3295	-0.7815 0.2645	g ₃	0.1471	0.2500	-0.1050 0.3992
	Constant	i _m	2.1820	0.5874	-5.7624 10.1265	i _y	6.3305**	0.0014	2.5131 10.1480
			R ² = 0.076 F(4, 111) = 2.20, < .01				R ² = 0.21 F(5, 110) = 6.00, < .0001		

Source: PROCESS model outcome. Table design taken from Hayes (2018). Indirect effect (mediation) = ab ; Direct effect = c' ; Total effect = c . *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Appendix 2D: Statistical inferences of the model

Researchers generally want to know whether “chance” can be discounted as an explanation for effects obtained through hypothesis tests. Constructing an interval estimate of effects can reveal the sampling variance in any estimate and help for this purpose (Hayes, 2018). In a mediation analysis, bootstrapping generates an empirically derived representation of the sampling distribution. This is used to construct a confidence interval for the effects of mediation (Hayes, 2018). Bootstrap confidence intervals respect the irregularity of the sampling distribution and yield more accurate inferences than other methods (Wood, 2005). Here, bootstrapping (5,000 samples) was used to generate the direct, indirect, and total effects of the model in Table 2.4.

To draw inferences about the total effect of the model (c), we followed Hayes (2018) and Woods (2005). Inferences can be framed in terms of a null hypothesis test, by determining whether an interval estimate includes zero. Table 2.4 shows that the total effect of c is not statistically significant. At a 95% confidence level, the true value falls between -0.1763 and 0.1769. This range includes zero, which cannot be ruled out as a plausible value for the total effect. To determine the direct effect of the model (c'), we must ascertain whether an interval estimate for the true value includes zero. As Table 4 shows, the direct effect is negative and not statistically significant. The true value of the direct effect lays in between -0.2779 and 0.0604, which includes zero.

Finally, the indirect effect quantifies the extent to which two cases that differ by a unit of self-interested motivation differ on perceived influence (motivations affect information exchange, which in turn affects perceived influence). As shown above, information exchange (M) appears to serve as a mediator: $ab = 0.1090$. Thus, the indirect effect is relevant; the effect of X on Y is mediated through a mechanism represented by information exchange M . The interval estimates reveal a true value between 0.0274 and 0.2113, which excludes zero. The indirect effect is positive to a statistically significant degree.

CHAPTER 3. WHERE DO GOVERNANCE NETWORKS COME FROM? AN ANALYSIS OF OPPORTUNITY STRUCTURES IN INFORMATION EXCHANGE NETWORKS

ABSTRACT

Information exchange is the lifeblood of high in demand governance networks. It has been long contended that the phenomenon of shared beliefs makes it possible for actors to exchange critical information and achieve collective goals. However, some studies have shown that when actors attempt to establish contact with potential partners, they tend to do so, by choosing strategies that minimize transaction costs. In this paper, we argue that information exchange emerges when potential benefits outweigh transaction costs of creating and maintaining those relationships. This paper proposes and analyzes a set of opportunity structures that actors use for contact making in organizational contexts, based on the following factors: (1) preference similarity in participatory motivations, (2) institutional venues, (3) social capital, and (4) preferential attachment to influential actors. Unique survey data collected from ten multi-stakeholder partnerships (MSPs) in Africa, Eurasia, and Latin America have been used to assess opportunity structures in technical and political information-exchange networks. Results from Exponential Random Graph Models (ERGMs) show that the effect of preference similarity is absorbed once institutional venues are taken into account, unveiling an often-overlooked characteristic that facilitates communications between actors. However, MSPs engage in network structures that hinder social capital and heterogeneous interactions, rendering collective action somewhat impractical. The present analysis makes an important contribution to the literature of governance networks by providing evidence-based findings and recommendations, focused on specific opportunity structures that maximize outreach and access to new information.

Key words: multi-stakeholder partnerships, information exchange, ERGMs, social capital, collective decision-making, public-infrastructure sector

Ethics and integrity statements

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Introduction

To achieve solutions across conflicting policy arenas, decisions are increasingly made within governance networks. These networks rely on a variety of organized public and non-public actors that maintain relationships for resource exchange, collaboration and policy influence (Ansel & Gash, 2008; Klijn & Koppenjan, 2015). The question of how governance networks work in practice has been reflected in a large number of studies over the last decades, exploring different dimensions of networks such as composition, leadership, and fragmentation (Lecy, Mergel & Schmitz, 2014; Kapucu, 2015; Isett, Mergel, Leroux et al., 2011).

A recurrent subject in the literature, however, is the endeavour to understand why actors are willing to exchange resources to some actors but not to others (Liefeld & Schneider, 2012; König & Bräuninger, 1998; Jones, Hesterly & Borgatti, 1997). Information exchange is a case in point. Exchanges of crucial resources such as information to address complex issues can overcome collective-action dilemmas prevalent in most collaborations (Ansel & Gash, 2008; Carpenter, Esterling & Lazer, 2004). The understanding of this process is significant in settings of ever-changing conditions and complexity such as governance networks (Angst & Brandenberger, 2020; Berardo & Scholz, 2010). To understand how participation, collaboration, and decision-making operate in governance networks, it is necessary to identify the factors that underlie these exchanges (Haas, 2004; Fischer, Ingold & Ivanova, 2017). This paper investigates the rationales that bring actors together and drive them apart during the exchange of different types of information within governance networks.

Most analyses of information exchange within governance networks have focused heavily on the extent to which participating actors share similar preferences. This approach has its theoretical roots in the frameworks that explain formation of coalitions (Sabatier & Jenkins-Smith 1999). Researchers have posited that shared ideologies, attitudes, and policy-related motivations significantly influence the way in which actors structure themselves within collaborative networks (Henry, Lubell, & McCoy, 2011; Carpenter et al., 2004). The underlying principle here is that it takes less cognitive effort and negotiation time to communicate with similar actors than to interact with dissimilar ones (Henry et al., 2011; Carpenter et al., 2004).

According to researchers from the structural tradition, however, when actors choose potential interaction partners to exchange information with, they may also consider whether

they are easy and inexpensive to contact (Siciliano, Wang & Medina, 2021). Actors make strategic choices to reduce their transaction costs, while also employing *opportunity structures*. These are situational opportunities that exist in social, organizational, and institutional contexts. They provide a range of strategic options, which actors can use to achieve specific outcomes (Merton, 1995).

An expanding body of literature is now investigating various factors that shape, advance, and impede network emergence in a range of policy fields. For example, the structural tradition emphasizes that sharing participation in *institutional venues* is a key opportunity that actors frequently use to communicate with new partners (Zafonte & Sabatier, 1998; Leifeld & Schneider, 2012). In the *social capital* literature, actors tend to use existing relationships to form new ones (Henry et al., 2011; Berardo & Scholz, 2010). Studies of *preferential attachment* argue that actors establish new relationships based on the perceived influence and popularity of others in their surroundings; these relationships allow them to be heard and to coordinate with others for a more effective inclusive agenda setting (Stokman & Berveling, 1998; Ingold & Leifeld, 2016).

Despite recent calls for more research on governance-network formation (Siciliano et al., 2021; Turrini, Cristofoli, Frosini et al., 2010), few studies have investigated the multiple causal mechanisms that underlie network formation. We argue that establishing information relationships with others in governance networks is not incidental. Actors are likely to use several opportunity structures simultaneously to minimize costs and maximize access to required information (see also Leifeld & Schneider, 2012; Henry et al., 2011).

Although preference similarity has been widely used to explain network emergence (Leifeld & Schneider, 2012; Sabatier & Weible, 2007), it may not explain the process through which actors assess all possible ways of making contacts. For this reason, the present paper proposes and analyzes multiple opportunity structures simultaneously. Instead of assuming that competing theoretical explanations explain network emergence in isolation, we combine these approaches, arguing that multiple opportunity structures simultaneously impact the emergence of governance networks.

We test our theoretical explanations by applying Exponential Random Graph Models (ERGMs) to a unique relational dataset collected in 2020. We surveyed organizational actors in multi-stakeholder partnerships (MSPs), tasked with implementing anti-corruption

mechanisms in the public-infrastructure sectors of ten countries from Latin America, Africa, and Eurasia. MSPs are real-world examples of complex governance systems that rely on collective action, engaging a diverse set of stakeholders from the public and non-public sectors (Hermans, Sartas, Van Schagen et al., 2017; Faul, 2016).

To achieve their objectives, MSPs in our sample, employ two broad categories of critical information. While *political information* helps stakeholders to steer and influence the implementation of transparency and accountability mechanisms in their socio-political contexts, specialized *technical information* is used to analyze the infrastructure developments and contracts that must be evaluated for feasibility, value for money, and red flag identification (see Fischer et al., 2017; Brockmyer & Fox, 2015). This study assesses opportunity structures by testing them in networks with both types of information, while recognizing that the exchange of technical and political information may serve different purposes.

Our findings show that opportunity structures help to overcome transaction costs and to advance information exchanges within MSPs. Even when stakeholders share similar beliefs, their behavior and contact-making decisions are conditioned by other types of opportunity structures. This finding reveals the logic behind the formation of webs of information, based on the speed and ease with which new contacts can be made. Attendance at institutional venues, such as issue committees, was largely responsible for information exchange across the various networks tested in this study, and for both categories of information. Results indicate that within these committees, however, contact-making occur among stakeholders affiliated to the same sector. The latter, sets significant limitations to the flow of innovative ideas and knowledge. The absence of reciprocity and triadic relational structures seems to add to this situation, by reducing the social capital in MSPs.

The present study makes a significant contribution to the governance-network literature in three different ways. First, it reveals the inner relational dynamics of high-demand partnerships in the field of international development. These have received scant attention in empirical research using network analysis (see Faul, 2016). Second, this paper proposes a set of measures consistent with theoretical expectations, contributing to the ongoing effort to clarify the relationship between theoretical conceptualizations and the structural characteristics that determine network emergence. Third, from a methodological point of view, it analyzes several real-world networks stacked in block diagonal matrices as input for ERGM analysis, facilitating the detection of general patterns across a wide range of data points. By modeling

the tie-formation process in this way, this paper offers a unique perspective on network formation; the concepts discussed here have typically been researched in the context of isolated, single networks. These three contributions can help managers, policymakers, and practitioners to design, maintain, and rewire governance-network processes to achieve more effective collective-action outcomes.

Literature and Theory

The exchange of information within governance networks is a process of contact making. It enables the spread of knowledge, evidence, and opinions on a range of different issues, allowing actors to gain a contextual understanding of various situations. However, actors cannot maintain information-exchange relationships with all other potentially relevant actors (Angst & Brandenberger, 2021).

Establishing and maintaining contact with others is an expensive endeavor, requiring the investment of time, energy and knowledge (Fischer & Sciarini, 2016; Fischer & Maag, 2022). The time and commitment dedicated to contact-making cannot be spent on other social activities. Network actors must constantly weigh the cost/benefit trade-offs involved in establishing and maintaining contacts. They may try to reduce the costs of contact-making by using opportunity structures to improve information-exchange efficiency. Opportunity structures are pre-existing contexts available in a range of different social, institutional, and organizational settings; they make it possible to achieve specific outcomes in various ways, without significant effort or cost (Merton, 1995).

Previous governance and policy-network studies have identified some general driving forces behind the establishment of information-exchange relationships (Siciliano et al., 2021; Leifeld & Schneider, 2012). To explain the mechanisms by which actor relationships are formed and dissolved, we divide these driving forces into two types categories: endogenous and exogenous opportunity structures (see also Monge & Contractor, 2001).

Endogenous opportunity structures consist of network-specific mechanisms that typically involve self-organizing network properties (Henry et al., 2011). Such relational and social-opportunity structures (Fischer & Sciarini, 2016) relate to micro-level network patterns, which influence the emergence of new relationships. In other words, network relationships are

formed based on pre-existing relationships (Lusher et al., 2013). By contrast, exogenous opportunity structures consist of general theoretical mechanisms that identify actor incentives and behavior, leading to relationship formation (Henry et al., 2011). Such mechanisms are exogenous to the network—determined by individual attributes or contextual network characteristics (Siciliano et al., 2021).

The following subsections revise the main theories used to study network emergence. We examine the underlying mechanisms that make information-exchange relationships more or less likely to exist. We further formulate a set of hypotheses derived from these theoretical assumptions.

Endogenous theories of network formation

Reciprocity

Reciprocity is a social occurrence that relies on an existing channel of communication. This channel reduces transaction costs, encouraging the creation of an additional relationship between two actors (Granovetter, 1985). Defined as the tendency to return a behavior in kind (Henry et al., 2011), reciprocity is generally regarded as a basic norm of social (as opposed to institutional) relationships; it is thus a common structural feature of human and organizational networks (Siciliano et al., 2021).

Despite its intuitive importance, this relational opportunity structure is a social process, frequently observed more often than chance in policy networks that rely on communication. According to Nisar and Maroulis (2017), relationships between street-level bureaucrats, based on reciprocal communication, emerge from the expectation that what has been given will be returned. For the receiver, the act of returning information is not associated with any costs. Both Huang (2014) and Isett and Provan (2005) have argued that single actors are unlikely to absorb knowledge and evidence-based information. Instead, these processes take place between two actors who require repetitive interactions to transfer and assimilate information. In a reciprocal way (Berardo & Scholz, 2010).

Reciprocity is thus a fairly basic opportunity structure for developing trust and social capital within networks (Siciliano et al., 2021). It is also associated with flat or non-hierarchical

governance structures (Jones et al., 1997) because reciprocal relationships imply that actors have similar levels of expertise, as well as access to and need for information.

Hypothesis 1. *An actor who receives information from another actor is more likely to respond within the relationship by sending information back.*

Triadic closure

In social networks, it is generally more expensive to approach strangers than friends of friends. According to Granovetter (1973), individuals have a greater-than-chance likelihood of forming ties with others who share a common friend: a phenomenon referred as *triadic closure*. Triadic closure informs two actors about the quality of a potential third partner involved in a social setting (Berardo & Scholz, 2010; Carpenter et al., 2004).

The same rationale applies to inter-organizational networks. The number of partners an organization has can serve as an indicator of relational quality, collaboration, and the capacity for powerful alliances (Leifeld & Schneider, 2012). Organizations are thus more likely to choose and trust other organizations within the same social neighborhood as existing partners (Henry et al., 2011).

Recent studies have demonstrated the importance of network relationships embedded within closed triadic relationships. Various rationales have been offered to explain the emergence of third-party structures. For example, Berardo and Scholz (2010) have studied third-party configurations in collaborative networks in ten U.S. estuaries. They posit that triadic configurations promote cooperative dynamics within networks by lowering the costs associated with finding new contacts and deciding whether they are worth the effort. For these authors, triadic closure leads to high clustering and density in networks, increasing group cohesion. According to Henry et al. (2011), on the other hand, this network structure represents realized social capital, because the actors not only cooperate, but also share norms and distribute redundant information to monitor and sanction opportunistic behavior (see also McAllister, Taylor & Harman, 2015).

Based on these theoretical expectations, we would expect information to be exchanged between two unconnected actors who share a third common contact, suggesting that

information exchanges occur within neighborhoods, with actors trusting those whom their collaborators already trust.

Hypothesis 2. *The more shared partners two organizations have, the more likely they are to establish an information-exchange relationship, completing a triadic configuration.*

Exogenous theories of network formation

Institutional venues

Institutional venues in governance networks have emerged as policy-coordination facilitators, helping to avoid fragmentation during collective decision-making processes. Such venues can take the form of forums or policy committees, which provide an inclusive space for repeated interactions, integrating different perspectives and opinions about issues at hand (Fischer & Sciarini, 2015).²²

While some governance-network committees focus on providing information and consultation, others negotiate and coproduce solutions (Fischer & Sciarini, 2016; König & Bräuninger, 1998). Issue-based committees provide participants with low-cost contacts and information, which would be expensive to acquire outside such committees. Williamson has defined transaction costs as those costs linked to “planning, adapting, and monitoring task completion under alternative governance structures” (1981, p. 553). Thus, institutional venues as an opportunity structure, is strongly influenced by transaction-cost theory, which emphasizes efficiency in resource transmission (Siciliano et al., 2021).

Individuals are likely to need some form of transactional cost analysis to determine whether issue-committee participation and social activities, such as information sharing, will advance their own interests (Fischer & Maag, 2022). Committees that build familiarity and reduce the transaction costs associated with interaction can help actors overcome barriers that could otherwise hinder the formation of communication relationships (Herzog & Ingold, 2019;

²² In the literature, such opportunity structures have also been referred to as “policy venues” (Fischer & Leifeld, 2005); “advisory groups” (Parkins 2002); “advisory committees” (Vasseur, Lafrance Ansseau et al. 1997); “working groups” (Klijn, Koppenjan & Termeer, 1995); and “roundtables” (Turcotte & Pasquero, 2001).

Zafonte & Sabatier, 1998). For example, Hamilton & Lubell (2018) have found positive evidence to support the hypothesis that climate-change policy forums make it more cost- and energy-efficient for actors to interact, search for, and monitor collaborative partners.

Network actors who participate in networks via issue committees choose the path of least resistance and reduce their communication costs, facilitating the exchange of information and future interactions. The more issue committees two actors participate, the more likely they are to interact, develop mutual trust, and form a collaboration (Fischer & Sciarini, 2016).

Hypothesis 3. *The more issue committees two actors belong to, the more likely they are to exchange information.*

Perceived influence

Another factor shown to play a role in network emergence is perceived influence. Actors tend to establish relationships with other actors they consider influential, on the grounds that these influential actors can support agenda setting and mobilize key resources for the collaboration (Hermans et al., 2017). Naturally, influential agents are seen as potential collaborators by many actors, especially if the quality of relationships with others in the network is unknown or perceived as risky (Berardo & Scholz, 2010).

According to Weible and Sabatier (2005), perceptions of influence have a moderate effect on network formation in relation to policy coordination. In a case study involving marine protected areas, these authors proved that network actors had to source information from more influential actors, regardless of their policy positions, to coordinate collective action. Hojnacki (1997) has echoed these assumptions, analyzing interest-group in Washington D.C., deciding whether an alliance with influential groups can bring them more benefits than working alone. According to Hojnacki, certain organizations perceived as influential are considered pivotal for the success of alliances and private interests; thus, the benefits accrued by interacting with them are considerable. Barabási and Albert (1999) posit that nodes (individuals or organizations) within networks tend to seek out links to better connected nodes, since group popularity can lead to further popularity.

This *preferential attachment* phenomenon is based on dependence theory (Pfeffer & Salancik, 2003). According to this, actors manage their relational ecosystems to maintain stable access to critical resources. They also tend to form strategic relationships with others, based on their own resource needs, which may include power, influence, and coordination capacity (Leifeld & Schneider, 2012; Ingold & Leifeld, 2016). Preferential attachment thus creates a self-reinforcing process, through which influential actors become increasingly popular (2015; Park & Rethemeyer, 2012). This conceptualization reflects a cognitive perspective, rather than a factual one: it does not matter who an actor is or what s/he does—only who s/he is perceived to be and what s/he is perceived to be doing (Ingold & Leifeld, 2016).

Hypothesis 4. *The greater an actor's perceived influence, the more likely that actor is to engage in information-exchange relationships.*

Preference similarity

In the field of network studies, rich empirical evidence documents the tendency for network actors to form relationships with others who share similar attributes (Siciliano et al., 2021). Various demographic attributes have been used as proxies for compatibility and preference alignment. However, some authors have explained the behaviors and relationships of actors embedded in communication networks by focusing on shared or similar beliefs (Leifeld & Schneider, 2012; Matti & Sandström, 2011). In the literature, “belief” is an umbrella term used to denote of the full range of actor’s cognitions, including ideology, values, perceptions, attitudes, and motivations, which can be used to assess patterns of interactions (Sabatier & Jenkins-Smith 1993, 1999; Sabatier & Weible 2007).

Studies conducted within the Advocacy Coalition Framework (ACF) (Sabatier & Weible, 2007) have made key contributions to the theoretical mechanisms behind these findings. The ACF classifies beliefs into a system of hierarchies, which range from deeply held core beliefs and normative convictions to policy-issue preferences (Weible & Sabatier, 2007). According to the ACF, network actors who share similar idiosyncratic attributes are more likely to connect because belief similarity brings them together, prompting them to create coalitions and/or defend their own positions against opponents (Weible & Sabatier, 2009; Zafonte & Sabatier, 1998).

For example, Elgin (2015) has argued that actors in organizational climate-change and energy-policy networks tend to establish information-exchange links with organizations that share similar policy objectives; together, they discuss potential solutions to climate change problems. In a study of California regional planning, Henry et al (2011) have shown that the shared norms and values associated with desired urban-development objectives positively influence the formation of relationships among organizational networks.

The present study observes the impact of an actor's motivation to participate in governance networks on the normative convictions implied in the ACF system of beliefs. There is an unresolved tension between two seemingly contradictory motivational rationales for actors to participate in governance networks (Reyes-Gonzalez, Agneessens & Esteve, *forthcoming*). Do actors collaborate to advance societal goals or to attain self-interested goals, such as reputation or access to lucrative opportunities? These two drivers feature in a range of studies, leading to very different behaviors and performances in organizational settings (Esteve & Schuster, 2020; Ryan & Deci, 2000).

It would be natural to expect then, that actors who share similar pro-social or self-interested motivations are more or less likely to form coalitions, causing networks to fragment into ideological and/or political subgroups (Matti & Sandström, 2011; Sabatier & Weible 2007). The present study assumes that actors in governance networks are motivated primarily by pro-social, rather than self-interested, goals (Ryan & Deci, 2000). We make this assumption for two reasons. First, governance networks tend to have more altruistic missions, as they are designed to tackle complex societal problems, where it is vital to establish trust and collaboration (Steets, 2010). Second, the alignment of pro-social motivations can moderate the impact of competition between actors, even when the collaborative resources are lacking. Pro-social motivations are assumed to benefit network actors, their constituencies, and society at large (Huxham & Vangen, 2004; Selsky & Parker, 2005). For these reasons, actors with pro-social motivations to participate in governance networks are more likely to exchange information actively than those holding self-interested motivations.

Hypothesis 5a. *Actors driven to participate in governance networks by pro-social motivations are more likely to share information with their peers.*

Hypothesis 5b. *Actors driven to participate in governance networks by self-interested motivations are less likely to share information with their peers.*

Table 3.1. summarizes the hypotheses set out above, briefly describing them and presenting the network configuration used to test them empirically through statistical analysis.

Table 3. 1 *Summary of network parameters for hypotheses*

Type	Hypothesis	Opportunity structure	Illustration	Explanation
Endogenous	-	Edge		Baseline propensity to form a tie for information exchange.
	H1	Reciprocity		Mutual ties between two actors.
	H2	Triadic closure		Models the propensity of a tie to be formed as part of a triadic configuration; the disposition to trust those whom one's partners already trust.
Exogenous	H3	Institutional venues		Models an actor's propensity to create ties with those who attend same-issue committees.
	H4	Perceived influence		Models an actor's propensity to receive incoming information ties, based on the existing number of influence nominations this actor has.
	H5a	Preference similarity		Models an actor's propensity to form ties based on values related to actors' pro-social or self-interested motivations for participating in networks.
	H5b			

Source: Authors' own elaboration.

Research setting

This study investigates multi-stakeholder partnerships (MSPs), which implement anti-corruption mechanisms in the public-infrastructure sector. Our focus on MSPs in this sector is timely and relevant for several reasons. First, the UN Sustainable Development Goals have recently reaffirmed the significance of public infrastructure for economic development and social policy (UN, 2021) across a range of developing nations. Second, the sector is characterized by large investments, discretion, and the need for significant regulatory intervention to avoid corruption (Hawkins & McKittrick, 2012). Third, the sector has important

crosscutting effects on other priority areas, including, but not limited to, transportation, education, and health (GI Hub, 2018).

The MSPs in this study are tasked with implementing the global Infrastructure Transparency Initiative (CoST), which combines features of a consultancy agency and an accountability-based non-governmental organization (Truex & Søreide, 2011). Its main objective is to disclose relevant information about public infrastructure projects in different countries, while independently assessing whether those projects deliver value for public money.²³ More than 20 countries are implementing CoST, from which ten are included in this study.

Along with CoST, other well-established transparency initiatives, including the Extractive Industries Transparency Initiative (EITI), the Open Government Partnership (OGP), and the Global Initiative for Fiscal Transparency (GIFT) (Brockmyer & Fox, 2015), rely on formal and independent multi-stakeholder partnerships for the implementation of anti-corruption mechanisms (Fraser & Carbonnier, 2022). By this means, the shared characteristics of the MSPs in our sample with the already mentioned global initiatives, provide external validity for the findings of this study. Results of this study can be then replicated and understood considering these similar research settings.

Data collection

A unique dataset was collected through an online survey, designed to reflect the relational data-collection literature on organizational networks (Agneessens & Labianca, 2022; Borgatti et al., 2013). Our survey included 15 items and was translated into five languages. We collaborated closely with the CoST International Secretariat (Program Director and Senior Policy / Research Adviser), who endorsed the distribution of the survey in several CoST-implementing countries during the second quarter of 2020.

The survey was built and distributed using Qualtrics (Qualtrics, Provo, UT). We followed a detailed calendarized protocol, sending survey invitations, distributions, and reminders to the

²³ The disclosure of information includes technical infrastructure specifications, such as estimated costs (forecasted and actual), contractor companies, project deadlines, and differences between original and final infrastructure contracts (Truex & Søreide, 2011).

private email addresses of active members of the MSPs. We followed formal organograms and stakeholder maps facilitated by the International Secretariat.²⁴ This allowed the identification and inclusion of relevant stakeholder organizations in the sample. We also considered network-boundary specifications (Berardo, Fischer & Hamilton, 2020), confirming the participation of all stakeholders that interacted within the MSPs during 2019 and 2020.

The Research Ethics Committee of the main author's university approved the study and guidelines of data collection, ensuring confidentiality for participants. Before the survey, participants were briefed on its purpose and voluntary nature. Most participants completed the survey in a single 20-minute session. Additional invitations were sent to participants who did not respond, and half-completed surveys were followed-up by telephone to gather as much complete data as possible. We removed two half-completed surveys, ensuring that all data were drawn from completed questionnaires.

Table 3. 2 *Composition of the sample*

Country	Response	Respondents	Orgs	PubS	PriS	CS	Aca	Med	Obs	NS	AT
El Salvador (2018)	100%	13	10	2	2	2	2	0	0	1	1
Costa Rica (2017)	93%	27	13	3	2	2	0	0	4	1	1
Guatemala (2010)	92%	24	13	3	2	4	0	0	2	1	1
Panama (2019)	100%	17	12	5	2	3	0	0	1	1	0
Honduras (2014)	81%	25	11	3	3	3	0	0	0	1	1
Malawi (2009)	88%	15	15	4	2	4	0	1	2	1	1
Ghana (2019)	92%	12	9	1	3	2	0	1	0	1	1
Ethiopia (2009)	100%	14	10	3	3	2	0	0	0	1	1
Ukraine (2015)	88%	14	11	1	3	5	0	0	0	1	1
Afghanistan (2017)	94%	16	12	3	3	4	0	0	0	1	1
Total*	93%	177	116	28	25	31	2	2	9	10	9

*Total number of participants and organizations represented in the sample as for 2020. Acronyms: public sector (PubS), private sector (PriS), civil society (CS), academia (Aca), media (Med), observer organization (Obs), National Secretariats (NS), and Assurance Teams (AT).

²⁴ Publicly available information on MSP official websites was also employed to retrieve lists of active stakeholders.

The survey recorded responses from the MSPs located in Latin America (El Salvador, Costa Rica, Guatemala, Panama, and Honduras), Africa (Ethiopia, Malawi and Ghana) and Eurasia (Ukraine and Afghanistan). These are all developing countries with low-to-medium Human Development Index (HDI) scores and relatively new democracies in the global south (UNDP, 2019).

The global response rate for the ten MSPs was 93%; at country level, response rates surpassed the 80% threshold, which naturally increases the confidence in this paper's findings. Table 3.2. above shows the composition of the ten MSPs in the sample, including foundation years, number of respondents per country, organizations, and sector affiliations.

Across all cases, the largest sectoral representation came from the civil society (31), followed by public-sector (28) and private-sector (25) organizations. The smallest sector representation comprised academic institutions, media outlets, and observer organizations (i.e., the World Bank, British embassies, and the Inter-American Development Bank). Apart from Panama, due to its recent formation shortly before the data-collection period, every partnership had an administrative National Secretariat and a technical Assurance Team.²⁵

The research setting featured a diverse range of actors and sectoral representation. Most importantly, the boundaries of network participants were clearly defined, with no important actors left out of the survey (see Appendix 3A). Our research design provides then internal validity for this study's findings (Berardo et al., 2020).

Operationalization

Aggregation of responses

The present study aggregates data at the organizational level. Individual survey responses were aggregated to obtain a single organizational response. Organization A is linked to Organization B if at least one survey respondent affiliated to Organization A names Organization B as a communication partner. This is an established practice in organizational and governance-

²⁵ MSPs request project information from procurement agencies and private companies by hiring an Assurance Team of professional infrastructure experts that reviews the technical information and highlight contract discrepancies. The MSPs, assisted by the National Secretariat, synthesize the Assurance Team's technical findings into an annual public report.

network studies (Agneessens & Labianca, 2022; Borgatti et al., 2013). Social-network analysis techniques are used to achieve the objectives of this study, and this aggregation procedure facilitates such analysis (Kapucu, 2015).

Network data: dependent variables

To operationalize the information-exchange network as the dependent variable, we have adopted the social-network approach (Borgatti et al., 2013). This method is used to explain empirically the relational preferences of actors who establish information relationships, from an interpersonal, as well as a structural, perspective (Borgatti et al., 2013). The respondents were asked the following:

*“Consider all your email, telephone interactions last year (January–December 2019) and face-to-face meetings with members of your multi-stakeholder group. In these interactions, how often did you provide information on public-infrastructure-related matters to people representing the following organizations and/or internal bodies that develop the work of the initiative, including the National Secretariat and Assurance Team?”*²⁶

Respondents used a network checklist to identify the organizations that participated in their MSPs, indicating those they had relationships with. This roster of names reduced respondent recall errors (Borgatti et al., 2013), while the responses created a reliable network structure for each organization’s neighborhood of information-exchange collaborators.²⁷

Responses to the information-exchange network question were collected using a 4-point Likert scale, which assessed the strength of information-exchange relationships (Borgatti et al., 2013; Agneessens & Labianca, 2022). To simulate networks and interpret network measures,

²⁶ Key elements in the information exchange included some or all of the following topics: infrastructure-project cost and time overruns, tender and contract awards, contract management, and the social and environmental impacts of infrastructure developments.

²⁷ The main advantage of using a roster for network questions (in addition to guaranteeing that the set of respondents matches the set of organizations inquired about) is the fact that respondents are less subject to recall error when discussing actual relationships maintained within the web of relationships (Borgatti et al., 2013).

we dichotomized those ties, disregarding their varying levels of intensity. This turned naturally valued ties into binary ones (present = 1 / absent = 0) (Borgatti & Quintane, 2018). Next, we obtained a directed information-exchange network, which reflected the inter- and intra-organizational relationships among study participants and the organizations they represented.

We split this general network into two separate networks, based on the nature of each information tie, either technical or political.²⁸ Although both types of information are part of a continuum (Angst & Brandenberger, 2021), standardized questions were used to distinguish between them, determining which type of information was shared most frequently by survey respondents (see Leifeld & Schneider, 2012).

We averaged the responses of survey participants who shared technical-level information about infrastructure projects in relation to (1) “cost and time overruns,” (2) “quality of project design,” (3) “tender and contract awards,” and (4) “poor contract management.” In an exploratory factorial analysis (EFA), the four items in this construct loaded >0.70, surpassing the threshold of accepted validity needed to ensure one-dimensionality (Hair et al., 2014). Reliability was judged using Cronbach’s alpha coefficient, from which we obtained an acceptable value of 0.93 for the construct (Cronbach, 1951).

We further averaged the responses of participants who shared political or strategic information about matters related to (1) the “safety and wellbeing of infrastructure workers,” (2) the “environmental and social impacts of infrastructure developments,” and (3) “follow-up recommendations to improve tender processes and the diffusion of information to the public.” The EFA results showed the one-dimensionality of this construct, with the three items also loading >0.70. The Cronbach’s alpha coefficient for the construct was 0.86, which falls within an acceptable range of reliability.²⁹

To determine whether a tie within the general information network transmitted technical or political information, we compared the average score of the constructs for each of the respondents. The higher-scoring information category determined whether a respondent's tie was classified as technical and/or political and included in the respective network. In a few cases, ties were considered both technical and political. These were included in both types of

²⁸ The Senior Policy and Research Adviser from CoST was consulted to determine which type of information about implementing anticorruption governance mechanisms in the public infrastructure sector can be categorised as political or technical information.

²⁹ The EFA is calculated and reported in the supporting material.

network structures. As each MSP in the sample had three types of networks (i.e., general, technical and political), we proceeded to stack them up by information type in block diagonal matrices as input for statistical analysis. This method made it possible to identify the general patterns of several networks simultaneously.

Table 3.3 presents descriptive data from the three information-exchange networks. As the general network included both technical and political ties, it was naturally the largest network in the sample, when ranked by total number of ties. Figures reveal that within MSPs stakeholders tend to exchange more technical than political information via their communication relationships. The technical network is denser (657 total ties), reflecting the heightened activity associated with such exchanges. By contrast, the political network is relatively sparse (243 total ties), with few participants engaged in strategic-partnership matters.

Table 3. 3 *Descriptive data of information exchange networks*

	General	Technical	Political
No. organizations	116	116	116
Total ties	833	657	243
No. of senders	97	75	29
No. of receivers	116	116	92
Network density	0.06	0.05	0.02

Perceived influence

To operationalize preference attachment, where influential actors are sought by others who wish to create relationships, the survey collected data via a second network question:

“Consider situations last year (January–December 2019) when you participated (with or without the right to vote) in initiative-implementation decisions. How often were you influenced by the information or arguments of people representing the following

organizations and/or internal bodies that develop work for the initiative, including the National Secretariat and Assurance Team?”³⁰

This was a straightforward and impersonal way to operationalize influence; the question condensed theoretical conceptualizations linked to perceptions of influence in network settings (Ingold & Leifeld, 2016). In addition, third-actor perceptions are generally more accurate than self-perceptions (Ingold & Leifeld, 2016). By using a network question outside the information-exchange network, we avoided common-source bias (Meier & O’Toole, 2013).

Responses were ranked using a Likert scale. The influence network was also dichotomized (1= the present tie; 0 = no ties), disregarding varying intensities. These data allowed us to build a binary, directed network matrix, with the row organization indicating which column organization was perceived as influential. We counted all the influence nominations that each organization received from survey respondents (incoming ties, $A \leftarrow B$). The more nominations an organization received, the greater its influence within the partnership was assumed to be (Ingold & Leifeld, 2016).

Preference similarity

Preference similarity was operationalized based on stakeholder motivation to participate in MSPs. We selected four of the most frequently recurring pro-social motivations in the partnership literature for partnerships that promoted the implementation of transparency and accountability governance mechanisms. We then adapted these items to the public-infrastructure-sector field (Brockmyer & Fox, 2015).

The following items were included in the survey within the pro-social motivation construct.³¹ Respondents were asked to rate the extent to which the following statements accurately described their motivation to participate in their respective MSPs: (1) “to contribute to the public debate about public infrastructure projects” (Truex & Søreide, 2011); (2) “to enhance transparency in governments” (Brockmyer & Fox, 2015); (3) “to co-produce public

³⁰ These arguments may have included professional knowledge, political views, and/or expertise in the implementation of the initiative.

³¹ Respondents were not informed of the classification of items at the time of the survey.

policies to tackle corruption” (Rich & Moberg, 2015); and (4) “to improve value for money in public infrastructure projects” (Steets, 2010; Brockmyer & Fox, 2015).

At the same time, we also investigated self-interested motivations for participating in partnerships. A second motivation classification was included in the survey to capture the characteristics of this construct: (1) “to engage with key public and private stakeholders” (Millar et al., 2004); (2) “to obtain reputational benefits” (Alsop, 2004); and (3) “to secure sources of funding for my home organization” (Steets, 2010).

Responses were collected using a Likert scale, with responses ranging from 0 (“not important at all”) to 10 (“very important”). In terms of the one-dimensionality of each construct, the EFA results showed that one item in both constructs of motivations failed to pass the first validity evaluation, due to the size of their loadings: <0.50 (Hair et al., 2014). We therefore removed the first item of the self-interested motivations construct, and the fourth item of the pro-social motivations one. The remaining items obtained acceptable validity scores and Cronbach’s alpha coefficients.

Issue committees

The following list of issue committees was built with the support of senior members of the CoST International Secretariat. Respondents were asked how frequently they contributed to MSP meetings, forums, or committees that dealt with issues related to the implementation of the initiative. Such bodies set out to: (1) “select a subset of national infrastructure projects”; (2) “select relevant indicators to assess infrastructure data”; (3) “advise on annual-report design and preparation”; (4) “interpret the findings of the infrastructure reports”; (5) “determine how best to communicate results to the public”; and (6) “follow up recommendations included in the annual report.”

We built a binary matrix, in which the row organization used columns to indicate which committees an actor attended (attendance = 1 / no attendance = 0). We then generated a co-occurrence matrix, using the following formula to indicate which pairs of organizations attended how many committees together:

$$C = M \circ M^t \quad (1)$$

When multiplied by its transposed version Mt , the binary matrix M (committee attendance) provides the co-occurrence matrix C of joint committee attendance by MSP stakeholders. The Hadamard Product is when two binary matrices with the same dimensions are multiplied to produce a third matrix of the same dimensions as the operands, where each element i, j is the product of elements i, j of the original two matrices (Styan, 1973).³² The resulting third matrix shows how many times two stakeholder organizations attended the same committee. This matrix is used as the tie covariate in the statistical network model.

Controls

Three additional variables are included as controls in the analysis. The first consists of *affiliation match* (categorical) that controls for the effect of sectoral homophily. Stakeholder organizations are more likely to seek alliances with those that share their same sectoral affiliation (McPherson, Smith-Lovin, & Cook, 2001) because coordinating with similar organizations produces a higher payoff. Second, *sector activity* (categorical) is a control that assigns organizations to seven categories, assessing which sector is more or less likely to create various types of information-exchange relationships. Affiliations included were: 1) public sector, 2) private sector, 3) civil society, 4) academia, 5) media, 6) national secretariat, 7) assurance team, and 8) observers. Finally, *time of participation* (continuous) controlled for the propensity of senior organizations within the MSP to exchange or not information with others.

Methods

Network data are relational in nature. They are statistically challenging to analyze because the basic assumption of data independence does not apply (Borgatti et al., 2013). Observations related to network ties are mutual (Fischer & Sciarini, 2016). This paper uses advanced statistical network analysis to predict information-exchange ties and collaboration between pairs of MSP organizational actors, both as a function of their individual attributes and as a function of the network structures they are embedded in.

³² We followed similar operationalization by Leifeld and Schneider (2012).

Exponential random-graph models (ERGMs) (Lusher et al., 2013) are used to test whether certain network configurations are observed at levels above or below chance (Lusher et al., 2013). The model assumes that stochastic processes form and shape networks, determining how actors create and discard ties under different social contexts (Lusher et al., 2013). ERGMs, which belong to a class of statistical inference models, are among the most popular and theoretically well-developed class of techniques used for network analysis (Lubell, Scholz & Robin, 2012).

Although the networks in our sample were measured at a single point in time, the use of ERGMs assumes that observed network configurations are the result of various past and ongoing social and organizational processes (Henry et al., 2011). In theory, network ties can form between any two actors; in practice, tie formation occurs more frequently within existing network structures (Lubell et al., 2012).

In ERGMs, the observed network structure represents the dependent variable (i.e., information exchange network), while network configurations constitute the independent variables (Lusher et al., 2013). Table 3.1 above illustrates some of the network configurations tested for this paper. ERGMs are well suited to this study, which simultaneously investigates several different network hypotheses (represented by structural configurations), using the *Statnet* package, version 2019.6 for the statistical computing environment R (Handcock et al., 2019).³³

The general form of the exponential random graphs is as follows:

$$P(y_{ij} = 1 \mid Y_{ij}^c) = \left(\frac{1}{c}\right) \exp \left\{ \sum_{k=1}^K \theta_k Z_k(y) \right\} \quad (2)$$

This shows that the model is predicting the probability of a tie between actors i and j , conditional on the rest of the network (all other ties). The thetas (θ_k) are the coefficients of the network configurations of interest, one for each of the K included statistics, $Z_k(y)$. $\left(\frac{1}{c}\right)$ is simply a normalizing constant that ensures that the probabilities stay within 0 and 1 (Lusher et

³³ See R code in Appendix G10.

al., 2013). The model is fitted via Markov Chain Monte Carlo Maximum Likelihood Estimation (MCMC MLE). The estimated coefficients can be interpreted like in a logit regression model. ERGMs estimate positive coefficients for the type of configurations that network actors tend to engage in, and negative for those they tend to avoid (Lusher et al., 2013).

Finally, model fit is also assessed by comparing the observed network to simulated networks. This process is called *Goodness of Fit*, which indicate the percentage of observed network statistics successfully simulated by the model for each of the network statistics included in the evaluation.

Findings and discussion

Table 3.4 presents the estimation results for six models. The first two are models of the general information-exchange network. This network is split into two: technical-information exchange (Models 3 and 4), and political-information exchange (Models 5 and 6). Models 1, 3 and 5 have been tested and evaluated using preference similarity as the only opportunity structure; complexity is then added to subsequent models by incorporating terms that correspond to the research hypotheses at the endogenous and exogenous levels.

In presenting different models simultaneously, we draw inferences by focusing on the direction and significance of the coefficients. Where a configuration is the likely outcome of a social process occurring within the network, the coefficient will be positive and significant; this shows that the configuration occurs at a higher frequency in the observed network than it would in a network generated by chance (Berardo & Lubell, 2016). Entries marked with an asterisk in Table 3.4 have statistical significance at conventional p -value levels.

Across all models, the *edges* term is comparable to the constant in standard statistical models. Although the network configuration term is used mainly for model stabilization, it also conveys important information (Lusher et al., 2013). The coefficients of edges across all networks are negative, suggesting that these networks contain fewer ties than expected. Such networks fail to achieve their relational potential, given the number of participating actors they include. This is the case, specifically for the political-information network, which has negative coefficients at a significant level ($p < 0.001$). Content wise, the MSPs in the sample operate predominantly with flows of technical, rather than political information.

Models 1, 3 and 5 estimate the effect of preference similarity. These models are run to assess the effect of preference similarity, given its wide acceptance in the literature as a factor for network emergence (Siciliano et al., 2021; Leifeld & Schneider, 2012; Matti & Sandström, 2011). The coefficients of Model 1 indicate that self-interested stakeholder organizations generally share more information than those driven by pro-social motivations. In Model 3, the exchange of technical information is led by self-interested stakeholders, while pro-social organizations play an important role in this type of information as well in Model 5, all things being equal.

This paper posits that MSP stakeholders use different opportunity structures to facilitate and expand their web of connections in a strategic way. Information exchange implies transaction costs that drive actors to search for partners through means other than preference similarity. These claims can be tested when preference similarity is held constant, and additional effects are included in the models.

For both types of motivation, the explanatory effect of preference similarity is attenuated in Model 2 when other opportunity structures are considered. The effect disappears completely in Model 4, and it remains statistically significant only for self-interested stakeholders in Model 6. Consistent with our argument, preference-similarity effects are relatively absorbed when the models include additional opportunity structures. However, there is no support for Hypotheses 5a and 5b. On the contrary, despite normative and pro-social MSP narratives (Steets, 2010), our results show that pro-social stakeholders play a less dominant role in information transactions overall, while self-interested stakeholders tend to focus on political-information exchanges, possibly to advance private objectives through collective decision making (see also Fischer & Maag, 2002).

Hypothesis 4 posits that the greater an actor's perceived influence, the more likely that actor is to engage in information-exchange relationships. In the present study, stakeholders try to maximize the benefits of communication and information access by selecting partners based on their level of influence. Influential partners provide access to new contacts and the opportunity to be heard and to participate in agenda-setting negotiations (Ingold & Schneider, 2014). However, our statistical analysis provides no evidence to support Hypothesis 4. For this opportunity structure, the estimates are statistically insignificant in the three complete models (Models 2, 4, and 6). In fact, the coefficient of the technical-information network is negative, suggesting that more influential stakeholders avoid collaborating on issues related to technical

aspects of the initiative implementation. Thus, 87% of stakeholders are likely to interact with popular partners when political information is being exchanged, compared to 43% of stakeholders when technical information is being exchanged.

According to Hypothesis 3, the more issue committees two actors belong to, the more likely they are to exchange information. This opportunity structure is found to be the strongest predictor of tie formation, being positive and significant ($p < 0.001$) across the three complete models. Shared access to one additional issue committee increases the odds of establishing an exchange information tie by 93% in the general information-exchange network, 94% in the technical-information network, and nearly 99% in the political-information network. These findings thus support Hypothesis 3.

The results of reciprocity and closed triads, corresponding to Hypotheses 1 and 2, respectively, show negative effects in all three complete models. The effects are stronger and statistically significant for reciprocity, suggesting that stakeholders are deeply averse to reciprocating relationships within these networks. Network participation is a passive role for most stakeholders, who receive information without giving any back. When it comes to political information, the effect is substantial in this respect. Although they are not statistically significant, the effects are also negative for closed triads, suggesting that stakeholders avoid triadic configurations with potential partners in their close neighborhood of contacts. In other words, friends of a friend are not my friends.

As for controls, this study begins by testing years of participation. As Table 3.4 shows, most senior stakeholders do not contribute to the exchange of general information and even less so to the exchange of technical information. This may be a consequence of attrition or a lack of interest among stakeholders; in either case, our findings reveal that MSPs face risks of losing momentum after some years of implementing governance mechanisms for transparency and accountability. Next, we tested the sector match (sector homophily) for exchanges between stakeholders affiliated with the same sector. Positive and significant results for this control reveal the nature of network relationships that favor information exchanges within, rather than between, sector boundaries. The third control provides a statistic for every stakeholder group in the sample, uncovering their propensity to share information.³⁴ The results show that six

³⁴ The term *nodematch* in the *Statnet* package for R excludes at least one group of stakeholders from this analysis. In our case, stakeholders affiliated to academic institutions in El Salvador have been disregarded. However, this omission does not confound the model and adding them would not significantly alter the other coefficients (see Appendix G10).

stakeholder groups are responsible for exchanging general information within the network: Assurance Teams and National Secretariats (as MSPs' administrative and technical internal bodies), but also civil-society organizations, media outlets (in African countries), and the public sector. Coefficients for the private sector stakeholders are the least stronger of this group.

Overall, our findings echo those of previous research (see Lubell et al., 2002; Leifeld & Schneider, 2012; Henry et al., 2011) in showing that opportunity structures can help to overcome transaction costs, fostering the emergence of information-exchange relationships. However, our results differ from those of previous studies because our research setting offers a different configuration of interpretations. First, we confirm that the effects of preference similarity diminish once other structures are included in the model. This finding also debunks narratives of network emergence driven primarily by associations between actors with similar beliefs. It also undermines normative discourses of equal partnering and participation, especially for stakeholders who participate in MSPs driven by pro-social reasons. Such actors appear to play a minor role in the exchange of political information, raising questions about their capacity to defend more socially desirable behavior when confronting their more self-interested counterparts in MSPs.

Second, it is important to highlight the absence of endogenous opportunity structures, such as reciprocity and closed triads, across the three complete models. The negative results for these configurations indicate that unrealized social capital constitutes a serious problem in information networks (Henry et al., 2011). Stakeholders do not self-organize into close-knit bonding structures to facilitate the flow of redundant information about collaborative efforts. When this information is missing (in particular, due to a lack of mutual relationships), stakeholders may be unable to identify, monitor, and/or penalize party defections in collective decision-making (Berardo & Scholz, 2010; Reyes & Esteve, *forthcoming*). The MSPs actors in our sample do not use existing channels of communication to build new relationships, even though this would be relatively easy to do and at a low cost. Instead, they structure themselves in ways that exploit opportunity structures that maximize outreach, but not necessarily access to new information, given the propensity of homophily revealed by the coefficient of affiliation match.

Third, committee attendance is by far the most popular opportunity structure for exchanging information, even in the technical- and political-information networks. MSP stakeholders rely heavily on such voluntary meetings to establish contact with other

stakeholders, possibly because the closeness of these encounters offers opportunities for contact-making. Communications intensify between stakeholders who participate jointly in institutional venues that promote deliberation, decision-making, and implementation. In line with recent research on collaborative governance (Hamilton & Lubell, 2018; Ulibarri & Scott, 2017), stakeholders in these MSPs use institutional, rather than informal, opportunity structures as cheap venues for acquiring new contacts (or maintaining them) during the exchange of relevant technical and political information.

Our findings are meaningful for partnership conveners, practitioners, and network managers. Regarding the design and management of governance networks, the configuration of these results reveals both, challenges and opportunities. As previously discussed, committees can play an important role in promoting more active stakeholder participation in collective decision-making. However, one control reveals that such interactions are likely to be primarily between organizations within the same sector affiliation. In other words, heterogeneous groups of actors rarely exchange information in MSPs, even though such practice would provide access to diverse sources of information. This suggests the presence of barriers in MSPs to find innovative solutions to complex problems. The lack of diversity reduces the potential impact of MSPs, given that homogeneous committees are less likely to experience cross-fertilization of ideas or debate of different policy solutions. Instead, they may simply reinforce existing sectoral silos of knowledge and communication.

In addition, private-sector organizations are underrepresented in the exchange of information. Actors from this sector may not be incentivized to participate actively in the MSPs, which reveals the struggle of these partnerships to build capacity across the sectors they engage with. At present, MSPs seem to respond less well to the needs of the private sector.

This study argues that the reduced evidence of political information exchange may reflect why some stakeholders remain in their “trenches”, showing a passive role in the collective decision-making. During the implementation of governance mechanisms, a lack of political information can create barriers to find consensual collective action, leaving stakeholders focused on ways to use technical information to advance their private interests or benefit their own constituencies, if any (Reyes-Gonzalez, Agneessens & Esteve, *forthcoming*). Unless a wide range of diverse actors can come together to discuss how to adapt and implement collective efforts for the sake of social gains, positive outcomes are likely to fall short of expectations for this MSPs (Schrack & Whitford, 2011; Faul, 2016).

A possible solution may be to rely more intensively on the role played already by the National Secretariats. These internal and administrative bodies of MSPs share most of the technical information. These bodies can stimulate strategic and political discussion in popular committees. Such an initiative could incentivize stakeholders to contribute new ideas about ways to advance collective objectives.

Table 3. 4 Exponential Random Graph Models

		General		Technical		Political	
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
-----		-----	-----	-----	-----	-----	-----
	<i>edges</i>	-2.28 **	-0.36	-0.6	4.02 *	-8.86 ***	0.17
<i>Preference similarity</i>		-0.7	-1.93	-0.68	-1.59	-1.19	-2.95
	<i>Self-interest</i>	0.08 ***	0.05 *	0.05 ***	0.02	0.06 **	0.07 **
		-0.02	-0.02	-0.01	-0.02	-0.02	-0.03
<i>Social capital</i>	<i>Pro-social</i>	0.12 **	0.12 *	0.01	0.07	0.37 ***	0.03
		-0.04	-0.06	-0.04	-0.05	-0.06	-0.07
	<i>Reciprocity</i>		-0.97 **		-0.86 *		-3.58 ***
<i>Institutional venues</i>			-0.36		-0.42		-0.96
	<i>Closed triads</i>		-0.08		-0.11 *		-0.01
			-0.04		-0.05		-0.08
<i>Preferential attachment</i>	<i>Committees</i>		0.59 ***		0.58 ***		0.91 ***
			-0.06		-0.06		-0.15
	<i>Influence</i>		0.31		-0.34		0.86
<i>Controls</i>			-0.33		-0.28		-0.61
	<i>Years</i>		-0.05		-0.06 *		-0.05
			-0.04		-0.03		-0.04
<i>Affiliation match</i>			0.87 **		0.81 *		1.01 *
			-0.3		-0.33		-0.5
	<i>Assurance Teams</i>		1.09 **		0.62		0.42
<i>Civil Society groups</i>			-0.4		-0.32		-1.05
			0.93 **		0.16		0.63
			-0.36		-0.28		-1.04
<i>Media outlets</i>			2.92 **		0.02		2.22
			-1		-0.49		-1.37
	<i>National Secretariats</i>		1.30 **		0.74 *		0.75
<i>Observer groups</i>			-0.43		-0.34		-1.07
			0.62		-0.07		0.02
			-0.4		-0.36		-1.07
<i>Private Sector</i>			0.88 *		0.41		0.64
			-0.34		-0.3		-1.12
	<i>Public sector</i>		1.09 **		0.53		0.38
<i>Log Likelihood</i>			-0.36		-0.3		-1.07
-----		-----	-----	-----	-----	-----	-----
	<i>AIC</i>	1572.59	804.16	1732.77	687.27	1177.62	328.46
	<i>BIC</i>	1588	896.63	1748.18	779.74	1193.03	420.93
	<i>Log Likelihood</i>	-783.29	-384.08	-863.39	-325.63	-585.81	-146.23

MCMC MLE. ***p < 0.001, **p < 0.01, *p < 0.

Goodness-of-Fit

As discussed at the beginning of this article, the primary goal of this research has been to find an appropriate model of information exchange. When ERGMs are applied, it is critical to assess the models' goodness of fit (Lusher et al., 2013). We have done this by simulating more than 1,000 networks for each of the three complete models in Table 3.4. We follow instructions from Brandenberger and Martínez (2019) to run the GOF evaluations and assessments.

As the results in Figure 3.1 show, the simulated networks for exchanging general, technical, and political information are almost indistinguishable from the original networks. To support this claim, Figure 3.1 plots five well-known statistics derived from the original networks (the bold black lines) and 1,000 simulated networks (the box plots). The chosen statistics, which determine which structural aspects of the networks are important in assessing fit, are degree, outdegree, indegree, closed triads, and edgewise shared partners (Lusher et al., 2013; Brandenberger & Martínez, 2019).

The first three statistics show the performance of nodes' degrees, outdegrees (the number of ties that nodes direct toward others), and indegrees (the number of ties directed toward the nodes). It is clear that the models for the three types of networks are relatively close to the mark. Although there is some minor variation in the distribution of the first three statistics, the simulated distributions appear to represent the original networks when the overall picture (including all statistics) is considered.

Only nodes with zero degrees or indegrees in the political-information network are strongly underrepresented by Model 6. This could be enhanced; however, it will be difficult to improve these statistics because the literature offers no guidance on why organizations should have zero degrees or indegrees in governance networks.

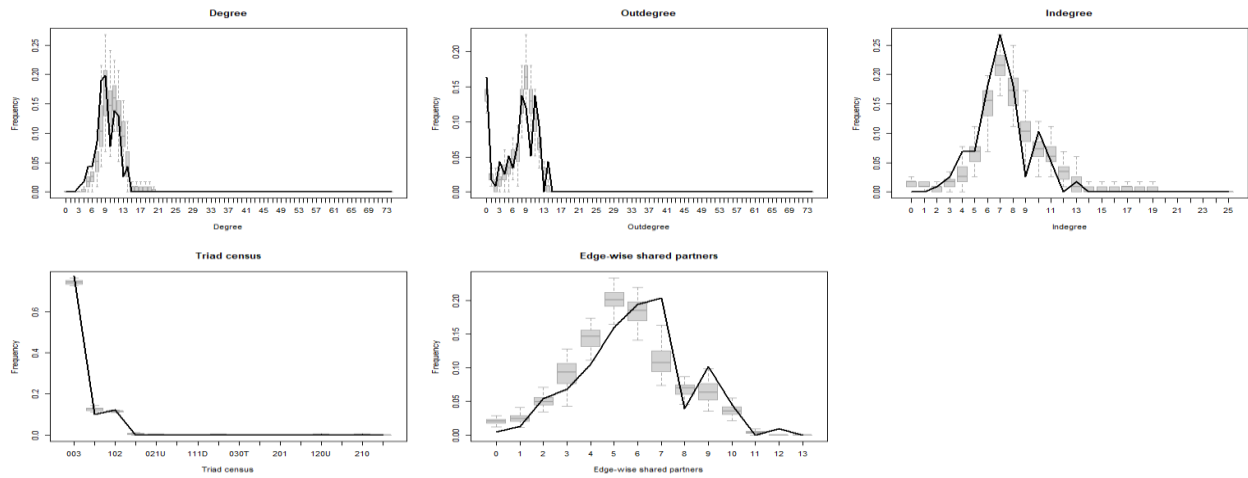
By contrast, the closed-triad statistic simulates the formation of various different triadic-closure configurations. This statistic performs very well in the three observed networks. The tick lines flow within the ranges of the boxplots, indicating that the configurations that represent triadic closure in the models are not that frequent in real information networks, as we have discussed above.

Overall, the estimated models fit the data well. They appear to capture most of the network variations. All five simulated graph statistics predict the original networks to an

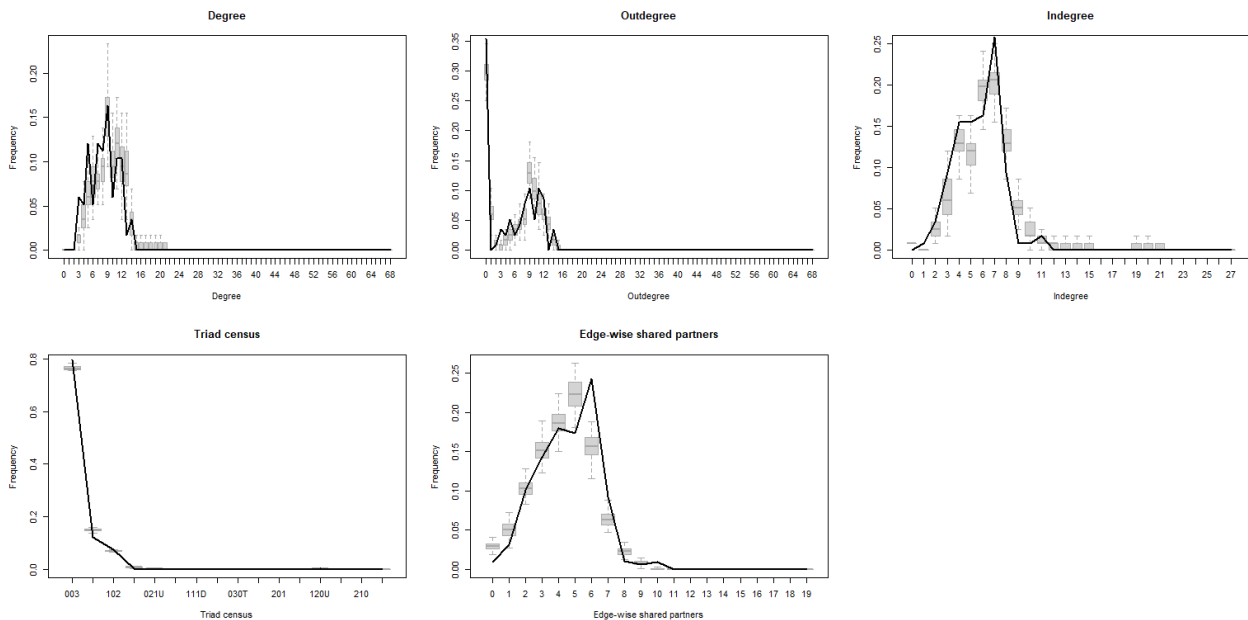
acceptable level (Lusher et al., 2013). These are particularly valuable results because they incorporate all relevant factors that contribute to form a network of information exchange.

Figure 3. 1 Goodness of Fit for information exchange networks

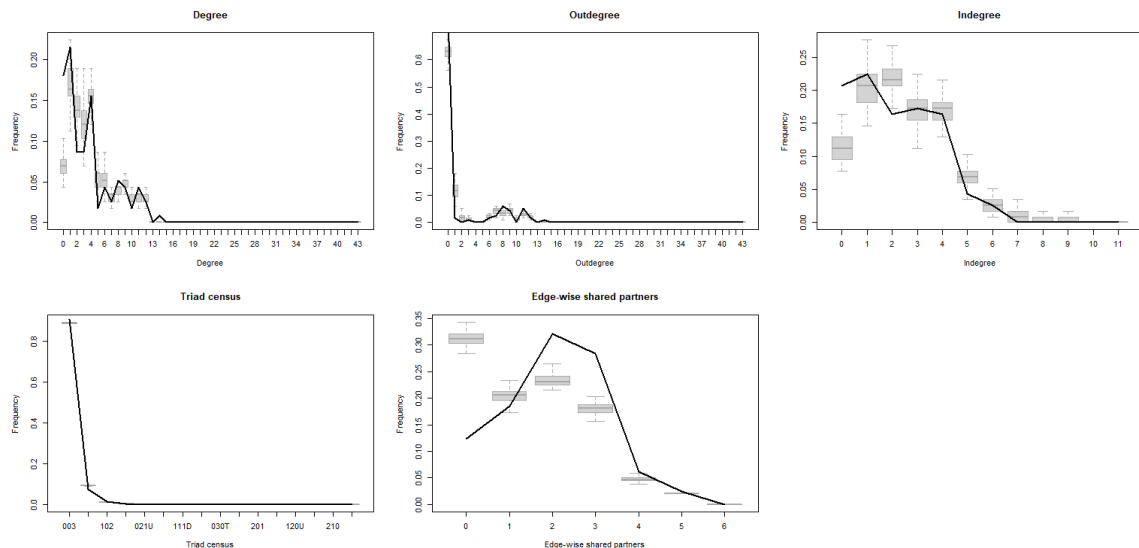
a) Global information exchange network (Model 2)



b) Technical information exchange network (Model 4)



c) Political information exchange network (Model 6)



Conclusion

This study shows that preference similarity, based on the motivation to participate in a multi-stakeholder partnership, can help to explain the formation of information ties. When other opportunity structures are included, however, we discover a range of new interpretations. Effects based on preference similarity tend to be minimized, mainly by institutional-venue opportunity structures. The results of this study confirm that stakeholders do take transaction costs into account when deciding when and with whom to establish information relationships. This holds true for both technical- and political-information networks.

The findings also reveal a lack of key network configurations for social capital, including reciprocity and closed triads. This suggests that information-exchange networks are centralized in favor of a group of privileged actors, who enjoy status but may not be perceived as influential. The study also highlights a strong tendency toward sector homophily. This effect, in combination with the important effect of committee attendance, appears to maximize new-partner outreach with relative ease by simplifying the contact-making process at a cost that is lower for stakeholders. However, this structure may have unintended consequences, making it harder for stakeholders to acquire new information and limiting their ability to propose collective and innovative solutions to complex problems at hand.

While we believe that our results provide compelling evidence regarding some of the underlying factors that sustain information exchange in governance networks, we find several limitations. First, cross-sectional methods, such as ERGMs, allow us to determine whether certain network configurations are prevalent at levels higher than chance, however they make it harder to make claims on how patterns of network change over time. However, future scholarship should map governance networks over time, since that will enable the design of a more accurate longitudinal analysis of network evolution. This could also be linked with assessments of the actual networks' performance while working to achieve their goals. Second, future research could also be fruitfully undertaken, by investigating issue committee attendance from a varied range of dimensions. For example, from the perspective of two-mode networks, where nodes connect each other through their joint participation in committees. Such analyses will disentangle new network configurations and assess the extent to which committee participation determines the structure of information exchange between stakeholders.

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Appendix 3A: CoST institutional framework and network boundary

The implementation of CoST unfolds under four key mandates: (1) the program implementation is delivered and monitored by a *national multi-stakeholder partnership* (MSP); (2) the MSPs agree upon criteria for selecting a subset of public-infrastructure sector projects for in-depth review, and select agencies or institutions to work with, for this purpose; (3) they request information from the relevant public sector procuring agencies, and in turn hires an *Assurance Team*³⁵ to review the information and highlight any discrepancies and reasons for concern (i.e., red flags); (4) the MSPs synthesize this information into an annual report and communicate the findings through media outlets to the public; lastly, (5) the MSPs make recommendations to governments to improve infrastructure projects and sector performance, while also following up progress on this regard (Truex & Søreide, 2010; Hawkins & Prado, 2019; Hawkins & McKittrick, 2012).

Every MSP relies on a *National Secretariat* that serves as a full-time administrative body that is responsible for the day-to-day activities for the implementation of CoST.³⁶ Some of these tasks entail the facilitation of communication between the *International Secretariat* and the MSPs, provision of technical support for stakeholders, and build capacity for the procuring entities to disclose data (CoST, 2019).

The role of the International Secretariat is largely to offer learning, support, and guidance to participating countries, and encourage additional countries to join (CoST, 2019). The international secretariat monitors progress of implementing countries and inform the *Board of Directors*. The board is the main decision-making body of CoST as it sets up the admission criteria and approves countries' applications to join the initiative. It also helps to raise funds and provide national-level support to CoST members (CoST, 2019).

In order to undertake analysis on social networks in an organizational setting, it is relevant to identify which actors should be counted in as members of the network, and thus be included in the data collection. The MSP is the organizational unit of CoST where the phenomenon of interest of this paper resides, because it is the space where multi-stakeholder interactions occur for information exchange and collaboration. That is, the MSPs represent the

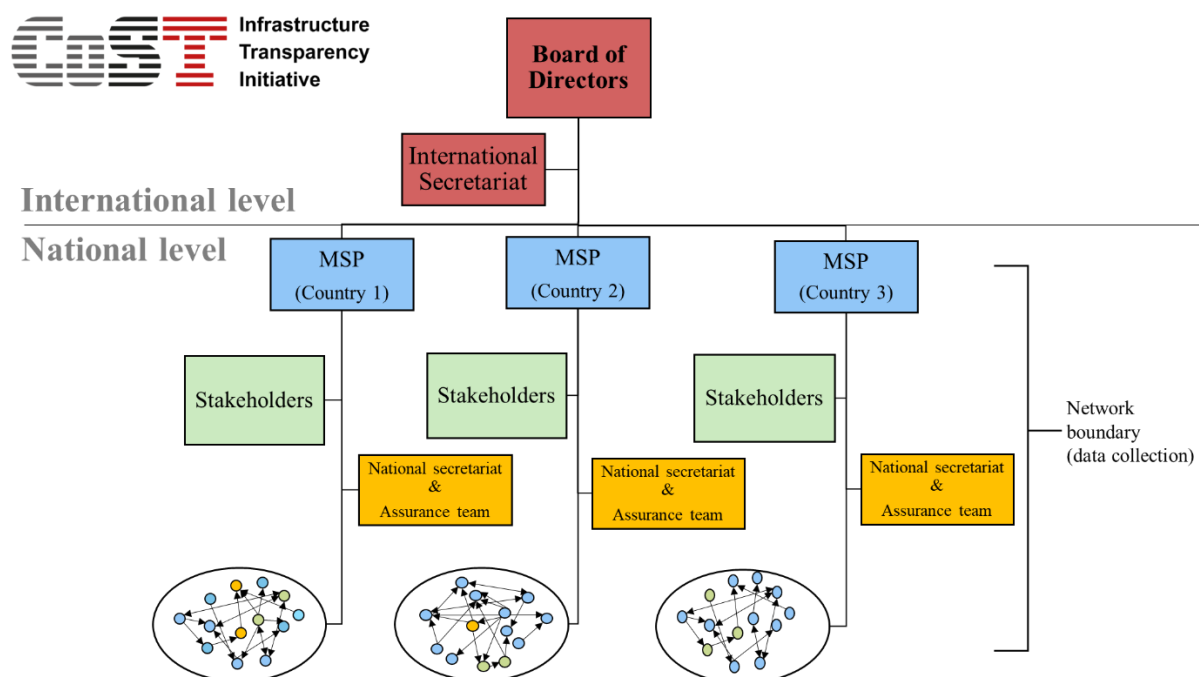
³⁵ These are independent groups of professionals: engineers, architects, scholars, and other experts.

³⁶ National Secretariats operate as *network administrative organization* (Provan & Milward, 1991), intending to organize and coordinate the activities of the participant stakeholders to produce better outcomes.

multi-stakeholder sphere where tasks of collective action unfold, and where influence asymmetries occur, given the presence of actors from different backgrounds and communities of practice.

The configurations of the MSPs within CoST's institutional framework represent an easily observed and recognized entity with "natural" boundaries of who participate and who does not: representatives of public and non-public constituency groups. Although not stakeholders *per se*, the National Secretariats and the Assurance Teams also are part of the MSPs and their networks of interactions. These defined our research design and data collection strategy. Figure 3 illustrates the demarcation of the networks of interests within the organigram of CoST as for 2020.

Figure 3 Organizational framework of CoST



Source: Author's own elaboration based on CoST's official website (2019).

Appendix 3B Supporting Information

Additional supporting information may be found in the online version of this paper at the publisher's website.

R codes for quantitative data (see Appendix G10)

- Descriptive data of networks
- ERGMs calculation
- Goodness-of-fit tests

CHAPTER 4. COLLECTIVE-ACTION RISKS IN GOVERNANCE NETWORKS: SELF-ORGANIZATION CAPACITY AND STRUCTURAL FUNCTIONS FOR INNOVATION

ABSTRACT

Participation in governance networks is risky, even if it has the potential to make all parties better off. Research has shown that actors' capacity to self-organize is largely based on how collective-action risks in collaborations are perceived. In contexts of widespread risk of partner defection, actors tend to form closed-knit bonding structures that facilitate cooperation and the flow of redundant information. While in settings where defection risks are lower, actors create bridging structures that provide coordination and access to new information. A parallel strand of research proposes the study of networks' capacity to innovate, as a result of their structural properties. In this paper, we couple both research threads and address (1) the extent to which collective-action risks perceptions shape structures of governance networks for actors to efficiently cope with collaborative problems, and (2) the extent to which these perceptions inhibit or facilitate functions for innovation. We collected data from multi-stakeholder partnerships (MSPs) tasked with the implementation of anti-corruption governance mechanisms in the public-infrastructure sector of five Latin-American countries. Exponential Random Graph Models (ERGMs) and semi-structured interviews have shown that bonding and bridging are not antagonistic network structures, indicating that stakeholders respond to both types of risks simultaneously. However, stakeholders organize themselves favoring hierarchical homophily rather than heterophily versions of these structures, which inhibit functions for innovative solutions.

Key words: risk hypothesis, innovation diffusion, multi-stakeholder partnerships, Latin-America, ERGMs

Ethics and integrity statements

Funding: We would like to acknowledge UCL Department of Political Science for their provision of funding to translate the online survey without which this research could not have been possible. The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript (Reference No.: 000140004).

Data Availability Statement: All relevant data are within the paper and its supporting information files.

Competing Interests: The authors have declared that no competing interests exist.

Ethical Approval: All participants provided written informed consent before to enrolment in the study. This study was approved by UCL Research Ethics Committee, ensuring participant confidentiality (Reference No.: 15829/001).

Introduction

There is an ever-increasing demand for political arenas to solve complex societal issues. This reflects the fact that no single actor or organization has sufficient knowledge, resources or authority to unilaterally deal with a given social problem (Fischer & Maag, 2022). In order to compensate for these constraints, governance networks have become one of the premier mechanisms to foster collaboration, where technical and consensual solutions are available to tap into by placing the right actors around a table of negotiation and deliberation (Huxham & Vangen, 2004; Park & Rethemeyer, 2012).

The integration of actors into informal, non-hierarchical structures, allows them to engage in voluntary relationships where they can seek advice, share information and work together to promote collective solutions to critical public concerns (Agranoff & McGuire, 2003). Governance networks, however, attempt to solve these problems facing multiple limitations such as lack of time, financial resources, competition, and partner defection (Agranoff & McGuire, 2003; Fischer & Maag, 2022). Because of these inherent constraints and uncertainties associated with collaborative processes, governance networks are likely to create adaptative mechanisms to cope with risks.

The nature of collective-action problems affects the relational structure of governance networks differently. Different relational strategies are required by actors to address these potential risks. For instance, when actors experience cooperation risks or fear of partner defection, they tend to self-organize in close-knit *bonding structures* that facilitate the flow of redundant information that allows them to identify and/or penalize defectors (Berardo & Scholz, 2010). On the other hand, while facing coordination risks, actors experience lower defection threats. In this context actors may build relationships that facilitate the emergence of *bridging structures* that provide access to new information and collaborators to better synchronize collective efforts (Berardo & Lubell, 2016). Both network structures allow actors to follow different partner-selection strategies, in order to gain higher payoffs when coping with collective-action risks imposed by fragmented authority settings (Feiock, 2013).

On the other hand, scholars, policy makers, and practitioners broadly agree that governance networks are likely to produce positive collaborative outcomes such as organizational flexibility, inclusiveness, and innovative solutions (Googins & Rochlin, 2000; Emerson, Nabatchi & Balogh, 2012). Innovation in collective action, most crucially, is the

process of integrating alternative or complementary insights from different sources about the political and institutional dimensions of a problem, which amplifies knowledge, learning and the discovery of new solutions (Hermans, Klerkx & Roep, 2015). Innovation goes beyond the simple implementation of new technological tools, but instead it requires the reordering of societal structures that enable the exchange of different types of information and use of knowledge collaboratively (Walker, 1981).

Much of the existing literature fails to recognize how governance networks support and deal with these multiple social processes simultaneously (Levy & Lubell, 2018). Extant research has not yet shown how collective-action risk perceptions impact not only actors' self-organization capacity in governance networks, but also how they facilitate or inhibit functions for innovation (Woolthuis, Lankhuizen & Gilsing, 2005; Hermans, Sartas, van Schagen et al., 2017).

In this paper, we overcome the lack of empirical research and evidence in the subject, by coupling elements of the risk hypothesis (Berardo & Scholz, 2010) and the innovation diffusion theory (Rogers, 2003). Both threads of research, support specific structures of governance networks to explore (1) the extent to which collective-action risks perceptions shape structures of governance networks for actors to efficiently cope with collaborative problems, and (2) the extent to which these structures inhibit or facilitate functions for innovation. Our interest lies in better delineating the role that governance networks play when dealing with these multiple social processes, and subject theoretical propositions from the literature to empirical testing.

This paper combines mix methods of data analysis to explore the nature of stakeholders' engagement in the information exchange and collaboration networks of five Latin-American multi-stakeholder partnerships (MSPs). These MSPs implement transparency and accountability mechanisms in the public-infrastructure sector of El Salvador, Costa Rica, Guatemala, Panama and Honduras under the aegis of the Infrastructure Transparency Initiative (CoST). We focus on corruption in the public-infrastructure sector because it is characterized by opportunism and competition. The sector can limit the capacity of stakeholders to address corruption problems together since it makes collaboration risky (Truex & Søreide, 2011; Pierre, 2011). Corruption also requires innovative strategies and diverse sources of information to address its multiple dimensions (Steets, 2010; Rich & Moberg, 2015). This makes the public-

infrastructure sector an ideal arena for examining how governance networks reconfigure their collaborative relationships according to actors' perceptions of collective-action risks.

Our analysis required statistical techniques that consider the interdependent nature of network relationships. Therefore, we model the network tie formations through Exponential Random Graph Models (ERGMs) (Lusher, Koskinen, & Robins, 2013). Results indicate that bonding and bridging are not necessarily antagonistic network structures, as it has been suggested in some venues of the literature. Although bonding structures are more dominant across the MSPs in our sample, bridging also plays an important role, indicating that MSPs address both coordination and cooperation problems simultaneously. However, the strong preference for bonding and bridging does not preclude the fact that stakeholders organize themselves collaboratively promoting homophily rather than heterophily versions of these structures, which decreases functions for innovation.

This study holds theoretical as well as practical value for researchers, practitioners, and policy makers. From a theoretical perspective, our analysis contributes to filling the existing gap between the study of risk perceptions for network formation and how this affects the micro level formation of structural functions that support innovative solutions. While research has been done separately on both research streams (Hermans et al., 2017; Berardo & Scholz, 2010), there has been a lack of research that couples both processes as part of governance networks' capacity to support multiple social processes that contribute to their sustainability and resiliency. From a practical perspective, there seems to be few studies offering a comparative analysis in this matter for emerging economies. The five case studies explored in this paper offer the opportunity to refine value propositions from the literature with practical implications by comparing governance networks that vary in their partner composition, institutional capacity, and *modus operandi*.

Literature and Theory

Cooperation and coordination risks

Collective action offers advantages for addressing problems collaboratively. And yet it also involves risks (Vangen & Huxham, 2003). In collaborative arenas, the nature of authority is generally fragmented, challenging assumptions for effective cooperation and coordination

(Berardo & Lubell, 2016). Participants may experience higher costs for engagement when there is no clear authority or hierarchy to abide to. This limits the opportunities to contribute to the collaboration effectively (Berardo & Scholz, 2010).

Collective-action risks are based on actors' assessments on the likelihood that collaboration efforts will fail to hold together or fail to effectively resolve collective issues. These risks come from partners failing to identify mutually beneficial opportunities; agree on how to share collective gains and costs; and fail to live up to their promises while behaving opportunistically (Feiock, 2013; Kim, Swann, Weible et al., 2022). These risks may lead to socially suboptimal outcomes for collective action (Olivier, 2019; Feiock, 2013; Kim et al., 2022).

The nature of collective-action risks is important, because it shapes the level of risk perceptions that particular collective-action issues impose on actors (Geys & Murdoch, 2008). The literature of policy decision-making and game theory identifies two stereotypical types of collective action risks by focusing on the sources of disagreement between actors (Olivier, 2019; Scharpf, 1997). These types of risks take the form of coordination and cooperation collective actions problems.³⁷

In settings where *coordination* is important, actors seek to agree on joint actions, because it is not in their best interest to defect or oppose to collective decisions that are advantageous for most of the parties (Olivier, 2019). In this case, risks do not involve defection, because any equilibrium or joint action is acceptable to all the parties (Feiock, 2013). Coordination risks stem from information asymmetries; when actors fail to secure information, producing, as a result, uncoordinated outcomes (Olivier, 2019). Therefore, actors may seek to coordinate decisions around central individuals or organizations through relationships that span across silos of knowledge and power (Granovetter, 1973; Burt, 1992).

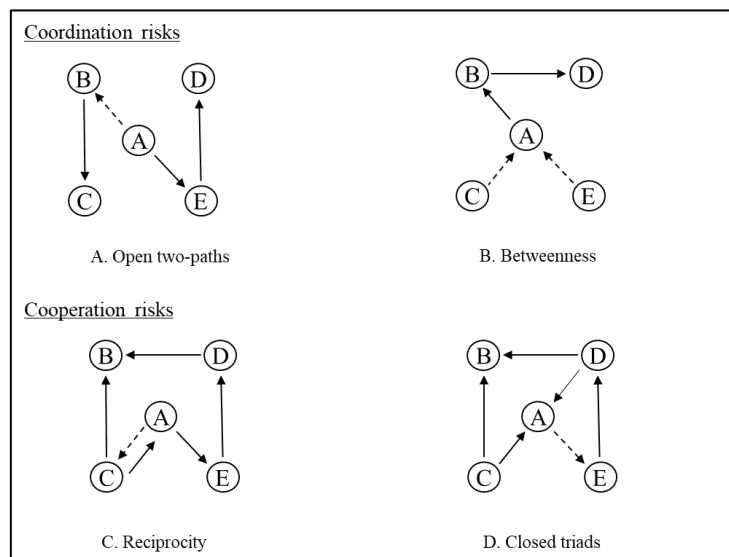
In these situations, actors must be aware of the direction of the collective endeavor, in order to coordinate their behavior with others within the network. Doing so requires that information reaches certain actors in the network quickly and efficiently, which can be

³⁷ A third collective action problem generally found in the literature is *division* (Feiock, 2013). Division problems occur when either the achievement of specific gains will cause some parties to experience more losses than the rest, or when parties have disagreements on how to distribute the costs or benefits of their joint work. However, several authors, have merged division with coordination risks in one single construct, because both risks require similar structural strategies to cope with them, favoring authority and spread of new information (Olivier, 2019; Feiock et al., 2012).

achieved through network structures that facilitate this purpose (Putnam & Goss, 2002). In theory, actors would be seeking “weak-tie” or bridging structures (Granovetter, 1983) that provide them with efficient methods of information exchange to assist their coordination with others. In general, these structures are associated with efficient transmission of information because they shorten the network’s average number of intermediaries required for information to travel more effectively and facilitate coordination (Feiock, Lee, & Park, 2012).

Figure 4.1 below shows four circles (B, C, D, E) that represent potential network partners for A in four different cases. The solid arrows indicate the relationships in existence at the time of A’s choice. The arrows point to the different actors in the network with whom A has already a relationship. The dashed arrow in the four cases represents a potential directed link that A is evaluating to create according to its risk context. The potential choice by A, reveals A’s preference for the network position to select a partner, independently of partners’ individual attributes.

Figure 4. 1 Network structures for coordination and cooperation risks



Source: Configurations based on network structures from Berardo & Scholz (2010).

Figure 4.1A shows the *open two-paths* as a bridging structure. From A’s perspective, one strategy to shorten path length is to seek partners, who in turn have the greatest number of unconnected partners to A. Given the configuration of actors, A would prefer to have a relationship with B to the extent that B can provide information about C. In contrast, a

relationship with D would close the existing two path $A \rightarrow E \rightarrow D$, and therefore this closed two-path would be redundant and inefficient in the sense that the additional cost of the link will not result in new information or a new collaborator (Putnam & Goss, 2002).

Figure 4.1B shows the structure of *betweenness* as a second structure for bridging (Olivier, 2019). Betweenness is a structural position and a measure that indicates the number of times an actor lies on the shortest path between other actors (Borgatti, Everett, & Johnson, 2013). This structural position shows which actors serve as “bridges” between others, and so they are able to observe and control information that passes through them. This position provides great influence over the flows of information around the network, which may facilitate coordination for collective efforts. Central actors in betweenness, whose relationships spread across a wide range of regions of the network play a vital role in the distribution and coordination of information for a network (Scholz, Berardo & Kile, 2008).

In Figure 4.1B, A sits in between B and D and the rest of actors, C and E. There is an opportunity for A to accept a relationship from C and E, which may facilitate coordination with actors B and D. The position confers to A the role of a *broker* or *intermediary*, accruing capabilities to coordinate flows of information and make others to follow specific directions of organization. This is one of the most efficient information distribution systems to address coordination risks (Feiock, Lee, & Park, 2012).

Thus, in situations where governance networks may face coordination risks, where uncooperative behavior is less rewarding, actors may seek nonredundant relationships, connecting with actors that provide access to other disconnected actors, facilitating access to distant parts of the network. More bridging would result in networks the favor circulation of less overlapping information, while at the same time offering structures for coordination and centralization of mandate.

Hypothesis 1. *Actors in governance networks exposed to coordination risks will adopt bridging structures (open two-paths and/or betweenness), emphasizing distribution of new information, but also of collaborators and authority.*

Cooperation, on the other hand, involves greater risk because there are conflicting interests among actors, even after a collective decision has been taken (Putnam & Goss, 2002). Once an actor has committed to invest time and resources in a collective action solution, partners may face the temptation to minimize their own involvement and defect the collective endeavor (Feiock et al., 2013). This is strongly linked to the prisoner's dilemma game in which an actor's best interest is to defect from a collaborative agreement (Ostrom, 1990). Cooperation risks can make collective action unattractive, unless credible commitments can be made by each party (Olivier, 2019).

Cooperation risks require the reduction of defection, for which actors tend to favor the generation and distribution of redundant information to monitor and sanction opportunistic behavior (Feiock et al., 2012; McAllister, Taylor & Harman, 2015). Under cooperation risks, the literature has shown that actors opt for developing "strong-tie" or bonding network structures, facilitating actors' abilities to monitor and influence neighbors (Coleman, 1988). This repeated interaction of closed groups enhances credibility and trust required to solve collective problems (Geys & Murdoch, 2008). Figure 4.1C and 4.1D above present two type of bonding structures that are likely to solve high-risk cooperation problems. Both scenarios include the same preexisting links as in Figure 4.1A and 4.1B, but the evaluation of potential relationships is differently.

It has been emphasized the importance of *reciprocal relationships* for cooperation in the development of social capital (Putnam, 1993; McAllister et al., 2015). Mutual exchanges of information help to develop stronger relationships that make punishment of defection more likely to occur, and if so, more effective. The structure provides a mechanism of mutual deterrence, encouraging commitments to the cause. In Figure 4.1C, A is able to strength its relationships with C if it reciprocates the contact that C has already established. The resultant reciprocal structure allows the identification of potential cases of defection, but also it provides access to information about other actors' behavior that are already connected with C. This in turn, increases the confidence of A, because reciprocity helps to strength A's credibility of the commitment of others to cooperate in the joint effort.

Figure 4.1D, on the other hand, shows a *transitive closed triad* structure. Closed triads represent another expression of redundant relationships (Putnam, 1993). Networks with higher density and overlapping ties reduce the costs of monitoring and sanctioning actors (Coleman, 1988). This can prevent defection more effectively due to the rich amount of information

available about each other's behavior and possibilities for combined punishment (Berardo & Scholz, 2010). Figure 4.1D illustrates that a direct relationship from A to E would form a transitive triad structure between A, E and D, providing flows of redundant information. A strong preference for transitive close triads produces closed clusters associated with social capital in which most of A's partners know each other. The creation of shared norms within the closed environment are more likely to emerge and less costly for those involved (Putnam, 1993; Coleman, 1988).

In cases where actors have high individual payoffs for uncooperative behavior, governance networks may self-organize in ways that reflect reciprocity and closed triads structures. These structures reinforce group surveillance since they link members to each other and prevent defection.

Hypothesis 2. *Actors in governance networks exposed to cooperation risks will adopt boding structures (reciprocity and/or closed triads), emphasizing redundant and overlapping ties between actors to overcome partner defection.*

Capacity of innovation

It is widely argued that governance networks have the capacity to bring positive benefits to the problems they intend to address (Googins & Rochlin, 2000; Emerson et al., 2012). Specifically, innovation has been touted as one of the most important advantages of these platforms (Hermans et al., 2017). Innovation is an interactive and non-linear process in which multiple actors exchange ideas reciprocally and challenge the *status quo* (Burt, 1987; Woolthuis et al., 2005). These interactions are thought to generate variety and novelty in collective action inputs; decision-making and solutions (Hermans et al., 2015).

Governance networks can play an important role in facilitating innovation for three main reasons. First, different groups of actors can provide alternative and/or complementary insights about the political and institutional dimensions of the problem at hand, amplifying knowledge, learning and the capacity to innovate (Hermans et al., 2017). Second, the heterogenous participation of actors allow them to negotiate what type of innovation is feasible,

economically viable, social-culturally and politically viable for their own constituencies (OECD & Eurostat, 2005). Third, actors in governance networks are more likely to accept and support the implementation of innovation when they have been part of its development process (Levy & Berardo, 2018). By this mean, innovation may not exclusively require new technology, but rather social restructuration that contributes to the awareness of individuals about their different interests and objectives; their critical interdependencies; and the importance of concerted action (Edquist, 1997; Woolthuis et al., 2005).

Hypothesis 3. *In governance networks, capacity to innovate requires the participation of a heterogeneous set of actors in collaborative relationships to contribute with unique knowledge and perspectives from their professional fields.*

Collaboration among actors is a central element of the governance approach in networks that seek to enhance both the capacity to innovate and the scaling of an innovation (Svendsen & Laberge, 2005). The capacity to innovate depends largely on repositories of knowledge available in the network (Schut, van Paassen, Leeuwis et al., 2014). Contributions of technical and political information from actors would broaden the knowledge base of the network, facilitating processes for the formulation innovative solutions (Googins & Rochlin, 2000; Emerson et al., 2012).

Collaborative relationships are natural conduits of knowledge (Hermans et al., 2017). Actors in governance networks contributing with knowledge on a number of subjects are more likely to be sought as collaborative partners, because they can fulfill needs and questions to solve complex problems, and proactively seek to reconcile different perspectives (Schut et al., 2014). Without the contribution of knowledge from actors, the processes that facilitate innovation is likely to fail (Hermans et al., 2018).

Hypothesis 4. *In governance networks, capacity to innovate requires the presence of actors whose contribution of knowledge makes them more attractive partners for collaboration.*

The scaling of innovation is defined as the ability of actors to create channels for diffusion of innovation both horizontally and vertically (Rogers, 2003). This requires institutional entrepreneurship and political influence for actors to establish relationships that cut across their technical and institutional boundaries (Hermans et al., 2017). Scaling of innovation refers then to the processes in which actors may expand information and knowledge to new locations of their organizational contexts.

Two types of scaling are relevant in this regard. *Outscaling* refers to the horizontal diffusion innovation among actors at the same administrative level (e.g., collaboration between actors at the national or local level). In other words, this diffusion of innovation reflects process of homophily in the social network lexicon, where information travels between actors that share similar institutional and/or hierarchical characteristics (Hermans, Stuiver, Beers et al., 2013). *Upscaling* of innovation refers to the vertical or cross-hierarchical diffusion of innovation. A process where low-scale actors can uptake institutional entrepreneurship and establish relationships with high-level counterparts to sustain processes of collaboration (i.e., collaboration across local and national levels). Upscaling is based then on processes of heterophily because actors employ strategies of lobbying and translating ideas and knowledge to higher institutional and political realms (Rogers, 2003; Hermans et al., 2013).

Hypothesis 5a. *In governance networks, outscaling of innovation requires actors of the same administrative level to collaborate each other (homophily), so that information and knowledge disseminate horizontally.*

Hypothesis 5b. *In governance networks, upscaling of innovation requires actors of different administrative levels to collaborate each other (heterophily), so that information and knowledge disseminate vertically or cross-hierarchically.*

Table 4.1 summarizes the five hypotheses proposed in this study. It classifies the function that links theoretical premises with network structures, as well as the type of network through which these functions are tested in this study: information and collaboration networks.

Table 4. 1 *Summary of hypothesis*

<i>Network</i>	<i>Hypothesis</i>	<i>Function</i>	<i>Network structure</i>
<i>Information exchange</i>	H1	Bridging	Open two-paths; betweenness
	H2	Bonding	Reciprocity; close triads
<i>Collaboration</i>	H3, H4	Capacity of innovation	Sector heterogeneity, knowledge centrality
	H5a, H5b	Scaling of innovation	Administrative level heterogeneity / homogeneity

Research setting

The Latin America region has been experiencing an alarming deceleration in the third decade of the 21st century. This has been intensified during the aftermath of the COVID-19 pandemic (OECD, 2020; Yepez-Garcia, Balza & Serebrisky, 2022). It is a priority for the governments of the region to reverse this trend and return to a path of strong and sustainable growth. In order to support inclusive development in the region, it is critical to expand and improve the access to and the quality of public services and infrastructure, such as public transport, waste management facilities, roads, railways, and airports (Kahn, Baron & Vieyra, 2018; Yepez-Garcia et al., 2022). In this respect, the Latin-American public-infrastructure sector lags emerging economies, and governments in the region still devote fewer resources to this sector than most countries in Asia and Europe (Kahn et al., 2018).

However, there are many reasons why more public money spent on large-scale public projects would not solve this problem. On the contrary, public money may not generate growth-enhancing public infrastructure, but rather boost corruption. Corruption in the public-infrastructure sector distorts fair competition through bribery, collusion, bid-rigging or other forms of manipulation and foul play. This leads to price overruns that end up passing extra costs on to the users, harming local economies and development in the region (Pierre, 2011; Hawkins & Prado, 2019).

Cooperation and coordination among stakeholders in the public-infrastructure sector arena may provide enormous benefits if they result in tangible results, for example reduced corruption, increased value for money, fair procurement processes, and public participation. But these collaborative processes beget greater risks because of the views, norms and values that collide among different stakeholders' interests (Taylor, Wallington, Heyenga et al., 2014; Steets, 2010). As non-government stakeholders become more active in processes of governance, this creates fragmentation of authority that enables disputes, conflicts, and desertion in collaborative efforts (Bulkeley & Betsill, 2013).

Thus, the benefits of addressing or not corruption in this arena through collective action may have different impacts to those involved in the process. Collective action may impose costs to some stakeholders, while also widens the gaps between winners and losers (Steets, 2010). A stakeholder, for instance, while collaborating with others may use information opportunistically to gain a competitive advantage, which sets up a classic prisoner's dilemma situation (Ostrom, 1990). These contextual situations make the public-infrastructure sector an ideal arena for examining how governance networks configure collaborative relationships according to perceptions of collective-action risks.

In light of this, strategies to improve the public-infrastructure sector in Latin America, include transparency reforms, civil society participation, and adherence to international transparency and accountability initiatives (Kahn et al., 2018; Yepez-Garcia et al., 2022). In this regard, the Infrastructure Transparency Initiative (CoST) stands out in the region. The initiative promotes the implementation of anti-corruption mechanisms, combining the participation of multiple levels and diverse types of organizations drawn from the public and non-public sectors to collaborate through collective-action platforms in the form of multi-stakeholder partnerships (MSPs) (Truex & Søreide, 2011).

MSPs are real-world examples of governance networks. Our focus on these anti-corruption partnerships is timely and relevant for several reasons. First, the United Nations' have recently reaffirmed the significance of these governance models to address some of the most pressing challenges from the Sustainable Development Goals (Faul, 2016). Second, interventions of MSPs generally have important cross-cutting effects on other policy arenas that help governments and policy makers to devise more legitimate public policies, by including a wider range of voices and perspectives (Steets, 2010; Rich & Moberg, 2015).

The MSPs in our sample merge characteristics of consultancy agencies and accountability-based non-governmental organizations that disclose key infrastructure information to the public (Truex & Søreide, 2011).³⁸ At the national level, MSPs are led by a National Secretariat, which serves as a full-time administrative body responsible for the management and guidance of activities. MSPs also work closely with Assurance Teams that are technical bodies of infrastructure professionals that support MSPs objectives through data collection and analysis of infrastructure projects of interest.³⁹ At the international level, the MSPs are supervised and monitored by CoST International Secretariat that evaluates partnerships' performance and informs to the board of directors (Hawkins & McKittrick, 2012). The five Latin American countries that are included in this study's sample cover most of country-level efforts of CoST in the region to tackle corruption in the public-infrastructure sector.

Along with CoST, other well-established global transparency initiatives, including The Extractive Industries Transparency Initiative (EITI), The Open Government Partnership (OGP), and The Global Initiative for Fiscal Transparency (GIFT) (Brockmyer & Fox, 2015), rely on formal and independent multi-stakeholder partnerships for the implementation of anti-corruption mechanisms (Fraser & Carbonnier, 2022). By this means, the shared characteristics of the MSPs in our sample with those aforementioned global initiatives, provide generalizability for the findings of this study.

Data collection

A unique dataset was collected through an online survey. The survey was designed following best practices from the relational data-collection literature on organizational network (Agneessens & Labianca, 2022; Borgatti et al., 2013). The survey included 15 items and was translated into Spanish. We collaborated closely with the CoST International Secretariat (i.e., Program Director and Senior Policy and Research Adviser), who endorsed the distribution of

³⁸ The disclosure of this information includes technical infrastructure specifications, such as estimated costs (forecasted and actual), contractor companies, project deadlines, and differences between original and final infrastructure contracts (Truex & Søreide, 2011).

³⁹ Infrastructure project information is requested from procurement agencies and private companies. For that, MSPs appoint an Assurance Team of professional infrastructure experts that reviews the technical information of contracts and highlight potential discrepancies. The MSPs and National Secretariat synthesize the Assurance Team's technical reports into annual public reports.

the survey in the CoST-implementing countries in the Latin-American region during the second quarter of 2020.

The survey was built and distributed using Qualtrics software (Qualtrics, Provo, UT). We followed a calendarized protocol, sending survey invitations, distribution, and reminders to the private email addresses of active members of the MSPs. We did this following formal organograms and stakeholder maps facilitated by the International Secretariat.⁴⁰ This allowed the identification and inclusion of relevant stakeholder organizations for the sample. We also considered network-boundary specifications (Berardo, Fischer & Hamilton, 2020), confirming that all respondents were stakeholders that interacted within the MSPs during 2019 and 2020.⁴¹

The Research Ethics Committee from University College London (UCL) approved the data collection instrument to ensure confidentiality and anonymity of participants. Before the survey, participants were briefed on the survey's purpose and its voluntary nature. Most participants completed the survey in a single 20-minute session. Additional invitations were sent to participants who did not respond the survey, and half-completed surveys were followed-up by telephone to gather as much complete data as possible.

The survey recorded responses from MSPs in El Salvador, Costa Rica, Guatemala, Panama, and Honduras. The global response rate for the five Latin American countries was 93%. At country level, response rates surpassed the 80% threshold. The countries in the sample share similar characteristics; they are all countries with low-to-medium Human Development Index (HDI) scores and represent relatively new democracies in the global south (UNDP, 2019).

Table 4.2 indicates the composition of the five MSPs, detailing foundation year of the partnership, number of respondents and the organizations represented at the time of data collection, and a breakdown of their sector affiliations.

Across all the partnerships, the largest sectoral representation comes from public sector (16 organizations), followed by the civil society (14) and private sector (11). The smallest representation comprised academic institutions and observer organizations (i.e., the World Bank, British embassies, and the Inter-American Development Bank). Apart from Panama, the

⁴⁰ In addition, we used publicly available information on MSPs' official websites to retrieve names and contacts of active stakeholders.

⁴¹ At the time of data collection, all participants of the survey, considered themselves members of the CoST initiative.

rest of the MSPs indicated to have an administrative National Secretariat and a technical Assurance Team within their organizational structure.

Table 4. 2 *Composition of MSPs in the sample*

Country	Response	Participants	Orgs.	PubS	PriS	CS	Aca	Obs	NS	AT
<i>El Salvador (2018)</i>	100%	13	10	2	2	2	2	0	1	1
<i>Costa Rica (2017)</i>	93%	27	13	3	2	2	0	4	1	1
<i>Guatemala (2010)</i>	92%	24	13	3	2	4	0	2	1	1
<i>Panama (2019)</i>	100%	17	12	5	2	3	0	1	1	0
<i>Honduras (2014)</i>	81%	25	11	3	3	3	0	0	1	1
<i>*Total</i>	93%	106	59	16	11	14	2	7	5	4

*Organizational composition as for 2020. Total number of survey participants and organizations represented by country. Public sector (PubS), Private sector (PriS), Civil Society (CS), Academia (Aca), Observer organization (Obs), National Secretariats (NS), and Assurance Teams (AT).

In order to complement qualitative data gathered from an online survey, semi-structured interviews were conducted by the authors of this study during the third quarter of 2020. A total of 13 individuals were interviewed after processing quantitatively survey responses. We adopted a purposive sampling technique to initially select key informants in the MSPs within each country. We further used the snowballing technique to ensure that the most appropriate stakeholders for sectoral representation were chosen for interviews (see Table 4.3).

Table 4. 3 *List of interviews by type of organization and sector*

Country	Participants	Organization	Sector	Acronym
<i>Costa Rica</i>	3	Costa Rica Integra	Civil society	CRCS2
		Equipo de aseguramiento	Assurance Team	CRAT
		Ministerio de Obras Públicas y Transportes (MOPT)	Public sector	CRPubS2
<i>El Salvador</i>	2	Ministerio de Obras Públicas	Public sector	ESPubS2
		Secretariado nacional	National Secretariat	ESNS
<i>Guatemala</i>	3	Cámara Guatemalteca de la Construcción	Private sector	GuPriS2
		Equipo de aseguramiento	Assurance Team	GuAT

Operationalization

		Ministerio de Finanzas Públicas (MIFIN)	Public sector	GuPubS3
<i>Honduras</i>	2	Secretaría de Coordinación General de Gobierno (SCGG)	Public sector	HonPubS3
		Colegio de Ingenieros Civiles de Honduras (CICH)	Private sector	HonPriS3
<i>Panama</i>	3	Secretariado nacional	National Secretariat	PanNS
		Fundación para el Desarrollo de la Libertad Ciudadana, Capítulo Panameño de Transparencia Internacional	Civil society	PanCS2
		Participación Ciudadana y Transparencia de la Alcaldía de Panamá	Public sector	PanPubS5
<i>Total</i>	13	-	-	-

All participants provided written informed consent prior to the enrolment in the interviews in 2020 (see Appendix 4A).
Acronyms will assist as references when a quote from the interviews is included in this paper.

In general, our research setting for both, quantitative and qualitative data, is characterized by its fluidity and diversity of actors and representation of sectors. Most importantly, the boundaries of network participants for the relational data were clearly defined, with no important actors left out of the survey. Our research design provides then internal validity for this study's findings (Berardo et al., 2020).

Operationalization

Aggregated responses

The present study aggregates data at the organizational level. Individual survey responses were aggregated to obtain a single organizational response. Organization A is linked to Organization B if at least one survey respondent affiliated to Organization A names Organization B as a communication partner (i.e., an established operationalization practice in organizational and governance-network studies) (Agneessens & Labianca, 2022; Borgatti et al., 2013). Social-network analysis techniques are used to achieve the objectives of this study, and the aggregation procedure proposed here facilitates such analysis (Kapucu, 2015).

Information exchange and collaboration network

We operationalize two networks for analysis: information exchange and collaboration networks. These networks were constructed from the same survey question, where respondents were asked to:

*“Consider all your email and telephone interactions last year (January–December 2019) and face-to-face meetings with members of your multi-stakeholder group. In these interactions, how often did you provide information on public-infrastructure-related matters to people representing the following organizations and/or internal bodies to develop the work of the initiative, including the National Secretariat and Assurance Team?”*⁴²

Respondents used a network checklist to identify organizations participating in their respective MSPs, indicating those they had information-exchange relationships with. This roster of names helped to reduce recall error from the respondents (Borgatti et al., 2013), and responses created a reliable network structure for each organization’s neighborhood of information-exchange agents, and collaborators.

Responses were collected using a 4-point Likert scale. Which provides the strength of the information-exchange relationship (Borgatti et al., 2013; Agneessens & Labianca, 2022). In order to simulate networks and interpret network measures, we dichotomized these ties, disregarding their varying levels of intensity. This turned naturally valued ties into binary ones (present = 1 / absent = 0) (Borgatti & Quintane, 2018).

To operationalize the information exchange network, we consider for analysis the relationships that organizations send to others (outgoing ties, $A \rightarrow B$). Thus, we build a directed networks with this data. On the other hand, to operationalize the collaborative network,

⁴² Key elements for information exchange included some or all of the following topics: infrastructure-project cost and time overruns, tender and contract awards, contract management, and the social and environmental impacts of infrastructure developments.

we considered only the reciprocal relationships of the information exchange network (mutual ties, $A < - > B$) and built an undirected network for every MSP in the sample, reflecting mutual interactions between organizations and assess functions for innovation (Hermans et al., 2017).

Risk perceptions

We distinguished two types of risks from collective-action problems: coordination and cooperation. The operationalization of perceptions of risks proceeded as follows. First, we identify the extent to which respondents agree or disagree to a series of statements that reflect cooperation and coordination collective-action problems. Second, we aggregated these individual responses at the organizational level. Third, according to the average perception of risk, we assigned a score to every MSP in the sample. Fourth, we compared results.

In coordination problems, actors do not face risks of party defection, and thus conflict between parties is rare. Each actor can select mutually advantageous paths of collective action that each other actor has already agreed on (Feiock, 2013). Thus, in order to operationalize the first component of the coordination construct, respondents were asked to think about their MSP as a decentralized organizational platform for the implementation of transparency and accountability mechanisms in the public-infrastructure sector, and indicate how agree or disagree they are with the following statement:

- 1) *“The MSP is an appropriate model for the implementation of the initiative, since it does not conflict with the interests of existing internal and external actors.”*

In the literature research on collective-action problems, there is generally the integration of a second component to coordination problems that stem from division problems (see Olivier, 2019; Feiock et al., 2012). In division problems, actors face the risk of failing to share inputs and outputs from joint action. Actors may encounter difficulties in dividing and distributing costs and benefits among participants due to lack of coordination. Perceptions of collaborative fairness is linked to these risks that inhibits participation and pose barriers to

collaboration (Feiock, 2013). We operationalized this second component of the coordination construct through the following statement below:

- 2) *“For my organization, participating in the implementation of the initiative through the MSP model has been beneficial despite the time and resources required to participate.”*

Higher scores for both components 1 and 2 serve as proxies to suggest that respondents’ perceptions of coordination risks are low. Respondents may have found in their MSPs ways to act together and adopt common norms of participation, as well as an equilibrium that is acceptable between costs of participation and rewards. We would expect, on the other hand, respondents to disagree with these statements if they have experienced conflicts with others and higher losses than the rest when taking part of collective-action decision making.

In cooperation risks, actors experience conflicting interests among collaborators, and face temptations to minimize their collaborative effort or to defect (Olivier, 2019; Feiock., 2013). Defection problems emerge when the decision of one actor can result in a worse condition for the rest of other participants (Berardo & Scholz, 2010). In a collaboration, reaching solutions consensually and the admittance of interdependence between actors to achieve mutual goals may suggest the lack of cooperation risks (McAllister et al., 2015; Feiock, 2013). We inquired respondents to provide their opinion on how agree or disagree they are with the following two statements:

- 3) *“Solutions have been reached in a consensual way by all the actors of the MSP.”*
- 4) *“The MSP is a practical governance model for the implementation of the initiative since neither party could do so on their own.”*

Lower scores for these two items would indicate the presence of cooperation problems; cases of selfish behavior may have been prevalent and higher chances of defection have been

experienced. Higher scores, on the other hand, would imply higher levels of commitment to make decisions collectively while fears of party defection are reduced.

The operationalization of these fourth items was undertaken on a Likert scale ranging from 0 (“strongly disagree”) to 4 (“strongly agree”), and a “NA” option for no answers. An exploratory factorial analysis (EFA) shows that both constructs loaded >0.70 , surpassing the threshold of accepted validity needed to ensure one-dimensionality (Hair, Black, Babin et al., 2014). Reliability was judged using Cronbach’s alpha coefficient, from which we obtained also an acceptable value for both constructs (Cronbach, 1951).

Innovation and scaling

There are several network characteristics that can result in empirically observable structures that may facilitate innovation and potential to scaling it. To test Hypothesis 3 and assess the level of heterogeneity of collaborative relationships, a typology was made in seven different categories. These categories refer to the sector affiliations of the organizations that participated in the survey. Affiliations groups offered as options in the survey were 1) public sector, 2) private sector, 3) civil society, 4) academia, 5) national secretariat, 6) assurance team, and 7) observers. The same logic is applied to Hypothesis 5a and 5b that postulates functions for scaling of innovation if collaborative ties are formed within or across administrative levels. Survey respondents indicated the level of administration to which their organizations belong to, such as 1) local, 2) national, or 3) supranational level.

For Hypothesis 4 that posits that contributors of knowledge are more likely to become attractive collaboration partners, we assessed frequencies of contributions (0 = never to 5 = very frequently) to six key areas of knowledge for the MSPs in the sample: (1) “selection of a subset of national infrastructure projects”, (2) “selection of relevant indicators to assess infrastructure data”, (3) “advice on the design and preparation of the annual report”, (4) “interpretation of the findings of the infrastructure reports”, (5) “determining how best to communicate results to the public”, and (6) “follow up the recommendations indicated in the annual reports”. We calculated the difference between the group average of every MSP and the average of every organization in all of these areas. We use this difference to assign a score for

every stakeholder organization, where positive values reflect higher contributions than the group's average, while negative values for lower contributions than the group's average.

Qualitative data treatment

The interview questions focused on three areas: (1) motivations and risks of participation in the MSPs, (2) experiences and lessons learned during the collective decision-making processes, and (3) the role of the national secretariats for steering the partnerships, and the assurance teams, when providing technical input for the assessment of infrastructure projects (see Appendix B).

All the interviews were audio recorded, transcribed, and imported into NVivo (12) for coding and analysis. Our approach to qualitative analysis was predominantly inductive (Glaser & Strauss, 1967) highlighting themes that emerged from the raw data, but also, we adopted a more theory-driven deductive approach, reflected in the research objectives for this study. We adopted an open-coding strategy to extract as many themes as possible from the answers, and we devise a list of subcategories for assessment.

Methods

Network data are relational in nature. Networks are statistically challenging to analyze because the basic assumption of data independence does not apply (Borgatti et al., 2013). Observations related to network ties are mutual by definition (Fischer & Sciarini, 2016). Thus, this paper uses advance statistical network analysis, which enables the prediction of ties formation for information exchange and collaboration between pairs of organizational actors. The analysis also takes into consideration organizations' attributes and the network structure they are embedded for the provision of statistical outputs for inference.

Exponential random-graph models (ERGMs) (Lusher et al., 2013) are used to test whether certain network configurations are observed at levels above or below chance (Lusher et al., 2013). The model assumes that stochastic processes form and shape networks, determining how actors create and discard ties under different social contexts (Lusher et al., 2013). ERGMs, which belong to a class of statistical inference models, are among the most

popular and theoretically well-developed class of techniques used for network analysis (Lubell & Scholz & Robin, 2012).

Despite the measurement of the networks in our sample was done at one point in time, the use ERGMs assumes observed network configurations to be the result of various past and ongoing social and organizational processes (Henry, Lubell & McCoy, 2011). In theory, network ties can be formed between any two actors; in practice, tie formation occurs more frequently within existing relationships (Lubell & Scholz & Robin, 2012).

In ERGMs the observed network structure represents the dependent variable (i.e., information exchange and collaboration networks), whereas the network configurations (i.e., bridging, bonding, etc.) constitute the independent variables (Lusher et al., 2013). Figure 4.1 above, indicates the network configurations we test for this paper. ERGMs are well suited to this study, which simultaneously investigates several different network hypotheses (represented by structural configurations), using the *Statnet* package, version 2019.6 for the statistical computing environment R (Handcock, Hunter, Butts et al., 2019).⁴³

The general form of exponential random graphs is as follows,

$$P(y_{ij} = 1 \mid Y_{ij}^c) = \left(\frac{1}{c}\right) \exp \left\{ \sum_{k=1}^K \theta_k Z_k(y) \right\} \quad (1)$$

This shows that the model is predicting the probability of a tie between actors i and j , conditional on the rest of the network (all other ties). The thetas (θ_k) are the coefficients of the network configurations of interest, one for each of the K included statistics, $Z_k(y)$. $\left(\frac{1}{c}\right)$ is simply a normalizing constant that ensures that the probabilities stay within 0 and 1 (Lusher et al., 2013). The model is fitted via Markov Chain Monte Carlo Maximum Likelihood Estimation (MCMC MLE). The estimated coefficients can be interpreted like in a logit regression model.

⁴³ See R code in Appendix G11.

ERGMs estimate positive coefficients for the type of configurations that network actors tend to engage in, and negative for those they tend to avoid (Lusher et al., 2013).⁴⁴

Finally, model fit is also assessed by comparing the observed network to simulated networks. This process is called *Goodness of Fit*, which indicate the percentage of observed network statistics successfully simulated by the model for each of the network statistics included in the evaluation.

Results

Networks descriptive information

We have constructed two networks for each country in the sample: a directed network of information exchange and an undirected network of collaboration. Both are illustrated in Figure 4.2, first and second row, respectively. We controlled the layout coordinates in both types of visualizations to obtain the exact node positioning and facilitate visual comparison between them. No loops were allowed in these networks which implies that a respondent cannot exchange information or collaborate with his/her own organization. The size of the nodes reflects, for the information exchange network, the number of outgoing ties that an organization sends to others ($A \rightarrow B$), and, for the collaboration network, the total number of ties an organization has (incoming and outgoing ties, $A \leftrightarrow B$). The shape and color of the node convey information on the node's sector affiliation and administrative level.

To disentangle macro-level characteristics of the network structures, we compare four main social network descriptive measures. First, *density* is the proportion of observed ties in a network to the maximum number of possible ties. Density is a ratio that ranges from 0 to 1, being 1 the highest number of ties possible in a network, given its total number of nodes (Borgatti et al., 2013). Second, *centralization* is a measure that indicates how centralized a network is around to one actor or a group of actors that are connected to the largest number of actors in the network (Borgatti et al., 2013).

⁴⁴ If a configuration is a likely outcome of a social process occurring within the network, this will be reflected in a positive and significant coefficient, indicating that the configuration occurs at a higher frequency in the observed network than in networks in which links are generated by chance (Berardo & Lubell, 2016).

To know how compact a network is, a third measure we used is *diameter*. It informs the shortest number of steps that flowing resources must take to go from one end to the other in the network (Luke, 2015). Diameter indicates the “worst case scenario” for sending information across a network; the highest the diameter, the slowest the information will travel across the network. Lastly, *clustering coefficient* indicates the tendency of networks to form structures of closed triangles. In other words, when two unconnected actors that share a common contact in the network, will tend to create a connection between each other (Luke, 2015). Just like density, clustering coefficient is a ratio ranging from 0 to 1.

Information exchange networks. Table 4.4 shows that networks in Guatemala, Panama and Honduras have the lowest densities of the sample (≤ 0.60). This characteristic is also reflected in largest centralizations in these networks (> 0.20), implying that few actors are located at the core of these networks and others at the periphery. On the other hand, El Salvador and Costa Rica show the largest densities (> 0.74), that is the largest amount of information exchange activity. The structure of these networks is also less centralized, indicating the presence of more horizontal structures for information flows.

Table 4. 4 Descriptive data from information exchange networks

	Density	Centralization	Clustering coefficient	Diameter
<i>El Salvador</i>	0.74	0.18	0.93	3
<i>Costa Rica</i>	0.83	0.15	0.90	2
<i>Guatemala</i>	0.52	0.31	0.81	2
<i>Panama</i>	0.60	0.32	0.83	2
<i>Honduras</i>	0.60	0.24	0.84	3

Clustering coefficient indicates that El Salvador and Costa Rica are the most “closed” networks in terms of triadic configurations of actors being connected each other in triadic structures (≥ 0.90). The diameter from Honduras and El Salvador indicates that information flows “slower” in these networks than in the rest of the sample. On average, information must travel through three organizations before it reaches all other participants in the network.

At first glance, the strong tendency for clustering from organizations in El Salvador and Costa Rica seem to respond to a self-organizing capacity that may suggest attempts to address fears of partner defection (cooperation problems). Conversely, given the figures of centralization, the networks with lowest densities such as Honduras, Panama and Guatemala

are likely to be playing out strategies to deal with coordination risks. These relatively more open networks are structured in a way that may facilitate coordinative functions.

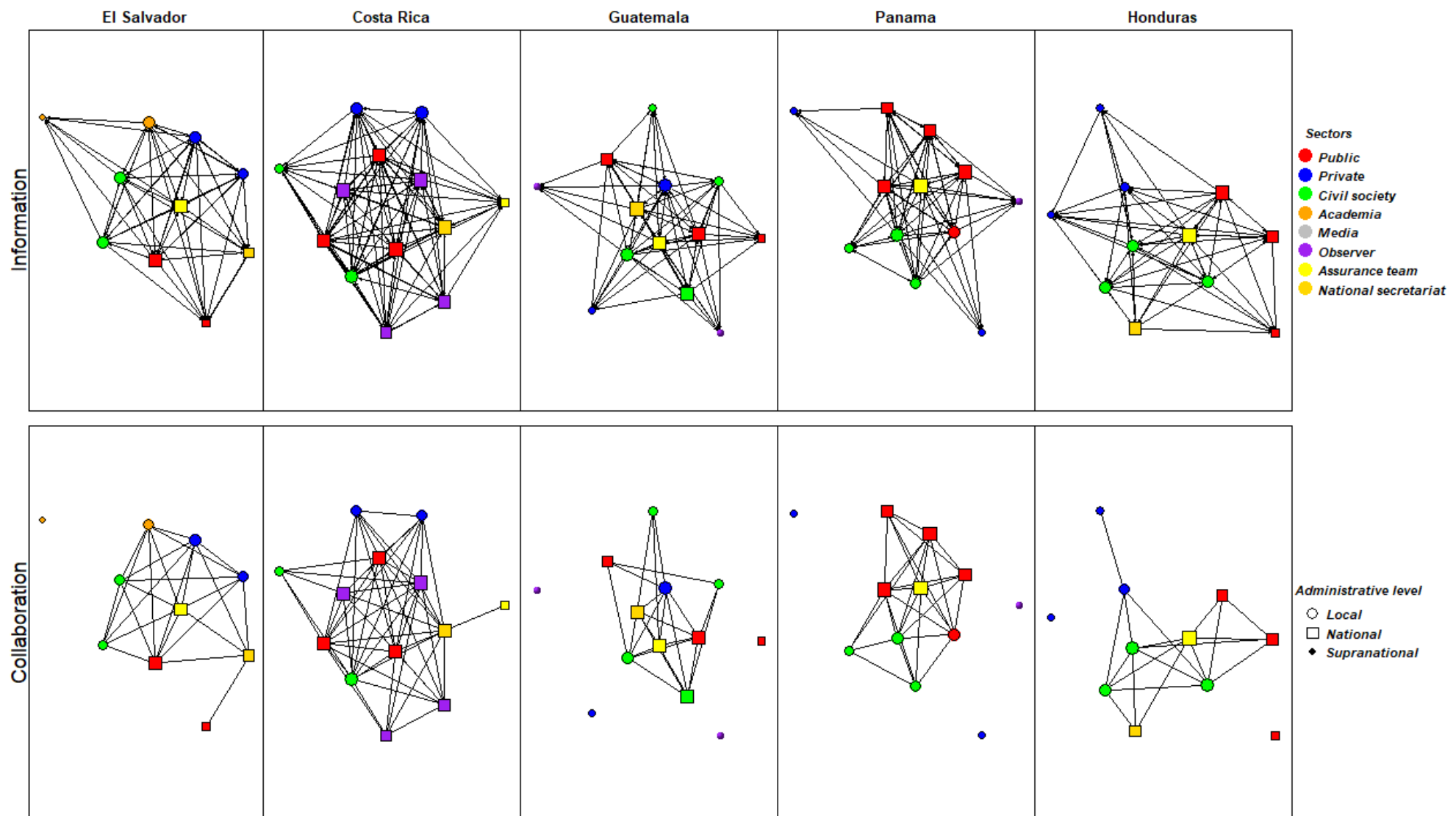
Collaboration networks. Figure 4.2 shows visualization for collaboration networks with less collaborative ties between stakeholders than those of information exchange. Such characteristics led not only to lower densities across the countries, but also to fragmented structures with some actors gravitating around the core of networks. A quick visual inspection of the second row of Figure 4.2 reveals that actors at the periphery tend to be primarily affiliated to the private and public sector as well as observer organizations, while none of them represents the civil society.

Previously identified patterns in the information exchange network remain for the collaboration networks. For instance, organizations in Costa Rica and El Salvador in Table 4.5 operate through the largest number of collaboration ties (density ≥ 0.74). As a result, they also have the lowest centralities of the sample (< 0.20). Conversely, while Guatemala, Panama and Honduras are the most centralized collaborative networks (> 0.20), they also show the lowest densities (≤ 0.52). The diameter remains stable for Honduras, Panama and El Salvador, whereas for Costa Rica and Guatemala the flow of information reciprocally become slower by adding one more step through which collaboration unfolds.

In general, results indicate that those less centralized collaborative networks, given their relatively more open structures, are more likely to operate as underlying structures that promote innovation diffusion and scaling (Hermans et al., 2017). However, to obtain a more complete picture, we need to run advance statistical models, taking into account attributes of the stakeholder organizations such as sector affiliation and administrative level and test our hypotheses.

Table 4. 5 Descriptive data from collaboration networks

	Density	Centralization	Clustering coefficient	Diameter
<i>El Salvador</i>	0.55	0.28	0.84	3
<i>Costa Rica</i>	0.70	0.26	0.82	3
<i>Guatemala</i>	0.30	0.34	0.71	3
<i>Panama</i>	0.42	0.36	0.80	2
<i>Honduras</i>	0.34	0.31	0.65	3

Figure 4. 2 Visualization of networks for information exchange and collaboration

Source: Plot graph by Igraph (1.3.1) for R.

Risk perceptions

To assess and compare perceptions of coordination and cooperation risks, we ranked MSPs in the sample according to their average score in the two risk constructs. The rank ranged from 1, the highest, to 5, the lowest. We further plotted a slope chart to show how different perceptions of risks fluctuate across every MSP. Three categories of lines convey this information. In Figure 4.3, the orange line indicates the rank for coordination risk, while the grey line represents cooperation risks. A third yellow line represents the density of every MSP's information exchange network, where the risk hypotheses are tested. This line follows the same logic: higher densities indicate higher ranks.

Figure 4.3 shows that the MSP in Costa Rica holds the highest ranks for cooperation and coordination risks perceptions. Both risks in the first place of the rank. The Costa Rican MSP also shows the highest density in the sample for its information exchange network. According to the data, this MSP seems to counterargue assumptions about densely interactive networks as functionable networks, to say seemingly free of problems related to trust and social capital as previously hypothesized by the literature (see Coleman, 1988; Putnam & Goss, 2002). Results suggest that in this MSP, organizations exchange information proactively, and yet perceptions about the direction of the partnership as well as fears of party defection are prevalent.

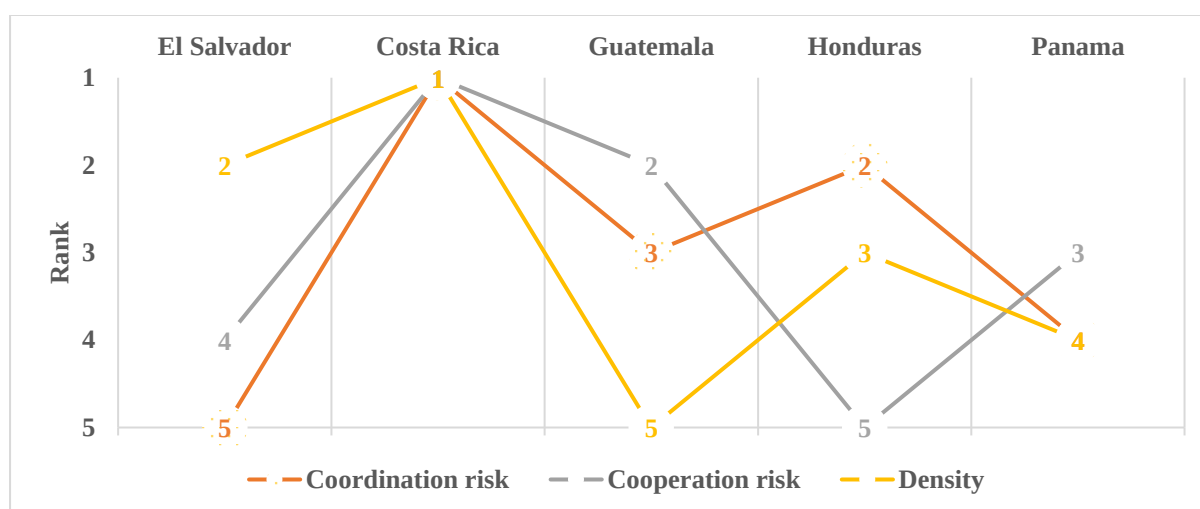
The MSP in El Salvador shows the lowest ranks for cooperation (4th) and coordination (5th) risks in the sample. Yet its density is the second highest. Contrary to Costa Rica, organizations in the MSP of El Salvador indicated to have more constrained perceptions about collective-action risks. The results for this MSP are, on the other hand, more aligned with theorizations of networks that manage to develop a high degree of information exchange activity as a result of lower perceptions of risks, higher levels of trust and social capital (Henry et al., 2011).

MSPs in Guatemala and Panama show similar directions in their ranks. In both countries, perceptions of cooperation risks are higher than those of coordination. Cooperation ranks in the 2nd and 3rd place, respectively, while coordination varies between the 3rd place for Guatemala and 4th place for Panama. At the same time, both countries have the lowest densities for information exchange. Their densities stand at the 5th and 4th place, respectively. An exception stands out in our sample, which is Honduras. The MSP in this country indicated to

experience higher coordination risks (2nd place in the rank after Costa Rica), and the lowest score for cooperation risks (5th) in the sample.

Overall, Figure 4.3 reveals that despite the varying levels of density in the information exchange networks, risk perceptions behave differently. Some countries are aligned to theoretical expectations of social capital while others differ. The analysis has also shown which type of risks are more likely to be experienced by stakeholders of the MSPs in the sample, and therefore we can anticipate possible network structures, because of this. We would expect then for Costa Rica, El Salvador, Guatemala, and Panama more bonding network structures, while for Honduras bridging structures seem more practical. However, given the presence of both types of risks in every MSPs, it could also be the case that bonding and bridging structures may be playing a simultaneous role, but to a different degree.

Figure 4. 3 Rank for collective-action risks per country



Higher ranks reflect higher scores in the constructs of coordination and cooperation risks.

Quantitative analysis

In this section, we elucidate results from the quantitative analysis through ERGMs (see Appendix E for a list of supporting information files). This method of advance network analysis supports the examination of network formation considering stakeholder organizations' attributes and their already existing relationships between them. The method allows to test

whether certain hypothesized network configurations are observed more or less than could be expected by chance alone (Lusher et al., 2013).

Developing an ERGM that converges on robust parameters is a difficult endeavor. The ERGM in this study included extra network configurations, not only to control for different characteristics of the networks and their actors, but also to allow the models to converge properly. Thus, we attempted to build the most complete models as possible. And so, we use 1000 random networks for simulation for each of the two types of observed networks per MSP in our data. We evaluated the fit of the models through Goodness of Fit (GOF) tests, available in Statnet package, version 2019.6 for R (Hunter, Goodreau & Handcock, 2008; Handcock et al., 2019) (see Appendix 4C for GOF results).

We use the information exchange networks to test Hypothesis 1 and 2 that posit that in the presence of cooperation and coordination risks, bridging and bonding network structures play out a role to explain organizations' self-organizing capacity within networks (Berardo & Scholz, 2010; Berardo & Lubell, 2016). Listed in Table 4.6, the structural coefficients from ERGMs provide a straightforward approach for analyzing the presence of these network configurations.

The *edges* term in Table 4.6 is comparable to the constant in other statistical models (Lusher et al., 2013). The network configuration term is used mainly for model stabilization, but it also conveys important information (Lusher et al., 2013). The coefficients of edges for El Salvador and Costa Rica are positive to a significant level, which suggest the presence of a strong tendency in these networks to create information exchange relationships. In both countries, the probability of creating a relationship is 99% higher than in the rest of the sample.⁴⁵ In countries where the edges coefficients are negative, such as in Panama and Guatemala, probabilities drop from 43% to 11%, respectively. In these networks there are fewer ties than expected in random-generated network simulations.

⁴⁵ In the same way as in logistical models, the exponent of the ERGM coefficient transforms the log-odds into odds ratios. Dividing by $1 + \exp(\text{coef})$ gives the probability of a tie (Lusher et al., 2013).

Table 4. 6 ERGM results for risk hypotheses

Configurations		El Salvador	Costa Rica	Guatemala	Honduras	Panama
	<i>Edges</i>	7.29 *	6.58 *	-2.18	0.62	-0.23
		(2.96)	(2.89)	(1.18)	(1.12)	(1.92)
<i>Bonding:</i>	<i>Reciprocity</i>	0.08	-0.76	0.28	1.4	-0.28
		(0.79)	(1.03)	(1.15)	(0.93)	(1.16)
	<i>Closed triads</i>	0.49*	0.26*	0.23 **	0.43 ***	0.35 ***
		(0.07)	(0.04)	(0.08)	(0.07)	(0.07)
<i>Bridging:</i>	<i>Twopath</i>	-0.45 *	-0.34 *	-0.56 ***	-0.60 ***	-0.47 **
		(0.21)	(0.15)	(0.15)	(0.15)	(0.16)
	<i>Betweenness</i>	0.17	0.93 ***	1.11 ***	0.22 *	1.23 ***
		(0.11)	(0.28)	(0.25)	(0.08)	(0.28)
<i>Control:</i>	<i>Years of participation</i>	-0.21	-0.04	0.29 *	0.01	-0.24
		(0.21)	(0.31)	(0.15)	(0.09)	(0.18)
-----		-----	-----	-----	-----	-----
<i>AIC</i>		103.89	124.32	110.25	105.24	87.34
<i>BIC</i>		116.39	139.57	128.55	121.44	104.64
<i>Log Likelihood</i>		-46.95	-57.16	-49.13	-46.62	-37.67

*Coefficients outcome from *statnet* (2019.6) and *ergm* (4.2.2) package in R. Standard errors in parenthesis.

*p < .05. **p < .01. ***p < .001.

Hypothesis 2 states that actors exposed to cooperation risks in governance networks will adopt bonding structures. Two network structures were hypothesized as relevant for this purpose: reciprocity and transitive closed triads. Results from the ERGMs show that coefficients for reciprocity (as shown visually in Figure 4.1C) are not statistically significant across all the MSPs. The MSPs in Panama and, even more surprisingly, in Costa Rica results are negative, which may indicate that mutuality in relationships is not the preferred strategy to share redundant information with the intention of addressing defection threats. Results show that stakeholder organizations in these partnerships favor other mechanisms for self-organization when it comes to bonding.

Structures of transitive closed triads (Figure 4.1D), on the other hand, are positive and statistically significant levels. Closed triads reflect the tendency of network actors to create clusters of three, where everyone has a relationship with each other. Given that all the countries

indicated to experience higher degrees of defection, these results are in line with theoretical expectations about cooperation risks and bonding network structures. As we observed above, the MSP in Honduras is the exception with the highest rank in coordination risks. Despite of this, its coefficient for closed triads is one of the strongest, positive and significant at the .001 level, even in the relative absence of cooperation problems. The over representation of this bonding structure across the MSPs, characterized predominantly by risks of partner defection renders evidence to support Hypothesis 2.

Hypothesis 1 states that actors exposed to coordination risks in governance networks will adopt bridging structures. Two structural configurations were proposed to reveal the extent to which stakeholders coordinate themselves around open structures (two-paths) and/or around brokers that attenuate absence of coordination (i.e., betweenness centrality).

Our model shows that the coefficients for two-path structures (Figure 4.1A) are negative at a significant level in all the MSPs. The negative effects are stronger in Guatemala, Honduras, and Panama. These coefficients indicate that stakeholder organizations in the five networks do not create relationships with partners that may maximize their access to unconnected ones.

The two-path structure is a pre-condition to form triadic configurations in networks (Henry et al., 2010). Thus, it seems reasonable have these results, given the parameters already explained above. Stakeholders in the MSPs avoid two-paths and prefer to close these social structures instead, forming triadic configurations of actors sharing redundant information between each other: “friends of friends are likely to become friends”.

The second network structure we revise for bridging is betweenness centrality (see detailed results in Appendix 4D). Table 4.6 show positive and statistically significant results coefficients in four out of five MSPs. The model indicates stronger positive effects at the .001 level for Costa Rica, Guatemala, and Panama, while for Honduras coefficients are more moderated. El Salvador shows no significant results in this respect. ERGM results suggests that information passing through certain organizations that are structurally located in privileged positions, that is, in between actors, explain most of the information exchange in these networks. These organizations may have the capacity to observe and control information flows. As discussed above, most of the MSPs have been exposed to some extent to coordination risks.

Even though these perceptions are less predominant than those of cooperation risks, we think this does not preclude our findings to provide support for Hypothesis 1.

We use stakeholders' years of participation in their respective MSPs as a control variable. Coefficients indicate that those organizations that have been participating for longer periods of time, do not contribute to the exchange of information. This could be the effect of attrition or lack of interest after some years of participation. Coefficients are negative, although not at statistically significant for MSPs in Panama, Costa Rica and El Salvador. On the other hand, in those networks with less density, such as Guatemala, novice organizations have indicated proactive attitudes towards information sharing.

We ran a second ERGM for the collaboration networks. Table 4.7 shows the coefficients for this model. By excluding El Salvador, coefficients from edges for the rest of the countries are negative. In general, there is a tendency for organizations in these networks against the creation of collaborative relationships. Based on thousands of simulations, coefficients for edges suggest that the observed networks in the sample do not materialize their collaborative potential, considering the number of actors participating in them. The visualization of networks above illustrates this effect with fragmented networks and organizations located at the periphery without collaborative relationships at all.

Hypothesis 3 posits that the capacity to innovate in governance networks requires the participation of a heterogeneous group of actors holding collaborative relationships. This facilitates diverse sources of information to interact and to come up with new ideas. By testing homogeneity of stakeholders' sector affiliations, we find positive coefficients in Costa Rica, Honduras and Panama.⁴⁶ Organizations in these countries seem to prefer establishing collaborative ties within groups of peers from the same sector (McPherson, Smith-Lovin, & Cook, 2001).

El Salvador and Guatemala, on the other hand, show negative results in this respect. Even though results are not significant at conventional statistical threshold, there is a tendency in the interactions of these partnerships for heterophily in collaboration. In other words, collaboration unfolds between stakeholders of different sectoral memberships, with potential

⁴⁶ Given the available set configurations for the *ergm* (4.2.2) package in R, we have chosen to test the homophily configuration for hypothesis 3 as it represent the opposite effect of heterophily for sector affiliation (see Appendix G11).

to facilitate cross fertilization of ideas and encourage innovation. The findings, however, do not support Hypothesis 3.

Table 4. 7 ERGM results for innovation hypotheses

<i>Configurations</i>	<i>El Salvador</i>	<i>Costa Rica</i>	<i>Guatemala</i>	<i>Honduras</i>	<i>Panama</i>
-----	-----	-----	-----	-----	-----
<i>edges</i>	0.77	-1.74	-3.61 *	-2.04	-2.24
	(3.50)	(2.45)	(1.80)	(2.15)	(1.32)
<i>Scaling:</i>					
<i>Homophily adm. level</i>	0.61	0.28	0.22	0.59	0.36
	(0.65)	(0.54)	(0.58)	(0.74)	(0.65)
<i>Diffusion:</i>					
<i>Homophily sector affiliation</i>	-0.60	1.76	-0.81	0.76	3.21 **
	(1.14)	(1.14)	(0.87)	(0.85)	(1.13)
<i>Knowledge contributions</i>	0.2	0.12	-0.04	-0.86 *	-0.37
	(0.38)	(0.30)	(0.32)	(0.39)	(0.28)
<i>Control:</i>					
<i>Meetings attendance</i>	-0.08	0.25	0.35	0.12	0.19
	(0.37)	(0.27)	(0.22)	(0.27)	(0.19)
-----	-----	-----	-----	-----	-----
<i>AIC</i>	70.48	100.68	97.46	72.41	76.14
<i>BIC</i>	79.51	112.46	109.25	82.45	87.09
<i>Log Likelihood</i>	-30.24	-45.34	-43.73	-31.21	-33.07

*Coefficients outcome from *statnet* (2019.6) and *ergm* (4.2.2) package in R. Standard errors in parenthesis.

*p < .05. **p < .01. ***p < .001.

Hypothesis 4 states that the capacity to innovate in networks requires the participation of actors making contributions of knowledge, promoting processes of knowledge co-creation and social learning. We find mixed evidence for this. Although the effect is not significant, positive coefficients for the MSPs in El Salvador and Costa Rica suggest that organizations that share more knowledge than their partnerships' average are attributable to the creation of collaborative relationships or that they are generally more sought by others to collaborate. In Guatemala, Honduras and Panama, more "knowledgeable" organizations are collaboration averse, or they are being ignored by other organizations for collaboration. Thus, we found no conclusive support for hypothesis 4.

Hypothesis 5a and 5b stipulate that diffusion of innovation can take the form of outscaling or upscaling, respectively. We test the homophily for organizations' administrative

level, and whether this explains collaboration relationships. Results in Table 4.7 show positive coefficients across all the MSPs, which unveils a tendency for homophily collaboration at the administrative level. Despite results are not significant, they indicate that collaboration operates primarily within groups of stakeholders from a specific level of administration, either at the local, national, or supranational level. Upscaling, on the other hand, is clearly not a function supported by any of the MSPs, suggesting barriers from local organizations to collaborate with higher-level government agencies. Evidence then support Hypothesis 5a, but not necessarily for Hypothesis 5b.

For this model, we controlled for number of meetings that organizations have attended during 2019-2020. Results for the control reveal that in most MSPs, attending more meetings explain, to a certain extent, organizations' capacity to collaborate with others. Coefficients are positive but not at a statistical level. El Salvador is the exception of this. Its coefficient implies that actors attending more meetings do not guarantee more reciprocal interaction between organizations.

Discussion

We measure the extent to which stakeholder organizations in MSPs have experienced two types of risks: (1) where multiple stakeholders want roughly the same thing without easily agreeing on how to achieve what they want (coordination risks), and (2) when free riding becomes a dominant strategy for some stakeholders, taking advantage of the efforts and commitments of others (cooperation risk). As shown, in most of the MSPs of the sample, perceptions about cooperation risks are more widespread than coordination risks.

Our statistical analyses reveal an interesting story for the MSPs of this study. Across partnerships, stakeholders create relationships that bring them closer with other actors, improving the quality of information available about how others behave. The three-member group structure of transitive closed triads is the most used bonding structure, according to our analysis. Closed triads provide to stakeholder organizations the ability to acquire information from others within their closest neighborhoods of partners, which serves to identify and monitor deceiving behavior (Berardo & Scholz, 2010; Berardo & Lubell, 2016). Results are supported by qualitative data. In this respect, a representative of the National Secretariat in El Salvador had to say:

“It has taken us few years participating in the initiative to learn to whom we should aim at and build relationships with in order to share “intelligence” about poor performers in the group. This is necessary for us, because then, eventually, we are able to take measures to incentivize improved participation or open the doors for exit.” (ESNS, 2020).

Similarly, we learnt from the Civil Society in Panama that:

“Newcomer stakeholders help us to assess better the collective capacities of the partnership. From them, we have learnt to avoid the risk of non-cooperative behavior of other associates. This is key for us... to take advantage of newcomers and the good ideas they bring to the collective from a wide range of perspectives.” (PanCS2, 2020).

The qualitative contributions from these organizations shed light on an ongoing process of shaping participation in MSPs, as a result of perceived risks that comes from potential free-riding cases, and the need to share information about them. MSPs tend to adopt a more “inward-looking” approach to reinforce communication with active actors to increase their capacities of communication and monitoring (Carlsson & Sandstrom, 2008).

The over-representation of negative results for two-paths, a hypothesized structure for bridging, is another important finding. Two-paths are often perceived as preconditions for transitive closed triads, as we already mentioned (Henry et al., 2011). The negative results for this structure at the statistical level can be interpreted as accomplished social capital. The lack of two-paths structures signals the existence of opportunities that organizations have already taken to promote information exchange relationships that are redundant in nature by closing subgroups of triads. A case in point was brought by a public servant in Guatemala, who said:

“[During] the first year of participation, we tried to expand our influence within the multi-stakeholder group. We teamed up for different activities of the initiative not only with the host organization, but also with those partners that invited us initially to participate in the implementation of the initiative. Our relationship became stronger as a result.” (GuPubS3, 2020).

This qualitative contribution portrays the tendency of inclusion of third actors into already existing dyadic structures that reinforces clustering effects, where group norms and social capital are likely to become persistent over time (Coleman, 1990).

Our findings resonate studies that have suggested that collaboration is an evolutionary process, and it may change from non-collaborative to collaborative equilibria across time (Henry et al., 2011; Imhof, Fudenberg, & Nowak 2005). We argue that given the lack of two-paths, as a bridging structure, and the high number of closed triads as a bonding structure, the MSPs in our sample signal dynamics at different points of a network evolutionary trajectory, moving towards a more cooperative equilibrium that relies on processes that cope primarily with risks of defection.

We have also shown the presence of information exchange relationships through bridging structures associated with coordination problems. Stakeholders occupying in-between positions fulfill coordination roles by maintaining a relationship in each group of stakeholders and providing them with a shot of nonoverlapping information that can be used to solve problems rather than to form a reputation (Olivier, 2019). Excluding the MSP in El Salvador, the rest of the partnerships are subject of these weak ties to connect with other groups with whom they had little or no contact up to that point. These bridging structures span structural holes (Burt, 1992), where messages fail to cross to others. Put it simply, the presence of this structure reduces the diameter of networks; it cuts distances between stakeholders so that information can move rapidly and efficiently from one part of the network to another through relatively small number of steps. A private sector director from Honduras informed that:

“It is the case that sometimes we must reach those very influential actors in the initiative to be heard so [we] can include issues of our concern in the agenda... And that requires patience and negotiation.” (HonPriS3, 2020).

The statement above reveals that some actors in the MSPs have relatively higher confidence in more centralized, and more influential actors. In their view, these influential actors will share information more accurately and help them to coordinate their interest with the rest of the participants (see McAllister et al., 2015; Hermans et al., 2017). In El Salvador, for instance, a prominent representative from the Ministry of Public Works indicated that:

“Without the support of the national secretariat, the coordination of tasks for the rest of the group would be blurry... And the implementation of the initiative would fall short of expectations. We may sacrifice credibility and lose momentum without the intermediation of this agency. For us [governments], busy all the time, every day [sic], we need these central roles that steer the efforts from everybody to get things done.” (ESPubS2, 2020).

This seems to reflect the sentiment of several stakeholders that rely on coordinators of collective action, because their role would help to contribute to good internal decision-making ability, low transaction costs, and conflict resolution (Carlson & Sandstrom, 2008).

We should emphasize, however, that the presence of powerful coordinators might also create situations where information is used or manipulated for private benefits. Actors may position themselves between diverse sources of political or technical information from which they can profit individually (Burt, 1992). That is, betweenness may also provide positions that can be vulnerable to exploitation if that is more favorable to the coordinator. Statements from interviews unveil that this is also the case, where coordinators can make inefficient choices for MSPs’ coordination. On this point, a technical worker, representative of the Costa Rican Assurance Team, indicated:

“Governmental offices tend to control the activities of the alliance, including the type of technical information that should be shared to the public... They care about public opinion, especially during the cycles of government elections. This creates conflict of interests and poor coordination in the implementation of the initiative.” (CRAT, 2020).

Overall, the statistical analysis of the data for the information exchange networks shows that bonding and bridging are not incompatible as one may have assumed. MSPs address both coordination and cooperation risks simultaneously through network configurations apt for the purpose. Interview data confirm instances of conflict amongst stakeholders behaving as hypothesized.

Given that bonding and bridging each facilitate different beneficial behaviours for network sustainability, it seems ideal to have some of each (Berardo, 2014; McAllister, McCrea, and Lubell, 2013; Henry et al., 2011). The Small World theory from network science has shown that both types of structures are not a zero-sum game; both can be simultaneously playing a significant role under certain circumstances (Watts & Strogatz, 1998).

When a setting is characterized by high levels of clustering, which provides bonding social capital, the formation of even a few of bridging relationships can dramatically reduce the average distance between individuals in a network, and thus create bridging social capital (Neal & Neal, 2019). Networks with characteristics of clustering and short distances are known as *small world networks*, which have been associated with innovation and problem solving (Neal & Neal, 2019).

However, the statistical analysis for collaborative networks reveals that stakeholders do not structure themselves in ways that facilitate functions for innovative collective problem solving. There was no significant evidence for heterogeneous interactions between stakeholders from different sectors nor for administrative levels. A representative of an NGO in Costa Rica noted that:

“Even though we are strongly encouraged to work with partners from other agencies, the reality is that we do find ourselves working more often with civil society colleagues who “speak” our own language and face the same structure of incentives to keep big interests at bay in the public-infrastructure sector.” (CRCS2, 2020).

The statement reveals the attitude of some stakeholders to minimize costs of contact-making (Reyes-Gonzalez, Agneessens & Esteve, *forthcoming*), favoring building relationships with actors of similar backgrounds for collaboration. Though, this sentiment reduces stakeholders’ ability to continuously identify and prioritize problems and opportunities as a diverse group, a touted benefit from collective action in governance networks (Scholz et al., 2008; Ostrom, 1990).

In the same vein, there is a tendency among organizations across all the MSPs to create collaborative relationships that do not cut across the boundaries of their administrative levels. Findings indicate that stakeholders belonging to the national level collaborate with their counterparts at the same level, and the same occur for actors at the local level. This characteristic shows the lack of institutional entrepreneurship (Hermans et al., 2017). Actors do not really interact across administrative levels nor *“keep ones’ ear open to other agencies”*, as it was put by a businessman in Guatemala (GuPriS2, 2020). The lack of collaboration across administrative levels reflects reduced opportunities for stakeholders to upscale innovation across administrative hierarchies.

A possible explanation for this absence of functions for innovation, is that networks of collaboration were found fragmented as shown in Figure 4.2. Fragmentation reflects a number of actors disconnected from each other, but most importantly, they are detached from those located at the core of the networks. When this takes place, interactions for knowledge absorption and new ideas cannot flow beyond the boundaries of the core of the network (Singh, Hansen & Podolny, 2010). Stakeholders who belong to the periphery of a network may find themselves removed from critical interactions, facing difficulties to collaborate and innovate (Brass, 1984).

The strong tendency of homophily for collaborative association within groups of sectors and administrative levels is a feature that aggravate functions for innovation. This analysis reveals that at the core of the collaborative networks, stakeholders tend to self-organize themselves in homophily-based groups. One reason for this behavior is familiarity. Two stakeholders who may share one or more attributes may prefer to interact with each other based on common grounds and attitudes (McPherson et al., 2001). Another reason is perceived safety and trust; it is safer to contact an actor with whom one is more familiar, reducing the cost of contact making in terms of cognitive effort and time (McPherson et al., 2001).

On the whole, the MSPs studied in this paper indicate that governance networks present more complex structural network landscapes than it has been previously thought (Faul, 2016; Steets, 2010; Park & Rethemeyer, 2012; Hermans et al., 2017). MSPs are capable to support multiple social processes at once, such as bonding and bridging. This is a positive characteristic that position networks towards a more collaborative equilibrium. Networks that maintain these multiple processes are capable to positively contribute to more resilient collective action systems in the face of collective-action risks (Levy & Lubell, 2018).

However, these structures seem to support predominantly the development of reputation, trust and cooperation rather than efficient transmission of information and interactions that span the boundaries of sector and administrative level, which are supposed to be facilitated by bridging structures. The fragmented and homogenous topography of the networks of the MSPs, reinforced with stronger effects of bonding structures, seem to counterbalance the capacity to foster innovation.

“Innovation is very pale when we work together. We tend to follow protocols of implementation already designed by the initiative... we proceed without much discussion on where exactly we can come up with creative ideas or strategies for solutions for the problems we face.” (PanNS).

The stakeholders of the MSPs in our sample are characterized more as active advocates of interests of their own group, which may explain the widespread fear for uncooperative behavior. On the other hand, organizations may not wish to support innovative solutions that

could produce potentially threatening or unintended consequences for the interests of their constituencies.

Conclusion

We used mixed methods to explore the relational nature of multi-stakeholder partnerships tasked with the implementation of transparency and accountability mechanism in the public-infrastructure sector of five Latin American countries. Statistical network methods showed that bonding and bridging structures to cope with perceptions of collaborative risks operate simultaneously in these partnerships. Bonding structures (as transitive closed triads) and bridging structures (as betweenness centrality) are not antagonistic. These findings cast new lights on the important phenomenon of small-world networks that incorporate both structures to address fears of defection and lack of coordination. These are not competing forces for network self-organization capacity, but rather combined forces that influence different network structures in tandem. However, while bonding and bridging preface conflict resolution within partnerships, they may also have an unintended negative side. These forces may also prevent self-organization capacities that favors heterophily in collaborative relationships. That is collaboration that cut across boundaries of sector affiliation and administrative level as facilitators for innovation and its scaling.

The inferences this paper can make are limited by survey response rates. Thus, we also use qualitative data extracted from 13 semi-structured interviews, where respondents offered evidence that support our qualitative findings.

This study has a limitation. While cross-sectional methods such as ERGMs permit the assessment of whether network configurations are more prevalent than would occur by chance, the method hinders the exploration of patterns of network change over time. Thus, continuous mapping of these MSPs over time would enable a longitudinal and more accurate analysis of the evolution of networks.

For future research, a wide range of alternative network structures can be explored to evaluate bonding and bridging effects in network formation. The selection of network configurations for this paper can be considered somewhat rather basic. However, it provided conceptual clarity for the interpretation of results from the statistical analysis. Future research

can take advantage of new conceptualizations to analyze bonding and bridging structures in more elaborated ways. For example, by operationalizing more complex centrality measures for bridging other than betweenness (i.e., Bonacich centrality) or employ two-network mode analysis for the exploration of social capital structures, including reciprocity and transitivity (e.g., Berardo, 2014). The same goes for the operationalization of functions for innovation, where a focus, for example, on learning processes among network actors, may serve as a more accurate proxy to draw conclusions about innovation capacities.

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APPENDIX 4A. SEMI-STRUCTURED INTERVIEW CONSENT FORM

LONDON'S GLOBAL UNIVERSITY



You have been asked to participate in this brief interview because of your current (or past) involvement in the implementation of the CoST program. This interview is part of the 2020 online survey CoST-UCL you have already responded and conducted by _xx_ from the Department of Political Science of University College London (UCL).

The interview aims to explore your general opinion about the motivations for participating in the implementation of CoST, its challenges so far in your country, and the way how you interact with other stakeholders. The results of this conversation will provide a better understanding of how stakeholders engage with information and knowledge exchange, as well the decision-making process of their multi-stakeholder groups (MSGs).

You should read the following five points below. You can ask questions about anything you do not understand, before deciding whether or not to participate in this interview.

1. The interview is expected to take about 45 minutes.
 2. This interview is voluntary. You have the right not to answer any question, and to stop the interview at any time or for any reason.
 3. Your responses are completely confidential and will only be used for academic and policy research. The material derived from this interview will be stored during the period of one year and destroyed at the end of it.
 4. If approved, this interview will be audio recorded so your responses can be used for reference.
 5. You will not be compensated for this interview.
-

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.*

☐ Yes

☐ No

☐ I give permission for this interview to be audio recorded.

I give permission for the following information to be included (if necessary) in the publications resulting from this study:

☐ my organisation's names ☐ my title ☐ direct quotes from this interview

Name of participant: _____

Signature / online confirmation of participation _____

Date _____

Signature of investigator _____ Date _____

* If you feel you have been treated unfairly, or you have questions regarding your rights as a research participant, you can contact the UCL's Research Ethics Committee at (ethics@ucl.ac.uk). Tel: 020 7679 8717 (London, UK).

APPENDIX 4B. SEMI-STRUCTURED INTERVIEW GUIDE

- a. *Introduction.* The aim of this section is to explain the research objectives, as well as the interview process. In this section the interviewer establishes rapport with the interviewee by answering any further question about the procedure and his/her rights as a research participant.
- b. *Warm up.* The aim of this section is to help the interviewee to relax and unwind by emphasising that there is no wrong or right answer. The interview starts with basic questions about the individual participant: name, age, and name of the organisation he/she represents.
- c. *Main body of the interview.* This section consists of 3 sections related to the research topic.

Background

- (1) Can you tell me about the organisation you represent in CoST?
 - a. How long have you been working for this organisation?
 - b. What roles have you performed during this time?
 - c. Do you have work experience from a different organisation/sector in the past?
- (2) Can you walk me through the process your organisation decided to participate in the implementation of CoST?
 - a. In your opinion, what were the organisational motivations to participate?
 - b. What were the drivers for you (as an individual) to participate directly with CoST? What dragged your attention about the initiative?
 - c. What could have been the main expectations?
- (3) From what you have learnt so far, what is the process through which CoST brings change in the public infrastructure sector?
 - a. What are the most important steps?
 - b. What do you think about the multi-stakeholder group as an implementation tool?
 - c. What else is required for a successful implementation?

Information exchange and interaction within the MSG

- (4) How important is to interact with members of other organisations from the MSG when it comes to issues related to CoST?
- How would you define the level of interactions that you (or other representatives of your organisation) perform with stakeholders of the MSG?
 - What can you get from these interactions? Information, knowledge?
- (5) Would you consider the information and knowledge being discussed in the MSG as valuable?
- For whom? CoST, your organisation, other entities?
 - In your words, what would be the main barriers you have experienced in exchanging valuable information within the MSG? Is difficult to send or receive information from others?
- (6) To achieve positive change according to the objectives of CoST, which are the organisations within the MSG that you would consider as the most important (or influential)?
- Why these actors and not others?
 - How would they trigger change in the infrastructure sector?

The role of the national secretariats and assurance teams

- (7) During the time of your participation in CoST, how would you describe the role and performance of the National Secretariat?
- How would you classify the National Secretariat? (a) As a facilitator for the organisation and management of the MSG; (b) as a conciliator or mediator between organisations in conflict; (c) as an entity with its own objectives; (d) other? Why?
- (8) Now, what you can tell about the role and performance of the Assurance Team in your country?
- How reliably is the information and evaluation they provide about the infrastructure projects?

(9) Do you have any suggestions for these entities to improve their role within the implementation of CoST?

(10) Is there anything else you would like to add to the previous questions of this interview?

D. Cool off. When the main topics have been covered, this section should begin to prepare for winding down the interview.

E. Closure. The interview will conclude by asking the respondents if they have anything, they would like to add to what they have already told, and if there is anything, they would like to ask the interviewer. This section concludes the interview by offering the respondent sincere thanks for taking the time to concede the interview.

END OF THE INTERVIEW

APPENDIX 4C: GOODNESS OF FIT TESTS

One of the most important aims of the statistical analysis proposed in this paper is to find the most appropriate models of information exchange and collaboration for every MSPs in the sample. Thus, ERGMs were checked for potential degeneracy and goodness-of fit through visual inspection of the standard plots that the *btergm* package (1.10.6) in R generates.

We used the default formula of *btergm* package of well-known network statistics for directed networks of information exchange: *outdegree* and *indegree* distribution, *dyad-wise* and *edge-wise shared partner*, *geodesic distance* and *triad census*. The plots of each function are included below, where the thick black line represents the distribution of the observed networks, and the box plots represent the simulated networks to assess the goodness of fit (Hunter et al., 2008).

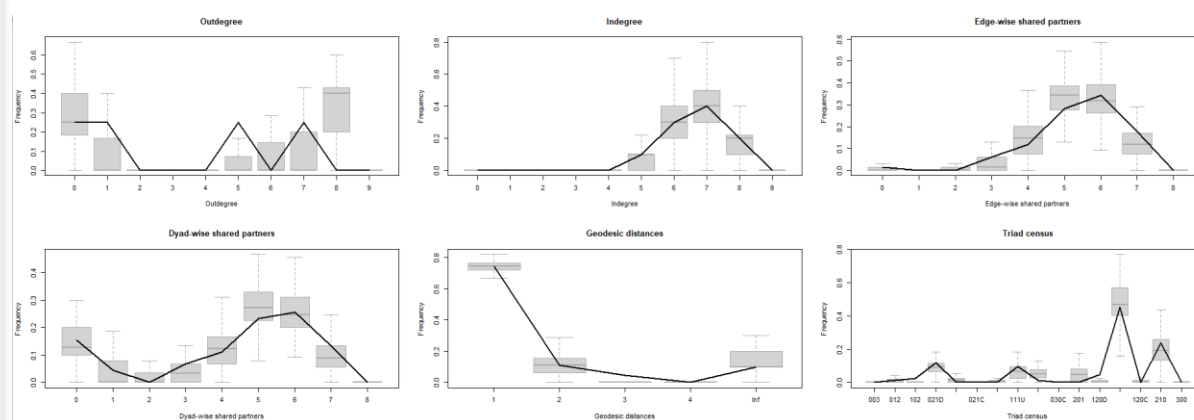
GOF information exchange networks

Figure 4.4 shows that simulated networks are indistinguishable from the original networks by eyeballing the six functions included in the GOF tests. In some minor instances, distributions of the original networks are hardly caught by the parametric model, especially in those of *indegree* and *outdegree* distributions. In cases such as MSPs in El Salvador, Costa Rica and Panama, these two distributions are slightly underrepresented by the simulations. However, by tweaking the ERGMs to improve this, would mean overfitting the models.

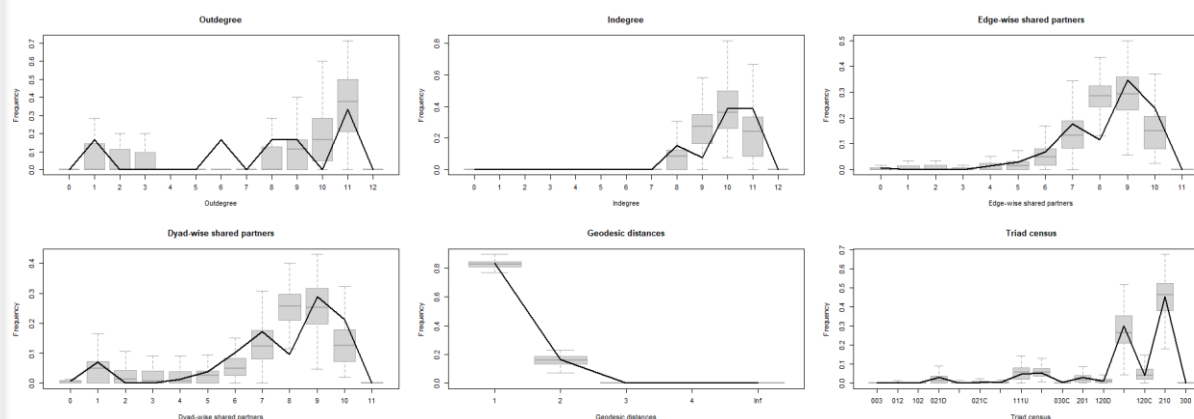
Overall, the simulated distributions for the information exchange networks seem to represent the original networks quite well if we consider the overall picture. The models seem to capture most of the variation within the most significant functions simulated in the GOF. The simulated graphs statistics predict the original networks with high-level accuracy.

Figure 4. 4 GOFs information exchange networks

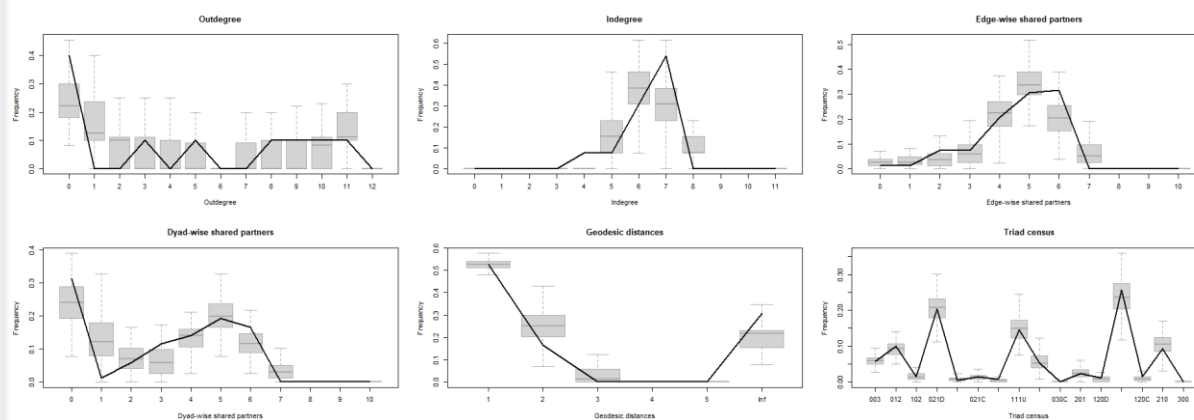
El Salvador



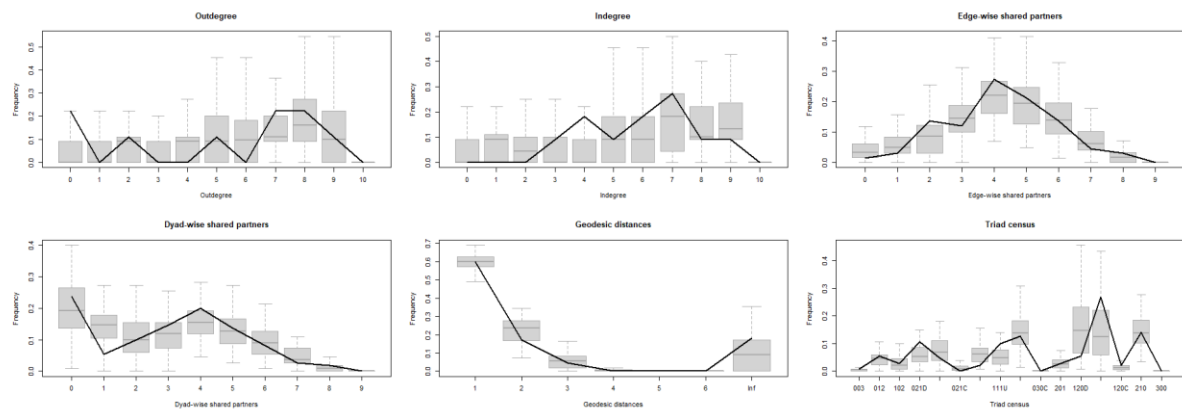
Costa Rica



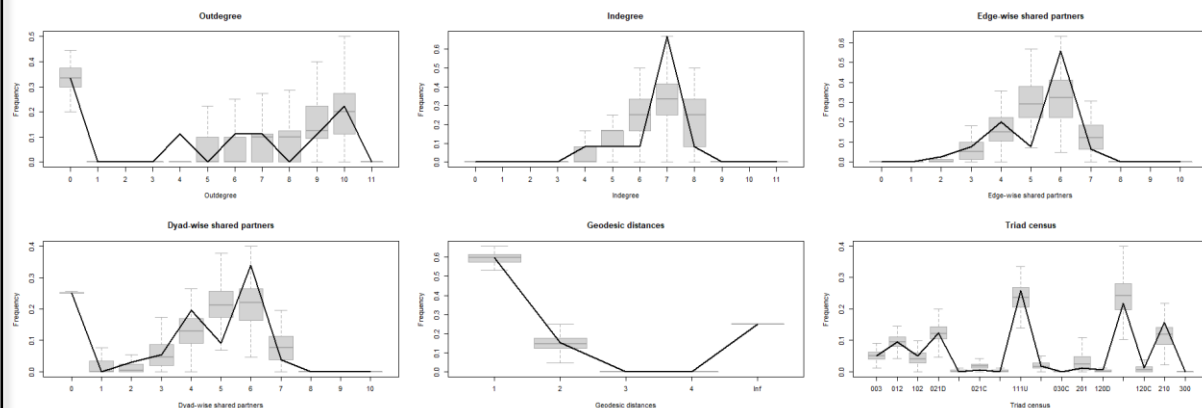
Guatemala



Honduras



Panama



APPENDIX 4D: BETWEENNESS FOR INFORMATION EXCHANGE NETWORK

<i>Sector</i>	<i>Costa Rica</i>	<i>El Salvador</i>	<i>Guatemala</i>	<i>Honduras</i>	<i>Panama</i>
<i>Aca</i>	-	0.40	-	-	-
<i>AT</i>	12.27	8.00	4.62	0.00	
<i>CS</i>	2.54	0.40	5.63	14.32	5.32
<i>NS</i>	0.00	2.73	4.17	3.37	2.87
<i>Obs</i>	5.59	-	0.00	-	0.00
<i>PriS</i>	0.30	3.73	5.42	9.37	0.00
<i>PubS</i>	5.30	2.73	6.17	1.95	11.82

*Sum of the scores of betweenness centrality per sector. Public sector (PubS), Private sector (PriS), Civil Society (CS), Academia (Aca), Observer organization (Obs), National Secretariats (NS), and Assurance Teams (AT).

APPENDIX 4E: QUANTITATIVE ANALYSIS

1. R codes for quantitative data
 - Descriptive data of networks
 - Network visualizations
 - ERGMs
 - Goodness-of-fit tests

CHAPTER 5. CONCLUSION

Governance networks have increased in popularity. As societies have grown and their problems become more complex, there has been an awareness that governments, working alone, can no longer handle the challenges that stem from these transformations. Instead, there has been a growing emphasis on replacing insular efforts with more integrated platforms of collaboration and collective action. These collaborations take the form of governance networks that promise to offer effective consensus-building, knowledge-sharing, and interest representation (Agranoff & McGuire, 2001; Mandell, 1999).

The difficulty has been that although governance networks are being energetically encouraged by governments and multilateral organizations in the form of public-private alliances, partnerships, or joint collaborations (WSSD, 2018; UNEP, 2017), a related growing concern is whether such arrangements are more effective than those involving a single actor in solving these problems. As a result, academic interest has increased in evaluating these collaborative platforms.

To date, strikingly little is known about three dimensions of governance networks. These dimensions have been neglected in the literature of public policy and public administration (Kapucu, 2015). Within the network-level scope for network effectiveness assessment, a framework developed by Provan and Milward (1995) and further extended by Turrini et al. (2010), I identified three dimensions of inquiry at the network level that remain scantily studied (see Table 1.1 in Chapter 1).

These are dimensions that refer, first, to the network actors' motivations to participate in governance networks. This first dimension unveils an alternative perspective to understand network integration by looking at the relationship between direction of participatory motivations (whether pro-social or self-interested) and how actors' perceptions of influence change, as a result of these motivations. Second, opportunity structures are evaluated as underlying conditions that facilitate or inhibit information exchange. As part of the network composition scope, this dimension sheds light on how actors' evaluations on maximizing information outreach modifies their behavior in the process of contact-making. Third, within the network inner stability scope, I explore how risks of collective action affect network actors' self-organization capacity and their capacity to innovate.

While several studies have highlighted these dimensions separately (see Esteve & Schuster, 2020; Ryan & Decy, 2000; Le Grand, 2003; Ansel & Gash, 2008; Carpenter, et al., 2004; Feiock, 2013; Roger, 2003), across a wide range of literatures, this body of work has not been adapted empirically to governance networks. This thesis set out to address some of these research opportunities.

The thesis employs relational data collected in 2020 from ten multi-stakeholder partnerships (MSPs) from Latin America, Africa, and Eurasia. These MSPs are tasked with implementing anti-corruption governance mechanisms in the public-infrastructure sector from El Salvador, Costa Rica, Guatemala, Panama, Honduras, Ethiopia, Malawi, Ghana, Ukraine and Afghanistan. These MSPs offer an example of complex governance systems managed collaboratively by organizations in the public and non-public sectors, under the aegis of the Infrastructure Transparency Initiative (CoST).

Summaries of chapters

Although governance networks are designed to flatten the power of individual actors, some are more influential than others. This sets the conditions for actors to increase their capacity to influence the collective decision-making process (Bryson, 2004; Faul, 2016). In the literature of sociology and organizational-studies, influence is generally understood as the perceived importance of actors involved in group dynamics, when evaluated by their peers (Ingold & Leifeld, 2016; De Klepper et al., 2017).

On the other hand, governance networks find challenging to motivate actors to share information and solve problems collectively. Actors have limited time, energy, and knowledge to spend on collaboration; the believe that their contributions will not be valued or rewarded as expected, is a feature identified in several studies (Fischer & Maag, 2022). Potential rewards for actors can be extrinsically self-interested (reputation, profit maximization, etc.) or intrinsically pro-social motivations (altruism, philanthropism, etc.) (Besley & Ghatak, 2018; Esteve & Schuster, 2020).

In Chapter 2, I explore this unresolved tension that unfolds among governance-network actors, fueled by two conflicting rationales. I addressed this tension by investigating whether pro-social or self-interested motivations attenuate or augment asymmetries of influence. By

employing social-network measures in a logistic regression path analysis, this chapter reveals that information is more likely to be exchanged by self-interested actors, rather than their pro-social counterparts. In MSPs, self-centered organizational stakeholders develop influence over others. Evidence shows that information exchange within networks serve as a mediator to explain perceived influence.

Findings may suggest that actors are more likely to engage in collaborations because they expect to be rewarded, either directly or indirectly. Perceived influence, which can be seen as a reward may accrue to participants who proactively exchange information, undermining MSPs' formal institutional narratives of inclusiveness and interests representation. Thus, Chapter 2 raises concerns about the collaborative contributions made by self-interested actors while participating in collective action platforms, which may end up amplifying disparities rather than equalizing them (see Faul, 2016; Schrank & Whitford, 2011). These results unveil a problematic scenario for MSPs if the knowledge and information exchanged are influenced by self-interested (rather than public goods-oriented) stakeholder motivations, given their associated biases and expected outcomes of the collaboration.

A second dimension of inquiry in this thesis is present in Chapter 3. It refers to the questions of how information exchange unfolds among several network participants? And what are the underlying conditions that facilitate or inhibit this process? Information exchange is the lifeblood of governance networks. Information exchange helps to overcome collective actions dilemmas that are prevalent in most collaborations, because information provides direction of the collective efforts. The understanding of this process is significant in settings of everchanging conditions, complexity and fragmented authority.

I argue that establishing information relationships within governance networks, is not incidental. Network actors may employ several opportunity structures simultaneously to minimize costs and maximize access to the information needed. By using Exponential Random Graph Models (ERGMs), Chapter 3 tests theoretical explanations of network emergence based on (1) preference similarity, but also on (2) institutional venues (policy forums or committees), (3) social capital, and (4) preferential attachment (influential actors). These opportunity structures were further tested in networks of technical and political information exchange, because these two types of information serve different purposes for MSPs.

Results from this chapter show that opportunity structures indeed help to overcome transaction costs. Despite stakeholders sharing similar beliefs of participation, their contact-making behavior is conditioned by other type of factors. This reveals a logic of weaving webs of information exchange considering the proximity of current and new contacts. Representative actors of stakeholder organizations that attended same institutional venues, such as committees for infrastructure project selection, disclosure of technical details to the public, and/or following up of recommendation to procurement agencies, are largely responsible for the exchange of information across the different networks in which the hypotheses were tested. Co-assistance to the same committees, rather than general meetings proved to be the main driver of network formation, even for the political and technical networks. However, information exchange in these settings rely heavily on homophily type of relationships, in opposition to heterophily interactions among the different sector affiliation. Findings cast a shadow on MSPs' capacity to work collaboratively based on cross-sectoral relationships.

Finally, Chapter 4 explores the argument that given the inherent uncertainties and ambiguousness of collaborative processes, governance networks are likely to create adaptive mechanisms to cope with risks. When actors experience cooperation risks or fear of partner defection, they tend to self-organize in bonding structures that facilitate the flow of redundant information. This helps to identify and penalize defectors (Berardo & Scholz, 2010). While facing coordination risks, on the other hand, actors experience lower defection threats and so they tend to create links that facilitate the emergence of bridging structures, providing access to new information and collaborators to synchronize collective efforts (Berardo & Lubell, 2016). Both network structures allow actors to follow different partner-selection strategies and gain higher payoffs when coping with collective action risks.

Through a mixed methods data analysis of actors' engagement in information exchange and collaborative networks of five Latin-American MSPs, Chapter 4 shows that bonding and bridging are not mutually exclusive strategies for actors' self-organization capacity. Although bonding structures are more dominant across the MSPs, bridging also plays an important role, indicating that MSPs address both coordination and cooperation problems simultaneously. However, the strong preference for bonding and bridging does not preclude the fact that stakeholders organize themselves through homophily rather than heterophily versions of these structures, which decrease functions for innovation. That is, actors prefer to mitigate risks by clustering with other actors from their same sector affiliation and same administrative level.

The consideration of these three dimensions of inquiry, scantily explored in the literature of public policy and public administration, is key for managers, policymakers and practitioners to make sense more broadly about network-level characteristics for governance networks. MSPs, as examples of networks of governance do not always assure stakeholder participation, a feature that is generally given for granted. Stakeholders' motivations, own evaluation of maximisation of contact-making and perceptions of risks have proved to play an important role in how networks are shaped, but also how they can be strategically rewired for better collaborative dynamics and outcomes.

Contributions

This thesis contributes to the fields of governance networks, multi-stakeholder partnerships and collective action, all characterized by polycentric governance systems of fragmented authority. This thesis does not pretend, though, to make specific suggestions on how to organize and manage multi-stakeholder collective action partnerships (for this, see Hemmati, 2002; Susskind & Cruikshank, 1987; Faysse, 2006). In what follows, I explain the main contributions that this thesis offers. These contributions unfold in three parts.

Contributions to theory

Theoretically, the thesis contributes to the fields of governance networks, multi-stakeholder partnerships and collective action, all characterized by governance systems of fragmented authority. It showcases a research approach that can enrich these fields as it draws on theoretical premises from political science (influence and power), psychology (motivations and perceptions) and new institutional economics (transactional costs). Further, it evaluates and offers fresh insights related to popular claims about theories related to collaborative risks (Berardo & Scholz, 2010), innovation diffusion (Rogers, 2003), the Advocacy Coalition Framework (Sabatier & Weible, 2007), social capital (Putnam, 1993; Coleman, 1988), resource-dependence and social-exchange (Pfeffer & Salancik, 1978; Blau, 1964).

Contributions to methods

Methodologically, this thesis contributes to the literature on relational data collection and treatment. Successful data collection took place thanks to the design of a distinctive online survey template used for data collection across different national contexts, languages, and sector boundaries (see Appendix G4). The survey template can be used in future research for network analysis, prioritizing confidentiality of participants.

Some of the concepts this thesis focuses on, have been, until now, researched mostly in the context of single- and isolated-network analysis. The thesis advances methodologically with special network data treatment by stacking several network matrices diagonally as input files for advanced network analysis techniques. This data structuration has enabled the identification and exploration of global patterns across a wide range of relational datapoints from different networks at the same time (see statistical analysis in Chapters 3 and 4).

Finally, network analysis is typically applied as a quantitative method, which has significant limitations. Quantitative methods can capture the form of relationships, but they are less suitable for capturing the content of relationships. Chapter 4 fills this gap, by offering mixed methods through semi-structured interviews and quantitative social network analysis approaches, with interview data substantiating and complementing statistical analyses.

Contributions to practice

In terms of practical application, this thesis tests mechanisms that can be used by partnership conveners, practitioners, and network managers to encourage or enrich stakeholder engagement in collective action endeavors. From Chapter 2, it was learnt that practitioners and conveners can design reward mechanisms that satisfy network actors' more private objectives, while enabling them to contribute to collective goals. This chapter also proves that establishing multi-stakeholder partnerships does not necessarily moderate existing asymmetries of influence or information. On the contrary partnerships may amplify these disparities, and thus, different collaborative platforms must be pondered before choosing MSPs as the prefer method for collective action.

From Chapter 3, important lessons can be drawn. By modeling the process of tie formation through the assessment of different opportunity structures, the study offers insights

to help policy-makers and practitioners in the design, maintenance, and rewiring processes of governance network for more effective outcomes. It also sheds light on which stakeholders prefer to share technical or political types of information, which may impact the way how they interact with others and create productive relationships.

Chapter 4 has also practical value. While research has been done separately on both research streams (risk hypothesis and innovation diffusion), there has been a lack of research that couples both processes as part of governance networks' capacity to support multiple social processes. This study contributes to understand networks' sustainability and resiliency by assessing whether certain types of network structures, as a result of risks perceptions, are more dominant than others, and how these affects impact positively or negatively networks' capacity to innovate.

From a practical perspective, the five Latin American case studies explored in Chapter 4 offer the opportunity to refine value propositions from the literature with practical implications. The chapter compared MSPs and found striking differences between them, possibly as a result of their partner composition, institutional capacity, and modus operandi in challenging contexts for the implementation of anti-corruption governance mechanisms. All of which should be taken into account in practical assessment for the viability in MSPs design and implementation.

Limitations and future research

The three stand-alone papers presented in this thesis face methodological limitations. While I believe that results from Chapter 2 provide compelling evidence regarding some of the determinants of influence, I am also aware that the mediation model employed here is the most rudimentary and simple model available for statistical analysis. It may greatly oversimplify the complex dynamics through which participatory motivations impact perceived influence in real-world processes. Chapter reveals, however, a key piece of the puzzle.

Future scholarship should explore the role of motivations in more elaborated models and verify whether this thesis' findings provide a valid explanation for networks' perceptions of influence when alternative mediating or moderating variables are considered (e.g., meetings attendance, network size and network maturity).

At present, I have assumed that the findings of this thesis may be generalizable to other types of networks and not only to governance networks, given that the cross-sectoral and multi-stakeholder nature is shared across these different types of networks (i.e., policy, collaborative, coordinative networks, etc.). More research is needed in this respect. Future research could be fruitfully undertaken by considering alternative types of networks as research settings. This would help to disentangle the conditions under which influence imbalances, for example, lead to fragmentation or disintegration of different types of networks that depends on the engagement of a number of actors to find solutions collaboratively.

Across the chapters, the data is characterized by actors that have presumably invested time and resources for the implementation of a transparency initiative at the country level. Data collected did not cover the founders of the initiative (the board of directors), which are representatives of stakeholder groups. The distinction between stakeholders at national and international level is important for global initiatives. The latter group may have different set of incentives to participate in governance networks, possibly unveiling a different rationale to the one found in this thesis. This is one limitation that future scholarship could try to overcome, by comparing relational behaviors among different levels of multi-stakeholder spaces through multi-level network analysis.

In Chapter 3, while cross-sectional methods such as ERGMs enable the assessment of whether certain network configurations are more prevalent than would occur by chance, it hinders the exploration of how patterns of network change over time. Continuous mapping of the MSPs over time would enable a longitudinal and more accurate analysis of the evolution of networks, linking the network analysis with the actual performance of the partnerships in achieving their goals (i.e., achieved outcomes).

In order to contribute to this chapter's findings, future research can pursue a deeper exploration of stakeholders' committee attendance from the perspective of two-mode network analysis (e.g., Berardo & Lubell, 2016), where nodes connect each other through their joint participation in committees. Such analysis would help to unravel new two-mode network configurations, and assess how the participation in these forums determine the structuration of information exchange between stakeholders.

From Chapter 4, a wide range of alternative network structures can be explored to evaluate bonding and bridging effects for network formation. The selection of network configurations

for this chapter can be considered somewhat basic. However, it provided conceptual clarity for the interpretation of results from the statistical analysis. Future research can take advantage of new conceptualizations to analyze bonding and bridging structures in more elaborated ways. For example, by operationalizing more complex centrality measures for bridging other than betweenness (i.e., Bonacich centrality, to assess relative power of nodes) or, as it has been mentioned before, by employing two-network mode analysis for the exploration of social capital structures (e.g., Berardo, 2014). The same goes for the operationalization of functions for innovation, where a focus, for example, on learning processes among network actors, may serve as a more accurate proxy to draw conclusions about innovation capacities, rather than approach presented in this thesis based on cross-sectoral and administrative level heterophily.

Along with CoST, other well-established transparency initiatives, including The Extractive Industries Transparency Initiative (EITI), The Open Government Partnership (OGP), and The Global Initiative for Fiscal Transparency (GIFT) rely on formal and independent multi-stakeholder partnerships for the implementation of anti-corruption mechanisms in a range of areas. An implication of this, is that results of this thesis can be explored and improved by collecting data from these alternative research settings, scantily studied in the literature within the three dimensions proposed in this thesis.

In spite of any limitations, the thesis stands to contribute to emerging approaches to study governance networks. The strong reliance on network analysis to measure variables and to methodologically treat the data, provided benefits and limitations, some of which I attempted to address by complementing network analysis with path analysis, semi-structured interviews and assuring a clear network boundary delimitation, according to best practices for network evaluations.

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GENERAL APPENDICES

APPENDIX G1. INVITATION RESEARCH PARTICIPATION

LONDON'S GLOBAL UNIVERSITY



To whom it may concern,

At the department of Political Science from the University College London (UCL) we are genuinely interested in the work being undertaken by the **[name of initiative]**. We believe that its efforts to develop standards to improve transparency and accountability in public infrastructure will shape a more pluralistic and sustainable landscape in this industry.

Clearly, this would not be possible without the advantages of multi-stakeholder collaboration. However, we know this is not an easy task to manage. There are endemic tensions and conflicts that deter effective accomplishment of collaborative objectives due to members' multiple institutional logics, power imbalances and the need for members' autonomy versus the interdependence that multi-stakeholder dynamics bring along.

Thus, the question of what moderate or augment these problems in terms of actor attributes and organisational structures has led us to develop an ambitious research programme. Based on anthropology, network governance and mathematical graph theories, we have developed an analytical tool box that enables a fine-grained analysis of the relational structure of members of multi-stakeholder organizations. The tool identifies the current state of communication, participation and integration of members and diagnoses potential new ways to encourage more effective collaboration and structure reconfiguration if necessary.

We, therefore, would like to invite **[name of initiative]** to take part of this research programme. In doing so, we would ask permission to collect data, through a brief online survey (15 min), from the members of its main decision-making bodies (either board of directors or general assembly), because it is in these platforms where the multi-stakeholder interactions unfold. Information will be treated confidentially at all occasions complying with the [General Data Protection Regulation \(GDPR\)](#), which means that no participant will be identifiable after the survey.

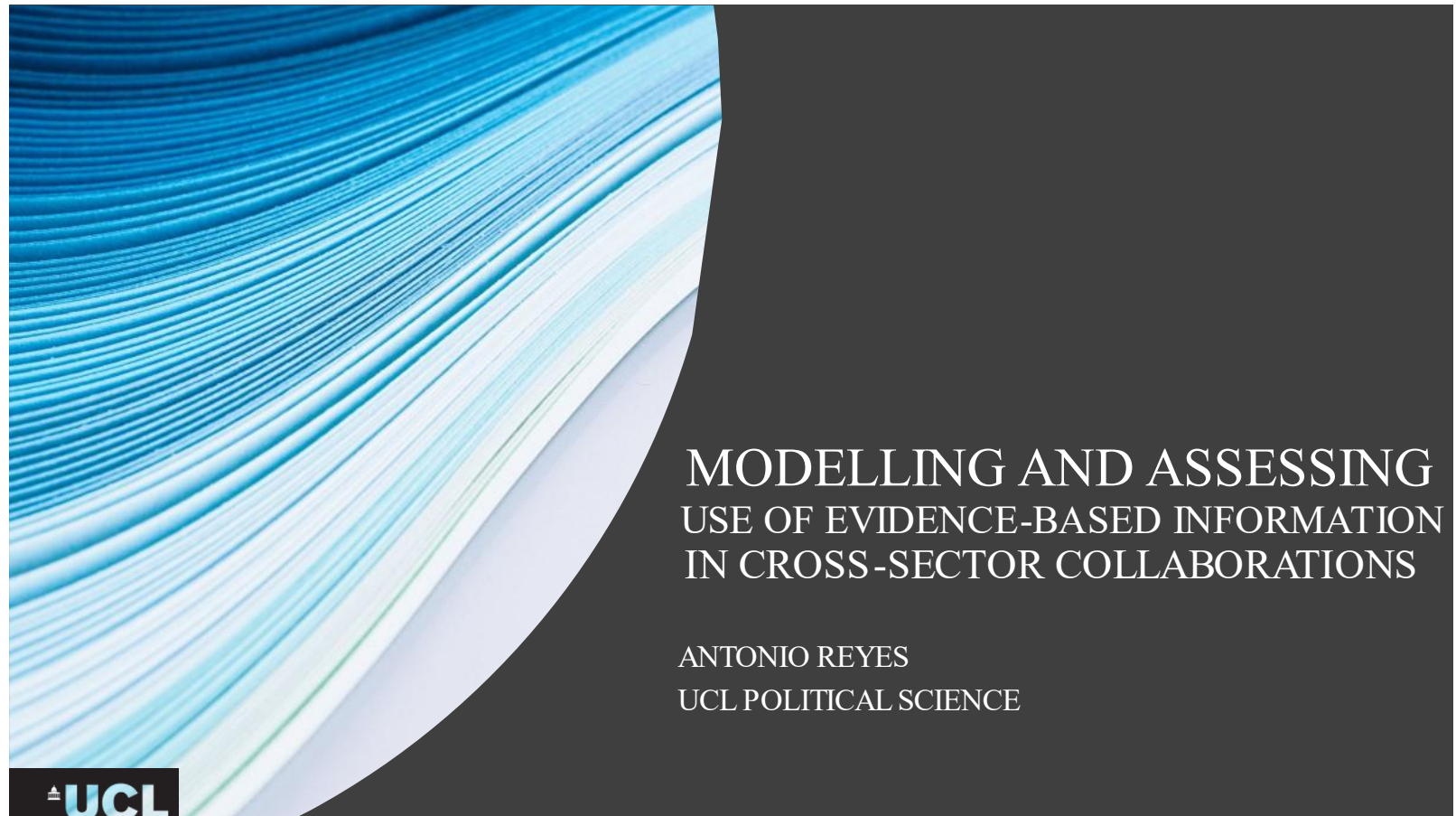
In return, we kindly offer (at no cost) a brief report that may assist decision-makers and managers to understand better the organisation and complement their existing management strategies for multi-stakeholder collaboration by identifying potentially the following information:

1. Topography of the relational network structure of members in main decision-making body.
2. Reciprocity in communication between these members (who are more popular or active).
3. Average distance to collaborate with all members of the main decision-making body (how easy is to communicate and cooperate within the organization).
4. Effective sectoral representation (how it departs from ideal levels).
5. Flows of information and bottlenecks.

Data collected will also serve as input for a doctoral research project to be presented in the [International Conference of Sustainable Development](#) organised by the United Nations and the Sustainable Development Solutions Network in 2020.

We will be very happy to present further details and participation requirements for this study by email or a video conference call. Thank you very much in advance. Sincerely, Antonio Reyes

APPENDIX G2. PRESENTATION OF THE RESEARCH PROJECT TO CoST (January, 2020)



Today's agenda

1. Research overview
2. CoST organizational characteristics
3. Survey
4. Strategies and time frames for survey deployment
5. CoST & UCL's Bartlett School of Construction collaboration.

Team

MA Antonio Reyes (Nottingham Uni) – Leader of project
PhD Student UCL's Department of Political Science



Dr Marc Esteve (Cardiff Uni) – 1st Supervisor
Professor of International Public Management at UCL

Dr Christian Schuster (LSE) – 2nd Supervisor
Professor of Public Management at UCL



Dr Filip Agneessens (Ghent Uni) – 3rd Supervisor
Professor of Social Networks Analysis and Organisational behaviour at
University of Oxford (Nuffield College) & University of Trento



Overview

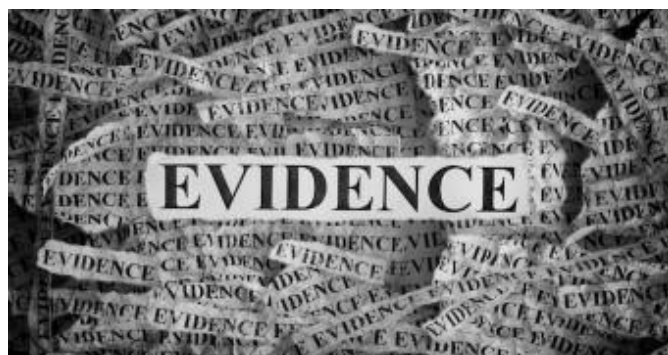
Little understating on the frameworks and mechanisms that bring about and sustain the use of certain types of information in cross -sector collaborations.

The use of evidence-based information cannot be easily monitored or enforced in organisations, let alone to trace it in more complex and uncertain settings involving multiple actors and tasks.

This research project explores the social processes that underly the flows of evidence information between members of crosssectoral collaborations and the conditions that facilitate its absorption and utilization.



Key collaborative resource: evidence -based information



Information that is produced by systematic procedures intended to measure organisational performance. Evidence-based information has the capacity to enhance not only performance, accountability and learning, but also to influence decision and behaviours of users.

Research questions

1RQ. How does use of evidence-based information vary between members of cross-sector collaborations, and why?

2RQ. How does evidence-based information influence outcomes in cross-sector collaborations?



Theories & Hypotheses

Network Theory. It analyses the effects of network phenomena on individuals' behavior.

Elements of analysis:

- Reciprocity (H1)
- Structural equivalence (H2)

Theory of networks: It assesses the effect of individuals' attributes on the formation of certain network structures.

Elements of analysis:

- Homophily (H3 & H6)
- Power / influence (H4)
- Mutual dependency (H5)



Focus on multi-stakeholder initiatives



MSIs are generally seen as a straightforward way ‘to get things done’ through consensus-seeking interaction of different stakeholders.

The presumption seems intuitive for practitioners and decision-makers, empirically there are several issues that make supporting this causal claim rather difficult.

Collaborative members are likely to have conflicting perceptions and goals when solving a problem in common, let alone coordination of strategies to work together.

Previous Research

Westerwinter, O. (2017). Measuring Transnational Public-Private Governance Initiatives in World Politics: A New Dataset. Manuscript: University of St. Gallen.

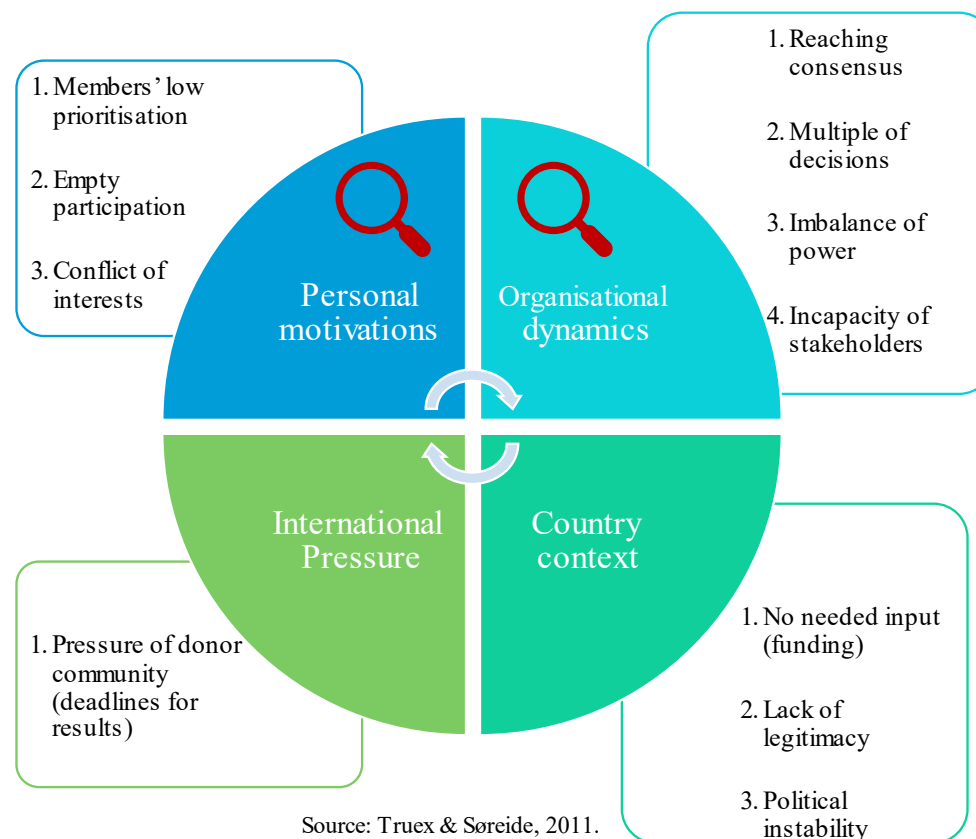
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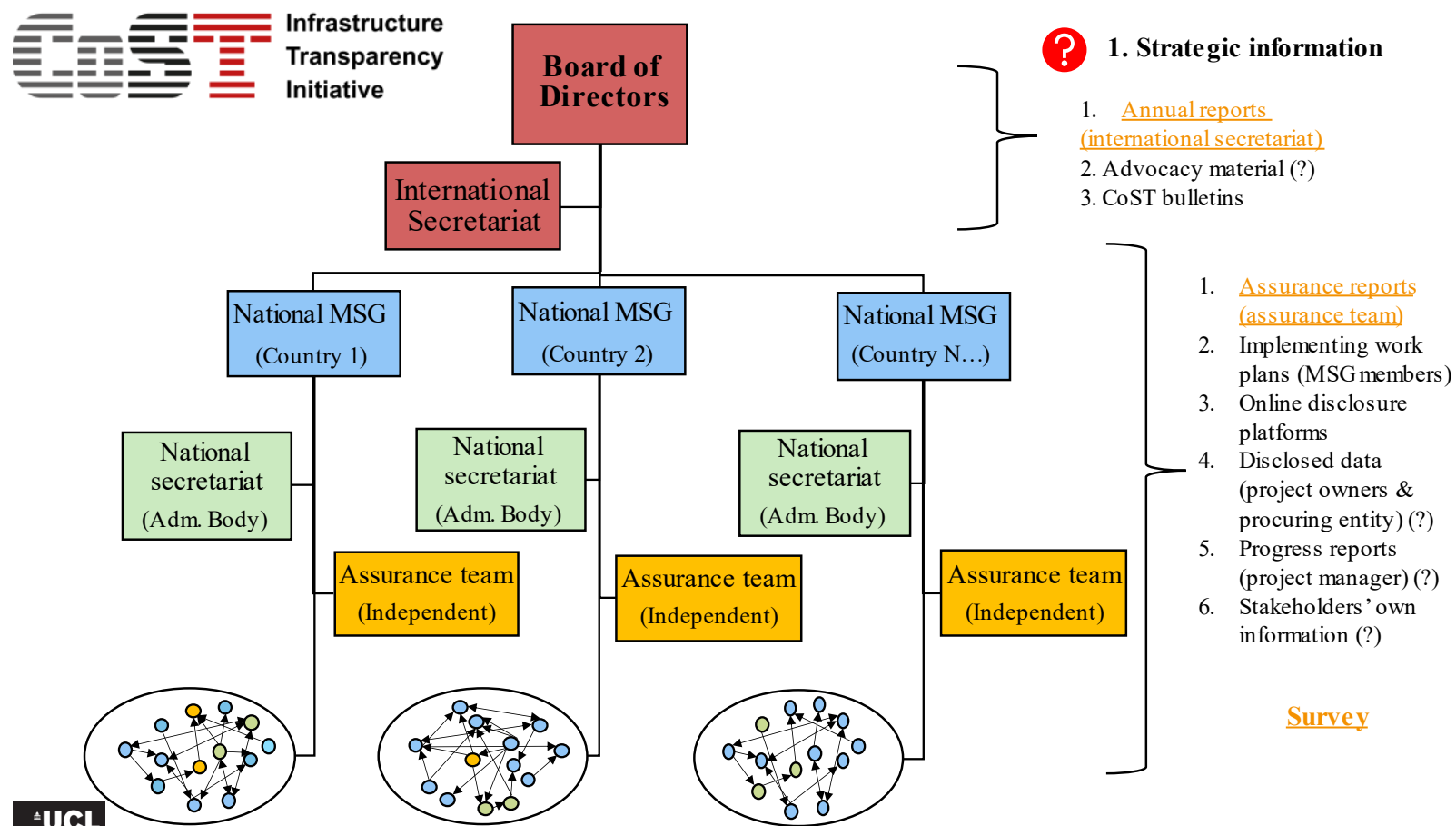
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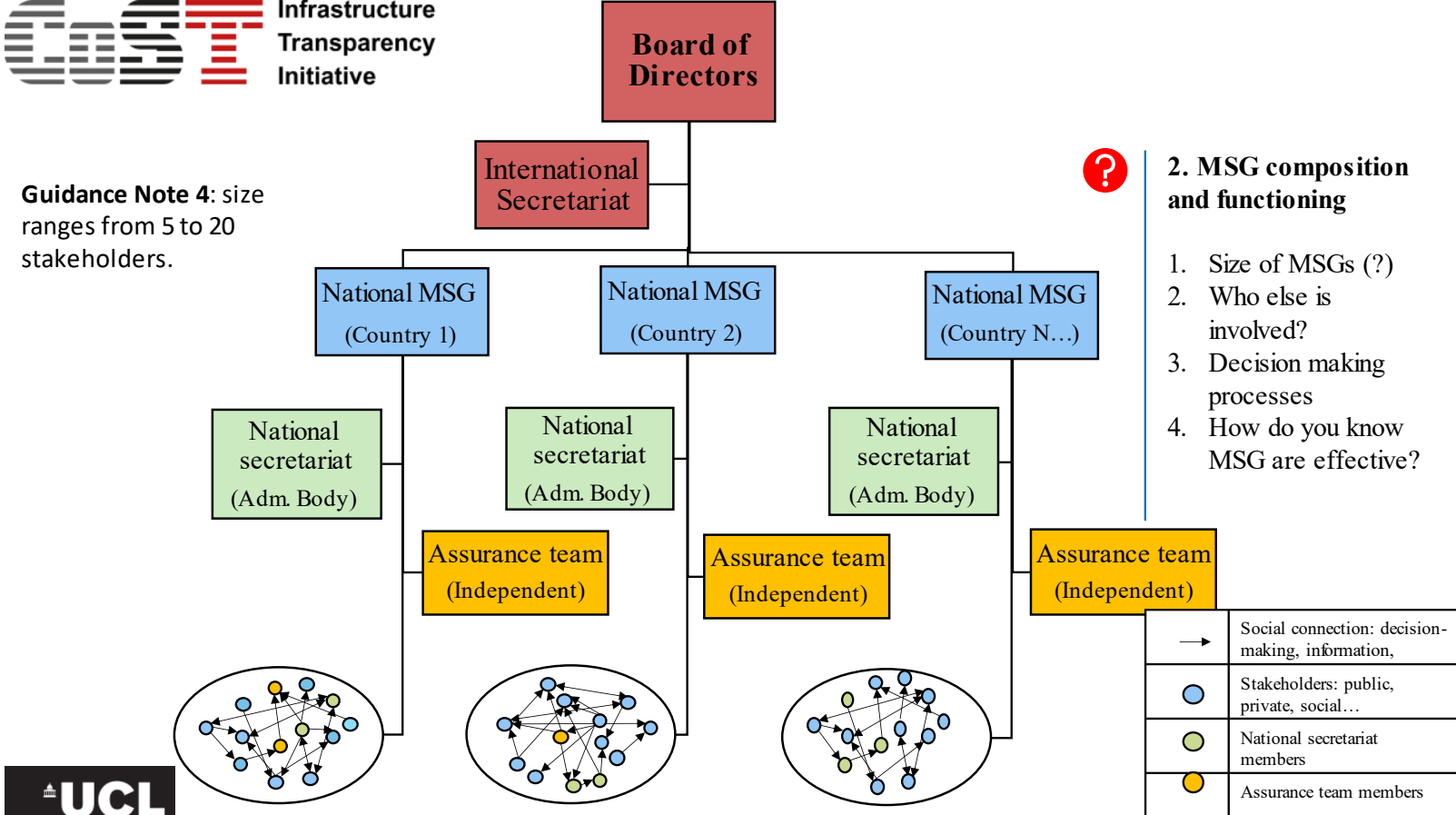
MSG Barriers to Implementation

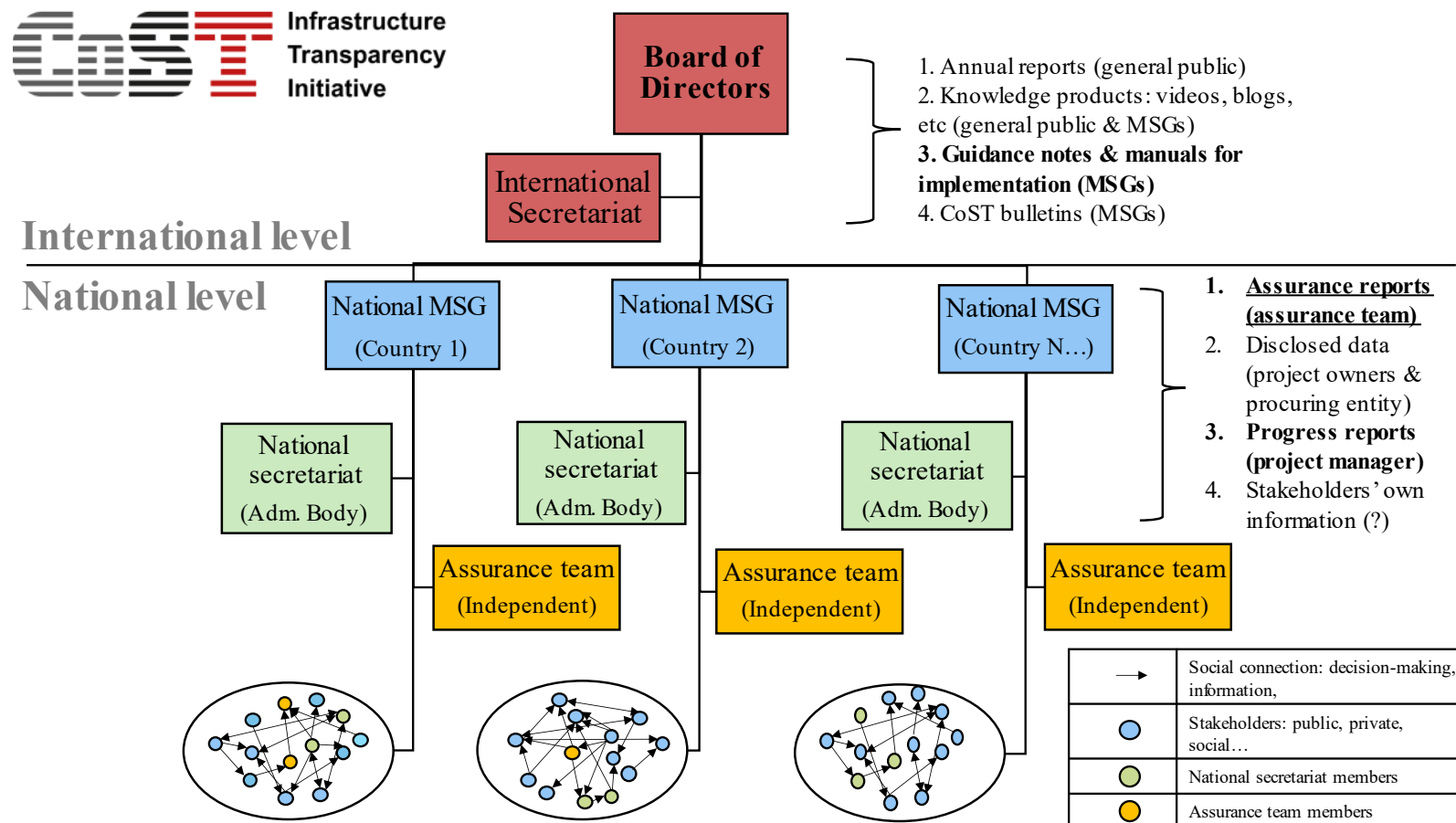






Guidance Note 4: size ranges from 5 to 20 stakeholders.





Countries selected for the sample



Source: <http://infrastructuretransparency.org> (2019).

Countries selected		Honduras	Thailand	Ukraine	Afghanistan	Malawi	Guatemala	Costa Rica	Ethiopia	El Salvador	Panama	Ghana
Information management	Early adopter of CoSTIDS	x					x					
	New Information platform	x	x			x		x	x			
Positive effects	Improved disclosure rates (2017-8)	x	x	NA	NA	NA	x			x		
	Long term outcomes: legal change / support of governments	x		x	x	x		x		x		
	CoST Training or support for disclosed data	x					x					
	MSG involvement with MSG					x	x					
	Overcome political instability					x	x					
Problems	Cost overrun (2017-8)					x	x					
	Time overrun (2017-8)											
	Direct / Emergency contracting		x				x		x	x		
	Security in projects	x			x							



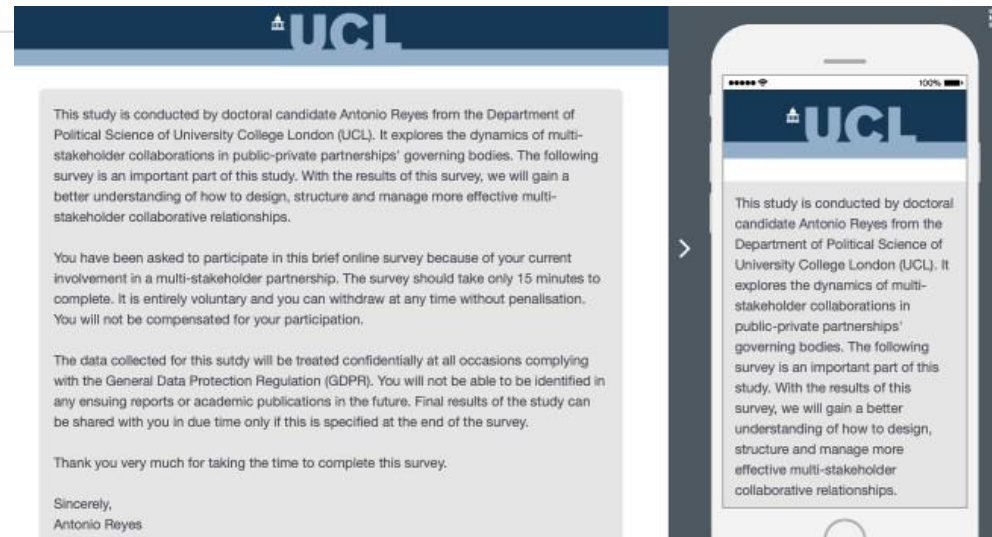
Other countries

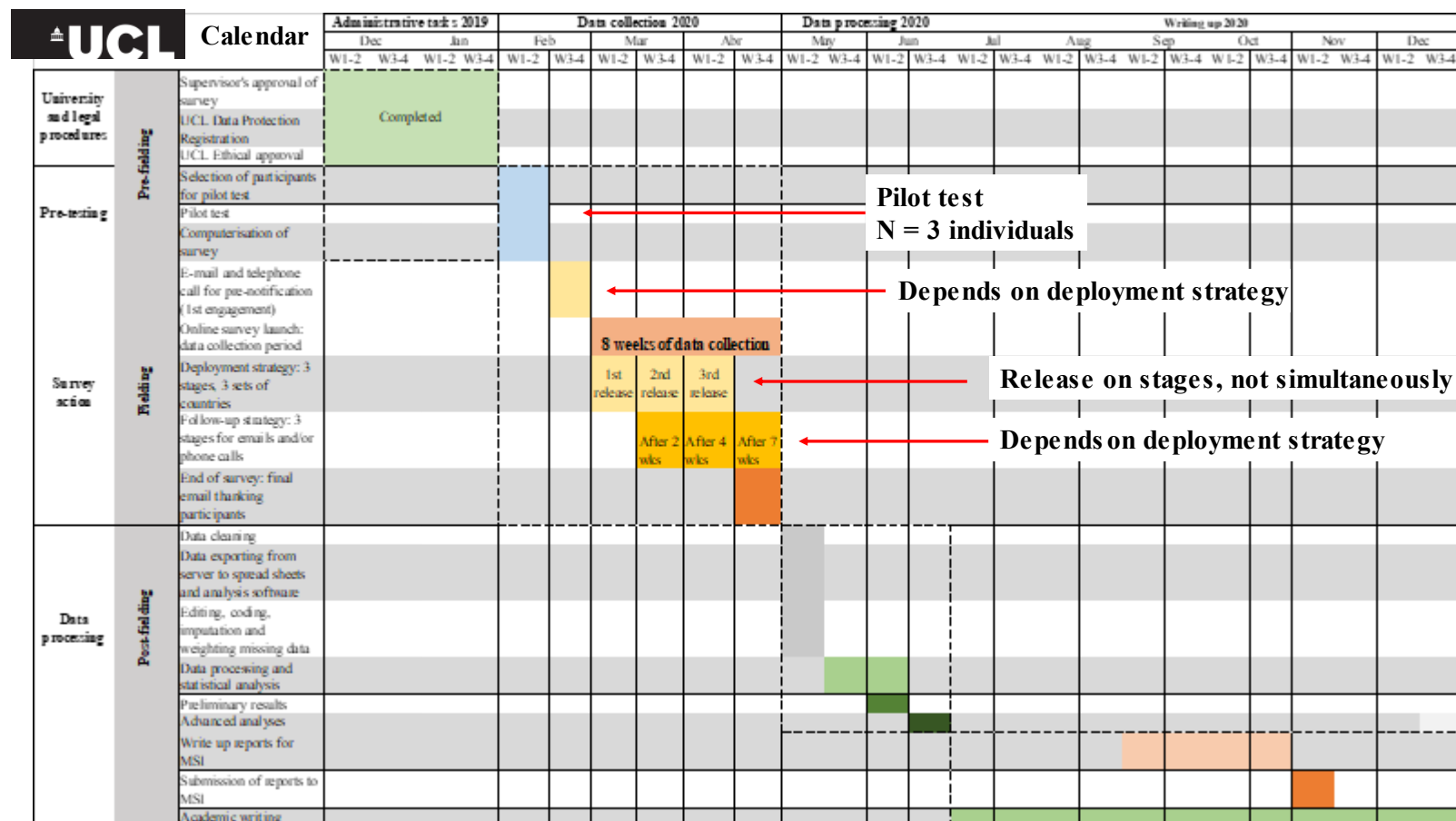
1. Uganda
2. Tanzania
3. Mexico
4. Ecuador
5. Argentina
6. Mozambique
7. Tanzania
8. Indonesia
9. Timor -leste

Source: Hawkins J & Prado MGFA (2019). CoST – the Infrastructure Transparency Initiative: from disclosed data to sector reform. Proceedings of the Institution of Civil Engineers – Civil Engineering.

Data collection instrument

- Online survey. Qualtrics Software. Data storage and data management remains in the European Zone (GDPR).
- Time response: 15 min.
- Items: 30 questions (customised items for every country).
- Language: English  (translations available)
- Time frame: 2 months
- Scenarios of response: consent, soft and hard no consent.







Strategies of survey deployment (estimation of response behaviour)

Strategy name	<u>Invitation</u>	<u>Survey</u>	<u>Follow-ups</u>	Social desirability	Incentives to reply
Highly official	International secretariat	International secretary	International secretary	High 	High
Official	International secretariat	National secretariat	National secretariat	Medium 	High
Relative official	International secretariat	Research team	Research team / National secretariat	Medium 	Medium
No official	Research team	Research team	National secretariat	Low 	Medium
No official	Research team	Research team	Research team	Low 	Low



Aim: To reduce social desirability in responses while incentivizing participation

Calendar

Information to collect



To recap:

1. Definition of sources of strategic information: name and number.
2. Size of participants in countries' MSG/secretariats and assurance teams.
3. Evaluation reports on MSG effectiveness. Alternatively, create an evaluation criteria for this (?)
4. Pilot test: February 2020: who may participate and when?
5. Selection of survey deployment.
6. Languages for the survey.

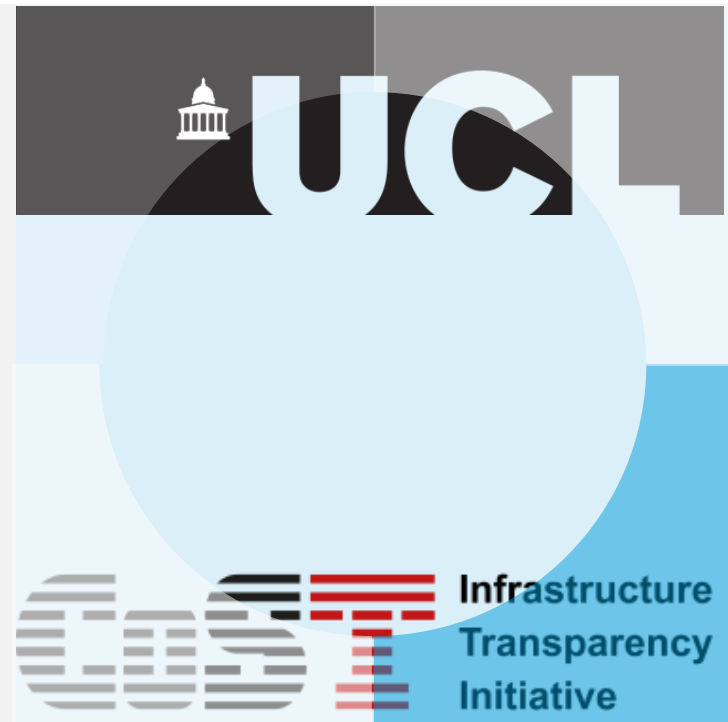
CoST & UCL collaboration

- **Bartlett School of Construction and Project Management**

1. Jacqui Glass (Prof in Construction Management)
2. Dr Armando Castro (Lecturer on project management, corruption and finance)

- **Ideas for collaboration**

1. Event: Presentation of results of CoST / new projects (i.e, South Bank University).
2. Invite students and/or scholars to be part of the assurance teams.
3. Other ?



Thanks

APPENDIX G3. NOTIFICATION OF ETHICS APPROVAL

UCL RESEARCH ETHICS COMMITTEE
OFFICE FOR THE VICE PROVOST RESEARCH



2nd August 2019

Dr Marc Esteve
School of Public Policy
UCL

Dear Dr Esteve

Notification of Ethics Approval with Provisos

Project ID/Title: 15829/001: Management Strategies in Multilevel Networks: The Case of Global Public-Private Partnerships

I am pleased to confirm in my capacity as Joint Chair of the UCL Research Ethics Committee (REC) that I have ethically approved your study until **2nd August 2020**.

Approval is granted on condition that you:

- Amend both consent documents:
 - include privacy notice (see point 14 of the PIL template) in the wording
 - add a tick box that they agree to processing of their personal data, and the 'public task' will be the lawful basis for processing their personal data
 - add who they can contact if they want to complain (the PI or ethics@ucl.ac.uk)

Ethical approval is also subject to the following conditions:

Notification of Amendments to the Research

You must seek Chair's approval for proposed amendments (to include extensions to the duration of the project) to the research for which this approval has been given. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing an 'Amendment Approval Request Form'
<http://ethics.grad.ucl.ac.uk/responsibilities.php>

Adverse Event Reporting – Serious and Non-Serious

It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator (ethics@ucl.ac.uk) immediately the incident occurs. Where the adverse incident is unexpected and serious, the Joint Chairs will decide whether the study should be terminated pending the opinion of an independent expert. For non-serious adverse events the Joint Chairs of the Ethics Committee should again be notified via the Ethics Committee Administrator within ten days of the incident occurring and provide a full written report that should include any amendments to the participant information

Office of the Vice Provost Research, 2 Tavilton Street
University College London
Tel: +44 (0)20 7679 8717
Email: ethics@ucl.ac.uk
<http://ethics.grad.ucl.ac.uk/>

sheet and study protocol. The Joint Chairs will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

Final Report

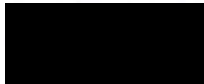
At the end of the data collection element of your research we ask that you submit a very brief report (1-2 paragraphs will suffice) which includes in particular issues relating to the ethical implications of the research i.e. issues obtaining consent, participants withdrawing from the research, confidentiality, protection of participants from physical and mental harm etc.

In addition, please:

- ensure that you follow all relevant guidance as laid out in UCL's Code of Conduct for Research: <http://www.ucl.ac.uk/srs/governance-and-committees/resgov/code-of-conduct-research>
- note that you are required to adhere to all research data/records management and storage procedures agreed as part of your application. This will be expected even after completion of the study.

With best wishes for the research.

Yours sincerely



Dr Lynn Ang
Joint Chair, UCL Research Ethics Committee

Cc: Christian Schuster, Jose Antonio Reyes Gonzalez

APPENDIX G4. ONLINE SURVEY ENGLISH VERSION TEMPLATE (QUALTRICS)

Start of Block: General: Instruction

Q1.1

We would like to invite you to participate in this brief online survey because of your work with the CoST program in [\\${e://Field/Country}](#). This is an independent study conducted by Antonio Reyes from the Department of Political Science of University College London (UCL) in the United Kingdom.

The aim of this study is to provide insights into how collaboration among multi-stakeholder groups works and how information is used to inform decision-making. Results from this study will be valuable to understand and enhance the functioning of CoST program.

This survey takes about 15 minutes to complete and your participation is voluntary, but very important for the outcome of this study. Responses are completely confidential and will only be used for academic and policy research. Therefore, your responses will be anonymized and reported in aggregated form (CoST [\\${e://Field/Country}](#) as a whole). You can choose to receive a copy of the results of this study only if this specified in the survey.

This is an independent study controlled by University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data in compliance with the General Data Protection Regulation (GDPR) within the European Union.

Thank you very much for your valuable time to participate.

Sincerely,

Antonio Reyes

Project coordinator

UCL - Political Science

—
* If you have any doubts or questions about the survey, please contact Mr. Reyes (antonio.reyes.16@ucl.ac.uk). ** If you have questions regarding your rights as a research participant, you can contact the UCL's Research Ethics Committee in the United Kingdom (ethics@ucl.ac.uk).

Q1.2 If you are happy to take part in this survey, please indicate this below:

- ☐ Yes, I consent to participate.
- ☐ No, I don't consent to participate.

End of Block: General: Instruction

Start of Block: General: Ending Survey

Q2.1 You are about to exit this survey. Are you sure about your decision?

- ☐ I wish to continue with the survey.
- ☐ I wish to exit the survey now.

End of Block: General: Ending Survey

Start of Block: General: Start message

Q3.1

Thank you for participating!

Q3.2

Please confirm that you have read and understood the terms of this online survey.

- ☐ I have read and understood the procedures of this online survey described to my satisfaction. I understand that my personal information will be used for the purposes explained to me in compliance with the data protection legislation GDPR for processing personal data.

Q3.3 Before we begin, please specify if you would like to receive a copy of the final report of this study in October 2020?

☐ Yes

☐ No

End of Block: General: Start message

Start of Block: General: CoST Body Selection

Q4.1

Which of the following bodies of CoST do you primarily work for, or are you member of?

☐ Multi-stakeholder Group (MSG)

☐ National Secretariat

☐ Assurance Team

☐ Donor or observer entity (e.g., the World Bank, the British Embassy, etc.)

☐ None of the above (please specify)

Q4.2

Alternatively, if you participate, officially or unofficially, in any other body within CoST, please indicate this here:

End of Block: General: CoST Body Selection

Start of Block: MSG: sector selection & job title in home organizations

Q5.1 Which sector best represents the organization or association you belong to, and that you represent in the in CoST?

- ☐ Public sector
- ☐ Private sector
- ☐ Civil society
- ☐ Academia / Think tank
- ☐ Media
- ☐ Intergovernmental entity

Page Break

Q5.2 What is your job level within the organization or association you belong to?

- ☐ Junior (entry level)
- ☐ Operative level
- ☐ Middle-level management
- ☐ First-level management
- ☐ Executive or top-level (senior)
- ☐ Representative
- ☐ Other (please specify) _____

Page Break

Q5.3 What is your job title within the public sector organization or association you belong to?

- ☐ Minister
- ☐ Vice minister
- ☐ Director
- ☐ Politician
- ☐ Parliamentarian
- ☐ Coordinator of projects
- ☐ Secretary
- ☐ Staff
- ☐ Auditor
- ☐ Consultant
- ☐ Advisor
- ☐ Other (please specify) _____

Page Break

Q5.4 What is your job title within the private sector organization or association you belong to?

- ☐ CEO
- ☐ President
- ☐ Chairperson
- ☐ Regional director
- ☐ Manager
- ☐ Project leader
- ☐ Board member
- ☐ Staff
- ☐ Advisor
- ☐ Consultant
- ☐ Auditor
- ☐ Honorary member
- ☐ Other (please specify) _____

Page Break

Q5.5 What is your job title within the civil society organization or association you belong to?

- ☐ Director
 - ☐ Regional director
 - ☐ Manager
 - ☐ Coordinator of projects
 - ☐ Staff
 - ☐ Other (please specify) _____
-

Page Break

Q5.6 What is your job title within the academic organization or association you belong to?

- ☐ Dean
 - ☐ Principal or provost
 - ☐ Professor
 - ☐ Researcher
 - ☐ Research assistant
 - ☐ Staff
 - ☐ Other (please specify) _____
-

Page Break

Q5.7 What is your job title within the media organization you belong to?

- ☐ Journalist
- ☐ Columnist
- ☐ Reporter
- ☐ Other (please specify) _____

Page Break

Q5.8 What is your job title within the intergovernmental organization or association you belong to?

- ☐ Consultant
- ☐ Economist
- ☐ Officer
- ☐ Specialist
- ☐ Other (please specify) _____

End of Block: MSG: sector selection & job title in home organizations

Start of Block: General: Roles within CoST

Q6.1 What is your role within the [multi-stakeholder group \(MSG\)](#) of CoST ? *Please select all those that apply.*

- ☐ Chair
- ☐ Vice chair
- ☐ General member
- ☐ Member of subcommittee
- ☐ Secretary
- ☐ Assistant secretary
- ☐ Other (please specify) _____

Page Break

Q6.2

What is your role within the [National Secretariat](#) of CoST?

Please select all those that apply.

☐

Country manager

☐

Administrative assistant

☐

Technical assistant

☐

Project / program assistant

☐

Finance officer

☐

Communication officer

☐

Social audit advisor

☐

Open data advisor

☐

Consultant

☐

Other (please specify) _____

Page Break

Q6.3 What is your role within the Assurance Team of CoST?

Please select all those that apply.

- ☐ Infrastructure professional
- ☐ Academic professional
- ☐ Project / program assistant
- ☐ Consultant
- ☐ Other (please specify) _____

End of Block: General: Roles within CoST

Start of Block: General: Motivations & participation in CoST

Q7.1 From all the meetings held by CoST (including subcommittees, if is the case) from January 2019 to December 2019, how many of them were you able to attend?

- ☐ None
- ☐ 1 meeting
- ☐ 2 meetings
- ☐ 3 meetings
- ☐ 4 meetings
- ☐ 5 or more meetings

Page Break

Q7.2 How important are the following choices that may reflect some of your motivations for participating in CoST ? *Please drag the dot in the slider to indicate your selection.*

	Not at all important	Moderately important	Very important								
NA	0	1	2	3	4	5	6	7	8	9	10
To improve value for money in public infrastructure projects.											
To obtain reputational benefits for the organization or association I represent in CoST.											
To engage with key public and private stakeholders in the sector of infrastructure of the country.											
To contribute to the public debate about public infrastructure projects.											
To secure sources of funding for the organization or association I represent in CoST.											
To enhance transparency in governments.											
To co-produce public policies to tackle corruption.											

Q7.3 If there are other important motivations for you to participate in CoST, please include them here:

Q7.4

How many years have you been developing CoST work, or have you been a member of the MSG?

Less than 12 months

- ☐ 1 year
- ☐ 2 years
- ☐ 3 years
- ☐ 4 years
- ☐ 5 or more years

Page Break

Q7.5 Thinking about the organization or association you belong to, and that you represent in CoST, how frequently do you do the following?

NA

Never Occasionally Very frequently

0 1 2 3 4 5 6 7 8 9 10

Provide updates about CoST-related issues to the directors of my organization or members of my association.	
Provide justifications of my activities and decisions within CoST to the directors of my organization or members of my association.	
Make a reference about CoST in reports and discussions with my colleagues.	
Follow recommendations of CoST in my own work.	

End of Block: General: Motivations & participation for CoST

Start of Block: General: Information Dynamics

Q8.1

To what extent have you read the following CoST Guidance Notes?

	None of it	Some of it	All of it	NA							
	0	1	2	3	4	5	6	7	8	9	10
Guidance Note 3: Developing an implementation plan.											
Guidance Note 4: Establishing a multi-stakeholder group and national secretariat.											
Guidance Note 5: Scoping study.											
Guidance Note 7: Designing an assurance process.											

Page Break

Q8.2 How frequently have you discussed the content from those Guidance Notes you have read with members of CoST when discussing CoST implementation issues?

If there are no options displayed below, please go to the next question. Otherwise, please provide an answer.

	Never	Occasionally	Very frequently								
	0	1	2	3	4	5	6	7	8	9	10
Guidance Note 3: Developing an implementation plan.											
Guidance Note 4: Establishing a multi-stakeholder group and national secretariat.											
Guidance Note 5: Scoping study.											
Guidance Note 7: Designing an assurance process.											

Page Break

Q8.3

During general meetings of CoST (or sub-committees meetings), how frequently did you use the knowledge from your professional experience for the following processes about CoST implementation?

	Never	Rarely	Occasionally	Frequently	Very frequently	NA
Selecting relevant indicators of the infrastructure data standard for the country.	☐	☐	☐	☐	☐	☐
Determining how best to communicate CoST activities and outcomes to the public.	☐	☐	☐	☐	☐	☐
Selecting the infrastructure projects for the assurance report.	☐	☐	☐	☐	☐	☐
Advising on the design and preparation of the assurance reports.	☐	☐	☐	☐	☐	☐
Interpreting the findings of the assurance reports.	☐	☐	☐	☐	☐	☐
Following up the recommendations of the assurance reports.	☐	☐	☐	☐	☐	☐

Q8.4 If there are other relevant topics for CoST in which you use your professional knowledge, please indicate them here:

End of Block: General: Information Dynamics

Start of Block: General: Assurance Reports (network question)

Q9.1

Notification

Before you answer the following set of questions, please be aware that your responses are confidential at any moment and they will not be revealed to anyone outside or within CoST.

Please feel free to respond honestly and confidently.

Thank you.

Page Break

Q9.2

Consider all the interactions from last year (January-December 2019) via email or telephone calls, and face-to-face meetings you had with members of CoST.

In these interactions, how frequently did you provide information about public infrastructure-related matters to people that represent the following organizations and/or bodies that develop CoST work?

Please provide an answer in the row with the name of your organization only if you have

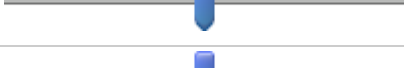
colleagues that also participate in CoST. If you are the only representative of your organization, please answer "Never".

	Never	Rarely	Occasionally	Frequently	Very frequently	NA
Organization X	☐	☐	☐	☐	☐	☐
Organization Y	☐	☐	☐	☐	☐	☐
Organization Z	☐	☐	☐	☐	☐	☐
CoST National Secretariat	☐	☐	☐	☐	☐	☐
CoST Assurance Team	☐	☐	☐	☐	☐	☐

Page Break

Q9.3 How frequently have you discussed the following topics with the people from the organizations and/or bodies of CoST you have selected in the previous question?

	Never		Occasionally		Very frequently					
0	1	2	3	4	5	6	7	8	9	10

Cost and time overruns in infrastructure projects.	
Tender and contract award.	
Safety and wellbeing of infrastructure workers.	
Environmental and social impacts.	
Quality of design and quality in infrastructure projects.	
Poor contract management.	
Following up findings and recommendations of the assurance reports.	

Q9.4 If there are other relevant topics that you have included in your communication with colleagues of CoST, please include them here:

End of Block: General: Assurance Reports (network question)

Start of Block: General: Perceptions on CoST outcomes

Q10.1 To what extent do you agree or disagree with the following statements about CoST work?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	NA
Transparency in public infrastructure projects has increased as a result of CoST initiative.	☐	☐	☐	☐	☐	☐
Corruption in public infrastructure projects has decreased as a result of CoST initiative.	☐	☐	☐	☐	☐	☐
Improvements in transparency thanks to CoST are likely to be durable in the future.	☐	☐	☐	☐	☐	☐
For my organization, participating in CoST has been beneficial despite the time and resources required to participate.	☐	☐	☐	☐	☐	☐
Solutions have been reached in a consensual way by all the stakeholders.	☐	☐	☐	☐	☐	☐

End of Block: General: Perceptions on CoST outcomes**Start of Block: General: Influence (network question)**

Q11.1 Consider the situations in the last year where you had to participate with or without the right to vote in the decision-making process of the implementation of the CoST program.

During these decisions, how frequently where you influenced by the arguments provided by people that represent the following organizations and/or bodies that develop CoST work?

Please provide an answer in the row with the name of your organization only if you have colleagues that also participate in CoST. If you are the only representative of your organization, please answer "Never".

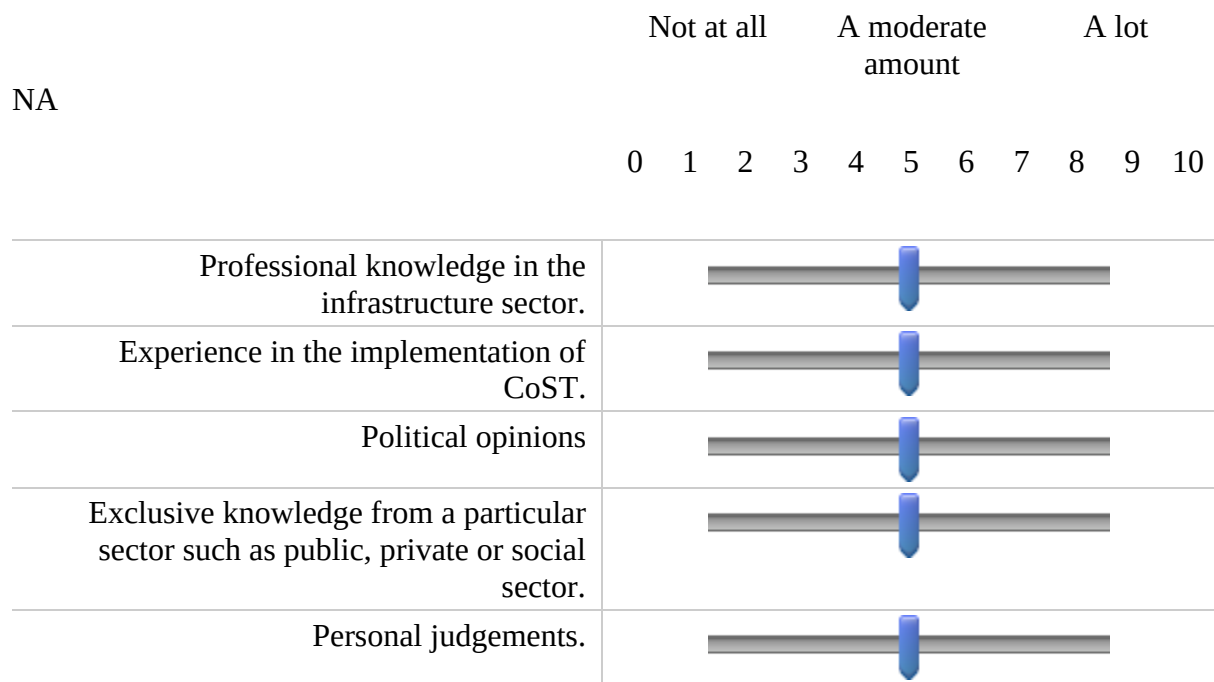
	Never	Rarely	Occasionally	Frequently	Very frequently	NA
Organization X	☐	☐	☐	☐	☐	☐
Organization Y	☐	☐	☐	☐	☐	☐
Organization Z	☐	☐	☐	☐	☐	☐
CoST National Secretariat	☐	☐	☐	☐	☐	☐
CoST Assurance Team	☐	☐	☐	☐	☐	☐

Page Break

Q11.2

How much where you persuaded by the following sources of information used in the

arguments of the people that represent the organizations and/or bodies of CoST that you have selected in the previous question?



Q11.3 If there are other sources of persuasive information used by members of CoST, please indicate them here:

Q11.4 How frequently do you rely on information provided by the following groups of people that may have an impact on how you participate and/or make decisions within CoST?

	Never	Rarely	Occasionally	Frequently	Very frequently
Ministers	☐	☐	☐	☐	☐
Politicians	☐	☐	☐	☐	☐
Court judges	☐	☐	☐	☐	☐
Academics or scientific researchers	☐	☐	☐	☐	☐
Journalists	☐	☐	☐	☐	☐
Community groups	☐	☐	☐	☐	☐
Infrastructure professionals: engineers and architects	☐	☐	☐	☐	☐
Representatives of chambers of commerce	☐	☐	☐	☐	☐
Bankers	☐	☐	☐	☐	☐
Consultants	☐	☐	☐	☐	☐
Family and friends	☐	☐	☐	☐	☐
Representatives of religious groups	☐	☐	☐	☐	☐

Q11.5 If there are other groups of people relevant for you and the way how you participate in CoST, please indicate them here:

End of Block: General: Influence (network question)

Start of Block: General: Embedded structures

Q12.1 Apart from the organizations that are already members of CoST $\{e://Field/Country\}$, are there other existing organizations or local networks in $\{e://Field/Country\}$ responsible for overseeing public procurement or auditing publicly funded infrastructure projects?

These could include NGOs, professional association bodies, infrastructure chambers of commerce, unions, research institutes or public agencies.

- ☐ Yes
- ☐ I don't know
- ☐ No

Page Break

Q12.2 Please provide the full name of these organizations, and assess how beneficial they have been for the transparency of public infrastructure information in your country.

If you do not know the name of more than one of these organizations, please select 'Not applicable'.

Not beneficial		Moderately beneficial		Very beneficial		Not Applicable				
0	1	2	3	4	5	6	7	8	9	10

Name of organization 1	
Name of organization 2	
Name of organization 3	

Page Break

Q12.3 Think about the multi-stakeholder group (MSG) in CoST [\\${e://Field/Country}](#), how agree or disagree are you with the following statements?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	NA
The MSG is a practical organizational arrangement for the implementation of transparency initiatives.	☐	☐	☐	☐	☐	☐
The MSG is an appropriate arrangement since it does not conflict with existing governmental structures in the country.	☐	☐	☐	☐	☐	☐
The MSG is sustainable over time since it has the capacity to overcome political and social conflicts in the country.	☐	☐	☐	☐	☐	☐

Q12.4

In case you have concerns about the multi-stakeholder group (MSG) work or ideas for its improvement, please include them here:

End of Block: General: Embedded structures

Start of Block: General: Demographics

Q13.1 Dear respondent, we are approaching to the end of this survey and we would like to know a bit more about you.

Q13.2 What is the highest educational level you have obtained?

- ☐ Primary education
 - ☐ High school graduate
 - ☐ College
 - ☐ Bachelor's degree / university level
 - ☐ Master's degree
 - ☐ Doctorate
 - ☐ Prefer not to answer
-

Page Break

Q13.3 How old are you?

- ☐ Under 18 years old
- ☐ 18 - 24
- ☐ 25 - 34
- ☐ 35 - 44
- ☐ 45 - 54
- ☐ 55 or older
- ☐ Prefer not to answer

Page Break

Q13.4 Please select your gender.

- ☐ Female
- ☐ Male
- ☐ Prefer not to answer
- ☐ Other (please specify) _____

End of Block: General: Demographics

Start of Block: General: Interview Invitation

Q14.1 Would you be willing to participate in a brief non-personal interview to expand on your opinions about the topics in this survey?

- ☐ Yes
- ☐ Maybe
- ☐ No

Page Break

Q14.2

How would you like to be contacted?

Please provide information on your contact details.

- ☐ Telephone call. _____
- ☐ Email. _____
- ☐ Skype call (Skype ID). _____

End of Block: General: Interview Invitation

Start of Block: General: Final comments

Q15.1 If you have any final comment about this survey, feel free to add it here:

End of Block: General: Final comments

* Please contact Mr Reyes if there is anything that is not clear or if you would like more information about this study (antonio.reyes.16@ucl.ac.uk).

** The controller for this study will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at (data-protection@ucl.ac.uk).

*** If you feel you have been treated unfairly, or you have questions regarding your rights as a research participant, you can contact the UCL's Research Ethics Committee at (ethics@ucl.ac.uk). Tel: 020 7679 8717.

APPENDIX G5. SEMI STRUCTURED INTERVIEW CONSENT FORM

LONDON'S GLOBAL UNIVERSITY



You have been asked to participate in this brief interview because of your current (or past) involvement in the implementation of the CoST program. This interview is part of the 2020 online survey CoST-UCL you have already responded, and conducted by doctoral candidate Antonio Reyes from the Department of Political Science of University College London (UCL).

The interview aims to explore your general opinion about the motivations for participating in the implementation of CoST, its challenges so far in your country, and the way how you interact with other stakeholders. The results of this conversation will provide a better understanding of how stakeholders engage with information and knowledge exchange, as well the decision-making process of their multi-stakeholder groups (MSGs).

You should read the following five points below. You can ask questions about anything you do not understand, before deciding whether or not to participate in this interview.

6. The interview is expected to take about 45 minutes.
7. This interview is voluntary. You have the right not to answer any question, and to stop the interview at any time or for any reason.
8. Your responses are completely confidential and will only be used for academic and policy research. The material derived from this interview will be stored during the period of one year and destroyed at the end of it.
9. If approved, this interview will be audio recorded so your responses can be used for reference.
10. You will not be compensated for this interview.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.*

☐ Yes

☐ No

☐ I give permission for this interview to be audio recorded.

I give permission for the following information to be included (if necessary) in the publications resulting from this study:

☐ my organisation's names ☐ my title ☐ direct quotes from this interview

Name of participant: _____

Signature / online confirmation of participation _____ Date _____

Signature of investigator _____ Date _____

* If you feel you have been treated unfairly, or you have questions regarding your rights as a research participant, you can contact the UCL's Research Ethics Committee at (ethics@ucl.ac.uk). Tel: 020 7679 8717 (London, UK).

APPENDIX G6. SEMI-STRUCTURED INTERVIEW GUIDE

- d. *Introduction.* The aim of this section is to explain the research objectives, as well as the interview process. In this section the interviewer establishes rapport with the interviewee by answering any further question about the procedure and his/her rights as a research participant.
- e. *Warm up.* The aim of this section is to help the interviewee to relax and unwind by emphasising that there is no wrong or right answer. The interview starts with basic questions about the individual participant: name, age, and name of the organisation he/she represents.
- f. *Main body of the interview.* This section consists of 3 sections related to the research topic.

Background

- (4) Can you tell me about the organisation you represent in CoST?
 - a. How long have you been working for this organisation?
 - b. What roles have you performed during this time?
 - c. Do you have work experience from a different organisation/sector in the past?
- (5) Can you walk me through the process your organisation decided to participate in the implementation of CoST?
 - a. In your opinion, what were the organisational motivations to participate?
 - b. What were the drivers for you (as an individual) to participate directly with CoST? What dragged your attention about the initiative?
 - c. What could have been the main expectations?
- (6) From what you have learnt so far, what is the process through which CoST brings change in the public infrastructure sector?
 - a. What are the most important steps?
 - b. What do you think about the multi-stakeholder group as an implementation tool?
 - c. What else is required for a successful implementation?

Information exchange and interaction within the MSG

- (11) How important is to interact with members of other organisations from the MSG when it comes to issues related to CoST?
- a. How would you define the level of interactions that you (or other representatives of your organisation) perform with stakeholders of the MSG?
 - b. What can you get from these interactions? Information, knowledge?
- (12) Would you consider the information and knowledge being discussed in the MSG as valuable?
- a. For whom? CoST, your organisation, other entities?
 - b. In your words, what would be the main barriers you have experienced in exchanging valuable information within the MSG? Is difficult to send or receive information from others?
- (13) To achieve positive change according to the objectives of CoST, which are the organisations within the MSG that you would consider as the most important (or influential)?
- a. Why these actors and not others?
 - b. How would they trigger change in the infrastructure sector?

The role of the national secretariats and assurance teams

- (14) During the time of your participation in CoST, how would you describe the role and performance of the National Secretariat?
- a. How would you classify the National Secretariat? (a) As a facilitator for the organisation and management of the MSG; (b) as a conciliator or mediator between organisations in conflict; (c) as an entity with its own objectives; (d) other? Why?

(15) Now, what you can tell about the role and performance of the Assurance Team in your country?

- a. How reliably is the information and evaluation they provide about the infrastructure projects?

(16) Do you have any suggestions for these entities to improve their role within the implementation of CoST?

(17) Is there anything else you would like to add to the previous questions of this interview?

F. Cool off. When the main topics have been covered, this section should begin to prepare for winding down the interview.

G. Closure. The interview will conclude by asking the respondents if they have anything, they would like to add to what they have already told, and if there is anything, they would like to ask the interviewer. This section concludes the interview by offering the respondent sincere thanks for taking the time to concede the interview.

END OF THE INTERVIEW

APPENDIX G7: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 1/2)



REPORT ON CoST-UCL ONLINE SURVEY RESULTS (1/2)

September 2020



UCL School of Public Policy

Ethics Committee Project ID: 15829/001

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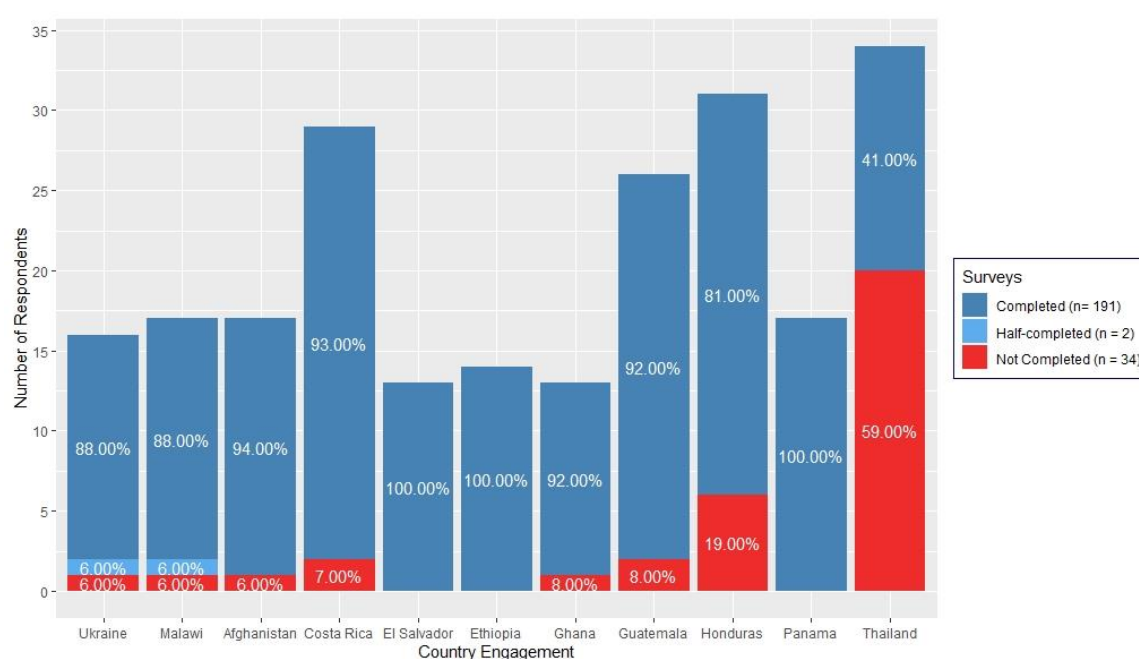
SECTION 1: INTRODUCTION

This report presents interim findings of the CoST-UCL online survey. The report includes four sections of aggregate results and global trends: composition of respondents and demographics (Section 2), respondents' engagement with CoST guidance notes (Section 3), perceptions of the implementation of CoST (Section 4), and perceptions about the role of the multi-stakeholder group as an organisational model (Section 5). A more detailed account of results at the country level is provided in the final section of appendices of this report.

Response rate

The survey was distributed in 11 implementing countries during the second quarter of 2020 (from April 1st to May 14th). The survey was translated into five languages (i.e., English, Spanish, Farsi, Ukrainian and Thai). The global response rate recorded 85% of participation with 191 completed surveys and 2 partially completed. Figure 1 shows that almost all the countries in the sample obtained a response rate above 80% except for Thailand that amounted to 41%.

Figure 1. Response rate by country

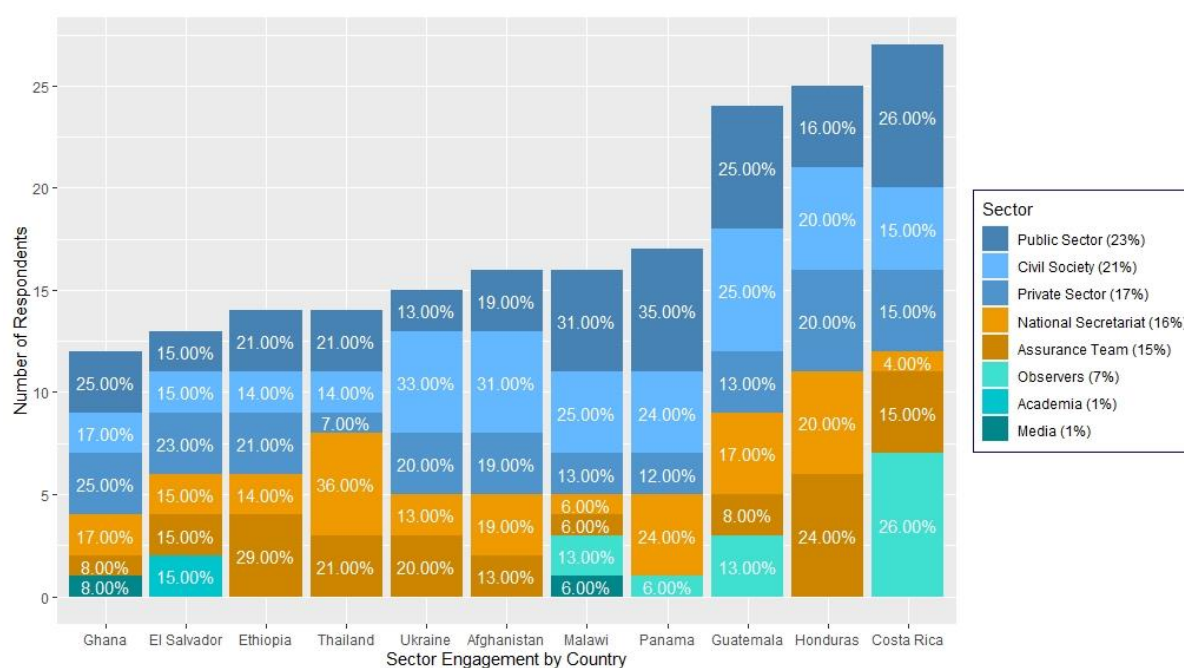


SECTION 2: COMPOSITION OF RESPONDENTS

Responses by sector

The largest participation in the survey by sector comes primarily from representatives of the public sector (23%) and civil society (21%). This is followed by 17% of those surveyed representing private firms and/or private sector associations. In a smaller proportion, the survey also collected data from observers and collaborators (7%) on behalf of intergovernmental organisations like the World Bank, the Inter-American Development Bank or British embassies. Just under 2% of the participation was recorded for individuals that work for academic institutions and media outlets. National internal bodies of CoST, on the other hand, reported a relatively similar engagement with 16% for National Secretariats (NS) and 15% for Assurance Teams (AT). Figure 2 shows the breakdown of participation by sector and country.

Figure 2. Composition of respondents by sector

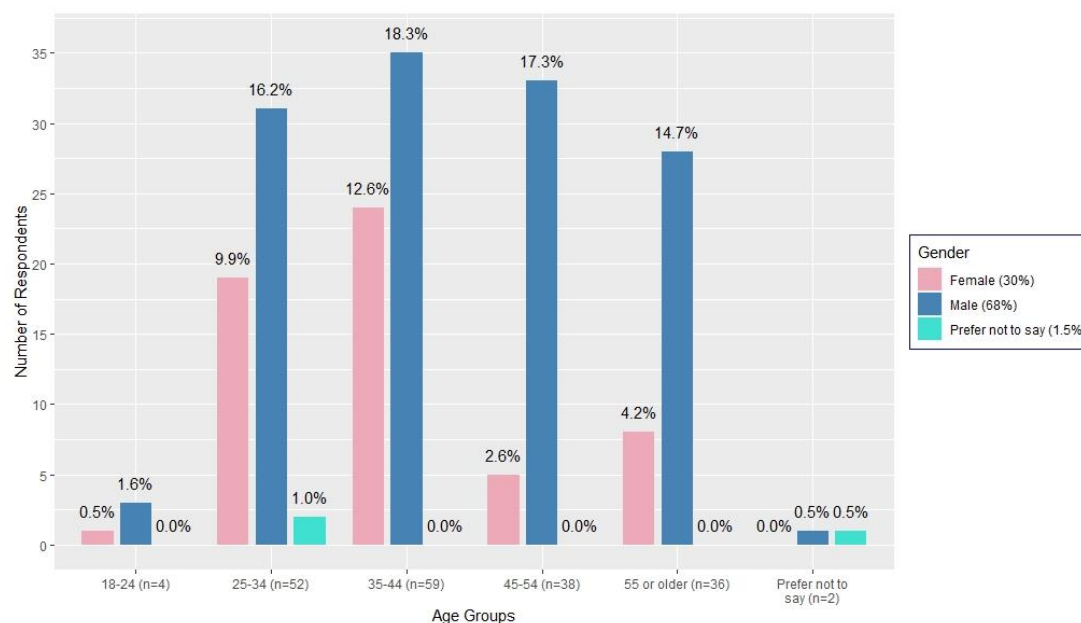


Responses by gender and age

The composition of participants by gender and age groups is shown in Figure 3. Of the 191 respondents that completed the survey, over 68% identified themselves as men and only 30% as women. Female participation in the survey was not only significantly lower in all age groups. The largest representation of women falls in two main age groups that range from 25-34 years old to 35-44 years old. The gender gap is even more considerable for older participants, which

suggest that older men may possibly wield considerable influence over the implementation of the initiative in their home countries.

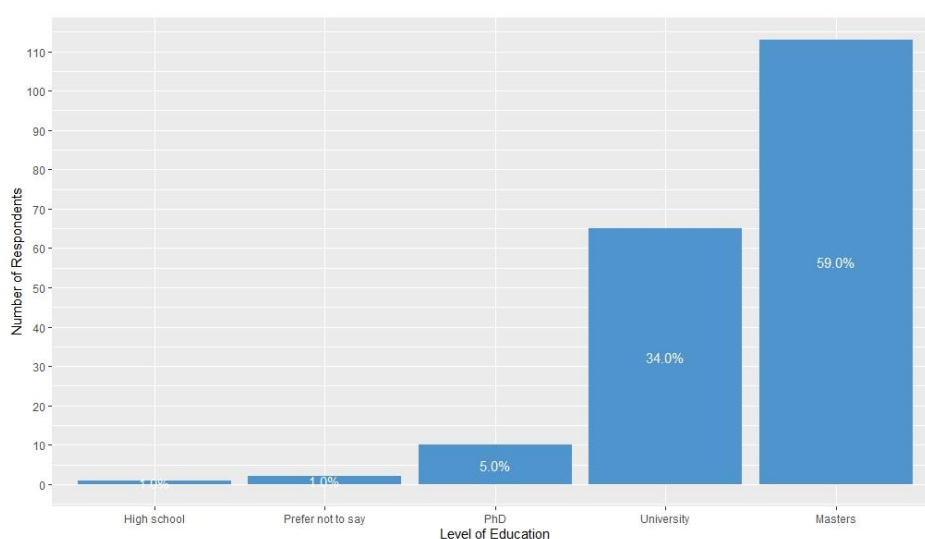
Figure 3. Composition of respondents by gender and age group



Respondents' level of education

The survey also collected data on levels of education. Results show a consistent trend towards higher education in the greatest proportion of respondents. Almost 60% of those surveyed indicated that they have a completed a master's degree when the survey took place, 34% a bachelor's degree and only 5% a PhD (see Figure 4). The results seem promising for the effective engagement of individuals in the implementation of transparency initiatives that are traditionally known for requiring a significant set of skills and knowledge that higher education helps to provide.

Figure 4. Respondents' level of education



SECTION 3: GUIDANCE NOTES (Q8.1. & Q8.2.)

This section describes results from two survey questions related to CoST Guidance Notes (GNs). The objective of both questions is to measure the level of engagement of CoST members with the different contents of the guidance resources available to them and how the topics of these resources remain relevant throughout the day-to day conversations with other members. The questions asked respondents to provide an answer to the extent they have read the GNs (Q8.1) and the frequency they have discussed the content of GNs with other colleagues (Q8.2) in a 10-point Likert scale. The answer choices included five main GNs that are relevant for the implementation of CoST (see Table 1). If the respondent answered “not applicable” or “none” to one of these four items in Q8.1., the next question excluded such item in the answer choices as it would be expected that a GN that has not been read, it most certainly will not be discussed afterwards.⁴⁷

Table 1. Details on Q8.1. & Q8.2.

No	Question	Items	Answer choices
Q8.1.	To what extent have you read the following CoST Guidance Notes?	1. GN3 Developing an implementation plan 2. GN4: Establishing a MSG and NS 3. GN5 Scoping study	None 0 Few of it 1-3 Some 4-6 Most 7-9

⁴⁷ This assumption was challenged in the analysis of results by region (below). Result suggest that despite the low engagement of some CoST members with the content of GNs, they include frequently topics related to such GNs in their conversations with other members.

		4. GN6 &7 Designing a disclosure and assurance process	All of it 10
Q8.2.	How frequently have you discussed the content from the following Guidance Notes?		Not Applicable
			Never 0
			Rarely 1-3
			Occasionally 4-6
			Frequently 7-9
			Very frequently 10
			Not Applicable

Global results

This section includes two heat maps with the global responses recorded for Q8.1. and Q8.2. The maps show the percentages of participation per type of question and type of GN. Every GN has recorded a different number of responses (n) and this is specified at the end of the names of GNs in the maps. The difference in the number of responses for every item of the questions result in percentages that are not consistent across GNs. These results therefore need to be interpreted with caution when analysing a specific guidance note. The data, however, may suggest that CoST members tend to focus on reading and/or discussing GNs in very different ways, perhaps depending on the implementation stage their home countries are transitioning.

Figure 5 shows that well over half of those surveyed have read some, most or all the contents of the GNs. This pattern is observable in the right-hand side of the map with stronger tones of red colour. The GNs 6 and 7 feature in this regard. This question item has the largest number of responses from participants (n = 180). That is, GNs that refer to the disclosure and assurance processes seem to be the most important among respondents of the survey, and above 70% of these participants claimed to have read most or all the content available in these guidance resources.

On the other hand, relatively less popular GNs refer to the establishment of a MSG and NS (GN4), and the development of an implementation plan (GN3). Respondents indicated that they have not read none of these materials, or they have done it scantily by 14% and 17% in cumulative terms, respectively. By contrast, results in this end of the spectrum for GNs 5, 6 and 7 range between 11% and 13%. Although the difference between them is not alarming, the results reveal that in general GNs 4 and 3 are the least read resources by respondents that provided an answer to these items.

Figure 5. Global results for read GNs (Q8.1.)

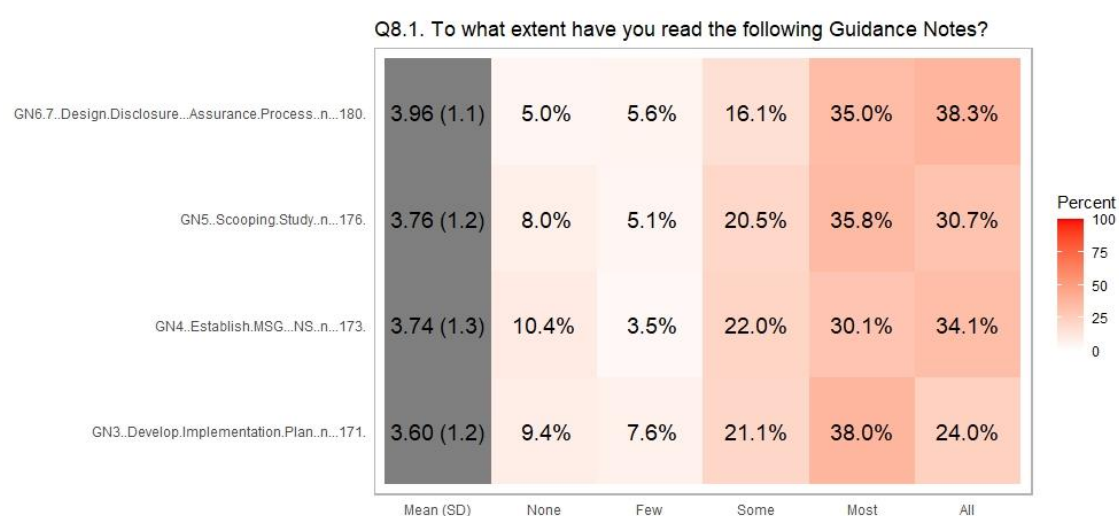
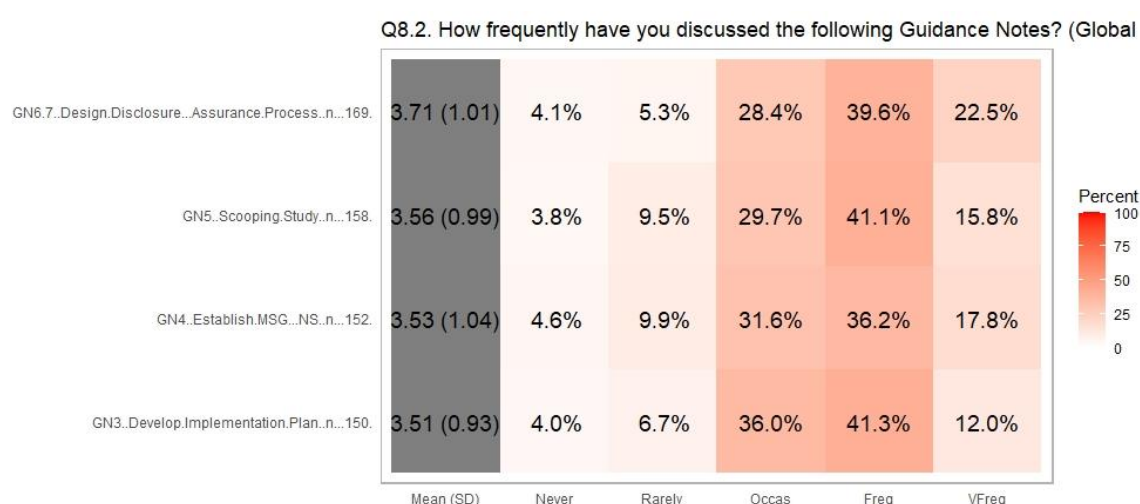


Figure 6 indicates that those surveyed have discussed the contents of GNs with other colleagues occasionally or frequently. The latter occurring more predominantly in the results than the former. Similarly to Q8.1., the largest number of participants provided a response ($n = 169$) to the question item of GNs 6 and 7, and whose content was included frequently and very frequently in the conversations of more than 60% (cumulative percentages) of these participants with their colleagues. Considering the previous results, it is evident the importance attributed to these guidance resources above others by members of the MSGs, NS and AT.

In terms of low frequencies, about 13% and 14% of the respondents claimed to include information of GNs 4 and 5 only rarely or never in their conversations with colleagues. While GNs 3, 6 and 7 accumulated 11% and 9%, respectively, in the low frequency categories, difference with other GNs is again not too high. Nevertheless, a possible conclusion can be drawn from this data in that processes related to administrative tasks like setting up a MSG and a NS are less relevant as a guidance resource and as a topic of conversations between respondents.

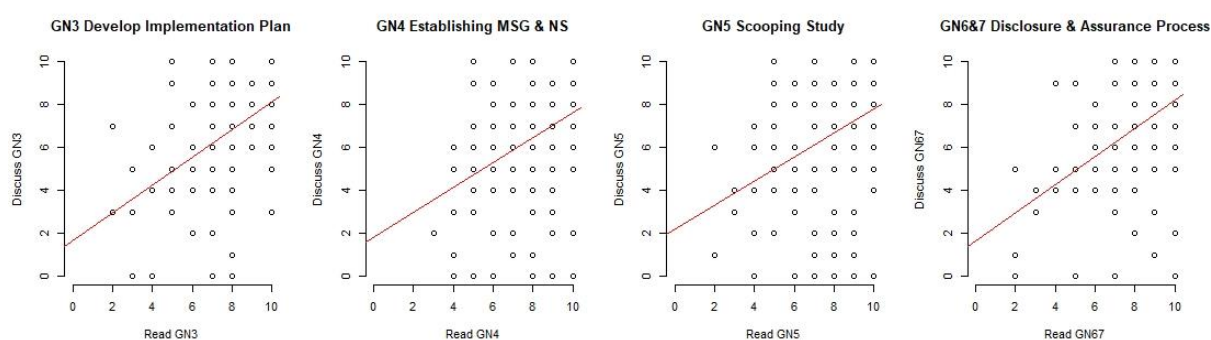
Figure 6. Global results for discuss GNs (Q8.2.)



Correlation between variables

To get an idea about how the activities of reading and discussing GNs change together, Figure 7 shows a set of correlations where reading and discussing are taken as the independent and dependent variables, respectively. Figure 7 includes a scatterplot to illustrate the general behaviour of respondents in terms of these two variables, all else being equal. The red line reports a positive correlation between both variables that is present in the four quadrants of the scatterplot. That is, the more aware a CoST member is about the content of GNs, the more frequently she/he will include this content in the conversations with other members of CoST. The results are statistically significant in all the quadrants and the correlation of variables is higher for GNs 3, 6 and 7, where for each unit of increase in reading these GNs, talking about their content increases by 0.65 (i.e., the slope of the red line is steeper and so the strength of the effect) compared to the coefficient of 0.54 for GNs 4 and 5.

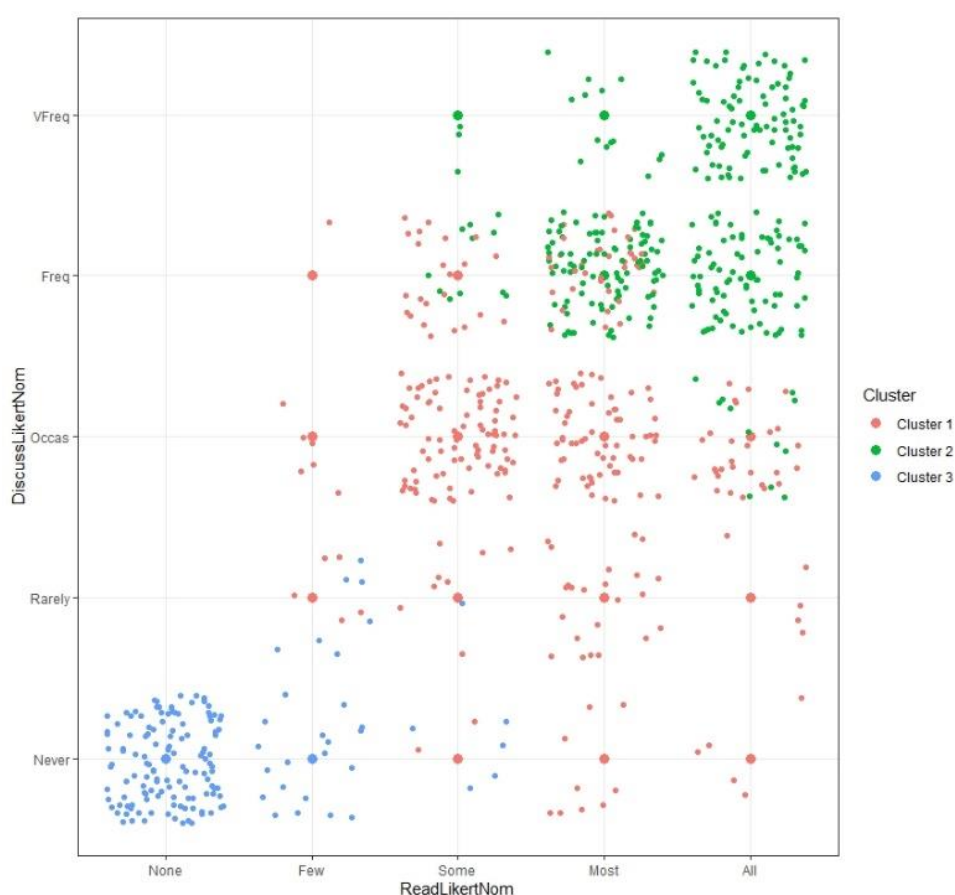
Figure 7. Relationship between variables



Clustering of data points

A basic algorithm was also run to split responses into main groups considering the aggregate data of both read and discuss GNs. The algorithm is based on the search for a number of representative datapoints among the observations of the data set. After finding them, clusters are constructed by assigning each observation to the nearest representative datapoint. The general trend described in the correlation analysis above is corroborated in Figure 8., which also shows three main clusters for the answers recorded, independently of the type of GNs.⁴⁸ Decision makers may employ this clustering of data as a tool for the release of specific information to groups of members that have shown a particular behaviour in their engagement with the material of CoST.

Figure 8. Cluster of responses



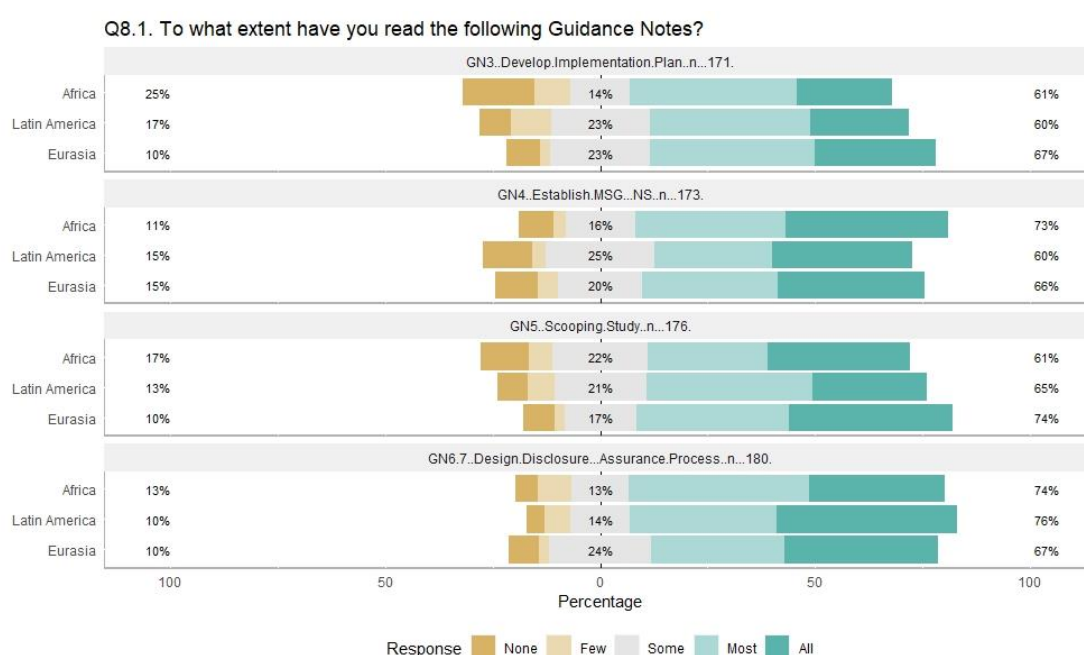
⁴⁸ In order to run the algorithm more effectively, all the “NAs” or not available datapoints had to be recoded to zeros. Thus, the size of cluster 3 (blue dots) is smaller in the actual data. That is, the lower left corner of Figure 8 is artificially more robust than what it should be. The alteration in data did not affect the other clusters.

Results by region

This section reports results that reveal detailed patterns by region not seen in the aggregate data. The regions included are Latin America (i.e., El Salvador, Costa Rica, Guatemala, Honduras, and Panama), Africa (Ethiopia, Malawi and Sekondi-Takoradi, Ghana) and Eurasia (Afghanistan, Ukraine, and Thailand). Figure 9 and 10 below break down responses by regional subgroups and by type of question. The responses are further grouped into "low", "neutral", and "high" scores which provides a richer visual understanding of the regional trends. Each score value has its own colour, and each score category is summarized by a cumulative percentage value at the left and right sides of the charts. That is, for Q8.1, a low score is represented by the sum of the percentage of response choices categorised as "never" and "few", and a high score by the sum of the percentage of response choices categorised as "most" and "all".

When it comes to read GNs, respondents tended to select higher scores in the Liker scale for question Q8.1. The bulk of answers skews to the right-hand side of Figure 9 suggesting a good engagement of most regions in this activity. There are regional responses that stand out at each level of the chart. For instance, the proportion of responses from Eurasia suggests the presence of CoST members that are more informed about the content of GN3, whereas the proportion of answers from Africa indicate more awareness of the processes for establishing a MSG and a NS (GN4). Results also show that most of the Latin American members have read all the content of GNs 6 and 7 and members from Eurasia countries indicated to have good knowledge about GN5 than their regional counterparts.

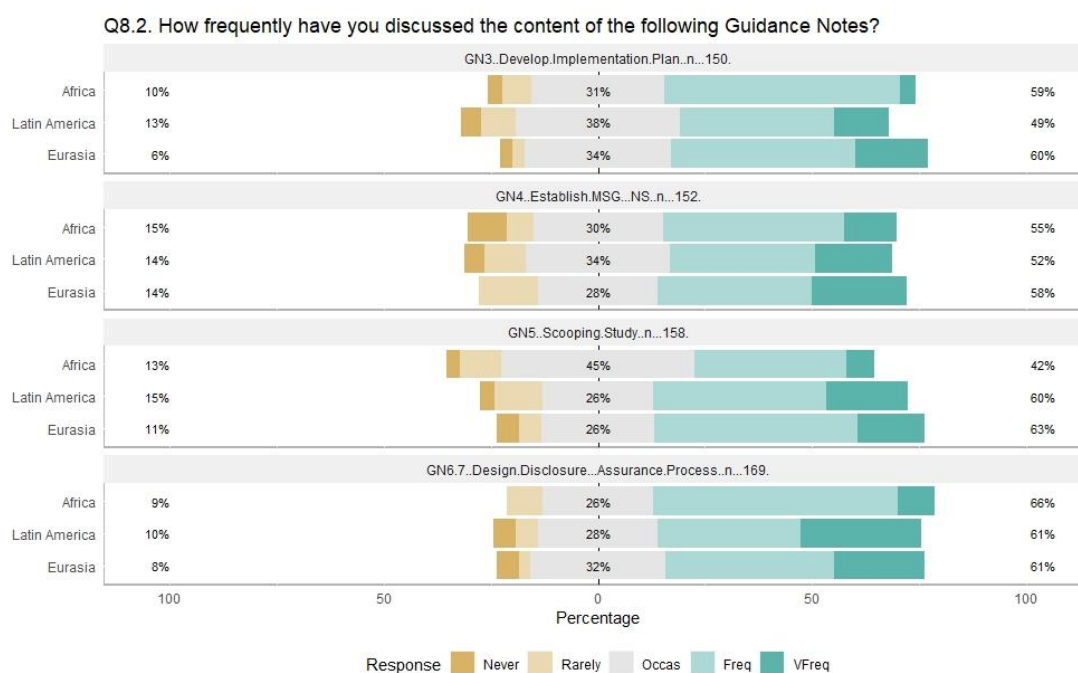
Figure 9. Results read GN (Q8.1.) by region



The lower proportion of responses that can be seen in the left-hand side of Figure 9 reveals a different set of patterns for every region. African countries show a higher cumulative percentage (66%) in this end of the spectrum compared to countries in Latin American (55%) and Eurasia (45%). Overall, the results suggest the presence of a greater number of African CoST members less engaged with the content of GNs. A case in point is Ghana and Malawi with the fattest red tails in the left-hand side of the density plots at the country level in Appendix I.⁴⁹

On the other hand, the general trend for discussing topics of GNs in Figure 10 reveals a more central position for the largest volume of responses. The size of the bars in the middle position categories is larger in Figure 10 than those observed in Figure 9. This indicate that respondents tend to discuss the content of GNs more occasionally and frequently than other frequencies and the tendency is observable in Latin American countries for GNs 4 and 5, Eurasia for GNs 3 and 5 and African countries for all the GNs.

Figure 10. Results for discuss GN (Q8.2.) by region



Although comparing directly both types of responses is methodologically inappropriate, because they were recorded through different scales of measurement, and a correct combination of them may be subjective, the direct comparison of bar sizes from Figure 9 and 10 seems convenient to obtain key information on the proportion of people that engage in each of these activities by region. Therefore, Figure 11 condenses the two previous charts and it shows responses into “low” and “high” scores without neutral values. Each bar has a

⁴⁹Appendices I-III contain density plots for every country in the sample. The frequencies for reading and discussing the content of GNs are included in the same figure per country. Please note that while using density plots on ordinal data (Likert scales) is statistically inappropriate, it can be useful for comparing trends and overlaps in frequencies of the variables of interest.

different colour that is assigned to positive scores (green), low scores (blue), and lowest scores (red).

The layout places negative responses (i.e., red bars) in the left-hand side of the new chart to signal the proportion of members by region that participate in the implementation of CoST with limited or no engagement with the GNs at all. At first glance, the picture again seems to be less positive for the African region, followed by Latin America and Eurasia.

Given that the number of responses for Q8.2. (discuss GNs) is lower than that of Q8.1. (read GNs), the discrepancy in the size of their respective bars may seem a logical outcome in Figure 11. Nevertheless, data may also tell us that the differences can be attributed to a larger number of respondents that talk occasionally and frequently about matters of CoST implementation that they think are related to the content of GNs, but such respondents may have not read entirely the GNs.

We can draw this possible conclusion because the number of respondents that have discussed occasionally and frequently topics of GNs is not consistent with the number of respondents that have engaged well or relatively well with this material.⁵⁰ A closer look at the density plots in Appendix III and IV provides further evidence of this tendency for countries like El Salvador, Guatemala, Honduras, Ukraine, and Thailand. That is, the density of responses for discussing content of GNs represented by the blue line is higher than the red one for some GNs in these countries.

Figure 11. Condensed results for read & discuss GNs



⁵⁰ This is just one possible interpretation. It is acknowledged that results are open to several other explanations according to national contexts.

SECTION 4: PERCEPTIONS OF CoST IMPLEMENTATION (Q10.1.)

Question Q10.1. collected data on respondents' perceptions about the of CoST work on the public infrastructure sector of their countries in terms of (1) decreased corruption, (2) increased transparency, and (3) long-term solutions. The question also asked respondents to provide their opinion on how the implementation has been delivered according to internal processes. That is whether (4) the benefits outweigh the costs of their participation, and whether (5) solutions are reached in a consensual way by all the stakeholders. The content and wording of items (see Table 2) was formulated and developed through the feedback of CoST Regional Managers and the International Secretariat during the pilot test of the questionnaire before the deployment of the online survey.

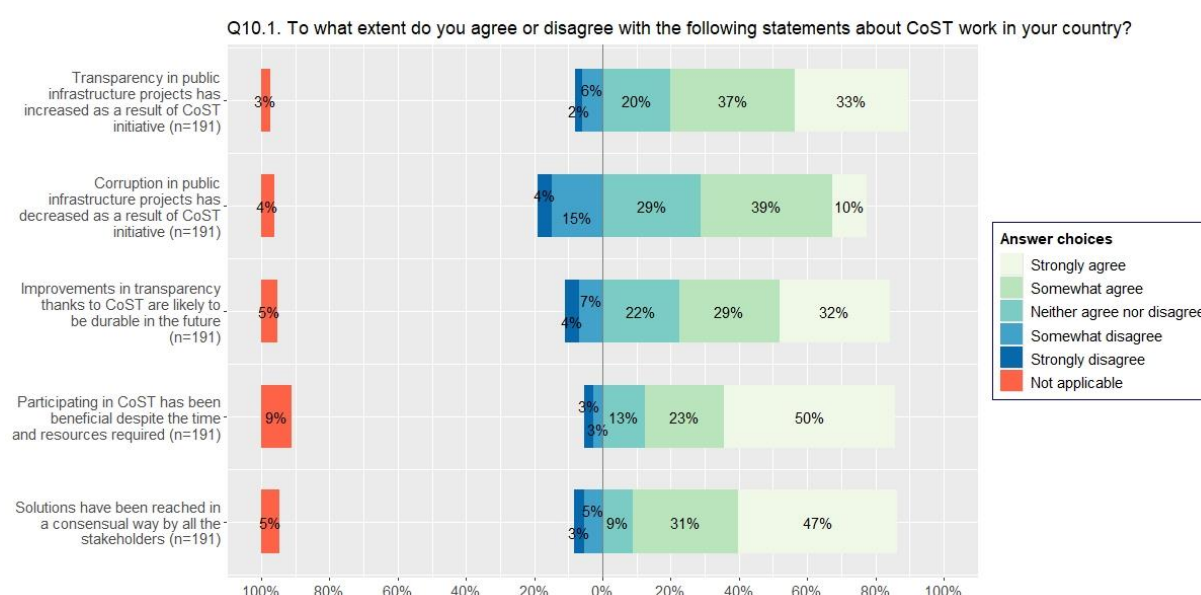
Table 2. Details on Q10.1.

No	Question	Items	Answer choices
Q10.1.	To what extent do you agree or disagree with the following statements about CoST work in your country?	- Corruption in public infrastructure projects has decreased as a result of the CoST initiative. - Transparency in public infrastructure projects has increased as a result of CoST initiative. - Improvements in transparency thanks to CoST are likely to be durable in the future. - For my organisation, participating in CoST has been beneficial despite the time and resources required to participate. - Solutions have been reached in a consensual way by all the stakeholders.	Strongly disagree 1 Somewhat disagree 2 Neither agree nor disagree 3 Somewhat agree 4 Strongly agree 5 Not Applicable

Figure 12 shows the results of 191 respondents. Overall, the scores support a positive view about the implementation of CoST in all the dimensions measured. Items that refer to the cost-benefit perceptions of participating in CoST and solutions reached consensually by all stakeholders have the highest cumulative scores for “strongly agree” and “somewhat agree” with 78% and 73%, respectively. In the same end of the spectrum of higher scores, increased transparency in the public infrastructure sector follows with 70%, long-term improvements in transparency with 61%, and decreased corruption with almost 50%.

Although these findings are encouraging, they must be interpreted with caution because the largest proportion of “Not applicable” responses was also recorded for the very same items with the highest positive scores. Findings at the country level in Appendix IV show that respondents from Afghanistan, Ethiopia, Honduras and El Salvador preferred to choose a “Not applicable” response rather than a negative response, to say “strongly disagree” or “somewhat disagree”, to the item about the cost-benefits of their participation in CoST. The pattern is also revealed in other items, where the size of red bars is larger than the blue ones. A likely explanation of this behaviour at the country level is that respondents have not seen the effects that the question item implies, or they have experienced them disapprovingly, but prefer not to judge them negatively in the survey.

Figure 12. Global results for perceptions of CoST implementation (Q10.1.)



SECTION 5: PERCEPTIONS OF THE MSG AS AN ORGANISATIONAL MODEL (12.3.)

Question Q12.3. collected data on respondents' perceptions about the MSG in three different dimensions: the (1) practicality of the MSG for the implementation of transparency initiatives, (2) the appropriateness of the MSG when considering other existent organisations and governmental structures, and (3) the sustainability of the MSG over time despite political and social conflicts. Table 3 details the content and wording of items for Q12.3. The question was formulated and developed through the feedback of CoST Regional Managers and the International Secretariat during the pilot test of the questionnaire before the deployment of the online survey.

Table 3. Details on Q12.3.

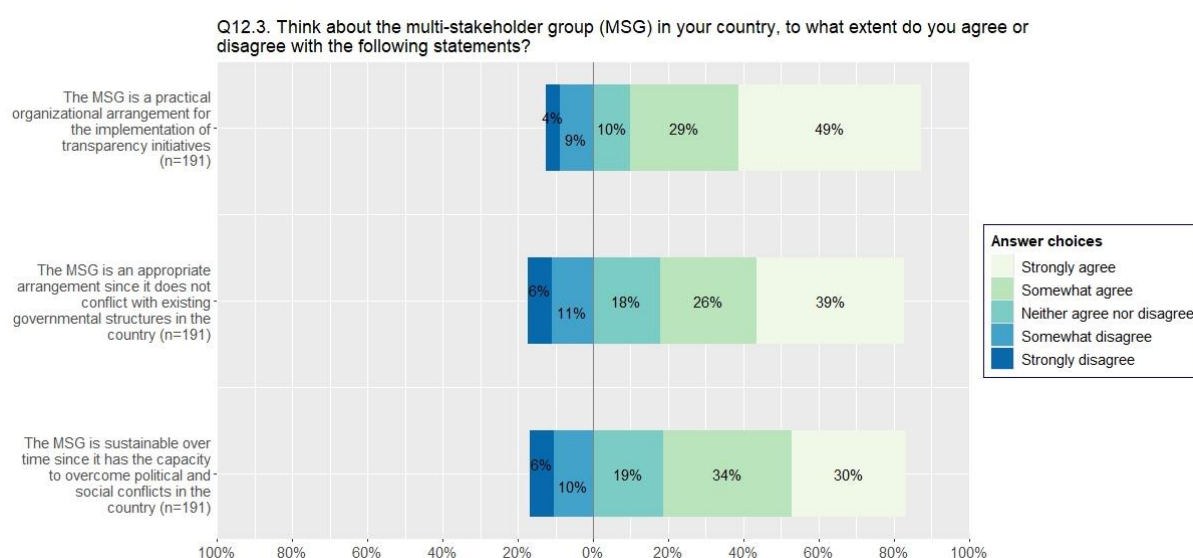
No	Question	Items	Answer choices
Q12.3.	Think about the CoST multi-stakeholder group (MSG) in your country, to what extent do you agree or disagree with the following statements?	- The MSG is a practical organisational arrangement for the implementation of transparency initiatives. - The MSG is an appropriate arrangement since it does not conflict with existing governmental structures in the country. - The MSG is sustainable over time since it has the capacity to overcome political and social conflicts in the country.	Strongly disagree 1 Somewhat disagree 2 Neither agree nor disagree 3 Somewhat agree 4 Strongly agree 5 Not Applicable

Figure 13 shows that whereas nearly 80% of those surveyed agreed that the MSG is a practical organisational arrangement for the implementation of the initiative, 10% remained indecisive about it, and only 13% reported to be somewhat disagree and strongly disagree about the proposition. Around 64% of the respondents indicated a higher level of agreement to the statement about the MSG as a sustainable organisational arrangement over time. This item also reports the higher proportion of respondents in the sample (19%) that are neither agree nor disagree with the statement, and a relatively smaller proportion (16%) that disagree in general. See Appendix V for country level results.

When it comes to the appropriateness of the MSG, given the lack of conflict with existing national structures, Figure 13 shows that 65% of the respondents agreed with this statement and 18% of the respondents showed a hesitant opinion towards it. Results of this item also shows the highest proportion of responses (17%) of Q12.3 recorded in the negative terrain of respondents' agreement.

Results from an additional question in the survey (Q12.1) provides contextual background to understand these findings. Q12.1. asked respondents whether they know the existence of organisations responsible for overseeing public procurement or auditing publicly funded infrastructure projects other than those already members of CoST in their countries. Of the 191 respondents that completed the survey, 117 (61.25%) indicated the existence of other organisations that share similar objectives with CoST, 55 respondents (28.79%) claimed not to know and only 19 (9.96%) responded with a negative answer. Overall, the findings suggests that the work of CoST in some countries may be overlapping the work of other organisations, which opens the opportunity for new alliances or the expansion of CoST membership. See results at the country level for Q12.1. in Appendix VI.

Figure 13. Global results for perceptions about the MSG as an organisational model (Q12.3.)



In order to further contextualise the findings from Q12.3., the survey also collected data on what respondents had to say about their concerns of the work of MSGs and how they would improve it. Appendix VII includes 92 responses that shed light upon the national contexts of

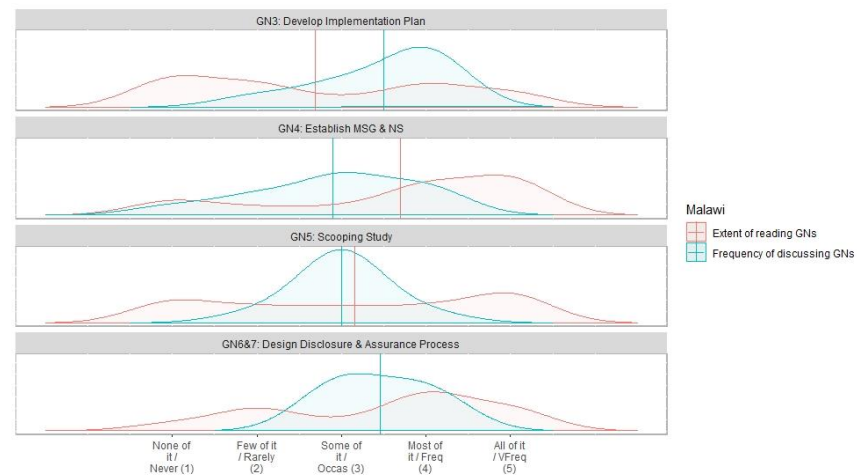
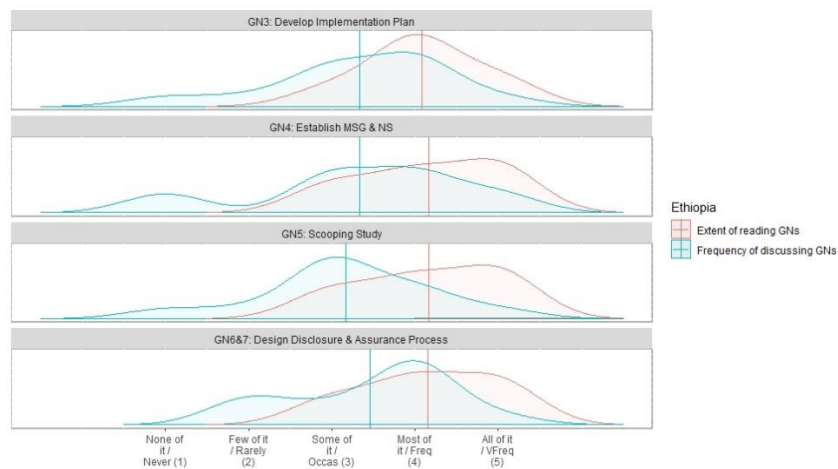
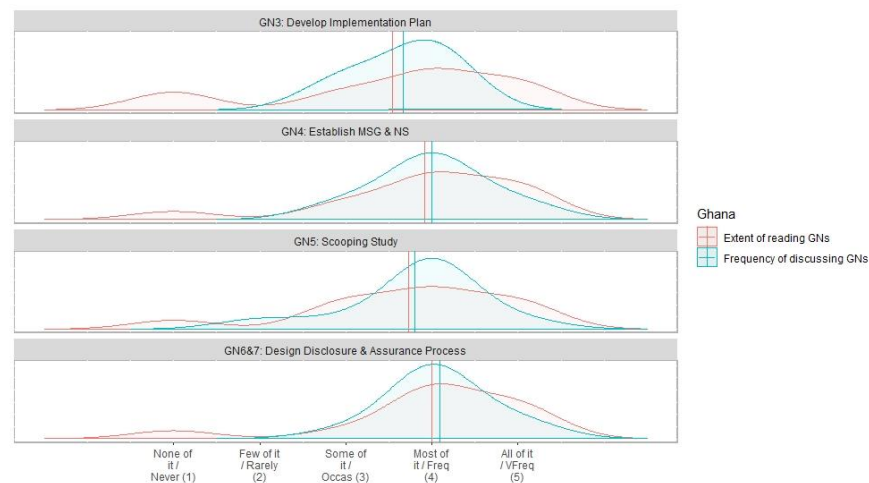
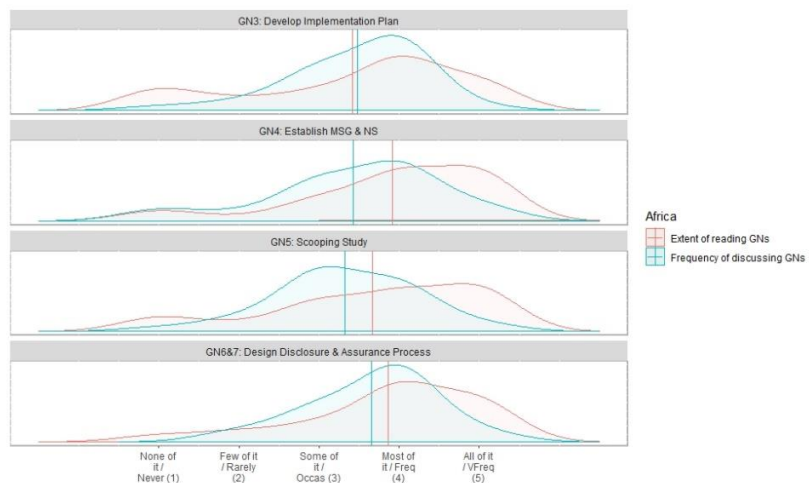
MSGs. The results suggest five main issues of respondents' concern: (1) change of government officials and continuation of projects, (2) MSGs co-opted by government interests, (3) administrative staff and leadership of MSGs acting independently, (4) need of capacitation and events for promoting CoST work, and (5) lack of a legal framework for MSGs to act authoritatively. Figure 14 illustrate a word cloud with the 100 most frequent words in respondents' opinions about their MSGs. The larger the size of the word, the larger the frequency of mentions.

Figure 14. 100 most frequent words in CoST members concerns (Q12.4.)

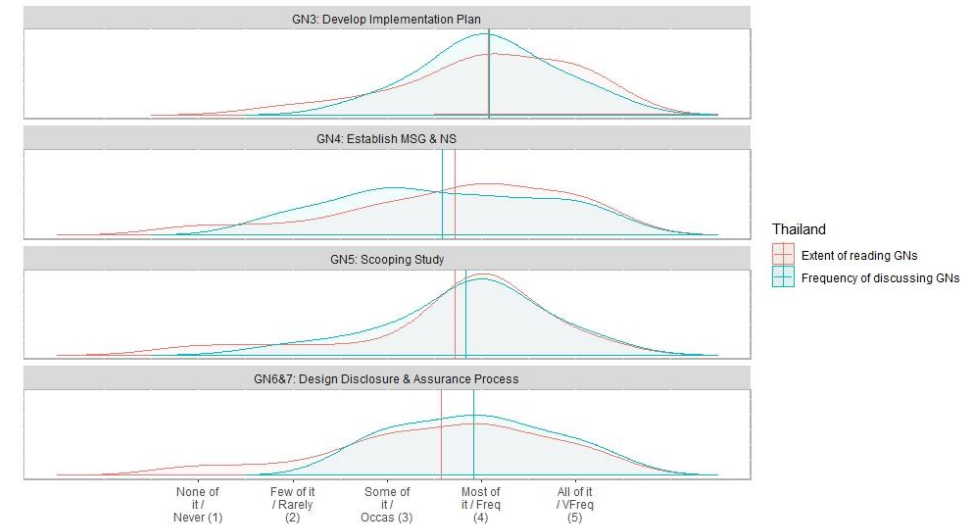
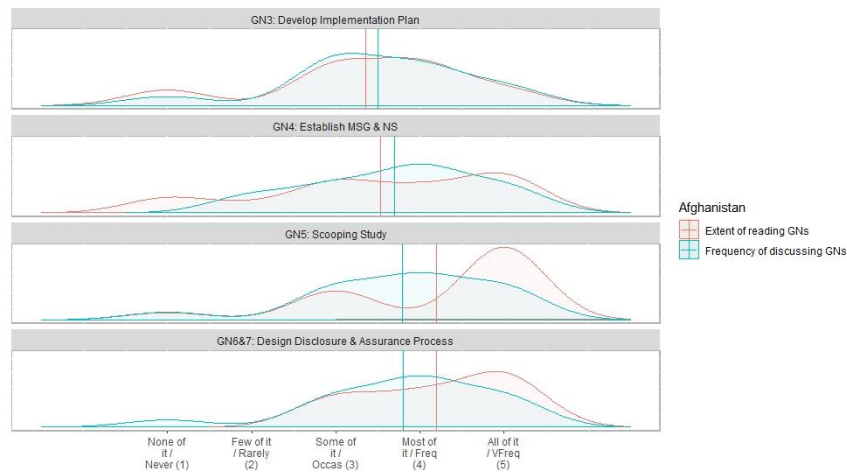
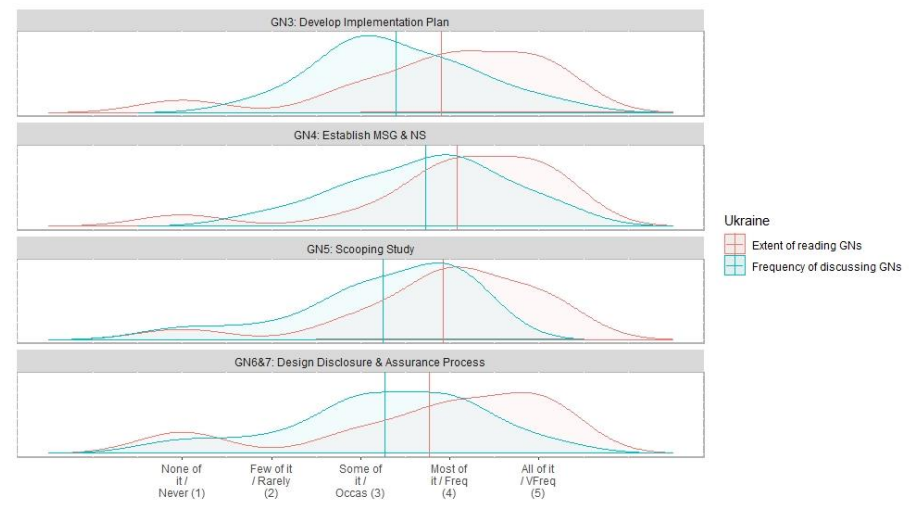
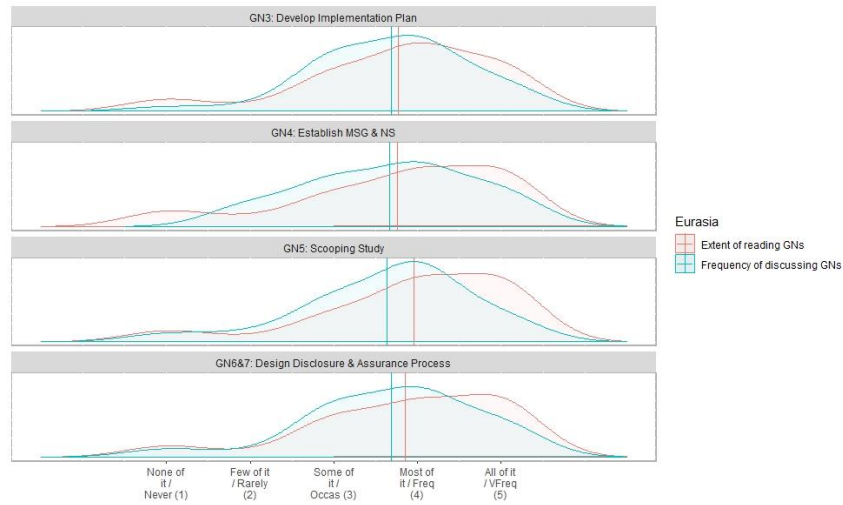


APPENDICES (Country level results)

Appendix I. Africa results: read & discuss GNs

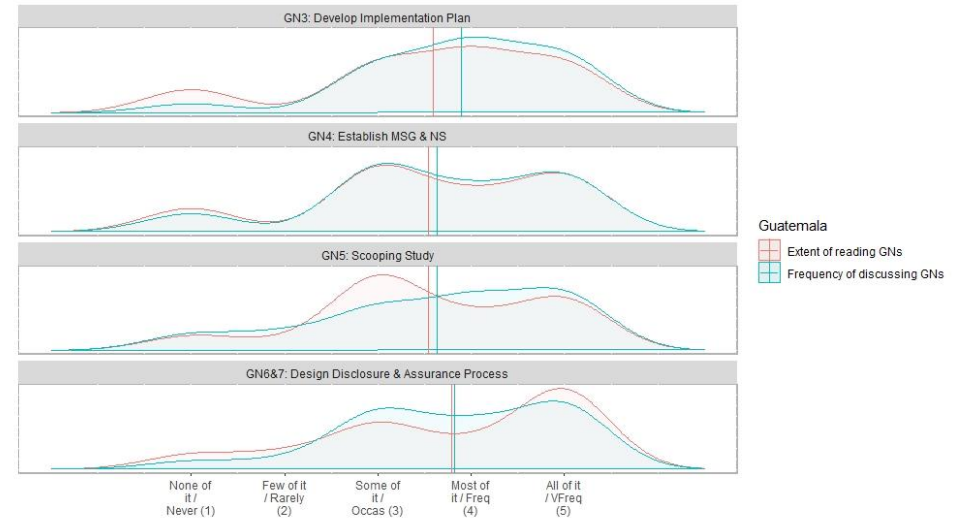
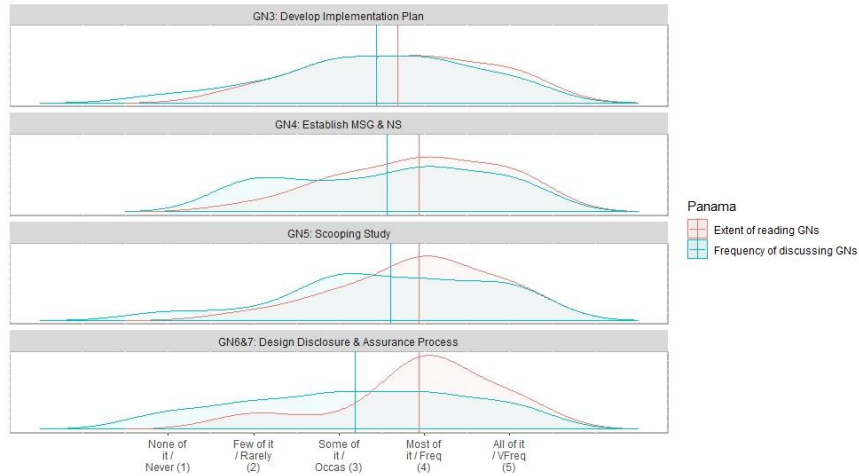
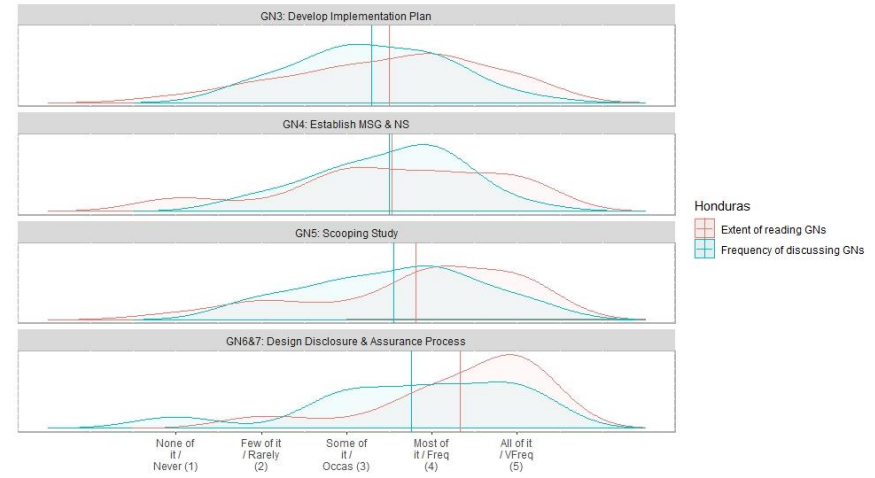
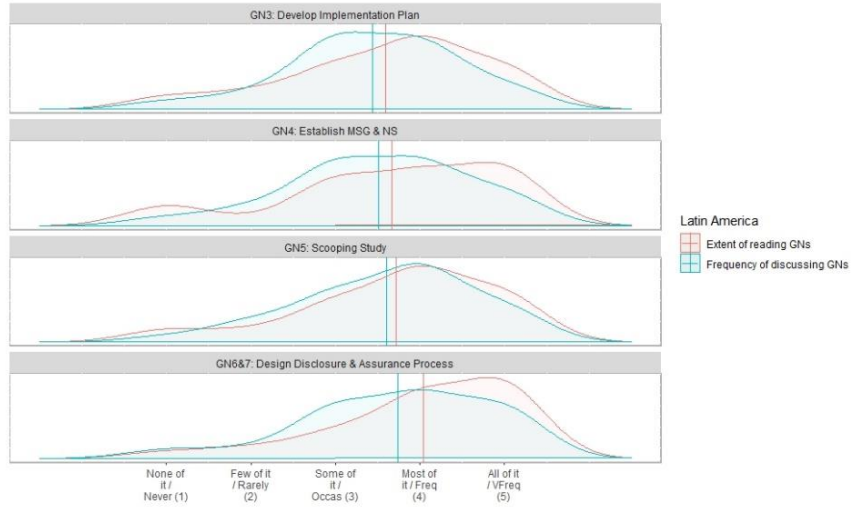


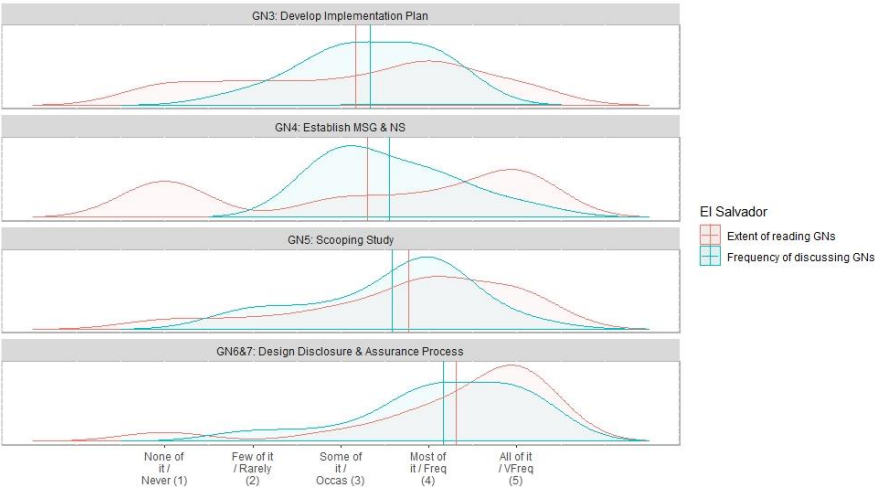
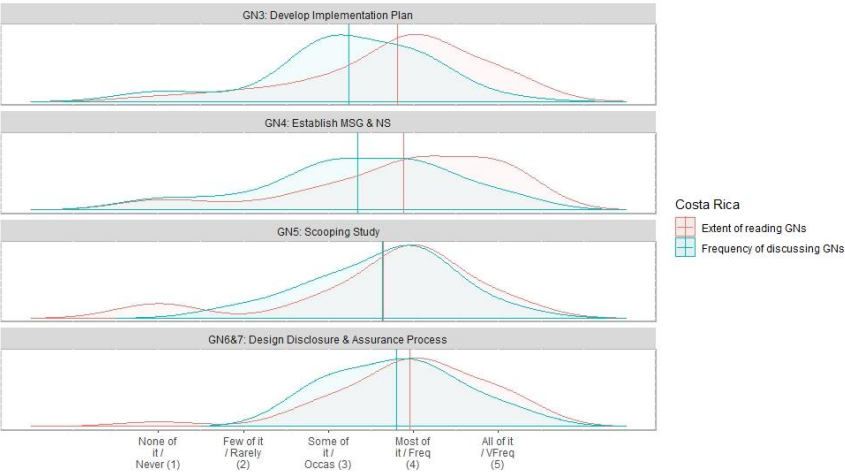
Appendix II. Eurasia results: read & discuss GNs



Appendix III. Latin America results: read & discuss GNs

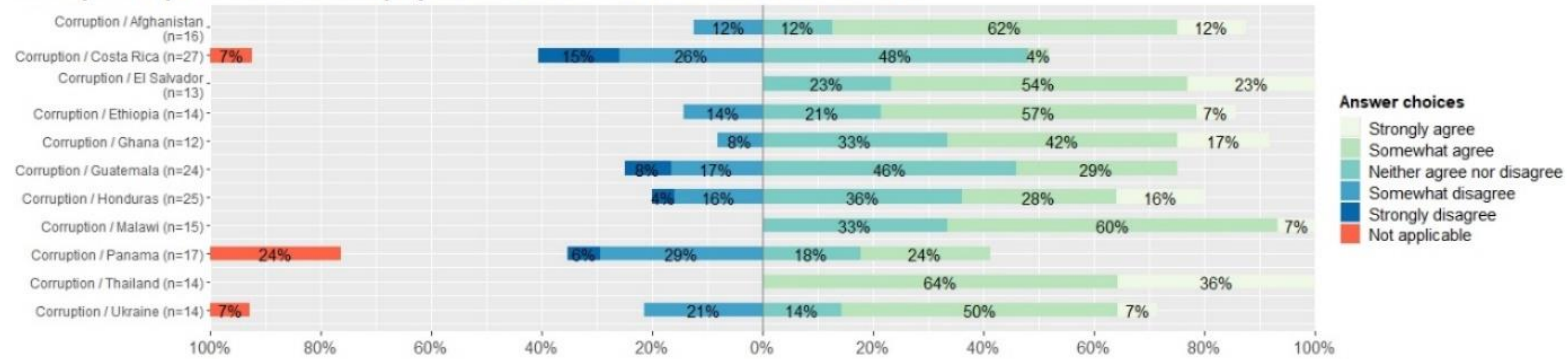
APPENDIX G7: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 1/2)



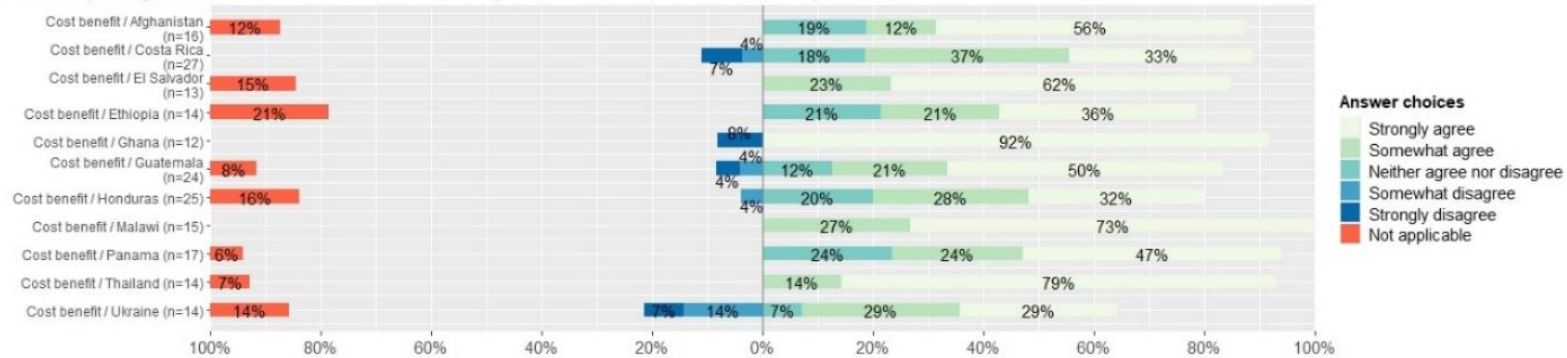


Appendix IV. Perceptions of CoST implementation

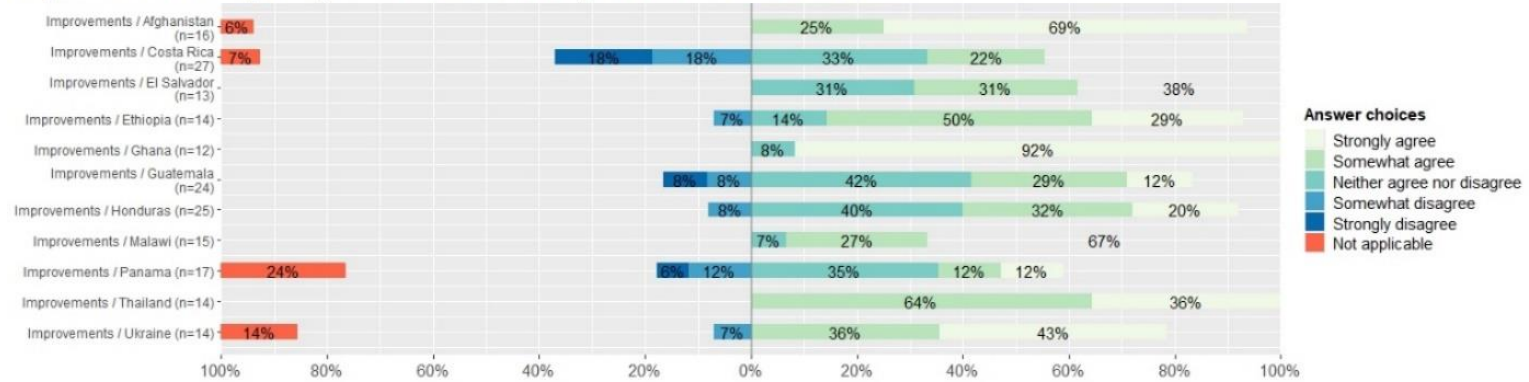
Corruption in public infrastructure projects has decreased as a result of CoST initiative



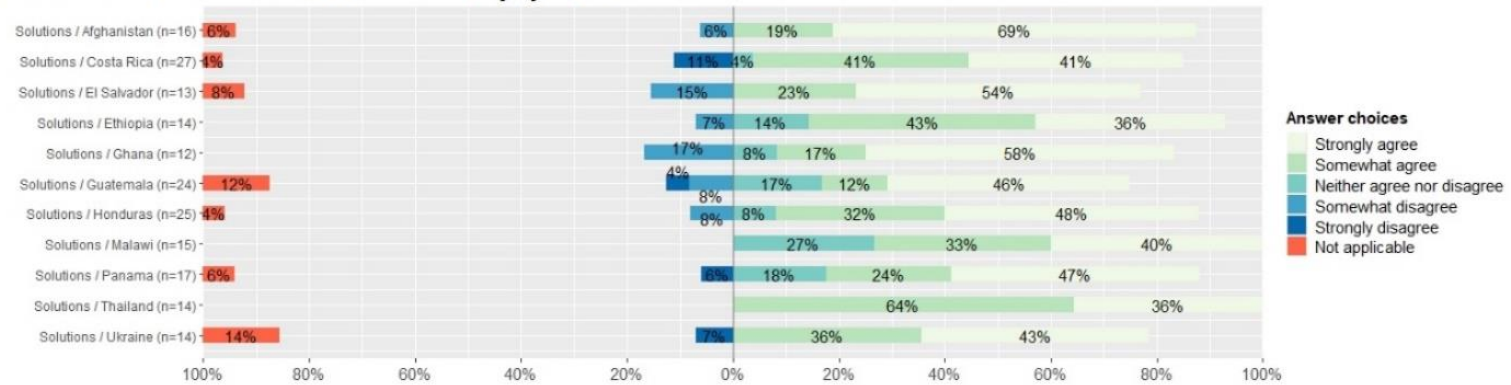
Participating in CoST has been beneficial despite the time and resources required

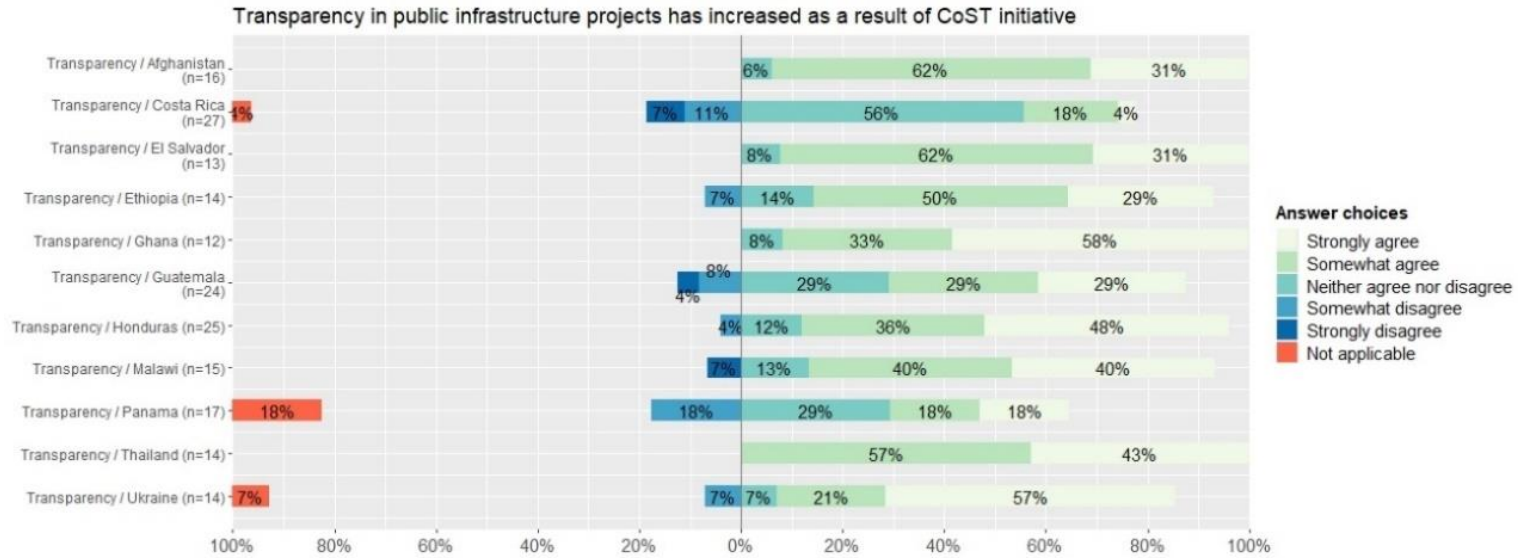


Improvements in transparency thanks to CoST are likely to be durable in the future



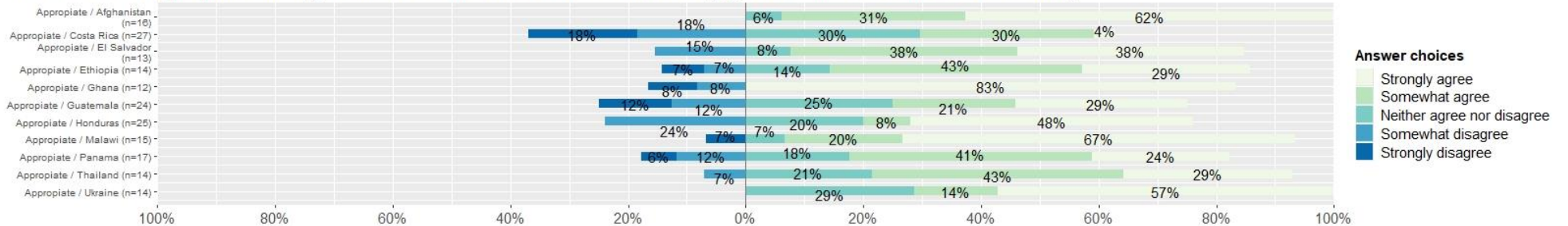
Solutions have been reached in a consensual way by all the stakeholders



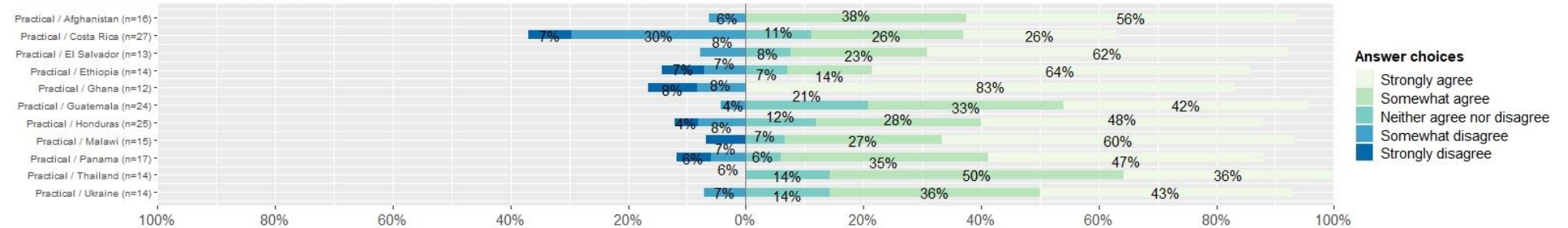


Appendix V. Perceptions of MSG as an organisational model

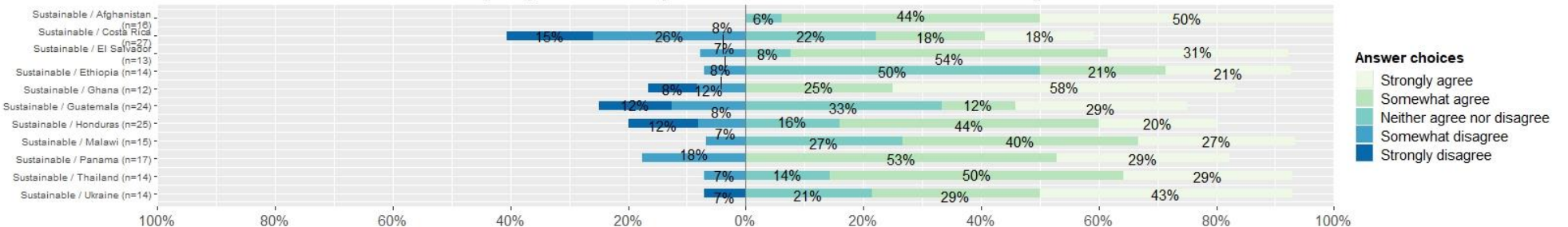
The MSG is an appropriate arrangement since it does not conflict with existing governmental structures in the country



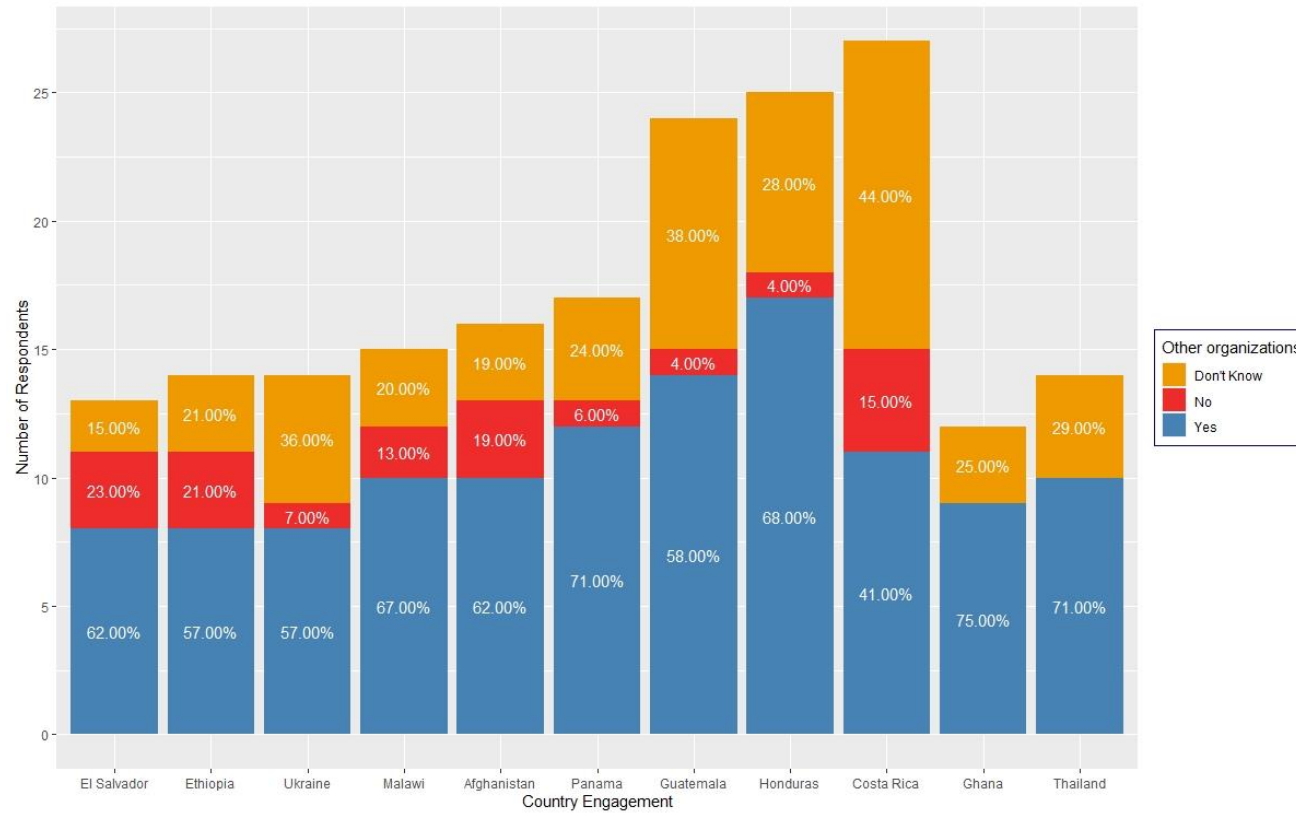
The MSG is a practical organizational arrangement for the implementation of transparency initiatives



The MSG is sustainable over time since it has the capacity to overcome political and social conflicts in the country



Appendix VI. Existing organisations that overlap with CoST work



Appendix VII. Concerns and/or suggestions to improve the work of MSGs

Country	Q12.4. In case you have concerns about the multi-stakeholder group (MSG) work or ideas for its improvement, please include them here. Responses:
El Salvador	The representatives of the institutions should only stay in office for one year. Presidents or coordinators must not be re-elected. The institution that manages the funds should not occupy the presidency. Representatives of each institution attend training workshops once and must pass the knowledge to other institutions. The representatives should be 100% committed to the objectives of COST and not for profit or personal interest.
El Salvador	I am concerned about changing members that happens very often. Also, we need to strengthen the relationship with the public sector. Mainly with central government, because since the change of government there is not much feedback with them.
El Salvador	The MSG is a structure that allows the exchange of opinions and knowledge. It encourages the participation of different sectors involved in the construction processes and in the training of future professionals in this area.
Panama	The multi-sectoral group is subject to government changes, making it difficult to monitor and continue previous projects. The figure of the information officer and the COST liaison (who is almost always the same person) of the institutions should be permanent.
Honduras	We must think of a legal framework where each contract establishes that they must be under the initiative oversight.
Honduras	Demand more commitment from its members.
Honduras	The need to follow up on the recommendations. When doing an analysis of actors, some of them have conflict of interest, it is important to carry out an adjust of their participation.
Honduras	The MSG could give weight and promote and monitor the follow-up programs of the recommendations made in the assurance reports.
Honduras	With a vision to institutionalize the initiative, one must have openness and good relationships with the government sector. Without neglecting the requirement of transparency and accountability, to join efforts and make the Initiative sustainable over time. This is regardless of changes of government and different political agendas. So, independence should be sought, but at the same time a sustainable financial support over time, safeguarding the CoST objective.
Honduras	I consider that sometimes you forget what role you play as a multisectoral group, because I observe that you are looking for your own interest as an institution.
Honduras	One of the problems of the MSG is the search for union interests by members of the MSG.
Guatemala	Participation of members of international financing organisations as collaborators.
Guatemala	It will depend on the will we have to do things right.

Guatemala	Socialization and publicity are important, due to the low presence of CoST in the changes in government. There are also changes in authorities and administrative personnel and who do not have knowledge of CoST.
Guatemala	Promoting accountability, transparency, and now, social auditing, requires a clear and open agreement between the parties (State, companies, CSOs and the community), to guarantee access to public information and freedom of expression with the use of the collected data. Unlike the other initiatives for transparency in Guatemala, CoST is the only one that has its headquarters in the Chamber that represents the interests of the contractor sector, which can be seen as a strength because there is interest from them to join a structure that promote transparency. Although, in a State captured by "rent seeking" behaviour that is very difficult to conceive in reality.
Guatemala	The multisectoral group is appropriate and can be sustainable over time if its autonomy is really maintained. The problem I see in Guatemala is that in the MSG most decisions are made by the Country Manager. We have had the case where the MSG meetings become more informative than decision-making because the activities or decisions have already been executed or taken by the Country Manager, which should not be. I think that there should be a manual or a more explicit form by the international secretary that defines the functions of this position. That is why I do not agree that the MSG group is sustainable over time and overcomes political and social conflicts. This is because a year ago the CoST initiative participated in the Open Government table but due to personal and ideological situations without consulting the MSG, the Country Manager decided to sign a statement with other civil society organisations of that technical table where they decided to withdraw from the initiative open government. To the organisation I represent, this caused serious problems as well as to the Ministry of Finance and Communications (which is why since that date the Ministry of Communications withdrew from CoST Guatemala) we did not share the statement, nor the decisions of withdraw from the initiative of the government of Guatemala. Other situations such as activities such as the municipal fair (ANAM) or meetings with donors or other actors where there is no consultation and invites to participate, which has practically been reflected in a weak MSG and with fewer and fewer actors. A list of situations.
Costa Rica	Lack of organisation in the MSG, they are political groups

Costa Rica	CoST CR is in a legal limbo. It exists by decree but does not have any legal status, which means that it cannot receive or generate funds. And, on the other hand, its operation is highly compromised because any internal norm they must do so via decree, but the same decree is an obstacle. For example, the Construction Chamber was blackmailing its permanence to boycott the Government, and in the end, although it did not attend, it could never be removed from the MSG because the decree has not defined how to do it. The arrangement is practical (3 sectors) but due to idiosyncrasy there is fear of making decisions on the part of the public sector, that is why there are proposals to modify the decree that has more than two years old. In other words, it is an aspect beyond the MSG own arrangement.
Costa Rica	The MSG in a quite diverse group, which has an advantage in the levels of representation but makes decision-making significantly difficult and is very slow in progress to improve transparency, as it often loses the north depending on the interest of each member or group of members.
Costa Rica	Need to strengthen legislation and internal organisation.
Ethiopia	The legal personality issue is not yet resolved. This is always making me somehow doubtful that, CoST is open for any interventions from the government's side.
Ethiopia	The MSG should periodically be elected for the sake of rotational leadership and decision making.
Ghana	The MSG is not strong enough to enforce wrongdoing. I think if the government can give it more powers it will help.
Ghana	Establishing their tenure of office, regular capacity building to be more responsible.
Malawi	My concern is that representatives of organisations seem not to share information from CoST and rarely act on findings from Assurance Reports as individual organisations.
Malawi	There is potential that MSG can be a victim of political manipulation by State machinery to support assertions of Government on public infrastructure issues.
Malawi	Need an advance drawn calendar of work and meetings drawn. We always seem following the convince of secretariat as opposed to mandatory work cut out.
Malawi	The critical issue about MSG is its leadership and secretariat. Having a secretariat at a public entity may not be the best of places for sustainability from political and social conflicts.
Malawi	MSG composition needs review from time to time.
Malawi	MSG members should not promote their own agendas but should look to the objective of the group when carrying out its duties. Allegations should be based on information that can be substantiated, not just aimed at spiting a particular group of people, since that dilutes objectivity.

Afghanistan	I'm not worried.
Afghanistan	Low Participation.
Afghanistan	Capacity and specialization of the members of the group of subordinate institutions. Failure to pay attention to sharing CoST activities with members of the institution, which is represented in the group of institutions.
Afghanistan	It is better to reconsider the presence of some institutions because they do not have an active presence and share, and in each case, the group of institutions involved in the decision must participate.

RESPONSES FOR Q15.: FINAL COMMENT

Country	Q15. In case you have a final comment, please provided it here:
El Salvador	Thank you for researching the importance and the functioning of the MSGs. Personally, I think it is an organisational mechanism that must keep working. This is independently the fact that each CoST country has an association as legal framework.
El Salvador	This is very interesting, and it made me to reflect on some topics and views about the MSG, as well the conflicts and factors that may influence their functioning.
El Salvador	Thank you for letting me to provide my opinion.
El Salvador	I think this survey is very interesting, and I will be waiting for the aggregated results in terms of the sectors and participant countries.
Panama	N/A
Panama	I like the CoST program. It is too good, and I would like to engage even more. I think it is important to support state companies so they can get good benefits of their investments under due transparency and diligence.
Panama	Thank you for taking me into account for this survey!
Honduras	Very interesting survey to review our compromises as members of the CoST MSG and incentivise us in providing more efforts to strength transparency in the sector.
Honduras	No comment.
Honduras	I hope my participation is useful.

Honduras	I consider that the MSG can be better, but they set their own limits. A change in the MSG authorities could not be that bad. For instance, the incorporations of Yudina Castillo from the SCGG injected courage to the group in the decision making. On the other hand, MSG members that have been there for long time they only make things to happen very slowly, looking for individual benefits rather than the collective benefit of the initiative. I have some time involved in CoST and I have so many things to learn still. So my opinion about the MSG may not be taken into account. I believe in this initiative with all my soul and I consider there are persons that are not fighting enough for this. Thank you very much and I'm available whatever else is needed.
Honduras	The MSGs should take a more proactive role by providing additional time to the MSG meetings to contribute to the priorities of the national secretariat. Effectiveness and support that is translated into real practice is needed rather than dialogue and demands. There should be availability from members to work in the commissions and not leave alone the national secretariat with the strategic compromises. Plus the MSG should not spend time nor efforts in engaging with operative topics of the national secretariat, because there is a tendency of some members of the MSG to do this in the day-to-day issues and they forget the priorities of CoST.
Honduras	As I mentioned at the beginning, I work for the administrative part of the initiative. Therefore, I cannot opine about some topics that are directed to the members of the MSG.
Guatemala	Our organisation, ASIJUAGUA, is new in the MSG. During 2020 it is expected to have a larger participation with quality knowledge of this important initiative.
Guatemala	Even though the survey has important topics, they are not precise.
Guatemala	It is important to consider the policies from the host country [Guatemala] because the success of the initiative depends on these. Currently, there is not enough personnel to achieve the objectives of assurance reports and socialization that the initiative requires.
Guatemala	Congratulations to CoST for running this study and success in the future results. We hope they help to improve the impact of CoST in the country.
Guatemala	The survey was very confused. I do not know if there was a validation exercise previously.
Guatemala	My competence is directly with the technical part in the design, implementation and development of the open data platform and the implementation with the OC4IDS standard, so I consider that many of the topics in this survey do not apply to my role.

Guatemala	Yes, there are actors that are shown in the survey and that have not participated in the MSG meetings of CoST (Gpat, Usaid, Plaza Publica). Some of them are duplicated for example Camara de Construcción is the same as Camara Guatemalteca de Construcción. Hivos is an international cooperation from the government of the Netherlands. It is not a civil society. Usaid as such has not had a relationship in the meetings with the GMS. Gpat is trying to get in the initiative. They asked to be members 3 weeks ago, I got the meeting with them because they are the transparency commission and open policy from the government. They can help us with the integration of work of the Ministry of Communication that left. Yet, the country manager has never been willing to call these people and invite them to our meetings -now online. Why? This information must be clarified because it can affect the results of the survey. You should think in a survey to evaluate the country manager and her/his team. Thank you for taking us into account. Greetings.
Guatemala	I think it is important to follow up the actions of CoST in every implementing country to assess their effectiveness.
Costa Rica	I do hope that CoST Costa Rica continues throughout the time. There are not many results yet because of the small amount of time in operations. However, in the future the initiative can offer benefits.
Costa Rica	You must bear in mind that Costa Rica has only made one assurance report that was published in November 2019.
Ethiopia	In countries like Ethiopia, it is the government that procures services construction works. Due to which the procuring public entities are in a position to manipulate tenders to their interest (mostly private). Appealing to the public regulatory bodies like PPA (Public Procurement Authority) is not as such worthwhile to stop irregularities in procurement of construction services. I recommend international financial institution should review the government's track record in combating corruption before extending any developmental loans and grants. That is when the government will be forced to take serious actions to keep regularities. And moreover, institutions like CoST will be listened more and more.
Ethiopia	The survey is good, and I hope it fulfils the purpose to which it is intended for.
Ethiopia	I look forward for the study report.
Ethiopia	No
Ethiopia	In order to meet the goal of the CoST the active involvement of Government is very important.
Ethiopia	In my opinion, this survey would have helped a lot, had it been done in short time intervals. Besides, it was advisable to have a part to comment on the International Secretariat.
Ethiopia	I want to know the final results of this survey if this can help the initiative to be one step ahead. Thanks
Ethiopia	It would have been good to get an initial concept note that would have detailed the objectives of the study.
Ghana	It was mostly easier to answer and simple to understand.
Ghana	I think it is too lengthy and clarity of questions could have been improved if it had earlier been piloted among research respondents

Ghana	No
Ghana	Just to say that CoST is a good initiative and must be championed to be accepted by national governments worldwide
Ghana	Am happy to be part of the CoST initiative and to share my opinion in this survey.
Malawi	N/A
Malawi	No further comment,
Malawi	Filling in was easier using Laptop than smartphone.
Malawi	None
Malawi	I feel CoST membership should be frequently reconstituted in a very transparent manner to enhance on ownership of the CoST work.
Malawi	The CoST program is the greatest thing to have happened in recent times in as far as infrastructure governance is concerned. Sustainability of the program in CoST Countries should be paramount as we forge ahead.
Malawi	None
Ukraine	Thank you for the opportunity to cooperate in the implementation of CoST standards in infrastructure construction projects.
Ukraine	Officially started working in the NGO "CoST Ukraine" in March 2020
Ukraine	I wish a successful continuation of the work of the Secretariat and the ONG.
Ukraine	Thanks for the poll!
Afghanistan	A poll was very helpful
Afghanistan	The result which come from such questionnaire can lead us to the think more about the improvement of COST and ensure transparency in the infrastructure sector and other public projects.
Afghanistan	I hope this poll will be conducted every three months.
Afghanistan	No comment
Afghanistan	Thanks for holding this poll. I hope that this work can continue to provide recommendations for improving the activities of the group of institutions involved.
Afghanistan	to increase the level of MSG engagement in CoST, we need to introduce some new motivational tools. These tools could be regular capacity building programme by CoST, certification process, holding events for appreciation of those MSG members that have contributed more in MSG meetings.
Afghanistan	It will be better to consider more educational programs and practical workshops to improve the capacity of the members of the group of talented institutions.
Afghanistan	The Transparency Initiative is a good institution to provide and support resources.

Afghanistan	I hope that by conducting this survey, the gaps in MSG will be filled and COST will become an institution with authority.
Afghanistan	In my opinion, this poll is important for strengthening CoST, and weak points can be followed up and corrected.
Thailand	Some of the questions were not adapted to the national context.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)



REPORT ON CoST-UCL ONLINE SURVEY RESULTS (2/2)

January 2021



UCL School of Public Policy

Ethics Committee Project ID: 15829/00

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Introduction

Fundamentally, mechanisms of multi-stakeholder groups (MSGs) and collective action are meant to encourage relationships among groups of actors, which constitute the foundation of any social network (Fowler & Biekart, 2017). The success in the production of desired outcomes requires establishing and managing social networks (Jones, Hasterly & Borgatti, 1997). The initial capacity of these outputs to produce positive results depends partially not only on the quality of the process in which these are defined, debated, and approved, but also on the ways diverse actors interact in the process (Aldrich, 1982; Andrews & Entwistle, 2010).

When assessing multi-stakeholder groups, and targeting areas of improvement, recommendations should consider who are engaged on the outputs, when, and how. It is relevant to understand who the key actors are and how they relate to each other, and how interactions, influence and information unfold between them (Ansell & Gash, 2008). In most cases, networks of relationships are very different from their formal design or the way they are supposed to operate. Therefore, the extent to which the informal network departs from the formal one (as institutionally prescribed in official documents) becomes a key component in the study of network relationships (Faul, 2016).

In this sense, the social network analysis (SNA) approach can add value to the Infrastructure Transparency Initiative (CoST) by offering a precise description of the multi-stakeholder dynamics and the coordination issues that public and non-public member organisations. This is both by identifying participation of organisations in the networks and by establishing how they relate to each other. That is, their connections and distance between them, which in turn define their place in the networks (Borgatti & Foster, 2003).

SNA provides key information on how sectors and organisations engage in flows of information while interacting in MSG meetings or other CoST implementation-related activities. Most crucially, it can amplify hardly observed process of influence and decision-

making, by identifying how organisations intervene in specific ways and may influence positively or negatively the tasks of MSGs.

Therefore, for this second report on the CoST-UCL Online Survey 2020, the SNA approach is adopted to study relational data collected from two network questions in the survey: (1) “Considering all your interactions (via email or telephone calls, and face-to-face meetings) you had with CoST members from January to December 2019, how frequently did you provided information about public infrastructure-related matters to people that represent the following set of organisations?” And (2) “how frequently have you discussed the following topics with the people from the organisations you have selected in the previous question?”⁵¹

This report presents findings on the analysis of informal networks from data provided by respondents of 10 implementing countries: El Salvador, Costa Rica, Guatemala, Honduras, Panama, Malawi, Ghana, Ethiopia, Afghanistan, and Ukraine.⁵² The report emphasises three network levels of analysis. The extent to which organisations are connected to others, and the extent to which their network as a whole is integrated, are two sides of the same coin. Therefore, the first level of analysis describes the general structure and behaviour of the whole network for each country in the sample (i.e., whole network measures), while the second level disentangle structural differences among member organisations and their network positions to reveal constraints and opportunities that arise from their embeddedness in the webs of interactions (node-level measures). Finally, the categorisation of member organisations by their individual sector affiliation, reveals a third level of analysis to determine how the public and non-public sectors contribute to the multi-stakeholder dynamics of the MSGs, and what are their priority topics of discussion within the network. This analysis also includes the interactions from the National Secretariats and Assurance Teams.

In the reminder, Sections 2 and 3 explain basic network graph concepts (e.g., node, tie, density, degree, etc.) that will allow the reader to follow more intuitively the descriptions of the networks, as well as to understand their possible implications for the network actors. Section 4 briefly describes the survey response rate and the sectoral composition of member organisations per country. Section 5 offers an interpretation of the SNA findings for every

⁵¹ Seven topics of discussion were included in the answer choices for the second network question: (1) Cost and time overruns in infrastructure projects, (2) tender and contract award, (3) safety and wellbeing of infrastructure workers, (4) environmental and social impacts, (5) quality of design and quality in infrastructure projects, (6) poor contract management, and (7) following up findings and recommendations from the Assurance Report.

⁵² An interactive platform for the visualisation of networks and results is also available at: <https://cost-uclsurveynetworks.shinyapps.io/CoST-UCLSurvey2020/>

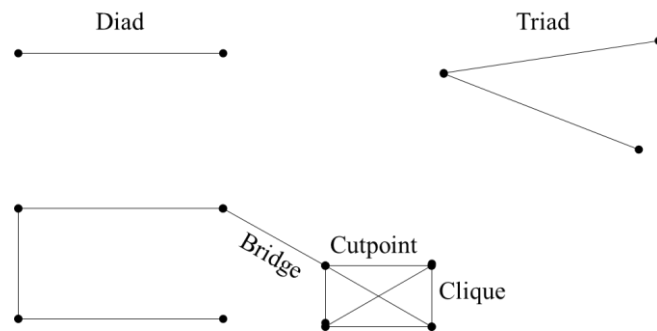
country in terms of their whole network and node level measures, and the type of information that is most predominantly discussed between sectors. A non-interactive dashboard with network visualisations and consolidated table of network measures is included in the description of every country, offering a visual display in a single sheet to monitor and compare data at a glance. In order to complement network findings, Section 6 presents an analysis on the personal attributes that increase the probabilities for individuals participating in CoST to expand their relationships with others. This report concludes with a section of final remarks and a summary.

Basic Concepts of Social Network Analysis

SNA studies the relation among actors. These can be humans, organisations or even countries (Scott, 2000). In social network graphs, the actors are represented by *nodes* (dots), and their relations are depicted by lines called *ties* or *relationships*. Ties are the links by which actors connect in a network (Borgatti & Foster, 2003). *Directed ties* or lines with arrow heads denote the orientation of the flow of relational contents. The relational contents can be material resources such as money transfers or non-material such as information, friendship, or admiration (Borgatti & Foster, 2003). A *dyad* is the most fundamental unit of analysis in SNA, as it is defined as a pair of actors and the ties between them. If the pair of actors have ties with a third actor, then the unit of analysis becomes a *triad*. In the network visualisations for this report, nodes represent CoST member organisations, and directed ties reflect the direction of flows of information between them and interaction during 2019.

In SNA, a *group* is a finite set of actors, whose ties are the object of analysis. Thus, a network can be constituted, partially or completely by subgroups. The identification of groups is relevant to analyse the concentration of ties in regions of the network, and the type of nodes that are part of those clusters. A *clique* is a highly cohesive subgroup structured by relational patterns that differ from those of their network. Identifying cliques is important for understanding not only their position in the network and the behaviour of their actors, but also their effects on the performance of the network in general. Cliques are one of the simplest types of cohesive subgroups, and because of their straightforward definition are also one of the easiest types to understand. Figure 2-1 illustrates dyads, triads, and, in a simplified version, a clique.

Figure 0-15. Visual representation of a Dyad, Triad and Clique



The line that connects the clique to the rest of the network in Figure 2-1 is called a bridge. *Bridges* are intermediate ties that link two groups in a network without specifically belonging to either of them (Scott, 2000). In turn, the node in the clique that connects it with the rest of the network by way of the bridge is a *cutpoint*, because its removal would increase the number of network subgroups. Cutpoints are actors whose absence from a network would break up and fragment the network structure. This concept helps identify which actors are essential to maintain or modify the network structure.

Furthermore, the study of network forms deals with the distribution of ties within the network, and it measures aspects such as cores and peripheries. Whereas the *core* is made up of actors that form a cohesive group and are densely tied to each other, the *periphery* is made up of actors not densely tied to the cohesive group (Borgatti & Everett 1999). Whatever the relational content linking the actors in the networks, it flows more intensely within the core, and only reaches the periphery through bridges, and cutpoints that may connect peripheral actors by way of cliques. Networks with small cores would operate in a hierarchical way, whereas those without cores would operate in a decentralized and possibly fragmented way. Networks with a large number of cliques would limit and encapsulate the flow of relational contents, thus generating low connectedness and contributing to hierarchical coordination.

Table 2-1 describes succinctly these basic concepts of SNA that are employed in the descriptions of networks for this report.

Table 0-4 Basic concepts of social network analysis

Concept	Definition
<i>Node</i>	An actor or entity that makes up the network.
<i>Tie</i>	A connection between two nodes. Also known as relationships or edges.
<i>Directed tie</i>	A tie that has a direction and it is indicated visually with an arrow. A tie going from one node to another, but not necessarily returned.
<i>Dyad</i>	A pairwise relation between actors.
<i>Triad</i>	A relation where two nodes share a common tie to a third node.
<i>Group</i>	A finite set of actors within a network.
<i>Cohesion</i>	Refers to how well connected a network is.
<i>Clique</i>	A maximal subset of actors in which every actor is connected to every actor.
<i>Bridge</i>	A tie that, if removed, would increase the number of components in a network.
<i>Cutpoints</i>	Nodes which, if removed, would increase the number of components in a network.
<i>Core</i>	A group or subgroup of nodes highly interconnected in a network.
<i>Periphery</i>	Actors that are not densely tied to the cohesive group.

Source: Borgatti et al., 2013.

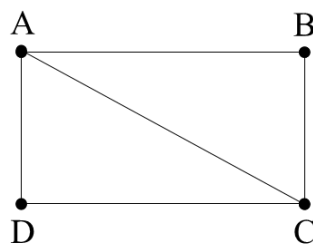
Macro and Micro Network Measures

As previously mentioned, this report describes the properties of networks in two main dimensions related to the macro and micro characteristics of the network and its actors. Focusing first on the network as a whole, one might be interested in the number of actors, the number of connections that are possible, and the number of connections that are actually present. Differences in the *size* of networks, and how connected the actors are through the *number of ties* tell us two critical things about the structure of networks, because of the limited or expanded resources and capacities that each actor has for building and maintaining ties. Usually, the size and ties are indexed simply by counting the number of actors and the number

of ties between them in a network. For instance, Figure 3-1 shows a size of four actors and five ties between them.

Furthermore, whole network can be studied through four additional concepts: density, cohesiveness, diameter and components. *Density* is the number of ties in a network, measured as the share of the highest possible number of ties. This measure enables the estimation of how close or how far a network is from the complete interconnection of its actors (Scott, 2000). The closer the density is to '1', the denser the network is in terms of the number of ties. Figure 3-1 has five lines, but it could have six if a line directly connected D to B. Thus, the figure's density is 0.83, equivalent to 5/6.

Figure 0-16. Basic structure of a network



Cohesive networks are sets of actors that are tied together through frequent, strong, and direct ties (Wasserman & Faust, 1994). A network displays a higher level of cohesion the higher the connectedness of ties among the actors. The measure is quite consequential for networks because useful information can spread more quickly where there are high rates of connection (Borgatti et al., 2013), and more connected networks may be better able to mobilise actors' resources, and to bring multiple and diverse perspectives to solve problems. A tie between D and B would contribute to a high degree of cohesiveness to the figurative network in Figure 3-1.

The *Diameter* of the network indicates the ease with which one actor may communicate with all others. The diameter of a network tells how "big" it is, in one sense (that is, how many steps are necessary to get from one side of it to the other) (Scott, 2000). In an ideal-type of network structure, all actors would be able to communicate with all others without intermediation. Thus, the closer the diameter is to '1', the easier and faster the communication path is between network actors (Borgatti et al., 2013).

The final element of whole network measures is *Components* that calculates the number cliques or subgroups in a network. Components may reflect the degree to which a network is likely to be fragmented in different subgroups or in actors that remain isolated in the peripheries of a network by not having relationships with others.

Focusing now on the micro characteristics of a network, within node level measures the concept of *Centrality* is paramount as it identifies the most relevant actors in a network. The notion of importance for this concept naturally varies across the context of networks. As a rule, however, centrality is structurally defined as the position of an actor within a network and can be determined using three main measures: Degree, Betweenness, and Closeness. The *Degree centrality* of a node is defined by the total number of ties the actor is connected. An actor is central if it is tied to a higher number of nodes within the network. This is an indicator of connectedness, and therefore of node's influence on others and the opportunities to be influenced by them. In practice, an actor's centrality can be useful for determining its importance for the diffusion of relational contents within a network or for pondering the effect of its absence on the network stability.

For directed graphs, however, a distinction is made between the actors to which the higher number of ties is directed (in-degree or incoming ties) and the actors from which the higher number of ties emerge (out-degree or outgoing ties), which makes it possible to measure two types of centrality: inward and outward centrality. For comparative purposes, both types of centralities are rendered through In-degree and Out-degree indexes, whose maximum value is 1. Therefore, an InDeg of '1' reflects a popular actor that has all potential incoming ties available in a network (inward centrality), while an OutDeg of '1' reflects an active actor sending outgoing ties to all the members in a network. This report presents network visualisations in both inward and outward centrality, so the reader is able to compare those CoST organisations that are more popular by receiving a larger number of incoming ties, and those that are more vigorous sending many outgoing ties to their network colleagues.

The second aspect of centrality is *Betweenness* that measures the degree to which an actor is located between the others in a network. That is, the degree to which an actor plays the part of a broker or a gatekeeper. Consequently, this measure can be interpreted as an indicator not only of the level of interpersonal relations of any actor, but also of that actor's level of authority. Betweenness centrality calculates the number of short distances that pass through a given node providing a measure of the node's relevance within the flows of resources in the

network. Betweenness is normalised in this report to compare the actual Betweenness of an actor to the maximum possible Betweenness the actor can achieve in the network. Thus, maximum scores of Betweenness would indicate an actor that is extremely central because it falls in between most dyadic ties in the network.

Closeness centrality measures how close an actor is to others within a network. Actors are central if they are close to all others because they can quickly interact with them and have easier access to their resources. The measure is particularly useful when the motive of network study is the diffusion of innovation or dissemination of information from relevant actors, because Closeness can be interpreted as well as the minimum time a resource can flow in the network (Wasserman & Faust, 1994). For directed networks, an actor is close to others depending on the number of outgoing or incoming ties the actor is embedded in. Thus, Closeness centrality in this report is rendered through InClose and OutClose indexes, whose maximum value is ‘1’ when the actor is nearby to all the other actors.

This report complements the study of actors’ centrality with two additional measures. The way actors of a network categorise themselves influences the extent to which they associate with others who are seen as falling into the same category. Thus, *Homophily* in this report measures the extent to which actors of a particular sector tend to have more and more frequent ties with actors of the same sector affiliation as themselves. Homophily reveals preferences of association that may limit the objectives of a multi-stakeholder group.

On the other hand, the *Reciprocity ratio* is a measure to understand the propensity of reciprocation between actors, and in this case, between sectors. The ratio is calculated within and between sectors by dividing a sector total incoming ties by its total number of outgoing ties. Then, when the ties of a sector are fully reciprocated, the reciprocity ratio is calculated as ‘1’, indicating mutuality in relationships, and underpinnings of partnership (Faul, 2016). Where a sector receives more ties than it claims (>1), this may suggest the presence of a privileged and powerful sector due to its popularity, but lack of mutual exchange with others. In the same way, a less privileged sector would claim more ties than are reciprocated (<1).

Table 0-5 Whole network and node-level measures summary

<i>Concept</i>	<i>Definition</i>
<i>Size</i>	Number of actors (nodes) in a network.

<i>No. ties</i>	Number of total ties present in a network.
<i>Density</i>	The proportion of all possible ties that are present.
<i>Connectedness</i>	The degree of how well connected a network is.
<i>Diameter</i>	The ease with which one actor may communicate with all others.
<i>Components</i>	Number of cliques or subgroups. Reflects the degree of potential network fragmentation.
<i>Centrality</i>	A class of constructs that characterise an actor's position within the network structure.
<i>Degree</i>	The number of total ties that an actor has with other actors.
<i>In-degree</i>	The number of ties that are directed to an actor in particular.
<i>Out-degree</i>	The number of ties that an actor sends to others.
<i>Betweenness</i>	The degree to which an actor is located between the others in a network.
<i>Closeness</i>	How close an actor is to the other actors within a network.
<i>Homophily</i>	The degree to which an actor have ties with others of similar characteristics like sector affiliation.
<i>Ratio reciprocity</i>	The degree of reciprocal ties between actors.

Source: Borgatti et al., 2013.

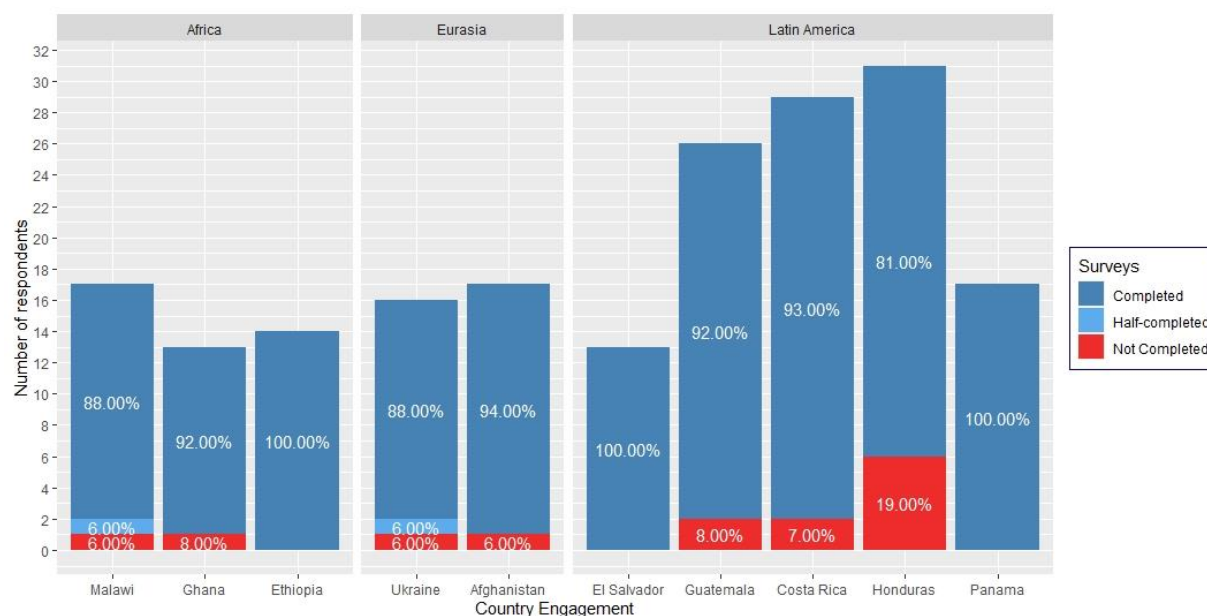
The ten case studies of this report use the different node-level measures explained in this section to identify the relational characteristics of CoST member organisations, which of them are more central than others, and whether they have preferential ties with other organisations representing the same sectors. Given that these measures capture different dimensions of the behaviour of organisations and their sectors, scores may differ across measures. Consistent scores across measures indicate that an organisation is rather central to the network; different scores, in contrast, indicate that an organisation is more central in one or another of these dimensions. See Table 3.1. above for a summary.

Survey Response Rate

The online survey was originally deployed in 11 implementing countries of CoST during the second quarter of 2020. The survey was translated into five languages (i.e., English, Spanish, Farsi, Ukrainian and Thai). For this report, however, data collected from CoST Thailand was dropped due to the low number of participants to complete their network structure design. As a result, the report describes findings of 10 countries, whose individual response rate surpasses

80%, as Figure 4-1 shows. The global response rate for this sample of countries is roughly 93%.

Figure 0-17. Response rate per country

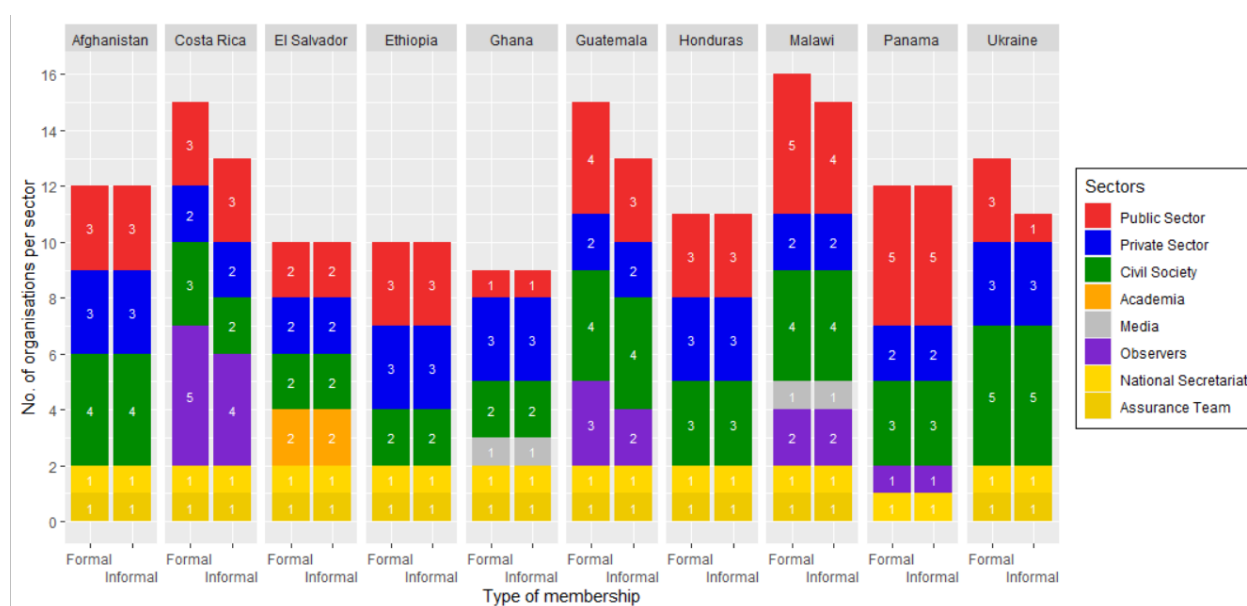


The survey was distributed through the software Qualtrics licensed to UCL. Personalised invitations were sent by email to a contact list provided by Country Managers through the intermediation of CoST International Secretariat. Hereafter, this contact list is referred as the *formal membership*. In the subsequent rounds of survey invitations and reminders for participation, the formal membership contact list was slightly updated. New organisational representatives were added for some countries, while others were dropped because they were not holding office when contacted. The modifications to the formal membership were supervised by Country Managers and approved by Regional managers, predominantly for the Latin American region that presented more membership adjustments than the other two regions.

The updated contact list is hereafter referred as the *informal membership*. It includes CoST members that indicated to be active in MSG meetings and CoST activities during 2019 and 2020. The informal membership contact list served as input data to plot and analyse the informal network structures of the countries in the sample and compare them with ideal networks structures, considering participation of those original members included in the formal membership.

In terms of representation by sector, Figure 4-2 shows that as for 2020 there was little discrepancy between the composition of formal and informal memberships. That is, CoST member organisations from all the sectors originally included in the formal membership participated in the survey. Minor inconsistencies were found for countries like Costa Rica and Guatemala, where a smaller number of observer and civil society organisations took the survey than what the formal membership stipulates. Results also recorded a smaller number of public sector organisations participating in the survey for Malawi and Ukraine. Regardless of these differences, Figure 4-2 shows that data collected for the informal membership is likely to provide a reliable picture on how sectors and their representative organisations interact and behave within CoST through SNA.

Figure 0-18 Organisational participation by sector: formal and informal membership



Countries' Network Analysis and Network Visualisations

This section presents findings of the SNA. Every country includes a brief explanation of the most relevant network trends, according to their whole network and node-level measures. In order to facilitate data comparison of the different network measures, a dashboard is also included. The dashboard serves as a visual display of the most important information, consolidated, and arranged in a single sheet so the data can be monitored and compared at a glance.

Every dashboard includes five elements: (1) three networks visualisations; (2) a Cleveland dot plot that informs members' average number of years participating in CoST, and number of meetings attended in 2019; (3) a horizontal bar chart that shows the most popular topics that network actors discuss and share information about; (4) a table for whole network measures; and (5) a table for node-level measures.

In the dashboard, the first network visualisation (elaborated from the formal membership contact list) shows the ideal type of network structure. Organisations from the MSGs are represented with equal number of incoming and outgoing ties (equal node size), reflecting the highest level of interconnection and communication they can possibly attain. The second network visualisation (elaborated with data from the informal membership) depicts the actual configuration of relationships between CoST member organisations. The size of nodes reflects the number of incoming ties every organisation receives from others. That is, the bigger the size of the node, the more popular it is for others to have a relationship with. In contrast, the third network visualisation (also elaborated with data from the informal membership) shows countries' informal network structure as well, but the size of nodes represents the number of outgoing ties that they have indicated to have with others. Thus, the bigger the size of the node, the more active it is in establishing connections within the network.

The survey did not capture specific relationships between individuals, but rather from individuals (respondents) indicating ties with CoST organisations. Thus, to standardise network measures and network visualisations, individual responses were aggregated to obtain a single organisational response on behalf of the organisation they represent in CoST. In doing so, network visualisations are displayed with directed ties from one organisation to another, and not from individual members to organisations.⁵³

The nodes are colour-coded according to the sector affiliation of every CoST organisation (including National Secretariats, and Assurance Teams).⁵⁴ Furthermore, nodes are labelled with the acronyms of their sector affiliation. This includes six sectors, plus two additional categories for National Secretariat (NS) and Assurance Teams (AT).⁵⁵ Appendix I

⁵³ This aggregation procedure is in compliance with the General Data Protection Regulation (GDPR) of the EU that assures the anonymity of individual participants in data analysis, and research publications (UCL Ethics Committee Project No. 15829/001).

⁵⁴ Colour code: Public sector (red), Private sector (blue), Civil Society (green), Academia (orange), Media (grey), Observer organisations (purple), National Secretariats (yellow), and Assurance Team (yellow).

⁵⁵ Acronyms: Public sector (PubS), Private sector (PriS), Civil Society (CS), Academia (Aca), Media (Med), Observer organisations (Obs), National Secretariats (NS), and Assurance Team (AT).

includes a code book for the identification of organisations' name and their sector code in this report.

Network visualisations were elaborated with R statistical software through Igraph (Csardi & Nepusz, 2006), Statnet (Handcock et al., 2018), and VisNetwork packages (Almende et al., 2019). In order to calculate the macro and micro network measures, data was entered into SNA software UCInet (Borgatti et al., 2013). An exclusive interactive network visualisation app for this report is also available online. It offers a learning platform that enhances the experience of network visual exploration and manipulation. All the networks in this report are available in the platform, as well as an interactive display for network measures and comparison. Please visit the following website: <https://cost-uclsurveynetworks.shinyapps.io/CoST-UCLSurvey2020/>

El Salvador

Whole network-level measures

The survey collected data from ten member organisations for CoST El Salvador. The participation of 13 respondents assured 100% response rate for the country. Figure 5.1.1. (a) illustrates an ideal network structure of interconnection between the Salvadoran organisations, whereas the informal network structure visualisation (b) and (c) reveals a more uneven pattern of interconnection. That is, the formal structure has the potential to reach 90 relational ties between member organisations, but the informal network structure has only 67 actual ties. Relationships of interactions and information flows in El Salvador unfold within 74% of its network capacity (See Table 5.1.1.).

Regardless of this, the small number of actors in the country confers to the informal network a great deal of connectedness with '0.9' for this measure. This places CoST El Salvador within the top three remarkably well-connected countries, just after Costa Rica and Malawi. Connectedness for El Salvador is consequential because despite not having all of the network possible ties, these are well distributed among organisations, which often means a greater exposure to more diverse information and innovation. By looking at the informal network diameter measure in Table 5.1.1., the longest path between organisations for this country is three, implying that, in the worst-case scenario, information disseminated in one side of the network is likely to pass through three organisations to reach all others the in network.

Due to its high connectedness, El Salvador shows neither cliques nor cutpoints through which the network can be fully fragmented in case of disintegration. However, the components measure of two, on the other hand, indicates signs of decentralisation between the core cohesive relationships and a single organisation, which is partially isolated at the periphery of the network.

Node-level measures

From a visual comparison of the informal network in its two versions, (b) inward and (c) outward centrality, differences in node sizes become clearer. The relational resources between member organisations differs in terms of outgoing ties and the incoming ties they receive from others, revealing a pattern of preferentiality between them to connect with a particular set of organisations. Node-level measures in Table 5.1.2. indicate that PriS2 (Colegio de Arquitectos

de El Salvador CADES), PubS2 (Ministerio de Obras Publicas) and NS1 (National Secretariat) are the most well-connected actors in El Salvador by number of total ties (16 degrees each). At first glance, the combination of different organisations at the core of the informal network is likely to be a positive feature for the implementation of CoST. The exposure to a richer pool of information and practices that this structural configuration creates can lead to stakeholder integration and innovation.

However, node-level measures also reveal that these actors may cope with constraints when trying to interact with members outside the core. While these entities attain the highest scores of OutDeg index '1' (i.e., they send share information to all other possible organisation in the network), their general InDeg index is '0.78', which certainly does not make justice to their level of relational activity and effort to connect with others (i.e., they have null response from some organisations).

On the other hand, PubS1 (Fondo de Conservacion Vial) and AT1 (Assurance Team) do not belong to the core, and yet they seem to be the most popular organisation due to the number of incoming ties they receive from others. Their index of incoming ties reaches almost 90% of all possible incoming ties in the network (InDeg = '0.89'). In fact, a visual comparison of the informal network (b) and (c) for PubS1 and AT1 in Figure 5.1.1. reveals that these organisations, despite their popularity, are not reciprocal. According to network theory (Emerson, 1962; Casciaro & Piskorski, 2005), this observed pattern may indicate disparities of relative power, because PubS1 and AT1 choose not to reciprocate to the same extent to others, limiting the levels of information they can contribute to the decision-making and activities of the MSG.

In the most extreme cases, PubS1 (Fondo de Conservacion Vial) and Aca1 (Universidad de El Salvador) present the lowest scores for outgoing ties (OutDeg). The latter with zero outgoing ties makes it a "sink" organisation, which is characterised as such due to its limited capacity to connect with others, remaining at the periphery of the network. The relational behaviour of Aca 1 and PubS1, may come as a surprise considering the average years that academic and public sector members have been engaged in CoST El Salvador, which is more than 4 years, and an average attendance of meetings of four and five times in 2019, respectively (see Figure 5.1.2.). Thus, despite the seniority of some members from the public sector and academia organisations in CoST, their relational structures suggest constrained contributions to the MSG relational dynamics.

The Closeness centrality measures (OutClose) shows that besides the very well connected actors, PriS2 (Colegio de Arquitectos de El Salvador CADES), PubS2 (Ministerio de Obras Publicas) and NS1 (National Secretariat), other organisations like CS2 (Sistema de Asesoría y Capacitación para el Desarrollo Local), Aca2 (Universidad Politécnica de El Salvador), CS1 (Asociación Transparencia, Contraloría Social y Datos Abiertos TRACODA) and PriS1 (Cámara Salvadoreña de la Industria de la Construcción) shape the contours of the central region of the informal network (the core) since their high OutClose index makes them structurally closer to every other organisational in the network.

When it comes to Betweenness centrality, the structural position of the Assurance Team (AT1) is the most privileged. The highest score of ‘11.11’ in this measure indicates the importance of the AT1 as an actor in the network. Despite having a lower number of total ties than those entities at the core and its limited average participation in CoST, AT1 falls in between most of the relationships in the network, which makes it a reference point for information dissemination and intermediation. AT1 may take advantage of its increasingly relevant position by diversifying its outgoing ties with unconnected ones, for example civil society and academia organisations, which currently are out of its relational scope, as indicated by the reciprocity ratio scores in Table 5.1.3.

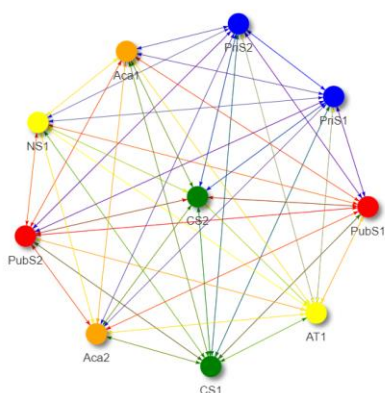
Information sharing

There are four main topics that members from CoST El Salvador indicated to discuss more when sharing information with other CoST colleagues (see Figure 5.1.3.). The most relevant of these relates to the assurance report and the follow up of its findings and recommendation. This is in line with the findings about the important role that AT1 plays in the web of information ties. Members from El Salvador also indicated that the second most discussed topic is quality and design of infrastructure projects, following in third and fourth place issues about contract award and contract management, respectively. Results reveal that these topics stand out from the others, especially because of the number of individuals representing the public sector that indicated to talk about them very frequently. While the rest of the sectors, including the NS and AT, showed to be well engaged with all the topics in general, the priorities for public sector organisations in CoST El Salvador seem to be very well defined.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

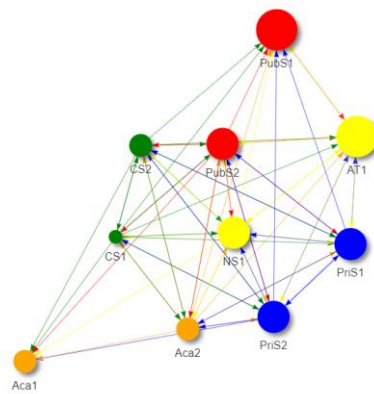
Figure 5.1.1. a) El Salvador formal network

Ideal-type map of the formal organisation



b) Informal network (inward centrality)

Node size: number of incoming ties



c) Informal network (outward centrality)

Node size: number of outgoing ties

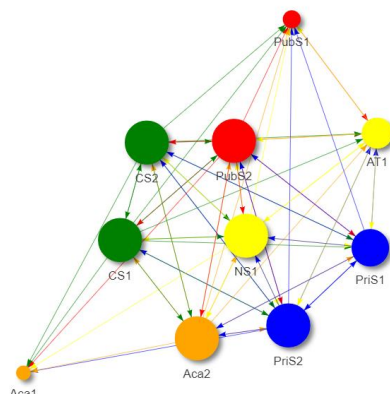


Figure 5.1.2. El Salvador (avg participation per sector)

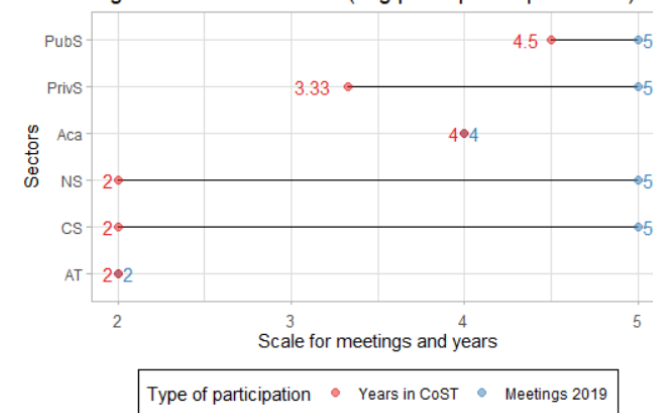


Table 5.1.1. Whole network-level measures

Country	Size		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
El Salvador	10	10	90	67	0.74	0.9	3	2

Legend: F, formal network; I, informal network.

Figure 5.1.3. No. of individuals in El Salvador sharing information about the following topics

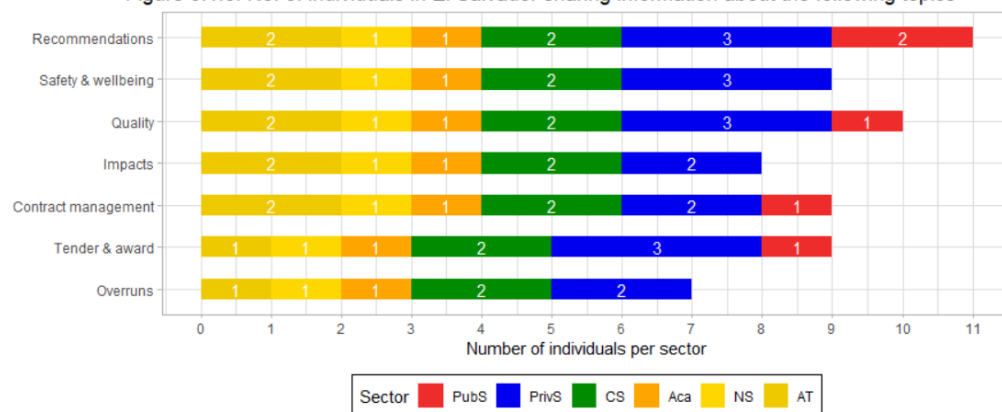


Table 5.1.2. Node-level measures

El Salvador	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
Aca1	6	0.00	0.67	0.25	0.69	0.00	NA
Aca2	15	1.00	0.67	1.00	0.60	0.56	0.11
AT1	13	0.56	0.89	0.69	0.75	11.11	0.00
CS1	14	1.00	0.55	1.00	0.56	0.00	0.11
CS2	15	1.00	0.67	1.00	0.60	0.56	0.11
NS1	16	1.00	0.78	1.00	0.69	3.80	0.00
PriS1	14	0.78	0.78	0.82	0.69	1.39	0.14
PriS2	16	1.00	0.78	1.00	0.69	3.80	0.11
PubS1	9	0.11	0.89	0.43	0.75	0.00	0.00
PubS2	16	1.00	0.78	1.00	0.69	3.80	0.11

Table 5.1.3. Reciprocity ratio by type sector

Sector	PubS	PriS	CS	NS	At	Acad	AveRecip
PubS	0.00	2.00	2.00	2.00	1.00	1.00	1.33
PriS	0.50	1.00	1.33	1.00	1.00	0.67	0.92
CS	0.50	0.75	1.00	1.00	0.00	0.50	0.63
NS	0.50	1.00	1.00	0.00	1.00	0.50	0.67
AT	1.00	1.00	0.00	1.00	0.00	0.00	0.50
Acad	1.00	1.50	2.00	2.00	0.00	0.00	1.08

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Costa Rica

Whole network-level measures

The survey collected data from 13 organisation in CoST Costa Rica through the participation of 27 respondents. This led to a response rate of 93%. In the ideal type of network structure in Figure 5.2.1 (a), 15 member organisations are represented. In this case, the formal network structure would be structured with a total of 210 possible ties. Nevertheless, the bulk of relations and interactions of Costa Rica was indicated to occur through 13 organisations and 130 ties between them.

Despite the absence of data from a civil society and an observer organisation that did not participate in the survey, the informal network of Costa Rica proves to be extraordinarily well connected. It has 83% of all the possible ties that those 13 organisations can possibly attain. The ties are very well distributed among all the network actors, and the connectedness score reaches its maximum of '1'. The global network structure for Costa Rica does not have unreachable actors, which makes it the most cohesive network of the sample. The macro characteristics of the informal network also provides to the country a high degree of compactness since it lacks relative isolated organisations at the periphery of the structure. As such, the whole informal network forms only one component (on group) of network actors without signs of potential fragmentations. For Costa Rica, two steps are necessary (diameter) for the information to get from one side of it to the other, implying a modest level of intermediation from very central actors who may be influencing flows of information and/or decision making.

Node-level measures

A careful look at the informal network in Figure 5.2.1. can be useful in revealing the little differences in the size of those member organisations that are more popular in graph (b) and those who indicated to be more active in establishing connections with others in graph (c). Node-level measures in Table 5.2.2., indicate a large number of organisations having more than 20 ties in total (degrees). This group includes AT1 (Assurance Team), CS2 (Costa Rica Integra), Obs1 (Contraloria General de la Republica), PubS2 (Ministerio de Obras Publicas y Transportes MOPT), PubS1 (Ministerio de Hacienda), PubS3 (Ministerio de Planificacion Nacional y Politica Economica), Obs4 (Oficina de la Primera Dama) and PriS2 (Union

Costarricense de Camaras y Asociaciones del Sector Empresarial Privado UCCAEP). Altogether, these actors indicated to have a tie with all other organisations in the informal network ($\text{OutDeg} = '1'$), and half of them receive more than 90% of reciprocation ($\text{InDeg} = 0.92$). The other half receives between 67% and 83% of all potential incoming ties available for an organisation in the network.

The relational trend of these group of actors explains a high degree of connectedness, suggesting a great deal of influence and intermediation in the informal network. The finding is also consistent with their OutClos and InClos indexes that reach the maximum of '1', and thus their proximity with all other actors in the network is direct. It could be argued that these organisations may play key roles in spreading information faster to all others in the informal network. Take for example the Assurance Team (AT1). This entity, as in the case of El Salvador, occupies the most central position according to the Betweenness score of '9.29', which confers it properties of highly efficient spreader and broker of information.

Those member organisations in “the middle”, that is members with a total number of ties ranging from 15 to 19, like Obs3 (Ministerio de Comunicacion), PriS1 (Fedecamaras Costa Rica), Obs2 (Defensoria de los Habitantes) and CS1 (Consumidores de Costa Rica) can also be influential in the informal network, depending on to whom they are connected. Thus, if Obs3, PriS1, Obs2 and CS1 reciprocate ties from those more central network members discussed above, their participation leverage could be more influential.

It may come as a surprise that Costa Rica's National Secretariat (NS1) is the least connected entity of the informal network. The NS1 interact through only 12 ties in total; 11 incoming ties and just one outgoing tie to AT1. Consequently, the size of this actor is the smallest in the network visualisation of outward centrality. A possible explanation for this limited relational pattern is that the survey recorded responses from just one individual representing the National Secretariat. However, while being one of the most senior members in Costa Rica in terms of participation (3 years) and meetings attended in 2019 (see Figure 5.2.2.), a more active role could have been expected. Regardless of the short period of participation in CoST (1.5. years on average), representatives from private sector organisations, in contrast, have indicated eager effort in their meetings attendance establish connection with most of all other organisations in the informal network.

As described earlier, Homophily is a measure that indicates preferentiality of member organisations to share ties with other organisations of same sector affiliation. In this sense, for

Costa Rica, observer organisations such as Obs2 (Defensoria de los Habitantes), Obs3 (Ministerio de Comunicacion) and Obs1 (Contraloria General de la Republica) have the largest scores in this measure: they connect more emphatically with observer organisations than with other sector entities. This is not a negative feature by itself, but it denotes an opportunity for them to diversify their ties.

Finally, Table 5.2.3. shows the reciprocity ratio by sector. As previously noted, the National Secretariat (NS1) has the largest number of unreciprocated ties in the informal network, having only reciprocation with AT1. On the other hand, on average, civil society (CS) and observer (Obs) organisations stand out in this ratio as they receive more ties from more organisation than they tend to reciprocate, which may be interpreted a sign of privilege and relative power over other sectors (Emerson, 1962; Casciaro & Piskorski, 2005).

Information sharing

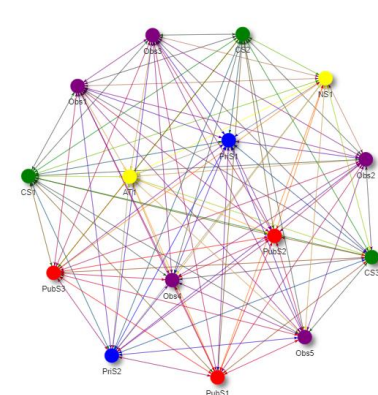
The horizontal chart in Figure 5.2.3. shows that representatives from all the sectors, including NS1 and AT1, share and discuss information about all the topics related to public sector infrastructure in Costa Rica. There are, however, some tendencies to highlight according to the number of respondents that indicated to have a preference in this regard. Among these topics, more than 20 respondents indicated to be engaged in issues related to contract tender and award. Furthermore, equal treatment by 20 people was given to matters about time and cost overruns, quality of projects and the management of infrastructure project. On the other hand, the least popular topics for members in Costa Rica were wellbeing of workers in the infrastructure sector, and social and environmental impacts of infrastructure projects.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

Figure 5.2.1. a) Costa Rica formal network

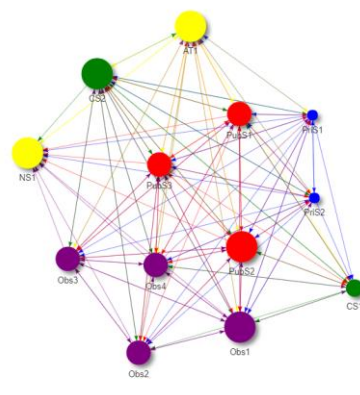
Ideal-type map of the formal organisation

Assurance Team
Public Sector
National Secretariat



b) Informal network (inward centrality)

Node size: number of incoming ties



c) Informal network (outward centrality)

Node size: number of outgoing ties

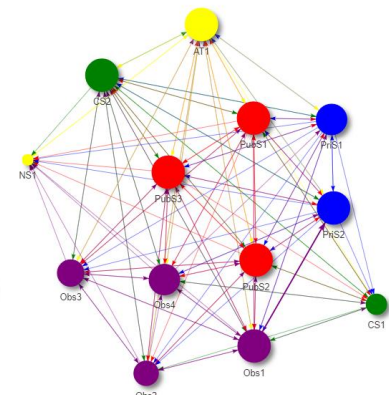


Figure 5.2.2. Costa Rica (avg participation per sector)

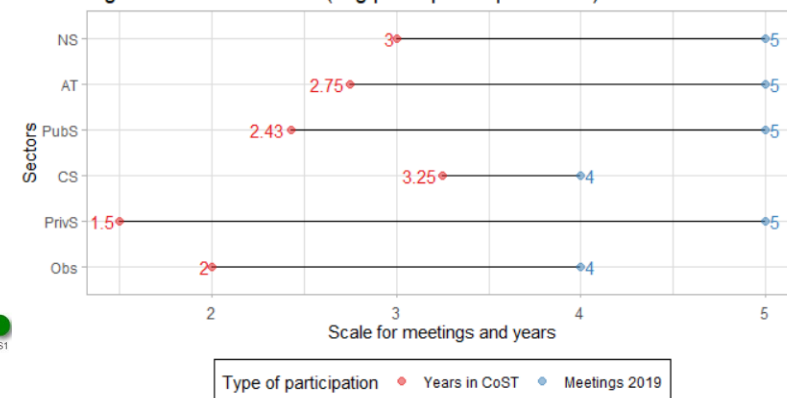
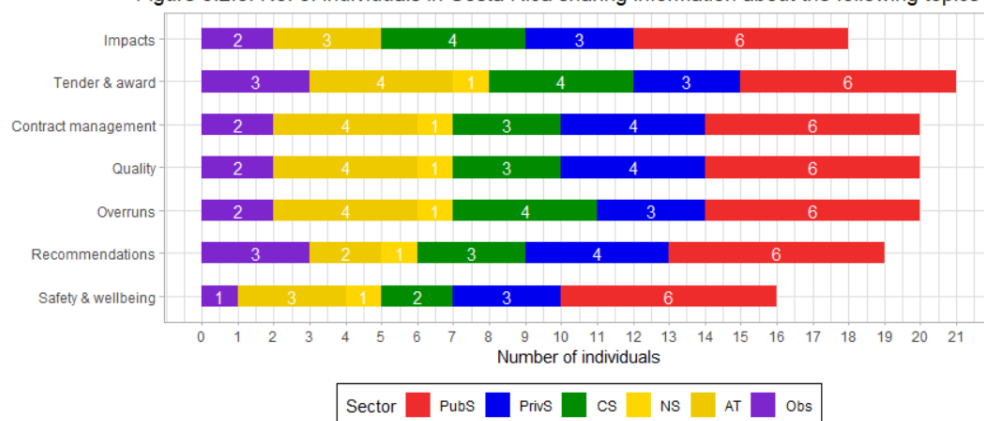


Table 5.2.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Costa Rica	15	13	210	130	0.83	1	2	1

Legend: F, formal network; I, informal network.

Figure 5.2.3. No. of individuals in Costa Rica sharing information about the following topics



Costa Rica

	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	23	1.00	0.92	1.00	1.00	9.29	0.00
CS1	15	0.50	0.75	0.67	0.75	0.15	0.17
CS2	23	1.00	0.92	1.00	1.00	1.77	0.08
NS1	12	0.08	0.92	0.52	0.54	0.00	0.00
Obs1	23	1.00	0.92	1.00	1.00	1.77	0.25
Obs2	18	0.67	0.83	0.75	0.83	0.58	0.38
Obs3	19	0.75	0.83	0.80	0.88	0.26	0.33
Obs4	21	0.92	0.83	0.92	0.96	1.62	0.18
PriS1	19	0.92	0.67	0.92	0.96	0.07	0.09
PriS2	20	1.00	0.67	1.00	1.00	0.15	0.08
PubS1	22	1.00	0.83	1.00	1.00	1.28	0.17
PubS2	23	1.00	0.92	1.00	1.00	1.77	0.17
PubS3	22	1.00	0.83	1.00	1.00	0.96	0.17

Table 5.2.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	Obs	AveRecip
PubS	0.89	1.00	0.83	0.00	1.00	0.92	0.77
PriS	1.00	1.00	0.50	0.00	1.00	0.57	0.68
CS	1.20	0.57	1.00	0.00	2.00	0.86	0.94
NS	0.00	0.00	0.00	0.00	1.00	0.00	0.17
AT	1.00	1.00	0.50	1.00	0.00	1.00	0.75
Obs	1.09	1.75	1.17	0.00	1.00	0.79	0.97

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Table 5.2.2. Node-level measures

Guatemala

Whole network-level measures

Guatemala is the third largest country surveyed in terms of number of respondents after Costa Rica and Honduras. The survey collected data from 24 individuals representing 11 public and non-public organisations (92% of response rate). Figure 5.3.1. (a) shows the formal organisational network as indicated in the formal membership for this country. The network presents complete participation of 15 member organisations and full connectedness between them through 210 ties. Naturally, the informal network reveals a more uneven relational pattern, and a considerably smaller number of ties. In Guatemala, the information is likely to flow only through 82 relationships between organisations, which is a density of 52%. This density depicts a network where members operate with slightly above half of its potential relational capacity. The reduced number of ties is also reflected in the connectedness measure, which is the smallest in the sample of all countries included in the report. Thus, the network analysis in this study suggests that Guatemala has the least cohesive network.

From a visual perspective, the informal network in Figure 5.3.1. does not look interconnected, and in fact some repulsed nodes from the core are easy to identify. The lack of a large number of ties, and the concentration of existent ones in the central region of the network also indicates a number of components. Guatemala has a core of well-connected member organisations, which makes a component, but it also has four isolated organisations located at the periphery of the network due to poor or null relational engagement with the core. The presence of such a large number of components makes the network fragile, because organisations at the periphery are more likely to disintegrate.

Node-level measures

As indicated above, Guatemala has several entities that show to be strongly interconnected (see centrality measures in Table 5.3.2.). In this sense, PriS2 (Camara Guatemalteca de la Construcción), AT1 (Assurance Team), CS1 (Acción Ciudadana), NS1 (National Secretariat) and PubS3 (Ministerio de Finanzas Públicas MINFIN) stand out in this regard with more than 15 relationships in total. Consequently, the location of these nodes is the central region of the informal network, establishing a cohesive group. The diversity of organisations in the core may suggest underpinnings of the principle of partnership. Here views from different sectors,

technical expertise, and the official guidance through the National Secretariat, are likely to be shared and discussed more frequently to steer the implementation of CoST. The number of outgoing ties for these central organisations indicate the presence of active relational dynamics from them to other organisations. However, these relationships are not reciprocated to the same extent, given that the index of incoming ties (InDeg) are almost half of the OutDeg index for these central actors.

The relational configuration of the organisations in the core of the network provides them a high score in the Closeness index for outgoing ties (OutClose above '0.80'), indicating a high proximity to every other organisation. On the other hand, and contrary to the findings from El Salvador and Costa Rica, the Betweenness measure in Guatemala indicates that a private sector representative chamber, PriS2 (Camara Guatemalteca de la Construcción), and not the Assurance Team (AT1) is the most central actor for this dimension as it falls in between most of the ties in the informal network. Nevertheless, this propensity in between is followed by National Secretariat and Assurance Team, who also play a relevant role.

Participation averages in Figure 5.3.2. shows that senior members in Guatemala belong to the private sector and the Assurance Team. On average they have participated more than 3.5. years in CoST Guatemala and attended more than three meetings in 2019. Thus, for the case of Guatemala, the relationship between seniority in CoST and higher ranks in the centrality measures seems to be stronger than in other countries.

At the periphery of the informal network, a set of poorly connected nodes. These are CS2 (Asociación de Ingenieros Jubilados de Guatemala ASIJUGUA), Obs1 (Banco Interamericano de Desarrollo BID), Obs2 (Embajada Británica), PriS1 (Camara de Industria de Guatemala), and PubS2 (Contraloría General de Cuentas). The number of outgoing ties for these nodes ranges from zero to three, which may reflect no relational interest within the network. As a result these actors' scores for Closeness and Betweenness the lowest, making them less reliable for the diffusion of information and less likely to spur collaboration from what a multi-stakeholder group may demand.

In terms of sectoral dynamics, two patterns stand out in these results. On the one hand, within the peripheral entities, the presence of two observer organisations (Obs1 and Obs2) might be justified if the nature of their role in the MSG is precisely just to be observers rather than active actors providing advice and guidance for the implementation of CoST. The reciprocity ratio by sector in Table 5.3.3. shows that in general observer organisations tend to

not reciprocate any tie that others sent to them, at all. On the other hand, two organisations from the civil society (CS1 and CS3) have shown the largest propensity in the network to connect with same sector organisations. The tendency to homophily is not necessarily a threat for this network, given that civil society organisations do not occupy entirely the core, and their presence through all the regions of the network is documented. Their homophily score may be, on the other hand, a sign of coordination, in order participate and make decision within CoST aligned to perspectives that benefit their interests.

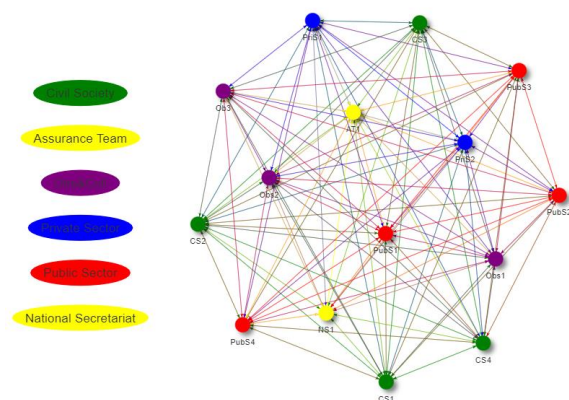
Information sharing

Horizontal bars in Figure 5.3.3. shows that representatives from all sectors in Guatemala indicated some sort of engagement with all the different types of information included as options in the survey. The largest number of respondents (15 individuals) indicated a preference to share and discuss information about the public sector infrastructure contracts, in terms of tender and award process, as well as the management of these. Other topics related to the recommendations from the Assurance Report, costs overruns and project deadlines, as well as the quality of the projects were also indicated as quite relevant by 14 respondents. The smallest group of respondents expressed concerns about social and environmental impacts of infrastructure projects (13 individuals), and the wellbeing and safety measures of infrastructure workers (10 individuals). The latter seems to be shared and discussed by a reduced number of actors from the public sector (one out of five), and civil society (three out of seven).

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

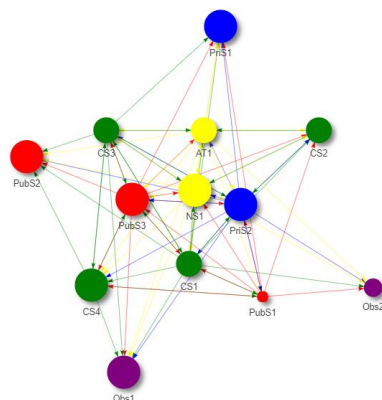
Figure 5.3.1. a) Guatemala formal network

Ideal-type map of the formal organisation



b) Informal network (inward centrality)

Node size: number of incoming ties



c) Informal network (outward centrality)

Node size: number of outgoing ties

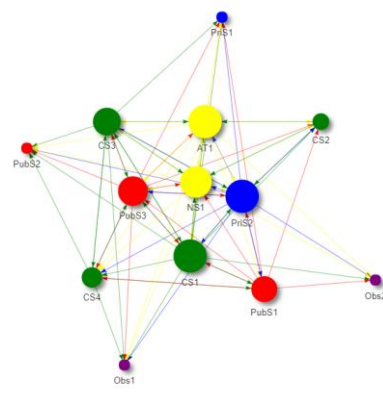


Figure 5.3.2. Guatemala (avg participation per sector)

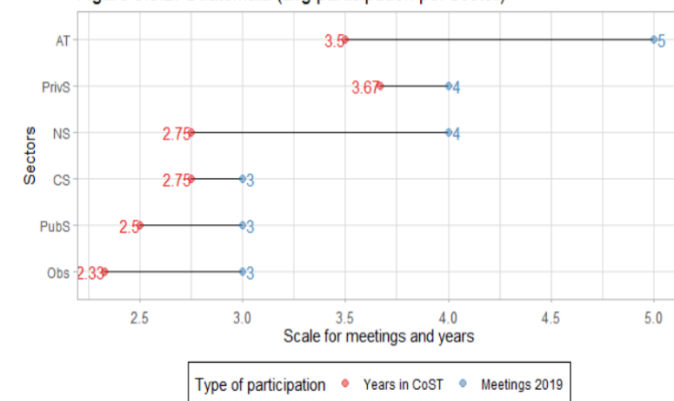


Table 5.3.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Guatemala	15	13	210	82	0.52	0.69	2	5

Legend: F, formal network; I, informal network.

Table 5.3.2. Node-level measures

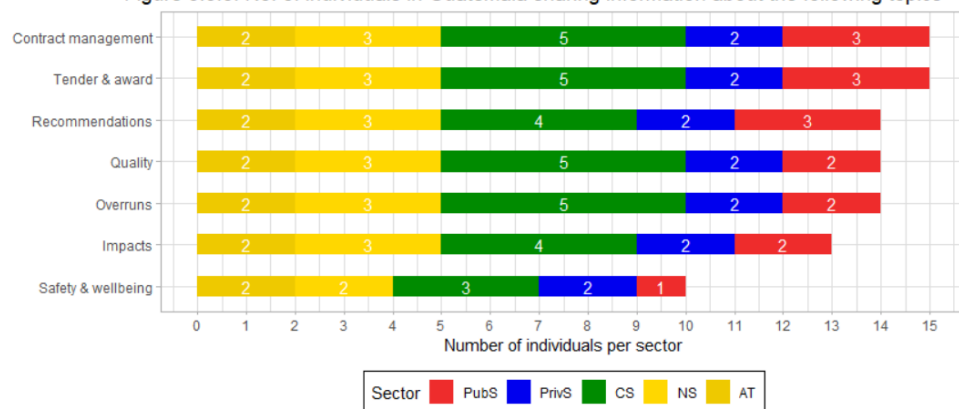
Guatemala	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	18	1.00	0.50	1.00	0.55	3.49	0.00
CS1	18	1.00	0.50	1.00	0.55	1.70	0.25
CS2	9	0.25	0.50	0.57	0.55	0.15	0.00
CS3	15	0.75	0.50	0.80	0.55	1.38	0.22
CS4	12	0.42	0.58	0.63	0.57	1.02	0.20
NS1	18	0.92	0.58	0.92	0.57	3.15	0.00
Obs1	7	0.00	0.58	0.33	0.60	0.00	NA
Obs2	5	0.00	0.42	0.33	0.55	0.00	NA
PriS1	7	0.00	0.58	0.33	0.60	0.00	NA
PriS2	19	1.00	0.58	1.00	0.57	4.10	0.08
PubS1	12	0.67	0.33	0.75	0.50	2.14	0.13
PubS2	7	0.00	0.58	0.33	0.60	0.00	NA
PubS3	17	0.83	0.58	0.86	0.57	2.52	0.10

Table 5.3.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	Obs	AveRecip
PubS	0.33	0.75	1.14	1.00	3.00	0.00	1.04
PriS	1.33	0.00	1.25	2.00	2.00	0.00	1.10
CS	0.88	0.80	0.83	1.33	1.33	0.00	0.86
NS	1.00	0.50	0.75	0.00	1.00	0.00	0.54
AT	0.33	0.50	0.75	1.00	0.00	0.00	0.43
Obs	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Figure 5.3.3. No. of individuals in Guatemala sharing information about the following topics



Honduras

Whole network-level measures

The survey collected data from 11 organisations in Honduras through the participation of 25 respondents (80% response rate). Honduras is the second largest country in the sample, in terms of number of participants after Costa Rica. Representatives from all organisations included in the formal membership participated in the survey. As a result, findings in this subsection present the complete organisational composition for the country. Whole network measures in Table 5.4.1. indicate that in spite of complete representation, the informal network of CoST Honduras has 66 ties out of 110. This is a density of 60%, which in turn indicates slack relational capacity.

A visual inspection of the informal structure in Figure 5.4.1. reveals a central portion of the structure where the intensity of ties concentrates the most. The ties are relatively well distributed among some relevant organisations. Thus, the connectedness of the informal network is '0.81', which is not bad for a network that works with slightly more ties than what its structure offers. In addition, the largest path to connect an organisation in Honduras is three steps away (diameter). Honduras is one of the biggest countries considering its diameter score. Along with El Salvador and Ukraine, the diameter of Honduras denotes a network structure that is not so compact as their counterparts in the sample. The repulsion effect to the peripheries of some actors in the network graph of the informal membership reflects this feature of low compactness, and the presence of components.

Node-level measures

In the informal network, all the organisations from civil society, CS1 (Asociacion para una Sociedad mas Justa), CS2 (Espacio Regional de Occidente de Honduras EROC), and CS3 (Fundacion Democracia sin Fronteras FDSF), as well as NS1 (National Secretariat) integrates a cohesive core. Having the largest number of total degrees, ranging from 14 to 16 ties as indicated in Table 5.4.2., these entities are focal points in the functioning of the structure.

A second layer of organisations, those in "the middle" in terms of number of total relationships, stand out in the Closeness and Betweenness measures. For instance, Pris2 (Camara Hondurena de la Industria de la Construcción CHICO) with 13 total ties, it occupies the highest rank in Betweenness score '10.40' in the informal network. This characteristic

confers to this private sector chamber the possibility to intermediate or interfere in the relationships between other member organisations. On the other hand, PubS1 (Gabinete Sectorial de Infraestructura Productiva GSIP) has also 13 total ties, and yet is the closest organisation to every other in the informal network. Its closeness centrality for outgoing ties ($\text{OutClose} = '1'$) is one of the highest. These results indicate that organisations in the core are not necessarily the most influential. The case of Honduras and its network structuration opens possibility for others entities to play a role in the backstage of the centre of action.

The relational pattern of AT1 (Assurance Team) reveals that despite its pivotal role in the implementation of CoST as a source of technical advice, members from this entity in Honduras remain to some degree isolated from the core. Whereas AT1 sends seven ties to other organisations, it only gets back four. That is, the role of the AT1 may not seem very relevant for other member organisations, and therefore its Betweenness score is zero. In contrast to countries like El Salvador and Costa Rica, where AT1 performs a more predominant role, in Honduras, representatives of this entity may experience serious limitations in their capacity to influence and guide activities of the MSGs.

Visualisations of the informal network in Figure 5.4.1. also show a set of nodes from the public and private sector that are repelled from the network. This is due to the lower number of outgoing ties they have with the rest. For PriS1 (Camara Hondurena de Empresas de Consultoria CHEC), PriS3 (Colegio de Ingenieros Civiles de Honduras CICH) and PubS3 (Secretaria de Coordinacion General de Gobierno SCGG) the number of outgoing ties ranges from zero to two. The presence of two private sector at the peripheries may raise concerns, given that their members have attended at least four meetings of the MSG in 2019, and participated for 3.2 years in CoST (see average participation in Figure 5.4.2.). Thus, the reduced relational structure of PriS1 and PriS3 may come as a surprise, considering other representatives of organisations that have participated less time in CoST, and yet are more integrated in the network.

Furthermore, Table 5.4.3. of reciprocity ratio reveals that the private sector has no reciprocal ties even with key entities such as the National Secretariat and the Assurance Team. In terms of homophily, PriS1 (Camara Hondurena de Empresas de Consultoria CHEC) and PriS2 (Camara Hondurena de la Industria de la Construcción CHICO) have shown a strong tendency for preferential connections with other private sector entities (more predominantly PriS1). In this case, homophily may become a seriously problem, when actors are not

embedded in a web of diverse relationships as they will tend to limit their contributions and miss opportunities to raise their concerns in relevant decision-making processes.

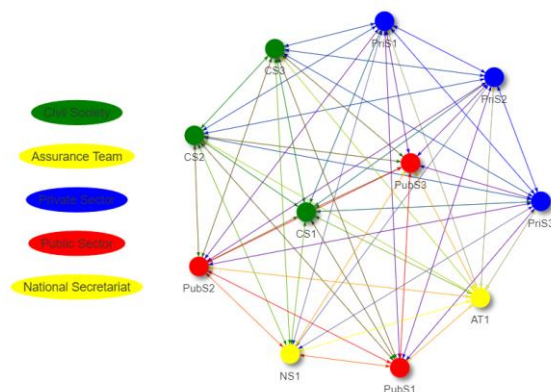
Information sharing

Most members of the National Secretariat and Assurance Team, as well as from the Civil Society indicated to cover the full range of topic options in their interactions with others. Differences become noticeable for the public sector, where the number of individuals engaging with the different topics fluctuates more. For instance, Figure 5.4.3. shows that relevant issues for the public sector do not necessarily include social and environmental impacts of infrastructure projects, nor the safety conditions of workers. Only one individual out of four representatives of the public sector indicated to be interested in these two topics, while four of them, indicated to share more information about issues related to contracts (tender, award, and management).

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

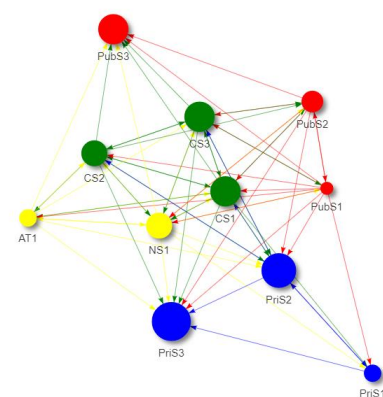
Figure 5.4.1. a) Honduras formal network

Ideal-type map of the formal organisation



b) Informal network (inward centrality)

Node size: number of incoming ties



c) Informal network (outward centrality)

Node size: number of outgoing ties

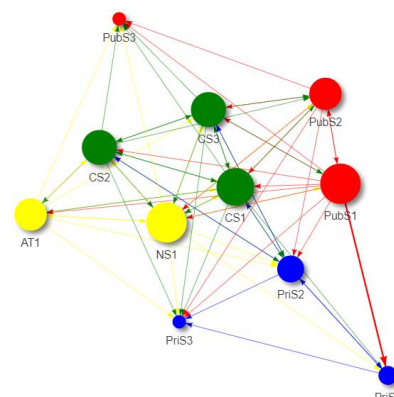


Figure 5.4.2. Honduras (avg participation per sector)

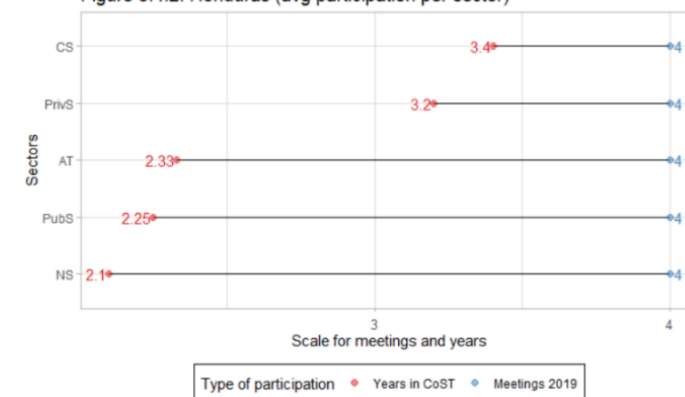


Table 5.4.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Honduras	11	11	110	66	0.60	0.81	3	3

Legend: F, formal network; I, informal network.

Figure 5.4.3. No. of individuals in Honduras sharing information about the following topics

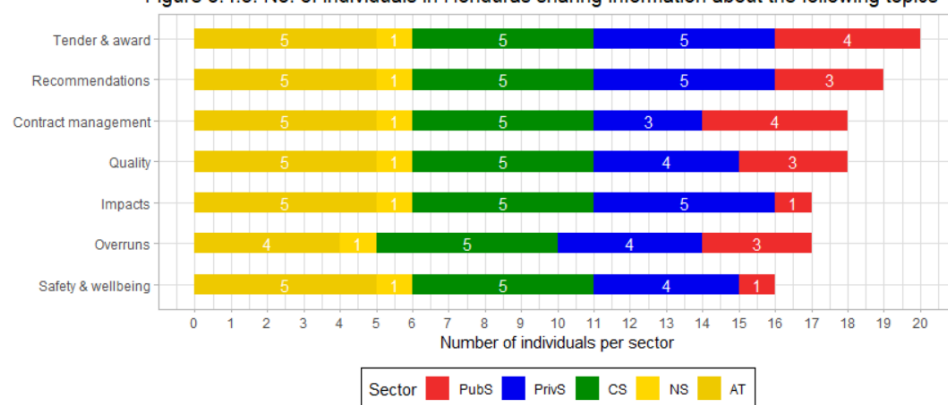


Table 5.4.2. Node-level measures

Honduras	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	11	0.70	0.40	0.77	0.48	0.00	0.00
CS1	16	0.90	0.70	0.91	0.59	5.77	0.22
CS2	14	0.80	0.60	0.83	0.56	3.88	0.25
CS3	15	0.80	0.70	0.83	0.59	6.24	0.25
NS1	16	1.00	0.60	1.00	0.53	3.74	0.00
PriS1	6	0.20	0.40	0.44	0.50	0.00	1.00
PriS2	13	0.50	0.80	0.67	0.63	10.40	0.40
PriS3	9	0.00	0.90	0.25	0.77	0.00	NA
PubS1	13	1.00	0.30	1.00	0.46	1.42	0.20
PubS2	12	0.70	0.50	0.77	0.50	0.74	0.29
PubS3	7	0.00	0.70	0.25	0.63	0.00	NA

Table 5.4.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	AveRecip
PubS	0.33	0.00	1.40	2	1.00	0.85
PriS	0.00	0.33	2.33	0.00	0.00	0.53
CS	0.71	0.43	1.00	1.00	1.50	0.93
NS	1.00	0.00	1.00	0.00	1.00	0.53
AT	1.00	0.00	0.67	1.00	0.00	0.53

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Panama

Whole-network measures

Data was gathered from 17 respondents, providing key information on 12 entities from CoST Panama. Individual responses were aggregated at the organisational level and coloured according to the sector they belong to. Figure 5.5.1 (a) shows the formal structure of the network assuming the highest level of interconnection between member organisations, and thus displaying ideal partnership network structure. Visualisations (b) and (c), on the other hand, show the informal network structure, where the size of nodes differs, according to organisations' popularity (inward centrality), and interest in establishing ties with other entities (outward centrality). Both types of visualisations, the formal and informal, reveal sharp contrasts. The informal structure departs from the ideal one despite it includes the same number of network actors. That is, the survey recoded 100% response rate for Panama and no difference with the formal membership. However, the informal structure operates with 79 ties out of 132 possible ones. Table 5.5.1. indicates that with a density of 0.59, the communication CoST Panama unfolds just above half of its relational capacity.

The components measure in Table 5.5.1. also indicates that in case of disintegration, the network can be fragmented from three loose nodes. There is a core of central and diverse organisations that is likely to prevail due to its cohesive structure and number of ties, while at the periphery, three organisations share zero outgoing ties with others may be more fragile. Due to the small number of member organisations, Panama's informal network is very compact, and no organisation is more than two steps or nodes (diameter) from any other, facilitating the flow of information and other relational contents.

Node-level measures

Looking at Table 5.5.2., a group of public sector entities such as PubS1 (Autoridad Nacional de Transparencia y Acceso a la Informacion Publica), PubS2 (Direccion General de Contrataciones Publicas DGCP), PubS4 (Ministerio de Economia y Finanzas), and PubS5 (Participacion Ciudadana y Transparencia de la Alcaldia de Panama), as well as from civil society CS3 (Movin Panama), and the National Secretariat (NS1) have the largest number connections. All of them with more than 15 total ties (degrees). The relational structure of these core network actors suggests a propensity to keep the network interconnected, but more

predominately between organisations of the public sector. This could be a positive highlight for the effective implementation of the initiate of CoST in Panama, reflecting the commitment from the government to the cause. However, the organisational composition of the core may also be prone to members to make decisions that favours views from the government. The likeliness of this scenario is high due to the lack of a diverse sectoral representation in the centre and of the absence of an Assurance Team to provide technical and neutral information about the infrastructure projects in the country.

Thus, if the private sector and civil society are encouraged to engage more with their public sector counterparts, CoST Panama would be able to reap the benefits of a more cohesive multi-stakeholder group. This seems to be a critical task for members of the private sector chambers as well as civil society foundations, given that the number of years participating in CoST Panama exceeds by far that of the public sector (see average participation in Figure 5.5.2.). In addition, the public sector seems to present a strong homophily tendency by connecting, to a great extent, with members from governmental entities. PubS3 (Instituto de Acueductos y Alcantarillados Nacionales IDAAN) is a case in point, because from six outgoing ties it sends to other actors, four are directed exclusively to public sector organisations. The high rank in the homophily measure makes the public sector a focal point for restructuring if it is deemed necessary.

As previously stated, the size of nodes differs more substantially for those organisations at the periphery, in both visualisations of the informal network. Network actors at the periphery are affiliated to the private sector PriS1 (Camara de Comercio Britanica en Panama) and PriS2 (Camara Panamena de la Construccion CAPAC), and the observer organisations Obs1 (Embajada Britanica en Panama). The number of incoming ties for these organisations ranges from 4 to 7, while their outgoing ties is zero. The reciprocity ratio by sector in Table 5.5.3. also reveals that these two groups of actors do not reciprocate ties from any other sector. Once again, the case of the private sector comes as a surprise due to its limited relational capacity regardless of its length participating in CoST Panama for more than 4 years. These aspects certainly raise questions about the nature of participation and the quality of contributions that this sector does to the implementation process.

Information sharing

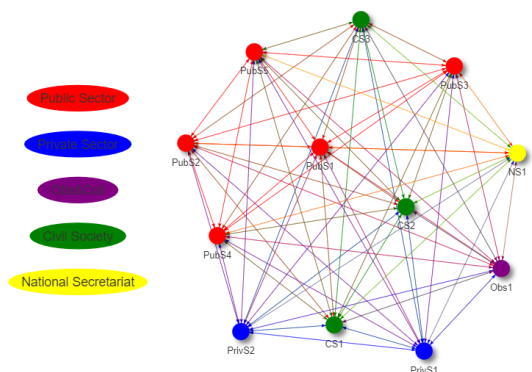
Figure 5.5.3. uncovers the order of relevant topics for members of CoST Panama. Most respondents (15 out of 17) indicated to discuss and share information about contract tender process and contract award, as well as overruns of time and costs for infrastructure projects. This is quite similar to the previous descriptions for Latin America countries, in particular the tendency to overlook issues related to safety and wellbeing of workers, and social and environmental impacts. The absence of an Assurance Team in the country also positioned the topic of recommendations from the assurance report out of the top priorities.

On the other hand, the presence of several governmental organisations in the core of the network is also reflected by the number of public sector representatives that engage in all the topics included for this survey question. In general, six individuals from this sector have a say in every issue, which may downsize the voice of other sectors, whose participation, as explained above, is more limited like the private sector. Furthermore, the civil society as well as members of the National Secretariat seem to have a more nuanced set of topic preferences to discuss in the network, given their fluctuating numbers.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

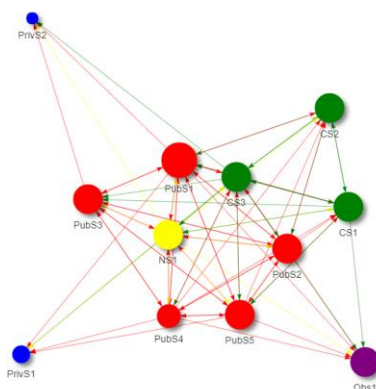
Figure 5.5.1. a) Panama formal network

Ideal-type map of the formal organisation



b) Informal network (inward centrality)

Node size: number of incoming ties



c) Informal network (outward centrality)

Node size: number of outgoing ties

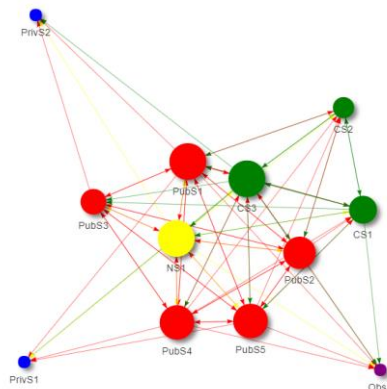


Figure 5.5.2. Panama (avg participation per sector)

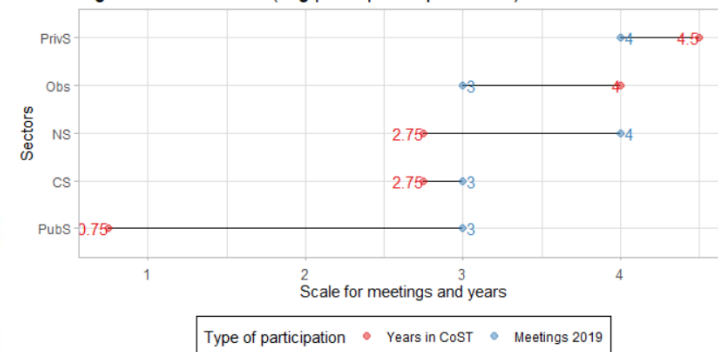


Table 5.5.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Panama	12	12	132	79	0.59	0.75	2	4

Legend: F, formal network; I, informal network.

Figure 5.5.3. No. of individuals in Panama sharing information about the following topics

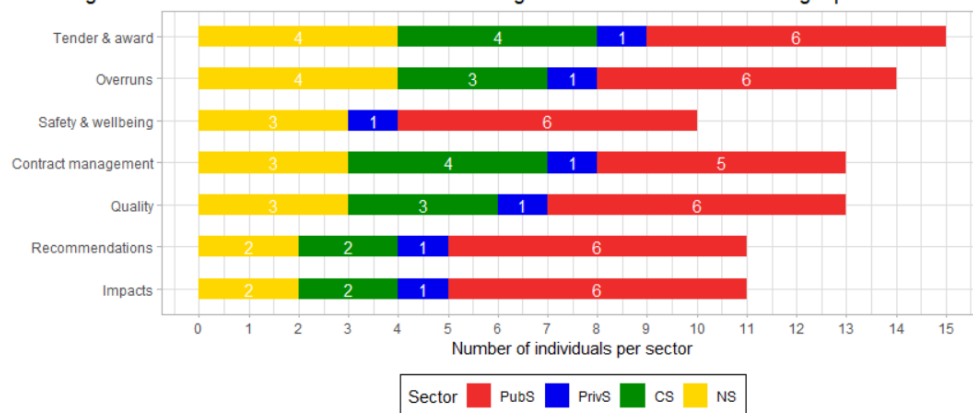


Table 5.5.2. Node-level measures

Panama	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
CS1	14	0.64	0.64	0.73	0.61	0.90	0.29
CS2	11	0.36	0.64	0.61	0.61	0.15	0.50
CS3	18	1.00	0.64	1.00	0.61	3.77	0.18
NS1	18	1.00	0.64	1.00	0.61	2.60	0.00
Obs1	7	0.00	0.64	0.33	0.65	0.00	NA
PrivS1	5	0.00	0.46	0.33	0.58	0.00	NA
PrivS2	4	0.00	0.36	0.33	0.55	0.00	NA
PubS1	19	1.00	0.73	1.00	0.65	4.72	0.36
PubS2	16	0.82	0.64	0.85	0.61	1.93	0.44
PubS3	13	0.55	0.64	0.69	0.61	1.24	0.67
PubS4	16	0.91	0.55	0.92	0.58	1.13	0.40
PubS5	17	0.91	0.64	0.92	0.61	1.69	0.40

Table 5.5.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	Obs	AveRecip
PubS	1.00	0.00	0.83	1.00	0.00	0.57
PriS	0.00	0.00	0.00	0.00	0.00	0.00
CS	1.20	0.00	1.00	1.50	0.00	0.74
NS	1.00	0.00	0.67	0.00	0.00	0.33
Obs	0.00	0.00	0.00	0.00	0.00	0.00

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Malawi

Whole network measures

Those surveyed from CoST Malawi indicated to represent 15 out of 16 member organisations (one respondent per organisation). Network visualisations in Figure 5.6.1. illustrate that in the informal network there are present four public sector organisations (red coloured nodes) instead of five as the formal membership indicated. In this sense, the informal network has 144 actual ties through which information and interactions flows. This is 96 relationships less from what the informal network could possibly produce if all member organisations from Malawi were actively engaging with each other. The density measure reflects this scarcity of ties with 68% of all its capacity. Despite lacking complete interconnection, the number of present ties in the informal network are well distributed among the reduced number of member organisations, consequently the connectedness score reaches '0.93', which concentrates in the central region of the network.

Potential fragmentation for Malawi may not be so severe as other countries in the sample. Malawi's informal network reveals two components which involves naturally the core and a self-isolated public sector that remains at the periphery due to zero outgoing ties (see global network measures in Table 5.6.1.). The size (number of organisations) and the number of ties makes the network to rank high in its degree of reachability. In Malawi no actor is more than two nodes away from any other. In other words, information is likely to be transmitted faster, generating a multi-stakeholder space able to mobilise resources more efficiently than other countries with higher diameter scores.

Node-level measures

In Malawi's informal network, NS1 (National Secretariat) and PubS2 (National Construction Industry Council NCIC) are key actors as they hold the largest number of relationships (27 ties in total). With that number of ties, these entities position themselves at the centre of most interactions in the network. Table 5.6.1. for node-level metrics shows that these actors' Closeness and Betweenness scores are among the highest compared to other organisations. That is, information in Malawi is likely to emerge and/or pass through these entities before reaching others in the informal network. Their structural position opens possibilities of brokerage and great influence.

Following closely the centrality measures from other well-connected organisations, there is a second layer in the core formed by organisations such as Med1 (Media Institute of Southern Africa MISA), CS4 (Council for Non-Governmental Organisations in Malawi CONGOMA), CS3 (Human Rights Consultative Committee HRCC), PubS1 (Malawi Anti-corruption Bureau), PubS3 (The Department of Buildings, Ministry of Transport and Public Works) and PriS2 (National Contractors Association), whose number of ties ranges from 20 to 25. The multiplicity of sectoral representation in the core exposes a rich network where multiple and diverse perspectives and practices are likely to converge. Moreover, the presence of a media outlet in the central structure of the network is also likely to be a positive

characteristic of the MSG to increase transparency and accountability of the networks and the role of its members.

A group of less well-connected nodes is represented by organisations that have been repulsed from the core. Within this group, PubS4 (Department of Statutory Corporations, Office of the President and Cabinet) has indicated no outgoing ties at all, which makes it the most isolated actor in the network. This is despite the eight ties it receives from organisations at the core that claimed a relationship with it. Other actors at the periphery are AT1 (Assurance Team) and Obs1 (The World Bank).

Despite the number of years participating in CoST, the Assurance Team indicated to attend few meetings per year, which may explain its constrained web of relations in the network. Due to the relevance for the implementation of CoST, in order to position AT1 at the centre of action in the informal network of Malawi, it may be worthwhile to increase its number of its representatives (currently led only by one individual), and/or encourage a more diverse set of connections to other sectors like the private one or observe organisations, from whom the AT offers no reciprocation at all as Table 5.6.3. indicates.

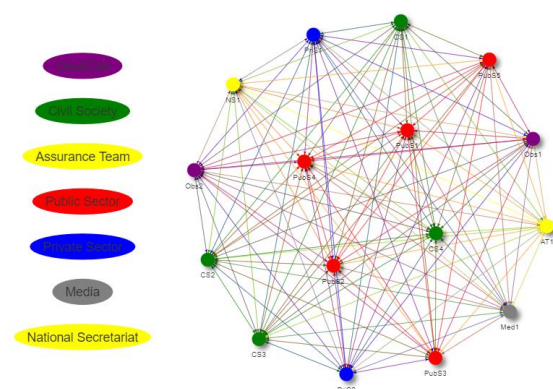
Information sharing

Figure 5.6.3. shows that at least one member from every sector in CoST Malawi has indicated to share information related to all the topic options presented in the survey. Consistent with the pattern identified for the Latin American countries above, topics not related to the contract of infrastructure projects are ruled out from the priorities of most members. A larger number of respondents, indicated to share information more frequently about contract tender and award, and time and cost overruns. Figure 5.6.3. also reveals that variation about topic priorities for CoST Malawi comes primarily from the civil society, private sector and observer organisations.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

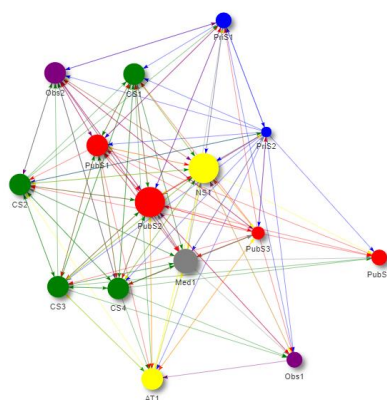
Figure 5.6.1. a) Malawi formal network

Ideal-type map of the formal organisation



b) Informal network (inward centrality)

Node size: number of incoming ties



c) Informal network (outward centrality)

Node size: number of outgoing ties

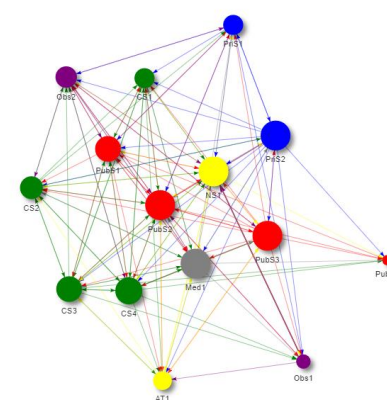


Figure 5.6.2. Malawi (avg participation per sector)

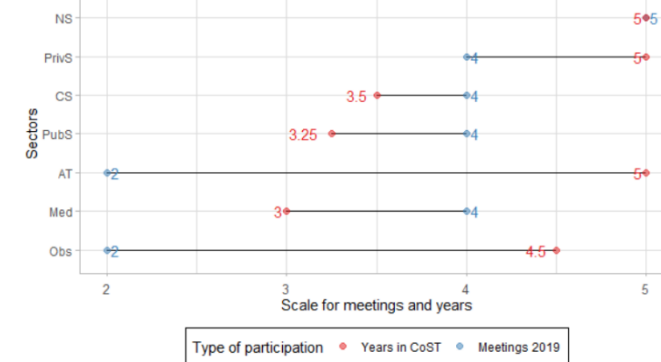


Table 5.6.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Malawi	16	15	240	144	0.68	0.93	2	2

Legend: F, formal network; I, informal network.

Figure 5.6.3. No. of individuals in Malawi sharing information about the following topics

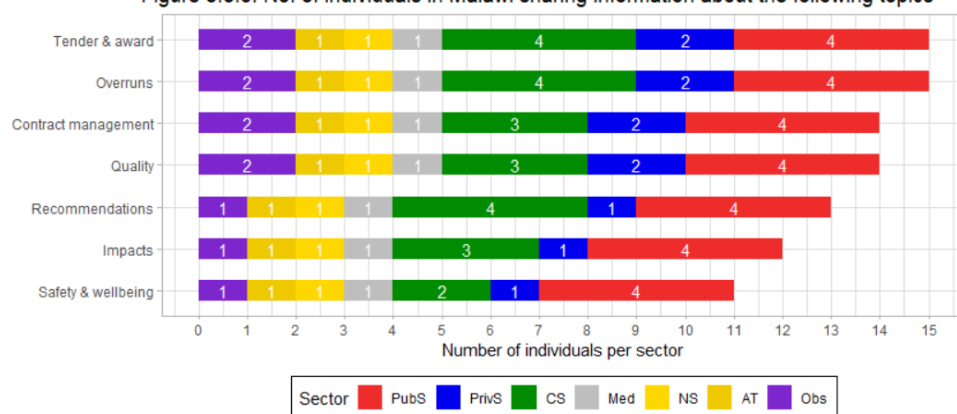


Table 5.6.2. Node-level measures

Malawi	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	16	0.43	0.71	0.64	0.74	1.10	0.00
CS1	17	0.50	0.71	0.67	0.74	0.52	0.29
CS2	19	0.64	0.71	0.74	0.74	1.26	0.33
CS3	21	0.79	0.71	0.82	0.74	1.37	0.27
CS4	22	0.86	0.71	0.88	0.74	1.57	0.25
Med1	25	1.00	0.79	1.00	0.78	3.34	0.00
NS1	27	1.00	0.93	1.00	0.88	6.76	0.00
Obs1	11	0.21	0.57	0.56	0.67	0.09	0.00
Obs2	18	0.57	0.71	0.70	0.74	0.93	0.00
PriS1	15	0.50	0.57	0.67	0.67	0.59	0.14
PriS2	20	1.00	0.43	1.00	0.61	1.17	0.07
PubS1	21	0.79	0.71	0.82	0.74	1.53	0.18
PubS2	27	1.00	0.93	1.00	0.88	6.76	0.21
PubS3	21	1.00	0.50	1.00	0.64	1.52	0.21
PubS4	8	0.00	0.57	0.33	0.70	0.00	NA

Table 5.6.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	Obs	Med	AveRecip
PubS	0.50	1.20	0.83	1.33	0.67	0.80	1.33	0.95
PriS	0.83	1.00	0.40	1.00	0.00	0.25	2.00	0.78
CS	1.20	2.50	1.04	1.00	0.67	0.40	1.00	1.12
NS	0.75	1.00	1.00	0.00	1.00	1.00	1.00	0.82
AT	1.50	0.00	1.50	1.00	0.00	0.00	1.00	0.71
Obs	1.25	4.00	2.50	1.00	0.00	0.00	2.00	1.54
Med	0.75	0.50	1.00	1.00	1.00	0.50	0.00	0.68

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Sekondi-Takoradi, Ghana

Network level measures

The survey collected data from 12 respondents representing nine member organisations from CoST Sekondi-Takoradi, Ghana (CoST Ghana). The informal structure captured data from all organisations originally indicated in the formal membership, and the response rate for the country is 92%. At first glance, a visual comparison between the formal (a) and informal network (b) and (c) in Figure 5.7.1. does not reveal substantial differences in network structure, but only in node size and position. According to the whole network measures in Table 5.7.1., Ghana's number of actual relationships amounts to 59. This is 81% of the potential number of ties that the informal network structure can offer between nine organisations. Despite not every connection is present, the country has the highest density for the African countries surveyed in this report, and the second highest in the sample after Costa Rica (83%). The inherent properties of Ghana's small network are also reflected in its high connectedness '0.88', revealing a cohesive group of multi-stakeholder organisations that facilitate flows of information and collaboration.

The informal network does not uncover cliques or cutpoints, which are generally features of a network structure prone to fragmentation. That is, information, and other valuable collaborative resource are likely to pass through every other member organisation almost with no intermediation, quicker than any other network configuration revised so far. However, the score in the components measure in Table 5.7.1. indicates the presence of one entity that seems to have very limited relational behaviour with others. This organisational actor is found then, in a relatively isolated position at the fringes of the network. Regardless of this, the global structure of Ghana shows that its members embedded in solid network foundations to reap the benefits of collective action.

Node-level measures

Table 5.7.2. reveals that most member organisations in Ghana (seven out of nine) are part of a cohesive core in terms of number of total ties (degrees) that ranges from 14 and 15 relationships. The organisations located in the core also indicated to send ties to every other entity in the informal network. Thus, their OutClose index reaches the highest score, implying a privileged proximity to very other actor due to their proactivity in establishing new or

maintaining actual connections with others. Moreover, within the core, two nodes stand out: AT1 (Assurance Team) and CS2 (STMA Citywide Settlement Upgrading Fund). According to the highest Betweenness score ('4.46'), these two entities are structurally located in the middle of every connection between organisations in the network. As mentioned previously, organisations ranking at the top for this centrality measure may be considered important actors in the decision-making process due to their structural position that increases the likeliness for them to adopt influential behaviours and control information (Scott, 2000).

Other organisations with central positions in the informal networks are CS1 (Friends of the Nation FoN), Med1 (Western Region Branch of Ghana Journalist Association), NS1 (National Secretariat), PriS1 (Adax Construction Ltd) and PubS1 (Sekondi Takoradi Metropolitan Assembly STMA). In particular, the presence of a media organisation and Ghana's National Secretariat at the core is likely to enrich what is already a diverse group of entities. This is an asset for CoST Ghana, because more information and more varied sources of knowledge and expertise converge at this region of the network, increasing the chances of effective collective action.

Table 5.7.2. also indicates that PriS2 (Architectural Spring Ltd) and PriS3 (SekondiTakoradi Chamber of Commerce and Industry STCCI) are organisations falling behind the general relational trend for Ghana. For the former, while receiving seven incoming ties from other nodes, it only sends back three. For the latter, regardless of receiving eight ties from all other organisations in the network, it chooses to send back none. This organisation receives multiple sources information and interaction opportunities, yet it does not take advantage of any. It becomes a "sink" that keeps information for itself.

The reciprocity ratio by sector in Table 5.7.3. reveals that the private sector is, in general, the sector that tends to not reciprocate any of the ties that other sectors claim to it (average reciprocity > 1). In addition, the participation of representatives of the private sector for less than one year (on average), and their presence in five meetings of CoST in 2019, were not sufficient opportunities to develop a more robust web of relationships like their counterparts in the Assurance Team and civil society hat show similar participation (see Figure 5.7.2.), but more social capital from their ties with actors in the network.

Information sharing

Those surveyed from CoST Ghana have indicated that they share information about the entire list of topics presented without revealing any preference. Ghana is the first country in the sample to report equal treatment to all the topic that the survey inquired.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

Figure 5.7.1. a) Ghana formal network

Ideal-type map of the formal organisation

b) Informal network (inward centrality)

Node size: number of incoming ties

c) Informal network (outward centrality)

Node size: number of outgoing ties

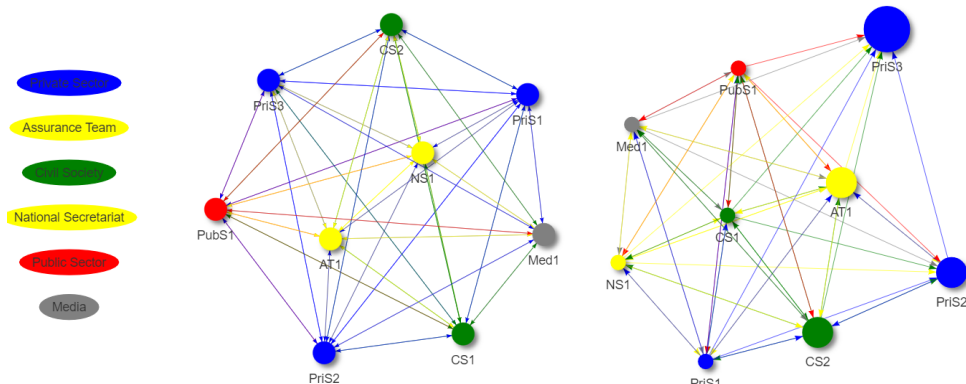


Figure 5.7.2. Ghana (avg participation per sector)

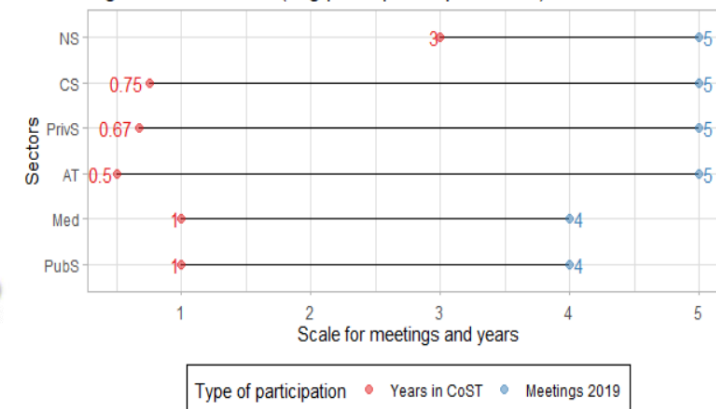


Table 5.7.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Ghana	9	9	72	59	0.81	0.88	2	2

Legend: F, formal network; I, informal network.

Table 5.7.2. Node-level measures

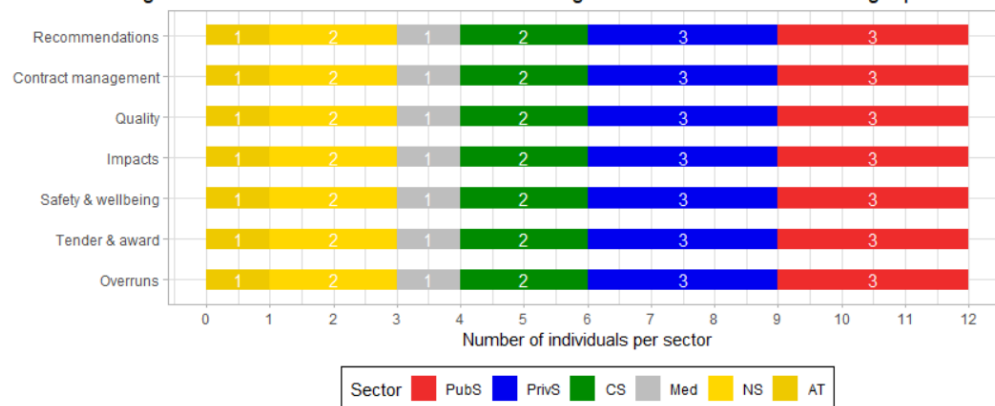
Ghana	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	15	1.00	0.88	1.00	0.80	4.46	0.00
CS1	14	1.00	0.75	1.00	0.73	0.00	0.13
CS2	15	1.00	0.88	1.00	0.80	4.46	0.13
Med1	14	1.00	0.75	1.00	0.73	0.00	0.00
NS1	14	1.00	0.75	1.00	0.73	0.00	0.00
PriS1	14	1.00	0.75	1.00	0.73	0.00	0.25
PriS2	10	0.38	0.88	0.62	0.80	0.00	0.33
PriS3	8	0.00	1.00	0.33	1.00	0.00	NA
PubS1	14	1.00	0.75	1.00	0.73	0.00	0.00

Table 5.7.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	Med	AveRecip
PubS	0.00	0.33	1.00	1.00	1.00	1.00	0.72
PriS	3.00	0.33	2.00	3.00	1.50	3.00	2.14
CS	1.00	0.50	1.00	1.00	1.00	1.00	0.92
NS	1.00	0.33	1.00	0.00	1.00	1.00	0.72
AT	1.00	0.67	1.00	1.00	0.00	1.00	0.78
Med	1.00	0.33	1.00	1.00	1.00	0.00	0.72

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Figure 5.7.3. No. of individuals in Ghana sharing information about the following topics



Ethiopia

Whole network measures

The survey recorded responses from 14 participants of CoST Ethiopia. These respondents represent 10 member organisations in the MSG, which is the number of entities originally indicated in the formal membership. The response rate for the country is 100%, allowing a more accurate description on how CoST Ethiopia and its members interact, and share information between them. Figure 5.8.1. (b) and (c) reveal the informal, but actual network structure plotted with data collected from surveys. A careful look at the graphs can give a good intuitive sense of the regions where the informal network diverges from its ideally model. From a total number of 90 possible ties, interactions and flows of communications in the informal network unfolds throughout 54 ties. Thus, the density of CoST Ethiopia is 60%, which is comparable to the one of Honduras, and it is slightly higher than the Panamanian (59%) and Ukrainian (50%).

The connectedness measure shows a relatively well distribution of ties among the organisations that keeps it compact. In fact, there is no member organisation more than two steps from any other, which is a useful feature for the spread of urgent information or instructions in the network. However, the number of components reveals the presence of two network actors that remain at the periphery with no outgoing ties whatsoever.

Node-level measures

CoST Ethiopia displays a core of three main member organisations. The NS1 (National Secretariat), AT1 (Assurance Team) and PubS2 (Federal Ethics and Anti-corruption Commission) are the most prominent entities of this group by having more than 15 ties in total (see Degrees in Table 5.8.2.). According to the Closeness centrality for outgoing ties (OutClose index), the extent to which NS1 and PubS2 establish connections with others makes them more approachable actors in the network, and therefore the closest to any other entity. In fact, from the sample of countries in this report, Ethiopia's informal network is the first in displaying a National Secretariat that plays such a remarkable role. Its structural position and capacity for spreading information stand out from the rest, as well as its privileged role intermediating relationship between other organisations. The presence of NS1 and AT1 in the core, furthermore, suggests a relational pattern that may be consistent with the nature of their

delegated tasks in the whole process of CoST implementation, in terms of communication and meetings coordination for the MSG, as well as assessing and providing technical information about infrastructure projects. Thus, the presence of both entities at the centre of action is likely to be an encouraging characteristic for CoST Ethiopia.

Another layer of relevant organisations in terms of relational resources are PriS2 (Consulting Engineers and Architects Association of Ethiopia), PubS1 (Ethiopian Roads Authority), CS1 (Call for Integrated Development), CS2 (Transparency Ethiopia), and PriS3 (Grade I Contractors Association of Ethiopia). These actors in the middle range of the number of total ties (ranging from 8 to 11 relationships) are influential in the network to the extent they are connected and reciprocated to the more prominent organisations described above. For Ethiopia, the relationship between members' participation in CoST and the consolidation of their relationships with others seems plausible like just a few countries in the sample. In general, with the exception of the public and private organisations discussed below, all others have been engaged in CoST activities for more than three years and have attended more than four meetings in 2019 (see Figure 5.8.2.).

At the end of the spectrum, PubS3 (Federal Public Procurement and Property Administration Agency) and PriS1 (Construction Contractors Association of Ethiopia) have claimed no ties with other organisations. Thus, they are positioned at the peripheries of the informal network, and the difference in these nodes' sizes in Figure 5.8.1. (b) and (c) is even more drastic than the rest. Within potential implications of this structural characteristic for PubS3 and PriS1 is that relevant information and/or contributions from their own organisations to the process of CoST implementation may not be propagated accordingly, let alone to be considered in the decision-making process. A more proactive participation of these two organisations in the network, would increase their reciprocity ratios (see Table 5.8.3.), currently undermining the role of civil society organisations, whose members attempt to establish a relationship with them, but find no correspondence.

Information sharing

In general, representatives of all sectors indicated to engage in the process of sharing information about all the issues for the Ethiopian public sector infrastructure. As revealed by respondents from other countries, in Ethiopia the topics that are not related to contracts and

legal procedures of infrastructure projects are relegated from the priorities of discussion, especially for those representatives of private firms and chambers as Figure 5.8.3. indicates.

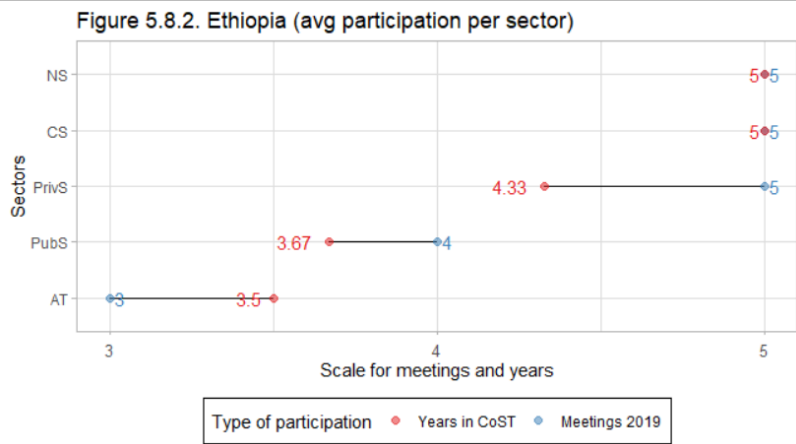
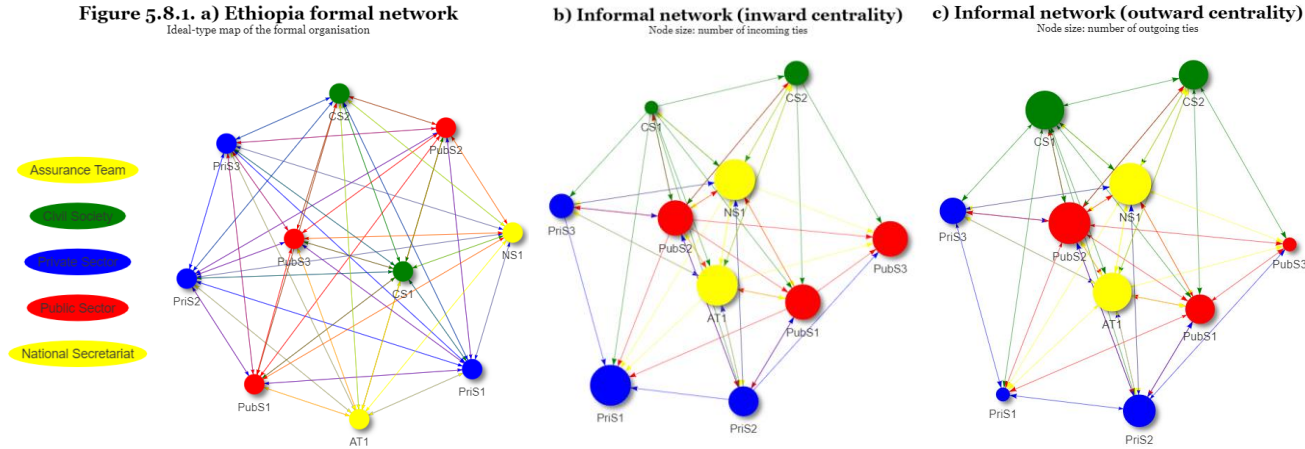


Table 5.8.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Ethiopia	10	10	90	54	0.60	0.8	2	3

Legend: F, formal network; I, informal network.

Table 5.8.2. Node-level measures

Ethiopia	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	15	0.89	0.78	0.90	0.69	6.01	0.00
CS1	10	0.89	0.22	0.90	0.50	0.00	0.13
CS2	9	0.56	0.44	0.69	0.56	0.23	0.00
NS1	16	1.00	0.78	1.00	0.69	10.18	0.00
PriS1	7	0.00	0.78	0.33	0.75	0.00	NA
PriS2	11	0.67	0.56	0.75	0.60	0.69	0.17
PriS3	8	0.44	0.44	0.64	0.56	0.00	0.25
PubS1	11	0.56	0.67	0.69	0.64	0.92	0.20
PubS2	15	1.00	0.67	1.00	0.64	6.94	0.22
PubS3	6	0.00	0.67	0.33	0.69	0.00	NA

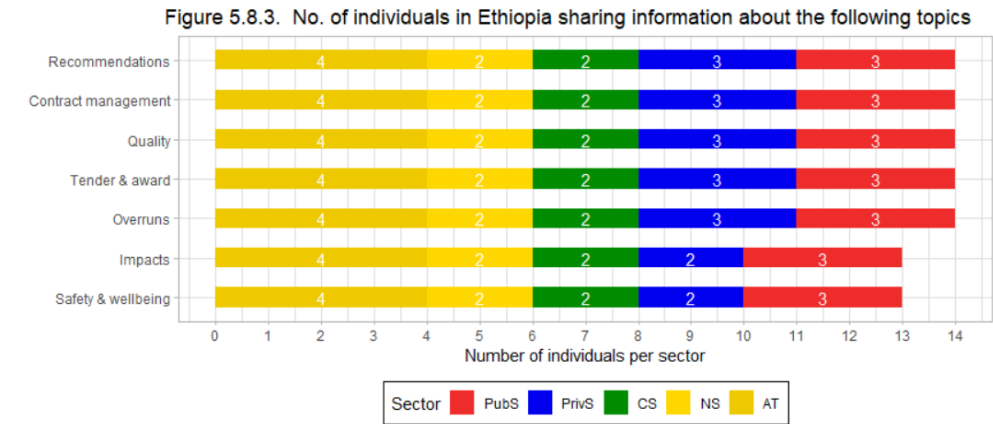


Table 5.8.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	AveRecip
PubS	1.33	0.80	2.50	1.50	1.50	1.53
PriS	1.25	0.00	0.00	1.50	1.50	0.85
CS	0.40	0.67	0.00	1.00	0.50	0.51
NS	0.67	0.67	1.00	0.00	1.00	0.67
AT	0.67	0.67	2.00	1.00	0.00	0.87

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Afghanistan

Network level measure

In the second quarter of 2020, 16 respondents from CoST Afghanistan took the survey. These represented 12 public and non-public member organisations. The response rate for the country is 94%, one of the highest. The survey recorded responses from most members organisations listed in the formal membership, except from one representative of a public sector ministry.

Visualisations (b) and (c) in Figure 5.9.1. reveal the composition of the informal network, where areas of very low number of ties can be spotted in the lower section of the graph, and, on the other hand, a concentration of multiple and reciprocal relationships is visible in most of the central region. Interactions and flows of information in Afghanistan occur throughout 97 existing relationships. This brings a density of 73%, which is the proportion of all possible ties that are present. Density is a good indicator of the extent to which network actors have high levels of social capital and/or social constraint. The latter being more the case for Afghanistan.

The whole network characteristics in Table 5.9.1. unveil two tendencies quite similar to other countries in the sample. Afghanistan's connectedness and number of components are very close to those of Panama and Guatemala. Afghanistan's connectedness score is '0.75', just like the score from Panama, and slightly higher than the one from Guatemala ('0.69'). Furthermore, Afghanistan's number of components is four, which also mirrors the one from Panama, and both of them are slightly lower than the one in Guatemala (five components). All together, these three countries rank in the top-three countries with the lowest scores in connectedness, as well as the top-three with the highest number of components. The structural characteristics of these countries offers opportunities to explore strategies that may incentivise members to adopt more active participation in the MSGs.

In the case of Afghanistan, connectedness is being affected by three member organisations that are located at the fringes of the network. The repulsion of their structural position within the informal network is due to their null connection with other actors. The relative self-isolation of these organisations from the core, stratifies the network in four main components, which may facilitate fragmentation of the network if ties are gradually reduced in the future between the core and these peripheral entities.

Node level measures

Table 5.9.2. for node-level measures indicates that those three member organisations that are repelled from the core of the informal network are PubS3 (Ministry of Transport), PriS3 (Global Trust Construction Company GTC) and PubS1 (Ministry of Economy). PubS1 and PubS3 are relevant ministries representing the public sector, and while between eight and nine organisations claim to have a tie with them (incoming ties), these ministries do not send back ties at all. The ministers do not have a connection with their more influential public sector counterpart PubS2 (Ministry of Energy and Water) that is located at the centre of the informal network. A similar pattern is observed for the private sector. A relative isolated PriS3 does not reciprocate or establish new communication channels with others in the network. This is despite its sector counterparts such as PriS1 (Afghanistan Builders Association ABA) and PriS2 (Afghanistan Chamber of Commerce and Industries ACCI) have shown a more relational behaviour in the central region of the network as well.

Social network analysis shows that both public and private sectors have organisations in Afghanistan that fall short the relational patterns from others in terms of interaction and information sharing. Figure 5.9.2. shows that members of both affiliations have the shortest periods of participation in CoST with an average of 2 years and 2.17 years for the public and private sector, respectively.

Node-level metrics also indicate that most of the member organisation in Afghanistan are located in the core of the informal network. Entities in this influential group entail the AT1 (Assurance Team), CS2 (Afghan NGOs Coordination Buruau ANCB), CS3 (Integrity Watch Afghanistan IWA), CS4 (South Western Afghanistan and Balochistan Association SWABAC), NS1 (National Secretariat), PriS1 (Afghanistan Builders Association ABA), PriS2 (Afghanistan Chamber of Commerce and Industries ACCI), and PubS2 (Ministry of Energy and Water). These organisations display a total number of 19 ties (degrees), indicating a very active role in the formation of new relationships or the preservation of actual ones with their network neighbours. All of these eight entities are central to all others in the network according to the Closeness centrality measure OutClose of '1'. Similarly, all of them reach the highest score in Betweenness index '0.22', suggesting the key role in the intermediation and creating of information. That is, their structural position allows them to be engaged in most of the flows of information and interactions available in the informal network.

What is interesting in the findings of the network analysis is the presence of four civil society organisations at the centre of action. Their homophily scores are among the highest in the network, implying coordination between them to act collectively. Their perfect reciprocity with the National Secretariat and Assurance Team, as the reciprocity ratios indicate in Table 5.9.3, makes civil society organisation influential actors who may steer directions of the decision-making process and outcomes of the MSG. However, the second strongest sector in terms presence in the core is the private sector, followed by just one public sector organisation. Overall, the diversity observed in the core of the informal network is an encouraging feature of CoST Afghanistan because its configuration is likely to facilitate an effective multi-stakeholder space for members to learn from each other and exchange valuable knowledge from their respective sectors.

Information sharing

The horizontal bar charts in Figure 5.9.3. indicate that all the sectors of CoST Afghanistan, including the members from the National Secretariat and the Assurance Team share and discuss information about matters related to key areas of the public sector infrastructure in the country: contract tender and ward, poor management of the contract, quality of project design, environmental and social impacts, cost and time overruns, etc. Recommendations from the Assurance Report, on the other hand, has been indicated to be a topic that a relatively smaller number of individuals share information about. All in all, the results have shown that members have a say in relevant topics for the implementation of CoST.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

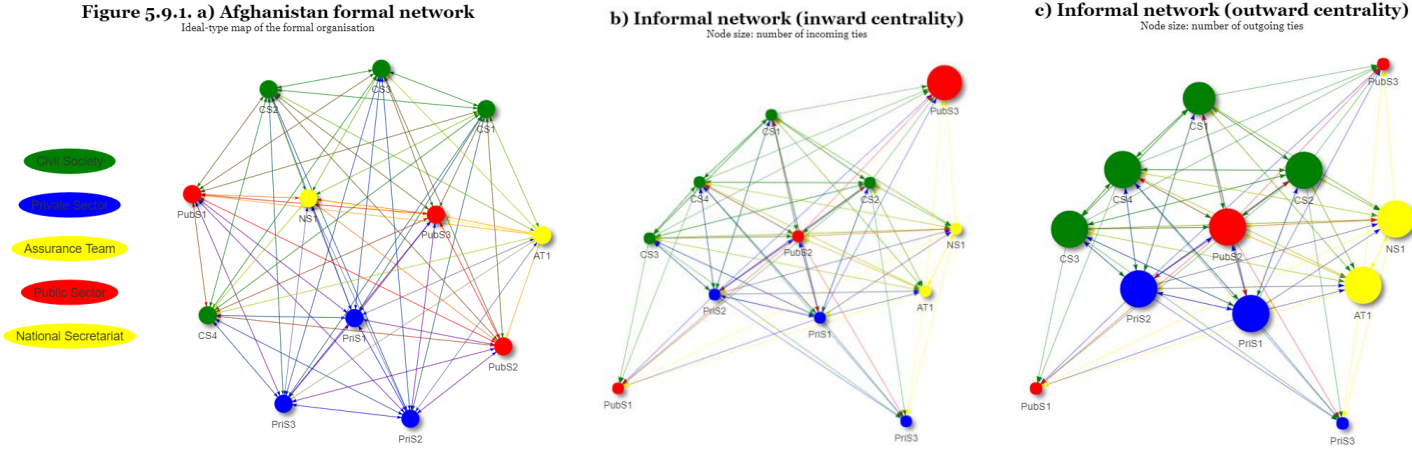


Table 5.9.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Afghanistan	12	12	132	97	0.73	0.75	2	4

Legend: F, formal network; I, informal network.

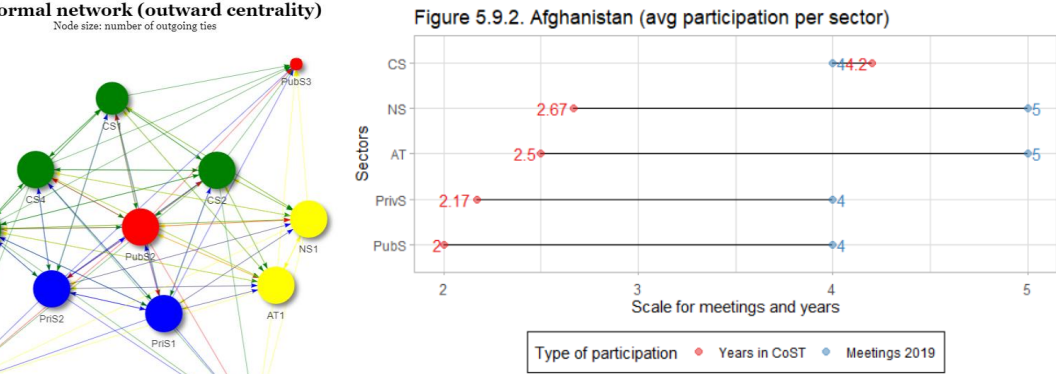
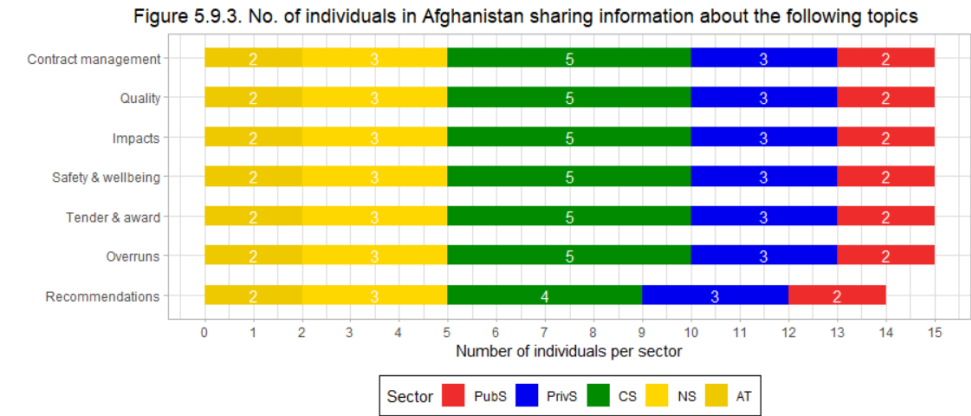


Table 5.9.2. Node-level measures

Afghanistan	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	19	1.00	0.73	1.00	0.65	0.22	0.00
CS1	17	0.82	0.73	0.85	0.65	0.00	0.33
CS2	19	1.00	0.73	1.00	0.65	0.22	0.27
CS3	19	1.00	0.73	1.00	0.65	0.22	0.27
CS4	19	1.00	0.73	1.00	0.65	0.22	0.27
NS1	19	1.00	0.73	1.00	0.65	0.22	0.00
PriS1	19	1.00	0.73	1.00	0.65	0.22	0.18
PriS2	19	1.00	0.73	1.00	0.65	0.22	0.18
PriS3	8	0.00	0.73	0.33	0.69	0.00	NA
PubS1	8	0.00	0.73	0.33	0.69	0.00	NA
PubS2	19	1.00	0.73	1.00	0.65	0.22	0.18
PubS3	9	0.00	0.82	0.33	0.73	0.00	NA

Table 5.9.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	AveRecip
PubS	0.67	2.00	2.75	3.00	3.00	2.28
PriS	0.50	0.33	1.38	0.67	1.50	0.88
CS	0.36	0.73	1.00	1.00	1.00	0.82
NS	0.33	0.67	1.00	0.00	1.00	0.60
AT	0.33	0.67	1.00	1.00	0.00	0.60

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Ukraine

Network level measures

The participation of 14 respondents in the survey conducted to the collection of data on 11 participating in CoST Ukraine. There were two representatives of public sector organisations that could not complete the survey during the time of deployment. In order to keep consistency with the responses of participants that managed to go through all the items of the questionnaire, these two half-completed surveys were not considered in the results described here.

CoST Ukraine obtained a response rate of 88%. The country displays the lowest density in the sample, because those surveyed claimed to interact and share information through only 55 ties between them. Yet, this is half of all the possible relationships the network can reach given the number of actual organisations that participated in the survey. Considering all the possible relationships from a complete network participation (presuming the responses from the 15 original respondents), the current density amounts to little more than 35%. Thus, findings suggest that half of Ukraine's relational capacity is underdeveloped.

Differences of interconnections are visible in the visualisations of the formal and informal network structures in Figure 6.0.1., where the position and size of nodes departs considerable from the ideal type. The lack of connections between member organisations makes it relative bigger than other network explored in this report. That is, in Ukraine's informal network, information or any other relational resource may travel slower as it takes up to three steps or nodes to go through from one side of the network to the other (see Diameter measure in Table 6.0.1). It is due to the lack of enough ties that the informal network shows signs of relative fragmentations with three components that entails the core, and separate two organisations that are located at the periphery.

Node-level measures.

Node-level metrics in Table 6.0.2 indicate that a group of civil society organisations hold the largest number of total ties (number of degrees). In this sense, CS1 (Center for Political Studies and Analysis Eidos), CS4 (Open Contracting Partnership OCP), and CS5 (Transparency International Ukraine) rank at top. These organisations interact with others with a range from 13 and 15 ties in total. According to the homophily measure also in Table 6.0.2., most of these ties are directed to members affiliated to the same sector, which suggests a higher level of

coordination between civil society organisations, which is a feature already observed in several countries. The Betweenness index of CS5 (‘11.56’) stands out as the highest in Ukraine. This privileged structural position suggests that CS5 leads interactions. CS5 is likely to be the source of most relevant information and spread it quicker and more efficiently than others. On the other hand, the location within the network structure of CS4 makes it the closest organisations to every other, which indicates not only a privileged position as well, but the capacity to influence network neighbours. Overall, and as previously discussed for the case of Afghanistan and Honduras, civil society entities that tend to participate predominantly in the core of the networks is a promising sign of an active and dynamic sector steering outcomes of the MSGs.

Other organisations such as PubS1 (Prozorro Sales), NS1 (National Secretariat) and AT1 (Assurance Team) do not perform bad in this regard. Their social interactions place them within an important range of ties (more than 10 degrees in total). The performance of the AT1 draws the attention, because despite the very short period of participation of its three representatives in CoST (1.67 years on average), they have managed to deploy what it seems an effective strategy to strength connections with other actors by attending a most of the meetings in 2019 (see Figure 6.0.2.). Together with the civil society, these organisations in “the middle” shape the contours of a diverse set of network actors that support all the relational activity of the network, reflecting a genuine multi-stakeholder space where exchange of valuable information and learning may be unfolding.

Private sector organisations, represented by PrivS1 (Association of International Road Carriers of Ukraine), PrivS2 (Business Ombudsman Council), and to a lesser extent, PriS3 (Federation of Transport Employers of Ukraine) remain at the periphery of the informal network. The two first organisation have no outgoing ties with any other actor, while they receive few incoming ties. The relational pattern of these two organisations raises a flag about little engagement despite a long track record of participation in CoST (see average participation in Figure 6.0.2). On the other hand, PriS3 is slightly more connected by sending ties to three neighbour nodes and receiving back four. In general, Table 6.0.3 reveals that private sector organisations do not reciprocate any of the most important relationships they have from more influential network actors like the civil society, the Assurance Team, and the National Secretariat. Thus, in Ukraine, the private sector seems to relegate the relational advantages and engagement that the multi-stakeholder groups offer.

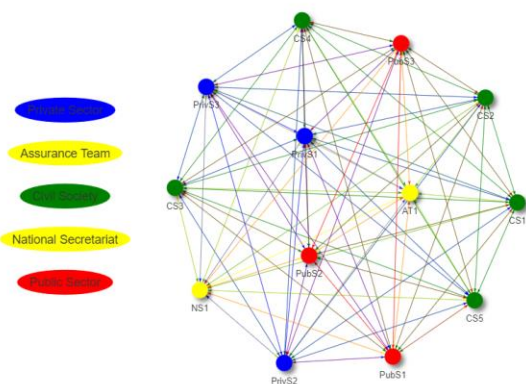
Information sharing

Figure 6.0.3. indicates that recommendations from the Assurance Report turned out to be the most popular topic of discussion among members of CoST Ukraine. Poor contract management and quality of infrastructure project follow in the chart. Consistent with the trend highlighted previously, the least relevant topics are social and environmental impacts of infrastructure projects, as well as safety and wellbeing of sector's workers. A closer look at the fluctuation in the number of individuals per sector reveals that differences in the preference of topics are led primarily by the interests of five individuals affiliated to the civil society, three (out of four) individuals from the private sector, and three from the Assurance Team. The results provide an insight of the aspects of the public infrastructure in Ukraine that matters the most for these actors.

APPENDIX G8: REPORT ON COST-UCL ONLINE SURVEY (RESULTS 2/2)

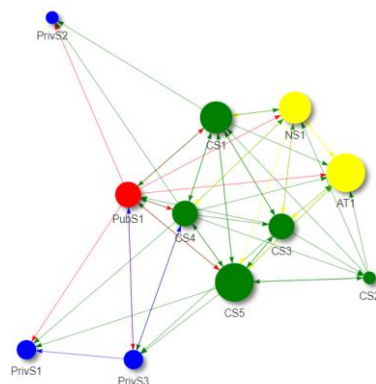
Figure 6.0.1. a) Ukraine formal network

Ideal-type map of the formal organisation



b) Informal network (inward centrality)

Node size: number of incoming ties



c) Informal network (outward centrality)

Node size: number of outgoing ties

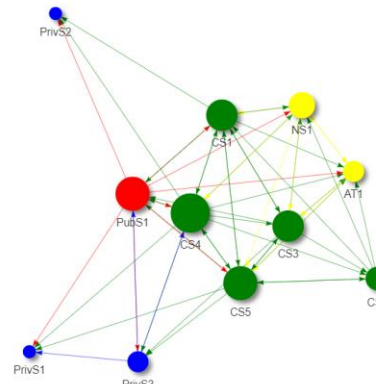


Figure 6.0.2. Ukraine (avg participation per sector)

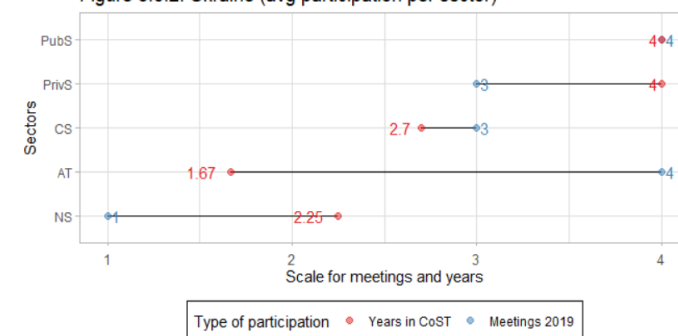


Table 6.0.1. Whole network-level measures

Country	Nodes		No. Ties		Density	Connectedness	Diameter	Components
	F	I	F	I	I	I	I	I
Ukraine	13	11	156	55	0.50	0.81	3	3

Legend: F, formal network; I, informal network.

Table 6.0.2. Node-level measures

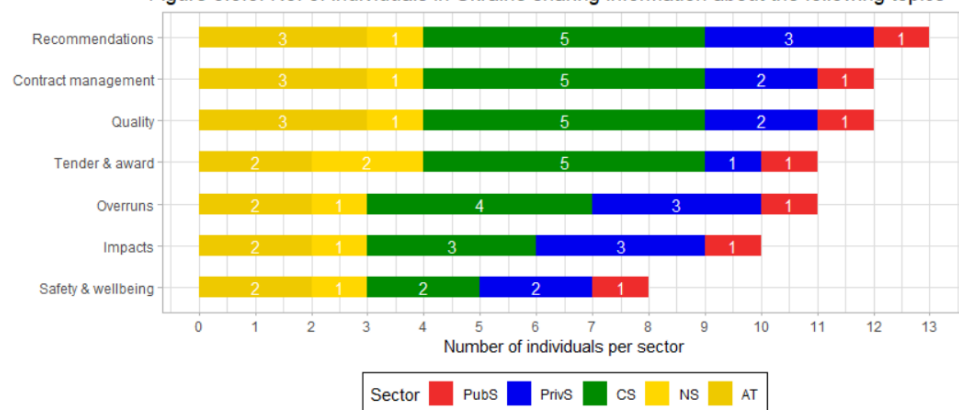
Ukraine	Degree	OutDeg	InDeg	OutClose	InClose	Betweenness	Homophily
AT1	10	0.30	0.70	0.56	0.59	0.68	0.00
CS1	13	0.70	0.60	0.77	0.56	5.18	0.43
CS2	7	0.40	0.30	0.63	0.48	0.18	0.50
CS3	12	0.70	0.50	0.77	0.53	4.20	0.43
CS4	15	1.00	0.50	1.00	0.53	9.79	0.40
CS5	15	0.80	0.70	0.83	0.59	11.56	0.50
NS1	11	0.50	0.60	0.67	0.56	2.33	0.00
PrivS1	4	0.00	0.40	0.25	0.56	0.00	NA
PrivS2	3	0.00	0.30	0.25	0.50	0.00	NA
PrivS3	7	0.30	0.40	0.59	0.50	0.59	0.33
PubS1	13	0.80	0.50	0.83	0.53	5.44	0.00

Table 6.0.3. Reciprocity ratio by sector

Sector	PubS	PriS	CS	NS	AT	AveRecip
PubS	0.00	0.33	2.00	0.00	0.00	0.47
PriS	3.00	0.00	7.00	0.00	0.00	2.00
CS	0.50	0.00	1.07	1.00	0.40	0.59
NS	0.00	0.00	1.00	0.00	1.00	0.40
AT	0.00	0.00	2.50	1.00	0.00	0.70

Sector with no reciprocal ties (0); Sector with reciprocal ties (1); Sector that receives more ties than it claims (>1); Sector that claims more ties than are reciprocated (<1).

Figure 6.0.3. No. of individuals in Ukraine sharing information about the following topics



Individual Attributes for Social Engagement: General Trends

This section presents findings that complement results from countries' social network analysis. It attempts to offer a bigger picture of the relational phenomena that occurs within CoST implementing countries included in this report. The analysis provides key information on the personal characteristics that make CoST individual members (and not their organisations) more likely to establish frequent and more enduring relationships with others in their respective MSG, and thus more likely to add value to the process of CoST implementation.

Method and variables

This section describes results from a multivariate regression analysis. This is a method used to measure the degree at which more than one independent variable (predictors) and one dependent variable, are linearly related. The method is broadly used to predict the behaviour of the dependent variable associated to changes in the predictor variables, once a desired degree of relation has been established. Thus, for this report, the multivariate regression offers a tool to point to the directions of variables than may be playing a role in determining individual behaviours in social settings, like social networks.

For this report, the dependent variable is the *average out degree* (AveOutDeg). The AveOutDeg was calculated for every respondent dividing the sum of the frequencies of the respondents' communication with others by the total number of ties the respondent indicated to have in 2019 with CoST colleagues. In order to capture the occurrences of communication in the survey, the frequencies were categories as follows: (0) Never, (1) rarely, (2) occasionally, (3) frequently, and (4) very frequently. For example, if a respondent indicated to share information with 10 actors in the MSG (10 ties), from which three of them happened occasionally in 2019, four very frequently, and three occurred only rarely, then the AveOutDeg of this hypothetical respondent would be 2.1, because the sum of frequencies is 21 $((2*3) + (4*3) + (3*1))$ divided by the total number of ties. Therefore, AveOutDeg is a continuous dependent variable, where the highest the average, the greater the number (and frequency) of ties the respondent indicated to have.

On the other hand, 10 independent variables were explored in the analysis. These are split in three main categories: demographics and professional background, motivations and perceptions about CoST, and participation process in CoST. As indicated in Table 6.1. below, demographics and professional background variables entail (1) respondent' demographics, (2) job title in home organisation, and (3) sector affiliation. Within the group of motivations and perceptions, the variables are: (4) motivations for participating in CoST, (5) perceptions about CoST outcomes, and (6) opinions about the practicality of the MSG as a vehicle for the implementation of the initiative. Participation process involves key aspects such as (7) number of MSG meetings attended in 2019, (8) years of participation in CoST, (9) level of engagement with Guidance Notes, and (10) the frequency and areas of CoST implementation where respondents were able to contribute, in their opinion, with exclusive knowledge from their profession.⁵⁶

Table 0-6 Independent variables for multivariate regression.

<i>Category</i>	<i>Independent Variable</i>	<i>Question</i>	<i>Answer choices</i>	<i>Operationalisation</i>
<i>Demographics</i>	1.1. Age	Please indicated your age.	- Less than 18 years old - 18-24 years old - 25-34 years old - 35-44 years old - 45-54 years old - 55 or older	Categorical: single answer
	1.2. Gender	Please indicate your gender.	- Feminine - Masculine - Other - Prefer not to respond	Categorical: single answer
	1.3. Education	What is the highest educational level you have obtained?	- Primary school - Secondary school - High school - University - Masters - PhD - Prefer not to say	Categorical: single answer
<i>Professional background</i>	2. Job title (seniority)	What is your job title within your organisation?	- Executive direction - Higher management - Intermediate management - Operative Level - Junior - Other	Categorical: single answer
	3. Sector affiliation / CoST internal body	Which sector best represents the organization or association you belong to, and that you represent in the in CoST?	- Public - Private - Civil Society - Academia - Media - National Secretariat - Assurance Team - Observer organisation	Categorical: single answer
<i>Motivations</i>	4. Participation in CoST	How important are the following choices that may reflect some of your motivations for participating in CoST?	- Improve value for money in public infrastructure projects. - Obtain reputational benefits. - Engagement with public and private stakeholders. - Contribute to the public debate. - Obtain sources of funding for my organisation. - Enhance transparency in the governments. - Help to co-produce public policies to tackle corruption.	Ordinal: average of items.

⁵⁶ For a description of the general results of some of these survey items, please refer to the 1st Report of CoST-UCL Survey (September 2020).

<i>Perceptions</i>	5.	Outcomes of CoST implementation	To what extent do you agree or disagree with the following statements about CoST work in your country?	- Transparency in public infrastructure projects has increased. - Corruption in public infrastructure projects has decreased. - Improvements in transparency are likely to be long-lasting. - Participation in CoST is worth despite the time and resources required to participate. - Solutions have been reached in a consensual way by all the stakeholders.	Ordinal: average of items.
	6.	Practicality of the MSG	How agree or disagree are you with the following statements about the MSG?	- Practical organisational arrangement for the implementation of the initiative of CoST. - Appropriate arrangement without conflict with existing governmental structures. - Sustainable over time.	Ordinal: average of items.
<i>Participation process</i>	7.	Meetings	How many meetings have you attended in 2019?	No. of meetings.	Interval: single answer 0 / 5 + meetings
	8.	Years	How many years have you been developing CoST work?	Years of participation in CoST.	Interval: single answer 0 / 5 + years
	9.	CoST Guidance Notes	Have you read and/or discuss with colleagues the following CoST Guidance Notes?	Extent of engagement (read & discuss) with the 3 rd , 4 th , 5 th , and 7 th Guidance Note.	Ordinal: average of items.
	10.	Professional knowledge	How frequently the knowledge from your professional experience is being used for the following processes of CoST?	- Selecting relevant indicators of the infrastructure data standard. - Determining how best to communicate CoST activities and outcomes to the public. - Selecting the infrastructure projects for the assurance report. - Advising on the design and preparation of the assurance reports. - Interpreting the findings of the reports. - Following up the recommendations from CoST.	Ordinal: average of items.

Results and discussion

Table 6.2. below shows the results of the multivariate regression. The first column lists the predictors or independent variables that were explored through 14 analytical models. The subsequent columns represent the composition of these models with a code name for differentiation. Starting from the variable of education (Edu) in the second column, the following models added a specific variable to the regression models. By adding up variables one by one into the multivariate regression, the monitoring of their statistical significance, and thus their relevance throughout all the models was simpler to assess. The variables that proved to be significant across all or most of the models are highlighted in red for easier identification.

Table 6.2. reveals that variables within the demographics category, age is the most important attribute for the relational pattern of CoST participants. According to this analysis, individuals who are within the range of 18 and 34 years old are more likely to build proactively their social networks with other colleagues of the MSGs. This variable (Q13.3Age.Dum9.Upto34) proved a level of significance throughout all the models of the regression, indicating a remarkable importance as a predictor. On the other hand, in the group of professional background variables, respondents' job title showed to be not an important variable across most of the models. However, looking at the third model (Job), it shows that members that hold an executive or, even more significantly, a high management position within

their home organisations are more likely to establish a larger number of connections with other CoST actors than members from a different level of seniority. The variables Q5.2JobSen.Dum1.Exec and Q5.2JobSen.Dum2.High are statistically significant in the third column of the regression.

Sector affiliation is another strong predictor to explain the probability for CoST actors to establish relationships with others. Results from the regression analysis suggest that those representing the National Secretariats (Country Managers and staff), as well as those affiliated to a civil society organisation are much more likely to actively create and maintain strong relationships within their multi-stakeholder groups. Results for the former group are consistent with the nature of work that secretariats are expected to handle in terms of coordination and guidance between. Therefore, in light of these results, it could be argued that most of the National Secretariats surveyed for this study were doing an exceptional job in 2019 in what social connections and information dissemination concerns.

To a lesser extent, findings for Q5.1Sector.Dum5.AT were not significant across all the models, but only in five. Results shows that being a representative or a collaborator on behalf of the Assurance Teams also increases the chances of having a large number of relationships. The network analysis of Costa Rica, Guatemala, Ghana, Ethiopia, and Afghanistan show the active role that the Assurance Team can have at the core of the networks, and the fact that in some of these countries, most of the members of the MSG shared information predominantly about the findings and recommendations of the Assurance Reports.

Table 0-7 Multivariate regression results

	Edu	Age	Gen	Job	Sector	Meetings	Years	Mot	Acc	GN	Know	Groups	CoST	MSG
(Intercept)	1.31 *** (0.14)	1.13 *** (0.20)	1.26 *** (0.21)	0.92 *** (0.24)	0.08 (0.41)	-0.06 * (0.42)	-0.06 * (0.43)	-1.61 ** (0.59)	-1.70 ** (0.60)	-1.58 ** (0.60)	-1.76 ** (0.61)	-2.16 *** (0.63)	-2.58 *** (0.64)	-2.44 *** (0.65)
Q13.2Education.Dum2.Master	0.13 (0.18)	0.18 (0.18)	0.17 (0.18)	0.11 (0.18)	0.14 (0.16)	0.13 (0.17)	0.13 (0.17)	0.11 (0.16)	0.10 (0.16)	0.13 (0.16)	0.13 (0.16)	0.13 (0.16)	0.16 (0.16)	0.16 (0.16)
Q13.2Education.Dum3.PHD	-0.22 (0.40)	-0.18 (0.40)	-0.21 (0.40)	-0.34 (0.39)	-0.15 (0.39)	-0.13 (0.36)	-0.13 (0.36)	-0.12 (0.35)	-0.13 (0.35)	-0.22 (0.35)	-0.15 (0.35)	-0.14 (0.35)	-0.10 (0.35)	-0.10 (0.35)
Q13.3Age.Dum9.Upto34	0.47 * (0.22)	0.45 * (0.22)	0.52 * (0.22)	0.58 ** (0.21)	0.50 * (0.20)	0.50 * (0.20)	0.50 * (0.20)	0.48 * (0.19)	0.50 * (0.20)	0.46 * (0.19)	0.48 * (0.19)	0.44 * (0.19)	0.43 * (0.19)	0.44 * (0.19)
Q13.3Age.Dum4.45-54	0.11 (0.24)	0.03 (0.24)	0.12 (0.24)	0.24 (0.24)	0.35 (0.23)	0.35 (0.23)	0.35 (0.23)	0.35 (0.22)	0.35 (0.22)	0.33 (0.22)	0.34 (0.22)	0.35 (0.22)	0.35 (0.22)	0.35 (0.22)
Q13.3Age.Dum5.55	-0.06 (0.25)	-0.12 (0.25)	-0.04 (0.25)	-0.04 (0.25)	0.14 (0.26)	0.13 (0.24)	0.13 (0.24)	0.20 (0.23)	0.19 (0.23)	0.14 (0.23)	0.14 (0.23)	0.25 (0.23)	0.25 (0.23)	0.26 (0.23)
Q13.4Gender.Dum1.Fem	-0.31 (0.19)	-0.12 (0.19)	-0.27 (0.19)	-0.18 (0.18)	-0.10 (0.18)	-0.10 (0.18)	-0.10 (0.18)	-0.07 (0.17)	-0.10 (0.18)	-0.15 (0.18)	-0.17 (0.18)	-0.19 (0.18)	-0.14 (0.18)	-0.15 (0.18)
Q5.2JobSen.Dum1.Exec	0.52 * (0.23)	0.27 (0.23)	0.33 (0.23)	0.33 (0.23)	0.35 (0.26)	0.35 (0.26)	0.35 (0.26)	0.36 (0.26)	0.36 (0.26)	0.40 (0.26)	0.38 (0.25)	0.35 (0.25)	0.34 (0.25)	0.33 (0.25)
Q5.2JobSen.Dum2.High	0.66 ** (0.24)	0.21 (0.32)	0.29 (0.30)	0.29 (0.30)	0.35 (0.29)	0.35 (0.29)	0.35 (0.29)	0.38 (0.30)	0.38 (0.30)	0.43 (0.29)	0.43 (0.29)	0.35 (0.29)	0.31 (0.29)	0.30 (0.29)
Q5.2JobSen.Dum4.Middle	0.40 (0.28)	0.18 (0.34)	0.34 (0.32)	0.34 (0.32)	0.36 (0.32)	0.36 (0.32)	0.36 (0.32)	0.36 (0.31)	0.36 (0.31)	0.36 (0.31)	0.35 (0.31)	0.32 (0.31)	0.32 (0.31)	0.31 (0.31)
Q5.2JobSen.Dum5.Opera	0.27 (0.28)	-0.34 (0.35)	-0.34 (0.33)	-0.34 (0.33)	-0.26 (0.32)	-0.26 (0.32)	-0.26 (0.32)	-0.26 (0.33)	-0.26 (0.33)	-0.14 (0.33)	-0.17 (0.33)	-0.15 (0.33)	-0.19 (0.33)	-0.19 (0.33)
Q5.1Sector.Dum1.Pub	0.91 * (0.43)	0.78 (0.43)	0.78 (0.43)	0.54 (0.41)	0.53 (0.41)	0.53 (0.41)	0.53 (0.41)	0.53 (0.41)	0.53 (0.41)	0.43 (0.41)	0.46 (0.41)	0.58 (0.41)	0.58 (0.41)	0.62 (0.41)
Q5.1Sector.Dum2.Pri	0.57 (0.41)	0.36 (0.39)	0.36 (0.39)	0.15 (0.38)	0.17 (0.38)	0.15 (0.38)	0.15 (0.38)	0.17 (0.38)	0.17 (0.38)	0.08 (0.38)	0.18 (0.38)	0.30 (0.38)	0.33 (0.38)	0.37 (0.38)
Q5.1Sector.Dum3.Civ	1.23 ** (0.41)	1.12 ** (0.39)	1.12 ** (0.39)	1.12 ** (0.38)	0.99 ** (0.38)	0.99 ** (0.38)	0.99 ** (0.38)	0.99 ** (0.38)	0.99 ** (0.38)	0.98 * (0.38)	0.94 * (0.38)	1.02 ** (0.38)	1.02 ** (0.38)	1.07 ** (0.38)
Q5.1Sector.Dum4.NS	1.54 ** (0.47)	1.36 ** (0.44)	1.36 ** (0.44)	1.12 ** (0.44)	1.12 ** (0.44)	1.12 ** (0.44)	1.12 ** (0.44)	1.25 ** (0.46)	1.06 * (0.46)	1.07 * (0.46)	1.24 ** (0.47)	1.31 ** (0.47)	1.33 ** (0.47)	1.33 ** (0.47)
Q5.1Sector.Dum5.AT	0.80 * (0.38)	0.73 * (0.36)	0.73 * (0.36)	0.58 (0.35)	0.58 (0.35)	0.58 (0.35)	0.58 (0.35)	0.58 (0.35)	0.58 (0.35)	0.58 (0.35)	0.56 (0.35)	0.69 (0.35)	0.72 * (0.35)	0.74 * (0.35)
X69Q7.1MeetingssAttendance	0.26 *** (0.05)	0.26 *** (0.05)	0.26 *** (0.05)	0.22 *** (0.05)	0.22 *** (0.05)	0.22 *** (0.05)	0.22 *** (0.05)	0.21 *** (0.05)	0.21 *** (0.05)	0.18 ** (0.05)	0.17 ** (0.05)	0.16 ** (0.05)	0.15 ** (0.05)	0.15 ** (0.05)
X78Q7.4LengthParticipation	-0.00 (0.05)	-0.00 (0.05)	-0.00 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)
Q7.2Motivations.Mean.FA2	0.09 ** (0.03)	0.09 ** (0.03)	0.09 ** (0.03)	0.09 ** (0.03)	0.09 ** (0.03)	0.09 ** (0.03)	0.09 ** (0.03)	0.09 ** (0.03)	0.09 ** (0.03)	0.09 * (0.03)	0.09 * (0.03)	0.07 * (0.03)	0.05 (0.03)	0.05 (0.03)
X73Q7.2Motivation.Contribute.Public.Debate	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)
X78Q7.2Motivation.Improve.Value.Money	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)
Q7.5Accountability.Mean.FA2	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)
Q7.5Accountability.Mean.FA3	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)
Q8.12DiscussReadGN.Mean.FA1	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)	0.07 * (0.04)
Q8.3ProfinKnowledge.Mean.FA2	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)	0.17 (0.09)
Q8.3ProfinKnowledge.Mean.FA3	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)	-0.06 (0.11)
Q11.4InfluenceGroups.Mean.FA4.Pol	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)	0.18 (0.12)
Q11.4InfluenceGroups.Mean.FA5.CS	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.13 (0.12)
Q11.4InfluenceGroups.Mean.FA6.Fam	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)	-0.12 (0.09)
Q10.1CoSTPerceptualOutcomes.Mean.FA2	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)	0.10 (0.08)
X109Q10.1CoSTPerceptualOutcomes.CostBenefit	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)
X110Q10.1CoSTPerceptualOutcomes.ConsensualSolutions	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)
Q12.3MSGPerceptualOutcomes.Mean.FA1	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)	-0.05 (0.09)
R ²	0.01	0.04	0.05	0.10	0.18	0.29	0.29	0.35	0.35	0.37	0.39	0.41	0.43	0.44
Adj. R ²	-0.00	0.01	0.02	0.05	0.11	0.22	0.22	0.27	0.27	0.29	0.30	0.31	0.32	0.32
Num. obs.	191	191	191	191	191	191	191	191	191	191	191	191	191	191

On the other hand, the analysis indicates that the variables coded as Q5.1Sector.Dum2.Pri for the private sector, and Q5.1Sector.Dum1.Pub for public sector, are not significant for the dependent of variable under scrutiny. In fact, in an alternative regression analysis not included here, where respondents with zero ties in their networks were removed (complete isolated actors), results showed that being affiliated to the private sector or an observer organisations were strong indicators for members to be less likely to expand their social network, let alone to connect with any other actor whatsoever. Countries that reflect this propensity primarily are Panama, Ghana, Ethiopia, and Ukraine, where the engagement of private sector organisations departs considerably from desirable levels for an integrated multi-stakeholder group.

Participation dynamics in CoST is the second set of variables that have shown strong relationship with the way how CoST members establish connections with others. The number of meetings attended in 2019 is remarkably relevant for this. The variable X69Q7.1MeetingssAttendance is statistically significant across all the models tested. Despite

the variable is self-evident for establishing connections in any organisational setting, it turned out to be even more important than the number of years respondents have participated in CoST. In this sense, the variable of years of participation (X78Q7.4LengthParticipation) performed negatively in the analysis. Therefore, seniority of members in CoST is not necessarily a factor that contribute to develop interconnected and cohesive networks of frequent communication, but rather it may prevent them.

Moreover, the multivariate regression analysis also sheds light on the role of CoST Guidance Nodes, which resulted very important to predict the propensity of actors to actively take advantage of the relational opportunities available in their MSG. As indicted in the first instalment of this report (September 2020), the majority of those surveyed indicated to be engaged to some extent with the Guidance Notes that refers to the (1) Developing of an implementation plan, (2) the establishing a multi-stakeholder group and national secretariat, (3) the scoping study, and (4) the designing an assurance process. But for those read how have read these guidance notes thoroughly, the chances to interact and share more information about relevant issues for the implementation of CoST are higher than for those members that have not engaged completely with the contents of these documents. The variable Q8.12DiscussReadGN.Mean.FA1 is statistically significant in the three models it was tested.

Respondents' perceptions about the impacts of CoST in the host countries, and their opinions about the MSG as an effective organisational instrument for the implementation of CoST, resulted no significant in this analysis. Motivations for participating in CoST, on the other hand, reveals a more significant contribution for this set of predictors. Table 6.1. above shows that the question about motivations to participate in CoST included seven items in the survey, roughly summarised in public good motivations (i.e., to improve value for money, to contribute to the public debate and enhance transparency and public policies in the government), and private good motivations (obtain reputational benefits, networking with key public-private organisations in the sector and obtain sources of funding). Results from the regression indicate those individual participants that are driven by private good motivations are more likely to expand their social network within CoST. The variable Q7.2Motivations.Mean.FA2 is found significant in five out of seven models it was tested.

Conclusions

This report has described the results of social network analysis from data collected in 10 CoST implementing countries in 2020. In Section 5, results were explained in terms of whole network and node-level measures, aiming at revealing the macro characteristics of the network such as size, density and connectedness, as well as the micro characteristics of every member organisation through their centrality measures, homophily and propensity to reciprocate relationships from different sectors in their respective networks.

In general, the whole network measures indicated that all the networks have a core or network centre of cohesive and multiple relationships involving extremely well-connected organisations that are likely to steer the implementation of CoST. The core of some countries is diverse in terms of sector representation, while in others, the core is dominated by a particular sector. Moreover, the study identified networks that are remarkably dense in terms of number of ties among their members: a feature that makes them quite resilient in case of fragmentation or disintegration. Furthermore, all networks in the study also presented organisations at the peripheries. These isolated entities indicated relationships with no one in their networks, despite others claimed relationships with them.

Overall, the micro characteristics of organisations and their relational patterns revealed their preferences in terms of association. While members of the National Secretariats and Assurance Teams tended to diversify their relationships with most organisations in the networks, organisations affiliated to the civil society, for instance, were more inclined to keep connection between colleagues of the same affiliation. In addition, there were several instances, especially in African countries, where private sector organisations performed poorly in terms of relational activity and information sharing.

The report also highlighted some of the possible implications of the network findings for members of the MSGs, including those in the National Secretariats and Assurance Teams. This information is likely to be useful if complemented with findings from Section 7, in case of network reconfiguration or design strategies to incentivise active engagement. The network visualisations included in this report revealed that every country is unique, and there is not a configuration one-size-fits-all to improve outcomes of the network, but rather precise

interventions to enhance the performance of actors, considering their propensities to connect with others and structural position.

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Appendices

Appendix I. Organisational code book

<i>Country</i>	<i>Organisation name</i>	<i>Sector</i>	<i>No. of respondents</i>	<i>Organisation code</i>
<i>Afghanistan</i>	Assurance Team	Assurance Team	2	AT1
	Afghan Engineers Association AEA	Civil Society	1	CS1
	Afghan NGOs Coordination Bureau ANCB	Civil Society	1	CS2
	Integrity Watch Afghanistan IWA	Civil Society	2	CS3
	South Western Afghanistan and Balochistan Association SWABAC	Civil Society	1	CS4
	National Secretariat	National Secretariat	3	NS1
	Afghanistan Builders Association ABA	Private Sector	1	PriS1
	Afghanistan Chamber of Commerce and Industries ACCI	Private Sector	1	PriS2
	Global Trust Construction Company GTC	Private Sector	1	PriS3
	Ministry of Economy	Public Sector	1	PubS1
	Ministry of Energy and Water	Public Sector	1	PubS2
	Ministry of Transport	Public Sector	1	PubS3
<i>Costa Rica</i>	Assurance Team	Assurance Team	4	AT1
	Consumidores de Costa Rica	Civil Society	2	CS1
	Costa Rica Integra	Civil Society	2	CS2
	National Secretariat	National Secretariat	1	NS1
	Contraloria General de la Republica	Obs&Coll	3	Obs1
	Defensoria de los Habitantes	Obs&Coll	2	Obs2
	Ministerio de Comunicacion	Obs&Coll	2	Obs3
	Oficina de la Primera Dama	Obs&Coll	1	Obs4
	Fedecamaras Costa Rica	Private Sector	2	PriS1
	Union Costarricense de Camaras y Asociaciones del Sector Empresarial Privado UCCAEP	Private Sector	2	PriS2
	Ministerio de Hacienda	Public Sector	3	PubS1
	Ministerio de Obras Publicas y Transportes MOPT	Public Sector	1	PubS2
	Ministerio de Planificacion Nacional y Politica Economica	Public Sector	2	PubS3
<i>El Salvador</i>	Universidad de El Salvador	Academia & ThinkTanks	1	Aca1
	Universidad Politecnica de El Salvador	Academia & ThinkTanks	1	Aca2
	Assurance Team	Assurance Team	2	AT1
	Asociacion Transparencia, Contraloria Social y Datos Abiertos TRACODA	Civil Society	1	CS1
	Sistema de Asesoria y Capacitacion para el Desarrollo Local	Civil Society	1	CS2
	National Secretariat	National Secretariat	2	NS1
	Camara Salvadorena de la Industria de la Construccion	Private Sector	1	PriS1
	Colegio de Arquitectos de El Salvador CADES	Private Sector	2	PriS2
	Fondo de Conservacion Vial	Public Sector	1	PubS1
	Ministerio de Obras Publicas	Public Sector	1	PubS2
<i>Ethiopia</i>	Assurance Team	Assurance Team	4	AT1
	Call for Integrated Development	Civil Society	1	CS1
	Transparency Ethiopia	Civil Society	1	CS2
	National Secretariat	National Secretariat	2	NS1
	Construction Contractors Association of Ethiopia	Private Sector	1	PriS1
	Consulting Engineers and Architects Association of Ethiopia	Private Sector	1	PriS2
	Grade I Contractors Association of Ethiopia	Private Sector	1	PriS3
	Ethiopian Roads Authority	Public Sector	1	PubS1

Ghana	Federal Ethics and Anti-corruption Commission	Public Sector	1	PubS2
	Federal Public Procurement and Property Administration Agency	Public Sector	1	PubS3
	Assurance Team	Assurance Team	1	AT1
	Friends of the Nation FoN	Civil Society	1	CS1
	STMA Citywide Settlement Upgrading Fund	Civil Society	1	CS2
	Western Region Branch of Ghana Journalist Association	Media	1	Med1
	National Secretariat	National Secretariat	2	NS1
	Adax Construction Ltd	Private Sector	1	PriS1
	Architectural Spring Ltd	Private Sector	1	PriS2
	SekondiTakoradi Chamber of Commerce and Industry STCCI	Private Sector	1	PriS3
Guatemala	Sekondi Takoradi Metropolitan Assembly STMA	Public Sector	3	PubS1
	Assurance Team	Assurance Team	2	AT1
	Accion Ciudadana	Civil Society	2	CS1
	Asociacion de Ingenieros Jubilados de Guatemala ASIJUGUA	Civil Society	3	CS2
	Asociacion Nacional de Municipalidades ANAM	Civil Society	1	CS3
	GUATECIVICA	Civil Society	1	CS4
	National Secretariat	National Secretariat	4	NS1
	Banco Interamericano de Desarrollo BID	Obs&Coll	1	Obs1
	Embajada Britanica	Obs&Coll	2	Obs2
	Camara de Industria de Guatemala	Private Sector	1	PriS1
Honduras	Camara Guatemalteca de la Construcción	Private Sector	2	PriS2
	Comision Presidencial de Gestion Publica Abierta y Transparencia GPAT	Public Sector	2	PubS1
	Contraloria General de Cuentas	Public Sector	1	PubS2
	Ministerio de Finanzas Publicas MINFIN	Public Sector	2	PubS3
	Assurance Team	Assurance Team	6	AT1
	Asociacion para una Sociedad mas Justa	Civil Society	2	CS1
	Espacio Regional de Occidente de Honduras EROC	Civil Society	2	CS2
	Fundacion Democracia sin Fronteras FDSF	Civil Society	1	CS3
	National Secretariat	National Secretariat	5	NS1
	Camara Hondurena de Empresas de Consultoria CHEC	Private Sector	2	PriS1
Malawi	Camara Hondurena de la Industria de la Construcción CHICO	Private Sector	2	PriS2
	Colegio de Ingenieros Civiles de Honduras CICH	Private Sector	1	PriS3
	Gabinete Sectorial de Infraestructura Productiva GSIP	Public Sector	1	PubS1
	Instituto de Acceso a la Informacion Publica IAIP	Public Sector	2	PubS2
	Secretaria de Coordinacion General de Gobierno SCGG	Public Sector	1	PubS3
	Assurance Team	Assurance Team	1	AT1
	African Institute of Corporate Citizenship AICC	Civil Society	1	CS1
	Malawi Economic Justice Network MEJN	Civil Society	1	CS2
	Human Rights Consultative Committee HRCC	Civil Society	1	CS3
	Council for Non-Governmental Organisations in Malawi CONGOMA	Civil Society	1	CS4
	Media Institute of Southern Africa MISA	Media	1	Med1
	National Secretariat	National Secretariat	1	NS1
	World Bank	Obs&Coll	1	Obs1
	African Development Bank AfDB	Obs&Coll	1	Obs2

<i>Panama</i>	Malawi Business Action Against Corruption	Private Sector	1	PriS1
	National Contractors Association	Private Sector	1	PriS2
	Malawi Anti-Corruption Bureau	Public Sector	1	PubS1
	National Construction Industry Council NCIC	Public Sector	1	PubS2
	The Department of Buildings, Ministry of Transport and Public Works	Public Sector	1	PubS3
	Department of Statutory Corporations, Office of the President and Cabinet	Public Sector	1	PubS4
	Fundacion Generacion Sin Limite de Panama	Civil Society	1	CS1
	Fundacion para el Desarrollo de la Libertad Ciudadana, Capitulo Panameno de Transparencia Internacional	Civil Society	1	CS2
	Movin Panama	Civil Society	2	CS3
	National Secretariat	National Secretariat	4	NS1
	Embajada Britanica en Panama	Obs&Coll	1	Obs1
	Camara de Comercio Britanica en Panama	Private Sector	1	PrivS1
	Camara Panamena de la Construccion CAPAC	Private Sector	1	PrivS2
	Autoridad Nacional de Transparencia y Acceso a la Informacion Publica	Public Sector	1	PubS1
	Direccion General de Contrataciones Publicas DGCP	Public Sector	1	PubS2
	Instituto de Acueductos y Alcantarillados Nacionales IDAAN	Public Sector	1	PubS3
	Ministerio de Economia y Finanzas	Public Sector	1	PubS4
	Participacion Ciudadana y Transparencia de la Alcaldia de Panama	Public Sector	2	PubS5

APPENDIX G9: R CODES FOR CHAPTER 2

```
# R-scripts for Chapter 2 "Shaping
Influence in Governance Networks: The
Role of Motivations and
#Information exchange".
# This script consists of 3 parts:
# 1) data loading,
# 2) variabels descriptive characteristics,
and
# 3) PROCESS mediation model.

#Delete previous commands
rm(list=ls())
#Set up the working directory where main
dataset is located
setwd("~/R/")
getwd()
#Packages
library(readxl) #install.packaged("readxl")
library(dplyr) #install.packaged("dplyr")
library(plyr) #install.packaged("plyr")
library(psych) #install.packaged("psych")
library(lattice) #install.packages("lattice")
library(texreg) #install.packages("texreg")
#install.packages("Rcpp")
library(ggplot2)
#install.packages("ggplot2")
library(likert) #install.packages("likert")
library(tidyverse)
#install.packages("tidyverse")
library(reshape)
#install.packages("reshape")
library(reshape2)
#install.packages("reshape2")
library(data.table)
#install.packages("data.table")
library(fpc) #install.packages("fpc")
library(sjmisc) #install.packages("sjmisc")
library(ggpubr)
#install.packages("ggpubr")
library(lmtest) #install.packages("lmtest")
library(tidytext)
#install.packages("tidytext")
library(caret) #install.packages("caret")
library(sjPlot) #install.packages("sjPlot")
```

```
library(GPArotation)
#install.packages("GPArotation")
library(psych) #install.packages("psych")
library(foreign)
#install.packages("foreign")
library(car) #install.packages("car")
##### 1. Data loading
#####
###
#Process
#Load the file "ProcessWorkSpace" from
R environment
#Dataset 57
data<-read.csv("Motivation.Dataset.csv")
##### 2. Variables
descriptive characteristics
#####
#Descriptive information of variables
describe(data)
data %>% summarise_if(is.numeric, var)
#for variances
var<-as.data.frame(var(data))
var
#Correlations
tab_corr(data,
          na.deletion = c("listwise",
"pairwise"),
          corr.method = c("pearson",
"spearman", "kendall"),
          title = "Variables",
          var.labels = NULL,
          show.p = TRUE,
          fade.ns = TRUE,
          use.viewer = T)
#VIF Test
Data.VIF<-lm(Influence.Nominations ~
Self.Interest.Motivations +
          Pro.Social.Motivations +
          Information.Outgoing.ties +
          Years.Participation +
          Job.Title +
          Prof.Knowledge.Contributions,
          data = data)
screenreg(Data.VIF)
car::vif(Data.VIF)
```

⁵⁷ Datasets available upon request.

```
##### 3. Process
mediation models
#####
#Process model
process(data = data, #model selected for
final paper June 2022
  y = "Influence.Nominations",
  x = "Self.Interest.Motivations",
  m = "Information.Outgoing.ties",
  cov = c("Job.Title",
    "Years.Participation",
    "Pro.Social.Motivations",

"Prof.Knowledge.Contributions"),
  model = 4, effsize = 1, total =1,
normal = 1, seed = 886115)
#Appendix models
#Single IV: Self-interested motivations
process(data = data, #model selected for
final paper June 2022
  y = "Influence.Nominations",
  x = "Self.Interest.Motivations",
  m = "Information.Outgoing.ties",
  cov = c("Job.Title",
    "Years.Participation",

"Prof.Knowledge.Contributions"),
  model = 4, effsize = 1, total =1,
normal = 1, seed = 886115)
#Single IV: Pro-social motivations
process(data = data, #model selected for
final paper June 2022
  y = "Influence.Nominations",
  x = "Pro.Social.Motivations",
  m = "Information.Outgoing.ties",
  cov = c("Job.Title",
    "Years.Participation",

"Prof.Knowledge.Contributions"),
  model = 4, effsize = 1, total =1,
normal = 1, seed = 886115)
```


APPENDIX G10: R CODES FOR CHAPTER 3

```
# R-scripts for Chapter 3 "Where do  
Governance Networks come From? An  
Analysis of Opportunity  
# Structures in Information Exchange  
Networks"
```

```
#Set up the working directory  
rm(list=ls())  
setwd("~/R/PhD") #<--- include one's  
directory
```

```
#Packages  
library(readxl) #install.packages("readxl")  
library(dplyr) #install.packages("dplyr")  
library(plyr) #install.packages("plyr")  
library(psych) #install.packages("psych")  
library(lattice) #install.packages("lattice")  
library(texreg) #install.packages("texreg")  
library(ggplot2)  
#install.packages("ggplot2")  
library(tidyverse)  
#install.packages("tidyverse")  
library(reshape)  
#install.packages("reshape")  
library(reshape2)  
#install.packages("reshape2")  
library(data.table)  
#install.packages("data.table")  
library(cluster) #install.packages("cluster")  
library(sjmisc) #install.packages("sjmisc")  
library(ggpubr)  
#install.packages("ggpubr")  
library(lmtest) #install.packages("lmtest")  
library(arsenal)  
#install.packages("arsenal")  
library(factoextra)  
#install.packages("factoextra")  
library(tidytext)  
#install.packages("tidytext")  
library(texreg) #install.packages("texreg")  
library(sjPlot) #install.packages("sjPlot")  
library(openxlsx)  
#install.packages("openxlsx")  
library(ggrepel)  
#install.packages("ggrepel")
```

```
library(GPArotation)  
#install.packages("GPArotation")  
library(foreign)  
#install.packages("foreign")  
library(multilevel)  
#install.packages("multilevel")  
library(magic) #install.packages("magic")  
library(UserNetR)  
#Networks packages  
library(sna) #install.packages("sna")  
#detach(package:sna)  
#remove.packages("sna")  
detach(package:igraph)  
detach(package:intergraph)  
library(network)  
#install.packages("network")  
#detach(package:network)  
#remove.packages("network")  
library(statnet)  
#install.packages("statnet")  
#detach(package:statnet)  
#remove.packages("statnet")  
#library(statnet.common)  
#install.packages("statnet.common")  
#detach(package:statnet.common)  
#remove.packages("statnet.common")  
library(ergm) #install.packages("ergm")  
#detach(package:ergm)  
#remove.packages("ergm")  
library(ergmito)  
#install.packages("ergmito")  
library(btergm)  
#install.packages("btergm")
```

```
#Dataset 58  
#Global Attributes  
AttributeData<-  
read.csv("Data.Opportunity.Structures.Ana  
lysis.csv")
```

```
##### Preparation of Individual  
Networks to assemble the General  
Information Exchange Network #####  
##Information exchange networks
```

⁵⁸ Datasets available upon request.

```
ElSalvadorQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "ElSalvadorQ9",
rowNames = T)
ElSalvadorQ9Info.mat<-
as.matrix(ElSalvadorQ9Info)
CostaRicaQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "CostaRicaQ9",
rowNames = T)
CostaRicaQ9Info.mat<-
as.matrix(CostaRicaQ9Info)
GuatemalaQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "GuatemalaQ9",
rowNames = T)
GuatemalaQ9Info.mat<-
as.matrix(GuatemalaQ9Info)
PanamaQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "PanamaQ9", rowNames
= T)
PanamaQ9Info.mat<-
as.matrix(PanamaQ9Info)
HondurasQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "HondurasQ9",
rowNames = T)
HondurasQ9Info.mat<-
as.matrix(HondurasQ9Info)
MalawiQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "MalawiQ9", rowNames
= T)
MalawiQ9Info.mat<-
as.matrix(MalawiQ9Info)
EthiopiaQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "EthiopiaQ9", rowNames
= T)
EthiopiaQ9Info.mat<-
as.matrix(EthiopiaQ9Info)
GhanaQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "GhanaQ9", rowNames =
T)
GhanaQ9Info.mat<-
as.matrix(GhanaQ9Info)
```

```
AfghanistanQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "AfghanistanQ9",
rowNames = T)
AfghanistanQ9Info.mat<-
as.matrix(AfghanistanQ9Info)
UkraineQ9Info<-
read.xlsx("Matrices.Countries.Info.Exchan
ge.xlsx", sheet = "UkraineQ9", rowNames
= T)
UkraineQ9Info.mat<-
as.matrix(UkraineQ9Info)
```

```
##Individual matrices to network formats
ElSalvadorNetInfo<-
network(ElSalvadorQ9Info.mat,
matrix.type = "adjacency", directed = T)
CostaRicaNetInfo<-
network(CostaRicaQ9Info.mat,
matrix.type = "adjacency", directed = T)
GuatemalaNetInfo<-
network(GuatemalaQ9Info.mat,
matrix.type = "adjacency", directed = T)
PanamaNetInfo<-
network(PanamaQ9Info.mat, matrix.type =
"adjacency", directed = T)
HondurasNetInfo<-
network(HondurasQ9Info.mat, matrix.type
= "adjacency", directed = T)
MalawiNetInfo<-
network(MalawiQ9Info.mat, matrix.type =
"adjacency", directed = T)
GhanaNetInfo<-
network(GhanaQ9Info.mat, matrix.type =
"adjacency", directed = T)
EthiopiaNetInfo<-
network(EthiopiaQ9Info.mat, matrix.type
= "adjacency", directed = T)
AfghanistanNetInfo<-
network(AfghanistanQ9Info.mat,
matrix.type = "adjacency", directed = T)
UkraineNetInfo<-
network(UkraineQ9Info.mat, matrix.type
= "adjacency", directed = T)
```

```
##### Preparation of Individual
Networks to assemble the Technical &
Political Information Exchange Networks
#####
```

```
ElSalvador.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "El Salvador",
7]) #677
names(ElSalvador.Type.Info)<-
c("Type.Info")
CostaRica.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Costa Rica",
7])
names(CostaRica.Type.Info)<-
c("Type.Info")
Guatemala.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Guatemala",
7])
names(Guatemala.Type.Info)<-
c("Type.Info")
Panama.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Panama", 7])
names(Panama.Type.Info)<-
c("Type.Info")
Honduras.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Honduras",
7])
names(Honduras.Type.Info)<-
c("Type.Info")
Malawi.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Malawi", 7])
names(Malawi.Type.Info)<-c("Type.Info")
Ghana.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Ghana", 7])
names(Ghana.Type.Info)<-c("Type.Info")
Ethiopia.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Ethiopia", 7])
names(Ethiopia.Type.Info)<-
c("Type.Info")
Afghanistan.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry ==
"Afghanistan", 7])
names(Afghanistan.Type.Info)<-
c("Type.Info")
```

```
Ukraine.Type.Info <-
as.data.frame(AttributeData[AttributeData
$X8GeneralInfoCountry == "Ukraine", 7])
names(Ukraine.Type.Info)<-
c("Type.Info")
```

```
##### Preparation Individual
Networks for Technical Information
Exchange #####
## Classification of ties and filter by type
of information
drop <- c("Type.Info")
ElSalvador.Type.Info.Tech.Net<-
cbind(ElSalvadorQ9Info,
ElSalvador.Type.Info)
ElSalvador.Type.Info.Tech.Net[ElSalvado
r.Type.Info.Tech.Net$Type.Info ==
"Political", c(1:10)] <- 0
ElSalvador.Type.Info.Tech.Net<-
as.data.frame(ElSalvador.Type.Info.Tech.
Net[,!(names(ElSalvador.Type.Info.Tech.
Net) %in% drop)])
ElSalvador.Type.Info.Tech.Net<-
as.matrix(ElSalvador.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
ElSalvador.Type.Info.Tech.Net<-
as.network.matrix(ElSalvador.Type.Info.Te
ch.Net, matrix.type = "adjacency",
directed = T)
```

```
CostaRica.Type.Info.Tech.Net<-
cbind(CostaRicaQ9Info,
CostaRica.Type.Info)
CostaRica.Type.Info.Tech.Net[CostaRica.
Type.Info.Tech.Net$Type.Info ==
"Political", c(1:13)] <- 0
CostaRica.Type.Info.Tech.Net<-
as.data.frame(CostaRica.Type.Info.Tech.N
et[,!(names(CostaRica.Type.Info.Tech.Net
) %in% drop)])
CostaRica.Type.Info.Tech.Net<-
as.matrix(CostaRica.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
CostaRica.Type.Info.Tech.Net<-
as.network.matrix(CostaRica.Type.Info.Te
ch.Net, matrix.type = "adjacency", directed
= T)
```

```
Guatemala.Type.Info.Tech.Net<-
cbind(GuatemalaQ9Info,
Guatemala.Type.Info)
Guatemala.Type.Info.Tech.Net[Guatemala
.Type.Info.Tech.Net$Type.Info ==
"Political", c(1:13)] <- 0
Guatemala.Type.Info.Tech.Net<-
as.data.frame(Guatemala.Type.Info.Tech.
Net[,!(names(Guatemala.Type.Info.Tech.
Net) %in% drop)])
Guatemala.Type.Info.Tech.Net<-
as.matrix(Guatemala.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
Guatemala.Type.Info.Tech.Net<-
as.network.matrix(Guatemala.Type.Info.T
ech.Net, matrix.type = "adjacency",
directed = T)
```

```
Panama.Type.Info.Tech.Net<-
cbind(PanamaQ9Info, Panama.Type.Info)
Panama.Type.Info.Tech.Net[Panama.Type
.Info.Tech.Net$Type.Info == "Political",
c(1:12)] <- 0
Panama.Type.Info.Tech.Net<-
as.data.frame(Panama.Type.Info.Tech.Net[,
!(names(Panama.Type.Info.Tech.Net)
%in% drop)])
Panama.Type.Info.Tech.Net<-
as.matrix(Panama.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
Panama.Type.Info.Tech.Net<-
as.network.matrix(Panama.Type.Info.Tech
.Net, matrix.type = "adjacency", directed =
T)
```

```
Honduras.Type.Info.Tech.Net<-
cbind(HondurasQ9Info,
Honduras.Type.Info)
Honduras.Type.Info.Tech.Net[Honduras.T
ype.Info.Tech.Net$Type.Info ==
"Political", c(1:11)] <- 0
Honduras.Type.Info.Tech.Net<-
as.data.frame(Honduras.Type.Info.Tech.N
et[,!(names(Honduras.Type.Info.Tech.Net)
%in% drop)])
Honduras.Type.Info.Tech.Net<-
as.matrix(Honduras.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
```

```
Honduras.Type.Info.Tech.Net<-
as.network.matrix(Honduras.Type.Info.Te
ch.Net, matrix.type = "adjacency", directed
= T)
```

```
Malawi.Type.Info.Tech.Net<-
cbind(MalawiQ9Info, Malawi.Type.Info)
Malawi.Type.Info.Tech.Net[Malawi.Type.
Info.Tech.Net$Type.Info == "Political",
c(1:15)] <- 0
Malawi.Type.Info.Tech.Net<-
as.data.frame(Malawi.Type.Info.Tech.Net[,
!(names(Malawi.Type.Info.Tech.Net)
%in% drop)])
Malawi.Type.Info.Tech.Net<-
as.matrix(Malawi.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
Malawi.Type.Info.Tech.Net<-
as.network.matrix(Malawi.Type.Info.Tech.
Net, matrix.type = "adjacency", directed =
T)
```

```
Ghana.Type.Info.Tech.Net<-
cbind(GhanaQ9Info, Ghana.Type.Info)
Ghana.Type.Info.Tech.Net[Ghana.Type.In
fo.Tech.Net$Type.Info == "Political",
c(1:9)] <- 0
Ghana.Type.Info.Tech.Net<-
as.data.frame(Ghana.Type.Info.Tech.Net[,
!(names(Ghana.Type.Info.Tech.Net)
%in% drop)])
Ghana.Type.Info.Tech.Net<-
as.matrix(Ghana.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
Ghana.Type.Info.Tech.Net<-
as.network.matrix(Ghana.Type.Info.Tech.
Net, matrix.type = "adjacency", directed =
T)
```

```
Ethiopia.Type.Info.Tech.Net<-
cbind(EthiopiaQ9Info, Ethiopia.Type.Info)
Ethiopia.Type.Info.Tech.Net[Ethiopia.Typ
e.Info.Tech.Net$Type.Info == "Political",
c(1:10)] <- 0
Ethiopia.Type.Info.Tech.Net<-
as.data.frame(Ethiopia.Type.Info.Tech.Net
[,!(names(Ethiopia.Type.Info.Tech.Net)
%in% drop)])
```

```
Ethiopia.Type.Info.Tech.Net<-
as.matrix(Ethiopia.Type.Info.Tech.Net,
matrix.type = "adjacency", directed = T)
Ethiopia.Type.Info.Tech.Net<-
as.network.matrix(Ethiopia.Type.Info.Tech.Net, matrix.type = "adjacency", directed = T)
```

```
Afghanistan.Type.Info.Tech.Net<-
cbind(AfghanistanQ9Info,
Afghanistan.Type.Info)
Afghanistan.Type.Info.Tech.Net[Afghanistan.Type.Info.Tech.Net$Type.Info == "Political", c(1:12)] <- 0
Afghanistan.Type.Info.Tech.Net<-
as.data.frame(Afghanistan.Type.Info.Tech.Net[,!(names(Afghanistan.Type.Info.Tech.Net) %in% drop)])
Afghanistan.Type.Info.Tech.Net<-
as.matrix(Afghanistan.Type.Info.Tech.Net, matrix.type = "adjacency", directed = T)
Afghanistan.Type.Info.Tech.Net<-
as.network.matrix(Afghanistan.Type.Info.Tech.Net, matrix.type = "adjacency", directed = T)
```

```
Ukraine.Type.Info.Tech.Net<-
cbind(UkraineQ9Info, Ukraine.Type.Info)
Ukraine.Type.Info.Tech.Net[Ukraine.Type.Info.Tech.Net$Type.Info == "Political", c(1:11)] <- 0
Ukraine.Type.Info.Tech.Net<-
as.data.frame(Ukraine.Type.Info.Tech.Net[,!(names(Ukraine.Type.Info.Tech.Net) %in% drop)])
Ukraine.Type.Info.Tech.Net<-
as.matrix(Ukraine.Type.Info.Tech.Net, matrix.type = "adjacency", directed = T)
Ukraine.Type.Info.Tech.Net<-
as.network.matrix(Ukraine.Type.Info.Tech.Net, matrix.type = "adjacency", directed = T)
```

Preparation Individual
Networks for Political Information
Exchange #####

```
ElSalvador.Type.Info.Pol.Net<-
cbind(ElSalvadorQ9Info,
ElSalvador.Type.Info)
```

```
ElSalvador.Type.Info.Pol.Net[ElSalvador.Type.Info.Pol.Net$Type.Info == "Technical", c(1:10)] <- 0
ElSalvador.Type.Info.Pol.Net<-
as.data.frame(ElSalvador.Type.Info.Pol.Net[,!(names(ElSalvador.Type.Info.Pol.Net) %in% drop)])
ElSalvador.Type.Info.Pol.Net<-
as.matrix(ElSalvador.Type.Info.Pol.Net, matrix.type = "adjacency", directed = T)
ElSalvador.Type.Info.Pol.Net<-
as.network.matrix(ElSalvador.Type.Info.Pol.Net, matrix.type = "adjacency", directed = T)
```

```
CostaRica.Type.Info.Pol.Net<-
cbind(CostaRicaQ9Info,
CostaRica.Type.Info)
CostaRica.Type.Info.Pol.Net[CostaRica.Type.Info.Pol.Net$Type.Info == "Technical", c(1:13)] <- 0
CostaRica.Type.Info.Pol.Net<-
as.data.frame(CostaRica.Type.Info.Pol.Net[,!(names(CostaRica.Type.Info.Pol.Net) %in% drop)])
CostaRica.Type.Info.Pol.Net<-
as.matrix(CostaRica.Type.Info.Pol.Net, matrix.type = "adjacency", directed = T)
CostaRica.Type.Info.Pol.Net<-
as.network.matrix(CostaRica.Type.Info.Pol.Net, matrix.type = "adjacency", directed = T)
```

```
Guatemala.Type.Info.Pol.Net<-
cbind(GuatemalaQ9Info,
Guatemala.Type.Info)
Guatemala.Type.Info.Pol.Net[Guatemala.Type.Info.Pol.Net$Type.Info == "Technical", c(1:13)] <- 0
Guatemala.Type.Info.Pol.Net<-
as.data.frame(Guatemala.Type.Info.Pol.Net[,!(names(Guatemala.Type.Info.Pol.Net) %in% drop)])
Guatemala.Type.Info.Pol.Net<-
as.matrix(Guatemala.Type.Info.Pol.Net, matrix.type = "adjacency", directed = T)
Guatemala.Type.Info.Pol.Net<-
as.network.matrix(Guatemala.Type.Info.Pol.Net, matrix.type = "adjacency", directed = T)
```

```
ol.Net, matrix.type = "adjacency", directed = T)
```

```
Panama.Type.Info.Pol.Net<-
cbind(PanamaQ9Info, Panama.Type.Info)
Panama.Type.Info.Pol.Net[Panama.Type.I
nfo.Pol.Net$Type.Info == "Technical",
c(1:12)] <- 0
Panama.Type.Info.Pol.Net<-
as.data.frame(Panama.Type.Info.Pol.Net[,!
(names(Panama.Type.Info.Pol.Net) %in%
drop)])
Panama.Type.Info.Pol.Net<-
as.matrix(Panama.Type.Info.Pol.Net,
matrix.type = "adjacency", directed = T)
Panama.Type.Info.Pol.Net<-
as.network.matrix(Panama.Type.Info.Pol.
Net, matrix.type = "adjacency", directed =
T)
```

```
Honduras.Type.Info.Pol.Net<-
cbind(HondurasQ9Info,
Honduras.Type.Info)
Honduras.Type.Info.Pol.Net[Honduras.Ty
pe.Info.Pol.Net$Type.Info == "Technical",
c(1:11)] <- 0
Honduras.Type.Info.Pol.Net<-
as.data.frame(Honduras.Type.Info.Pol.Net
[,!(names(Honduras.Type.Info.Pol.Net)
%in% drop)])
Honduras.Type.Info.Pol.Net<-
as.matrix(Honduras.Type.Info.Pol.Net,
matrix.type = "adjacency", directed = T)
Honduras.Type.Info.Pol.Net<-
as.network.matrix(Honduras.Type.Info.Pol
.Net, matrix.type = "adjacency", directed =
T)
```

```
Malawi.Type.Info.Pol.Net<-
cbind(MalawiQ9Info, Malawi.Type.Info)
Malawi.Type.Info.Pol.Net[Malawi.Type.In
fo.Pol.Net$Type.Info == "Technical",
c(1:15)] <- 0
Malawi.Type.Info.Pol.Net<-
as.data.frame(Malawi.Type.Info.Pol.Net[,!
(names(Malawi.Type.Info.Pol.Net) %in%
drop)])
```

```
Malawi.Type.Info.Pol.Net<-
as.matrix(Malawi.Type.Info.Pol.Net,
matrix.type = "adjacency", directed = T)
Malawi.Type.Info.Pol.Net<-
as.network.matrix(Malawi.Type.Info.Pol.
Net, matrix.type = "adjacency", directed =
T)
```

```
Ghana.Type.Info.Pol.Net<-
cbind(GhanaQ9Info, Ghana.Type.Info)
Ghana.Type.Info.Pol.Net[Ghana.Type.Info
.Pol.Net$Type.Info == "Technical",
c(1:9)] <- 0
Ghana.Type.Info.Pol.Net<-
as.data.frame(Ghana.Type.Info.Pol.Net[,!(
names(Ghana.Type.Info.Pol.Net) %in%
drop)])
Ghana.Type.Info.Pol.Net<-
as.matrix(Ghana.Type.Info.Pol.Net,
matrix.type = "adjacency", directed = T)
Ghana.Type.Info.Pol.Net<-
as.network.matrix(Ghana.Type.Info.Pol.N
et, matrix.type = "adjacency", directed =
T)
```

```
Ethiopia.Type.Info.Pol.Net<-
cbind(EthiopiaQ9Info, Ethiopia.Type.Info)
Ethiopia.Type.Info.Pol.Net[Ethiopia.Type.
Info.Pol.Net$Type.Info == "Technical",
c(1:10)] <- 0
Ethiopia.Type.Info.Pol.Net<-
as.data.frame(Ethiopia.Type.Info.Pol.Net[,
!(names(Ethiopia.Type.Info.Pol.Net)
%in% drop)])
Ethiopia.Type.Info.Pol.Net<-
as.matrix(Ethiopia.Type.Info.Pol.Net,
matrix.type = "adjacency", directed = T)
Ethiopia.Type.Info.Pol.Net<-
as.network.matrix(Ethiopia.Type.Info.Pol.
Net, matrix.type = "adjacency", directed =
T)
```

```
Afghanistan.Type.Info.Pol.Net<-
cbind(AfghanistanQ9Info,
Afghanistan.Type.Info)
Afghanistan.Type.Info.Pol.Net[Afghanista
n.Type.Info.Pol.Net$Type.Info ==
"Technical", c(1:12)] <- 0
```

```
Afghanistan.Type.Info.Pol.Net<-
as.data.frame(Afghanistan.Type.Info.Pol.N
et[,!(names(Afghanistan.Type.Info.Pol.Net
) %in% drop)])
Afghanistan.Type.Info.Pol.Net<-
as.matrix(Afghanistan.Type.Info.Pol.Net,
matrix.type = "adjacency", directed = T)
Afghanistan.Type.Info.Pol.Net<-
as.network.matrix(Afghanistan.Type.Info.
Pol.Net, matrix.type = "adjacency",
directed = T)
```

```
Ukraine.Type.Info.Pol.Net<-
cbind(UkraineQ9Info, Ukraine.Type.Info)
Ukraine.Type.Info.Pol.Net[Ukraine.Type.I
nfo.Pol.Net$Type.Info == "Technical",
c(1:11)] <- 0
Ukraine.Type.Info.Pol.Net<-
as.data.frame(Ukraine.Type.Info.Pol.Net[,!
(names(Ukraine.Type.Info.Pol.Net) %in%
drop)])
Ukraine.Type.Info.Pol.Net<-
as.matrix(Ukraine.Type.Info.Pol.Net,
matrix.type = "adjacency", directed = T)
Ukraine.Type.Info.Pol.Net<-
as.network.matrix(Ukraine.Type.Info.Pol.
Net, matrix.type = "adjacency", directed =
T)
```

```
##### Attributes
#Attributes for General, Technical &
Political Information Exchange Networks
#Sector / Categorical
ElSalvadorNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 2])
CostaRicaNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 2])
GuatemalaNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 2])
PanamaNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 2])
HondurasNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 2])
```

```
MalawiNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 2])
GhanaNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 2])
EthiopiaNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 2])
AfghanistanNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 2])
UkraineNetInfo %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 2])
ElSalvador.Type.Info.Pol.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 2])
CostaRica.Type.Info.Pol.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 2])
Guatemala.Type.Info.Pol.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 2])
Panama.Type.Info.Pol.Net %v% "Sector"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 2])
Honduras.Type.Info.Pol.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 2])
Malawi.Type.Info.Pol.Net %v% "Sector"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 2])
Ghana.Type.Info.Pol.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 2])
Ethiopia.Type.Info.Pol.Net %v% "Sector"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 2])
Afghanistan.Type.Info.Pol.Net %v%
"Sector" <-
```

```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 2])
Ukraine.Type.Info.Pol.Net %v% "Sector"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 2])
ElSalvador.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 2])
CostaRica.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 2])
Guatemala.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 2])
Panama.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 2])
Honduras.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 2])
Malawi.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 2])
Ghana.Type.Info.Tech.Net %v% "Sector"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 2])
Ethiopia.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 2])
Afghanistan.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 2])
Ukraine.Type.Info.Tech.Net %v%
"Sector" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 2])
get.vertex.attribute(Honduras.Type.Info.Po
l.Net, "Sector")
```

```
#Meetings / Continuous
ElSalvadorNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 4])
CostaRicaNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 4])
GuatemalaNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 4])
PanamaNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 4])
HondurasNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 4])
MalawiNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 4])
GhanaNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 4])
EthiopiaNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 4])
AfghanistanNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 4])
UkraineNetInfo %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 4])
ElSalvador.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 4])
CostaRica.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 4])
Guatemala.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 4])
Panama.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 4])
Honduras.Type.Info.Pol.Net %v%
"Meetings" <-
```



```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 4])
Malawi.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 4])
Ghana.Type.Info.Pol.Net %v% "Meetings"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 4])
Ethiopia.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 4])
Afghanistan.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 4])
Ukraine.Type.Info.Pol.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 4])
ElSalvador.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 4])
CostaRica.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 4])
Guatemala.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 4])
Panama.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 4])
Honduras.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 4])
Malawi.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 4])
Ghana.Type.Info.Tech.Net %v%
"Meetings" <-
```

```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 4])
Ethiopia.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 4])
Afghanistan.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 4])
Ukraine.Type.Info.Tech.Net %v%
"Meetings" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 4])
get.vertex.attribute(AfghanistanNetInfo,
"Meetings")
```

```
#Years / Continuous
ElSalvadorNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 5])
CostaRicaNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 5])
GuatemalaNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 5])
PanamaNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 5])
HondurasNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 5])
MalawiNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 5])
GhanaNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 5])
EthiopiaNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 5])
AfghanistanNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 5])
UkraineNetInfo %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 5])
```

```
ElSalvador.Type.Info.Pol.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 5])
CostaRica.Type.Info.Pol.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 5])
Guatemala.Type.Info.Pol.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 5])
Panama.Type.Info.Pol.Net %v% "Years"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 5])
Honduras.Type.Info.Pol.Net %v% "Years"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 5])
Malawi.Type.Info.Pol.Net %v% "Years"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 5])
Ghana.Type.Info.Pol.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 5])
Ethiopia.Type.Info.Pol.Net %v% "Years"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 5])
Afghanistan.Type.Info.Pol.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 5])
Ukraine.Type.Info.Pol.Net %v% "Years"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 5])
ElSalvador.Type.Info.Tech.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 5])
CostaRica.Type.Info.Tech.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 5])
Guatemala.Type.Info.Tech.Net %v%
"Years" <-
```

```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 5])
Panama.Type.Info.Tech.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 5])
Honduras.Type.Info.Tech.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 5])
Malawi.Type.Info.Tech.Net %v% "Years"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 5])
Ghana.Type.Info.Tech.Net %v% "Years"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 5])
Ethiopia.Type.Info.Tech.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 5])
Afghanistan.Type.Info.Tech.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 5])
Ukraine.Type.Info.Tech.Net %v%
"Years" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 5])
get.vertex.attribute(AfghanistanNetInfo,
"Years")
```

```
#Influence nominations / Continuous
ElSalvadorNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 6])
CostaRicaNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 6])
GuatemalaNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 6])
PanamaNetInfo %v%
"Influence.Indeg.Ave" <-
```

```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 6])
HondurasNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 6])
MalawiNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 6])
GhanaNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 6])
EthiopiaNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 6])
AfghanistanNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 6])
UkraineNetInfo %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 6])
ElSalvador.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 6])
CostaRica.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 6])
Guatemala.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 6])
Panama.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 6])
Honduras.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 6])
Malawi.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
```

```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 6])
Ghana.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 6])
Ethiopia.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 6])
Afghanistan.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 6])
Ukraine.Type.Info.Pol.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 6])
ElSalvador.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador", 6])
CostaRica.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 6])
Guatemala.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 6])
Panama.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 6])
Honduras.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 6])
Malawi.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 6])
Ghana.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 6])
Ethiopia.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
```

```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 6])
Afghanistan.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan", 6])
Ukraine.Type.Info.Tech.Net %v%
"Influence.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 6])
get.vertex.attribute(AfghanistanNetInfo,
"Influence.Indeg.Ave")
```

```
#Preference similarity: pro-social / self-
interest (as node attributes, continuous)
#self-interest motivations
ElSalvadorNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador",
14])
CostaRicaNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 14])
GuatemalaNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 14])
PanamaNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 14])
HondurasNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 14])
MalawiNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 14])
GhanaNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 14])
EthiopiaNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 14])
AfghanistanNetInfo %v% "Self.Interest"
<-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan",
14])
UkraineNetInfo %v% "Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 14])
```

```
ElSalvador.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador",
14])
CostaRica.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 14])
Guatemala.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 14])
Panama.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 14])
Honduras.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 14])
Malawi.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 14])
Ghana.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 14])
Ethiopia.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 14])
Afghanistan.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan",
14])
Ukraine.Type.Info.Pol.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 14])
ElSalvador.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador",
14])
CostaRica.Type.Info.Tech.Net %v%
"Self.Interest" <-
```

```
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 14])
Guatemala.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 14])
Panama.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 14])
Honduras.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 14])
Malawi.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 14])
Ghana.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 14])
Ethiopia.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 14])
Afghanistan.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan",
14])
Ukraine.Type.Info.Tech.Net %v%
"Self.Interest" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 14])
get.vertex.attribute(AfghanistanNetInfo,
"Self.Interest")
#pro-social motivations
ElSalvadorNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador",
15])
CostaRicaNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 15])
GuatemalaNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 15])
```

```
PanamaNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 15])
HondurasNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 15])
MalawiNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 15])
GhanaNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 15])
EthiopiaNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 15])
AfghanistanNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan",
15])
UkraineNetInfo %v% "Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 15])
ElSalvador.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador",
15])
CostaRica.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 15])
Guatemala.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 15])
Panama.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 15])
Honduras.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 15])
Malawi.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 15])
Ghana.Type.Info.Pol.Net %v%
"Pro.Social" <-
```

```

as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 15])
Ethiopia.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 15])
Afghanistan.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan",
15])
Ukraine.Type.Info.Pol.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 15])
ElSalvador.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "El Salvador",
15])
CostaRica.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Costa Rica", 15])
Guatemala.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Guatemala", 15])
Panama.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Panama", 15])
Honduras.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Honduras", 15])
Malawi.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Malawi", 15])
Ghana.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ghana", 15])
Ethiopia.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ethiopia", 15])

```

```

Afghanistan.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Afghanistan",
15])
Ukraine.Type.Info.Tech.Net %v%
"Pro.Social" <-
as.vector(AttributeData[AttributeData$X8
GeneralInfoCountry == "Ukraine", 15])
get.vertex.attribute(Ethiopia.Type.Info.Tec
h.Net, "Pro.Social")

```

```

#Institutional venues (preparation of
networks for every country square co-
occurrence matrix)
ElSalvador.Committee.Attendance.Occ.VF
.Ave<-
AttributeData[AttributeData$X8GeneralIn
foCountry == "El Salvador", c(8:13)]
rownames(ElSalvador.Committee.Attenda
nce.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralIn
foCountry == "El Salvador", c(3)]
ElSalvador.Committee.Attendance.Occ.VF
.Ave<-
as.data.frame(t(ElSalvador.Committee.Att
endance.Occ.VF.Ave))
ElSalvador.Committee.Attendance.Occ.VF
.Ave<-
crossprod(as.matrix(ElSalvador.Committe
e.Attendance.Occ.VF.Ave),as.matrix(ElSal
vador.Committee.Attendance.Occ.VF.Ave
))
diag(ElSalvador.Committee.Attendance.O
cc.VF.Ave)<-0
ElSalvador.Committee.Attendance.Occ.VF
.Ave.Net<-
network(ElSalvador.Committee.Attendanc
e.Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval =
FALSE, names.eval =
"Committee.Co.Attendance", matrix.type
="adjacency")
ElSalvadorNetInfo<-
set.edge.value(ElSalvadorNetInfo,"Commi
tee.Co.Attendance",ElSalvador.Committe
e.Attendance.Occ.VF.Ave)
ElSalvador.Committee.Attendance.Occ.VF
.Ave.Net2<-

```

```
as.matrix(ElSalvadorNetInfo,attrname="Committee.Co.Attendance")
get.edge.attribute(ElSalvadorNetInfo, "Committee.Co.Attendance")
ElSalvador.Type.Info.Pol.Net<-
set.edge.value(ElSalvador.Type.Info.Pol.Net, "Committee.Co.Attendance", ElSalvador.Committee.Attendance.Occ.VF.Ave)
as.matrix(ElSalvador.Type.Info.Pol.Net, attrname="Committee.Co.Attendance")
ElSalvador.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(ElSalvador.Type.Info.Pol.Net, attrname="Committee.Co.Attendance")
ElSalvador.Type.Info.Tech.Net<-
set.edge.value(ElSalvador.Type.Info.Tech.Net, "Committees.Occ.VFreq.Ave", ElSalvador.Committee.Attendance.Occ.VF.Ave)
as.matrix(ElSalvador.Type.Info.Tech.Net, attrname="Committees.Occ.VFreq.Ave")
#fit edgecov with information network
ElSalvador.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(ElSalvador.Type.Info.Tech.Net, attrname="Committees.Occ.VFreq.Ave")

CostaRica.Committee.Attendance.Occ.VF.Ave<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Costa Rica", c(8:13)]
rownames(CostaRica.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Costa Rica", c(3)]
CostaRica.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(CostaRica.Committee.Attendance.Occ.VF.Ave))
CostaRica.Committee.Attendance.Occ.VF.Ave<-
crossprod(as.matrix(CostaRica.Committee.Attendance.Occ.VF.Ave), as.matrix(CostaRica.Committee.Attendance.Occ.VF.Ave))
diag(CostaRica.Committee.Attendance.Occ.VF.Ave)<-0
CostaRica.Committee.Attendance.Occ.VF.Ave.Net<-
network(CostaRica.Committee.Attendance.Occ.VF.Ave, directed=FALSE,
```

```
vertex.attrnames = TRUE, ignore.eval = FALSE, names.eval =
"Committee.Co.Attendance", matrix.type = "adjacency")
CostaRicaNetInfo<-
set.edge.value(CostaRicaNetInfo, "Committee.Co.Attendance", CostaRica.Committee.Attendance.Occ.VF.Ave)
CostaRica.Committee.Attendance.Occ.VF.Ave.Net2<-
as.matrix(CostaRicaNetInfo, attrname="Committee.Co.Attendance")
get.edge.attribute(CostaRicaNetInfo, "Committee.Co.Attendance")
CostaRica.Type.Info.Pol.Net<-
set.edge.value(CostaRica.Type.Info.Pol.Net, "Committee.Co.Attendance", CostaRica.Committee.Attendance.Occ.VF.Ave)
as.matrix(CostaRica.Type.Info.Pol.Net, attrname="Committee.Co.Attendance")
CostaRica.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(CostaRica.Type.Info.Pol.Net, attrname="Committee.Co.Attendance")
CostaRica.Type.Info.Tech.Net<-
set.edge.value(CostaRica.Type.Info.Tech.Net, "Committees.Occ.VFreq.Ave", CostaRica.Committee.Attendance.Occ.VF.Ave)
as.matrix(CostaRica.Type.Info.Tech.Net, attrname="Committees.Occ.VFreq.Ave")
CostaRica.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(CostaRica.Type.Info.Tech.Net, attrname="Committees.Occ.VFreq.Ave")

Guatemala.Committee.Attendance.Occ.VF.Ave<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Guatemala", c(8:13)]
rownames(Guatemala.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Guatemala", c(3)]
Guatemala.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(Guatemala.Committee.Attendance.Occ.VF.Ave))
Guatemala.Committee.Attendance.Occ.VF.Ave<-
```

```

crossprod(as.matrix(Guatemala.Committee
.Attendance.Occ.VF.Ave),as.matrix(Guate
mala.Committee.Attendance.Occ.VF.Ave)
)
diag(Guatemala.Committee.Attendance.Oc
c.VF.Ave)<-0
Guatemala.Committee.Attendance.Occ.VF
.Ave.Net<-
network(Guatemala.Committee.Attendanc
e.Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval =
FALSE, names.eval =
"Committee.Co.Attendance", matrix.type
= "adjacency")
GuatemalaNetInfo<-
set.edge.value(GuatemalaNetInfo,"Commi
tee.Co.Attendance",Guatemala.Committe
e.Attendance.Occ.VF.Ave)
Guatemala.Committee.Attendance.Occ.VF
.Ave.Net2<-
as.matrix(GuatemalaNetInfo,attrname="C
ommittee.Co.Attendance")
get.edge.attribute(GuatemalaNetInfo,
"Committee.Co.Attendance")
Guatemala.Type.Info.Pol.Net<-
set.edge.value(Guatemala.Type.Info.Pol.N
et,"Committee.Co.Attendance",Guatemala.
Committee.Attendance.Occ.VF.Ave)
as.matrix(Guatemala.Type.Info.Pol.Net,att
rname="Committee.Co.Attendance")
Guatemala.Committee.Attendance.Occ.VF
.Ave.Pol.Net2<-
as.matrix(Guatemala.Type.Info.Pol.Net,att
rname="Committee.Co.Attendance")
Guatemala.Type.Info.Tech.Net<-
set.edge.value(Guatemala.Type.Info.Tech.
Net,"Committees.Occ.VFreq.Ave",Guate
mala.Committee.Attendance.Occ.VF.Ave)
as.matrix(Guatemala.Type.Info.Tech.Net,a
ttrname="Committees.Occ.VFreq.Ave")
Guatemala.Committee.Attendance.Occ.VF
.Ave.Tech.Net2<-
as.matrix(Guatemala.Type.Info.Tech.Net,a
ttrname="Committees.Occ.VFreq.Ave")

Honduras.Committee.Attendance.Occ.VF.
Ave<-
AttributeData[AttributeData$X8GeneralIn
foCountry == "Honduras", c(8:13)]

```

```

rownames(Honduras.Committee.Attendan
ce.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralIn
foCountry == "Honduras", c(3)]
Honduras.Committee.Attendance.Occ.VF.
Ave<-
as.data.frame(t(Honduras.Committee.Atten
dance.Occ.VF.Ave))
Honduras.Committee.Attendance.Occ.VF.
Ave<-
crossprod(as.matrix(Honduras.Committee.
Attendance.Occ.VF.Ave),as.matrix(Hondu
ras.Committee.Attendance.Occ.VF.Ave))
diag(Honduras.Committee.Attendance.Occ
.VF.Ave)<-0
Honduras.Committee.Attendance.Occ.VF.
Ave.Net<-
network(Honduras.Committee.Attendance.
Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval =
FALSE, names.eval =
"Committee.Co.Attendance", matrix.type
= "adjacency")
HondurasNetInfo<-
set.edge.value(HondurasNetInfo,"Committ
ee.Co.Attendance",Honduras.Committee.A
ttendance.Occ.VF.Ave)
Honduras.Committee.Attendance.Occ.VF.
Ave.Net2<-
as.matrix(HondurasNetInfo,attrname="Co
mmittee.Co.Attendance")
get.edge.attribute(HondurasNetInfo,
"Committee.Co.Attendance")
Honduras.Type.Info.Pol.Net<-
set.edge.value(Honduras.Type.Info.Pol.Ne
t,"Committee.Co.Attendance",Honduras.C
ommittee.Attendance.Occ.VF.Ave)
as.matrix(Honduras.Type.Info.Pol.Net,attr
name="Committee.Co.Attendance")
Honduras.Committee.Attendance.Occ.VF.
Ave.Pol.Net2<-
as.matrix(Honduras.Type.Info.Pol.Net,attr
name="Committee.Co.Attendance")
Honduras.Type.Info.Tech.Net<-
set.edge.value(Honduras.Type.Info.Tech.N
et,"Committees.Occ.VFreq.Ave",Hondura
s.Committee.Attendance.Occ.VF.Ave)
as.matrix(Honduras.Type.Info.Tech.Net,att
rname="Committees.Occ.VFreq.Ave")

```



```
Honduras.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(Honduras.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")
```

```
Panama.Committee.Attendance.Occ.VF.Ave<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Panama", c(8:13)]
rownames(Panama.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Panama", c(3)]
Panama.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(Panama.Committee.Attendance.Occ.VF.Ave))
Panama.Committee.Attendance.Occ.VF.Ave<-
crossprod(as.matrix(Panama.Committee.Attendance.Occ.VF.Ave),as.matrix(Panama.Committee.Attendance.Occ.VF.Ave))
diag(Panama.Committee.Attendance.Occ.VF.Ave)<-0
Panama.Committee.Attendance.Occ.VF.Ave.Net<-
network(Panama.Committee.Attendance.Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval = FALSE, names.eval =
"Committee.Co.Attendance", matrix.type = "adjacency")
PanamaNetInfo<-
set.edge.value(PanamaNetInfo,"Committee.Co.Attendance",Panama.Committee.Attendance.Occ.VF.Ave)
Panama.Committee.Attendance.Occ.VF.Ave.Net2<-
as.matrix(PanamaNetInfo,attrname="Committee.Co.Attendance")
get.edge.attribute(PanamaNetInfo,"Committee.Co.Attendance")
Panama.Type.Info.Pol.Net<-
set.edge.value(Panama.Type.Info.Pol.Net,"Committee.Co.Attendance",Panama.Committee.Attendance.Occ.VF.Ave)
as.matrix(Panama.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
```

```
Panama.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(Panama.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Panama.Type.Info.Tech.Net<-
set.edge.value(Panama.Type.Info.Tech.Net,"Committees.Occ.VFreq.Ave",Panama.Committee.Attendance.Occ.VF.Ave)
as.matrix(Panama.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")
Panama.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(Panama.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")
```

```
Malawi.Committee.Attendance.Occ.VF.Ave<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Malawi", c(8:13)]
rownames(Malawi.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Malawi", c(3)]
Malawi.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(Malawi.Committee.Attendance.Occ.VF.Ave))
Malawi.Committee.Attendance.Occ.VF.Ave<-
crossprod(as.matrix(Malawi.Committee.Attendance.Occ.VF.Ave),as.matrix(Malawi.Committee.Attendance.Occ.VF.Ave))
diag(Malawi.Committee.Attendance.Occ.VF.Ave)<-0
Malawi.Committee.Attendance.Occ.VF.Ave.Net<-
network(Malawi.Committee.Attendance.Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval = FALSE, names.eval =
"Committee.Co.Attendance", matrix.type = "adjacency")
MalawiNetInfo<-
set.edge.value(MalawiNetInfo,"Committee.Co.Attendance",Malawi.Committee.Attendance.Occ.VF.Ave)
Malawi.Committee.Attendance.Occ.VF.Ave.Net2<-
```

```
as.matrix(MalawiNetInfo,attrname="Committee.Co.Attendance")
get.edge.attribute(MalawiNetInfo,
"Committee.Co.Attendance")
get.vertex.attribute(MalawiNetInfo,
"vertex.names")
Malawi.Type.Info.Pol.Net<-
set.edge.value(Malawi.Type.Info.Pol.Net,
"Committee.Co.Attendance",Malawi.Committee.Attendance.Occ.VF.Ave)
as.matrix(Malawi.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Malawi.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(Malawi.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Malawi.Type.Info.Tech.Net<-
set.edge.value(Malawi.Type.Info.Tech.Net,
"Committees.Occ.VFreq.Ave",Malawi.Committee.Attendance.Occ.VF.Ave)
as.matrix(Malawi.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")
Malawi.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(Malawi.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")

Ethiopia.Committee.Attendance.Occ.VF.Ave<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Ethiopia", c(8:13)]
rownames(Ethiopia.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Ethiopia", c(3)]
Ethiopia.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(Ethiopia.Committee.Attendance.Occ.VF.Ave))
Ethiopia.Committee.Attendance.Occ.VF.Ave<-
crossprod(as.matrix(Ethiopia.Committee.Attendance.Occ.VF.Ave),as.matrix(Ethiopia.Committee.Attendance.Occ.VF.Ave))
diag(Ethiopia.Committee.Attendance.Occ.VF.Ave)<-0
Ethiopia.Committee.Attendance.Occ.VF.Ave.Net<-
network(Ethiopia.Committee.Attendance.
```

```
Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval = FALSE, names.eval =
"Committee.Co.Attendance", matrix.type = "adjacency")
EthiopiaNetInfo<-
set.edge.value(EthiopiaNetInfo,"Committee.Co.Attendance",Ethiopia.Committee.Attendance.Occ.VF.Ave)
Ethiopia.Committee.Attendance.Occ.VF.Ave.Net2<-
as.matrix(EthiopiaNetInfo,attrname="Committee.Co.Attendance")
get.edge.attribute(EthiopiaNetInfo,
"Committee.Co.Attendance")
Ethiopia.Type.Info.Pol.Net<-
set.edge.value(Ethiopia.Type.Info.Pol.Net,
"Committee.Co.Attendance",Ethiopia.Committee.Attendance.Occ.VF.Ave)
as.matrix(Ethiopia.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Ethiopia.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(Ethiopia.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Ethiopia.Type.Info.Tech.Net<-
set.edge.value(Ethiopia.Type.Info.Tech.Net,
"Committees.Occ.VFreq.Ave",Ethiopia.Committee.Attendance.Occ.VF.Ave)
as.matrix(Ethiopia.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")
Ethiopia.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(Ethiopia.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")

Ghana.Committee.Attendance.Occ.VF.Ave<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Ghana", c(8:13)]
rownames(Ghana.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Ghana", c(3)]
Ghana.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(Ghana.Committee.Attendance.Occ.VF.Ave))
```

```
Ghana.Committee.Attendance.Occ.VF.Ave<-
crossprod(as.matrix(Ghana.Committee.Attendance.Occ.VF.Ave),as.matrix(Ghana.Committee.Attendance.Occ.VF.Ave))
diag(Ghana.Committee.Attendance.Occ.VF.Ave)<-0
Ghana.Committee.Attendance.Occ.VF.Ave.Net<-
network(Ghana.Committee.Attendance.Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval = FALSE, names.eval =
"Committee.Co.Attendance", matrix.type = "adjacency")
GhanaNetInfo<-
set.edge.value(GhanaNetInfo,"Committee.Co.Attendance",Ghana.Committee.Attendance.Occ.VF.Ave)
Ghana.Committee.Attendance.Occ.VF.Ave.Net2<-
as.matrix(GhanaNetInfo,attrname="Committee.Co.Attendance")
get.edge.attribute(GhanaNetInfo,
"Committee.Co.Attendance")
Ghana.Type.Info.Pol.Net<-
set.edge.value(Ghana.Type.Info.Pol.Net,"Committee.Co.Attendance",Ghana.Committee.Attendance.Occ.VF.Ave)
as.matrix(Ghana.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Ghana.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(Ghana.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Ghana.Type.Info.Tech.Net<-
set.edge.value(Ghana.Type.Info.Tech.Net,"Committees.Occ.VFreq.Ave",Ghana.Committee.Attendance.Occ.VF.Ave)
as.matrix(Ghana.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")
Ghana.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(Ghana.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")

Afghanistan.Committee.Attendance.Occ.VF.Ave<-
```

```
AttributeData[AttributeData$X8GeneralInfoCountry == "Afghanistan", c(8:13)]
rownames(Afghanistan.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Afghanistan", c(3)]
Afghanistan.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(Afghanistan.Committee.Attendance.Occ.VF.Ave))
Afghanistan.Committee.Attendance.Occ.VF.Ave<-
crossprod(as.matrix(Afghanistan.Committee.Attendance.Occ.VF.Ave),as.matrix(Afghanistan.Committee.Attendance.Occ.VF.Ave))
diag(Afghanistan.Committee.Attendance.Occ.VF.Ave)<-0
Afghanistan.Committee.Attendance.Occ.VF.Ave.Net<-
network(Afghanistan.Committee.Attendance.Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval = FALSE, names.eval =
"Committee.Co.Attendance", matrix.type = "adjacency")
AfghanistanNetInfo<-
set.edge.value(AfghanistanNetInfo,"Committee.Co.Attendance",Afghanistan.Committee.Attendance.Occ.VF.Ave)
Afghanistan.Committee.Attendance.Occ.VF.Ave.Net2<-
as.matrix(AfghanistanNetInfo,attrname="Committee.Co.Attendance")
get.edge.attribute(AfghanistanNetInfo,
"Committee.Co.Attendance")
Afghanistan.Type.Info.Pol.Net<-
set.edge.value(Afghanistan.Type.Info.Pol.Net,"Committee.Co.Attendance",Afghanistan.Committee.Attendance.Occ.VF.Ave)
as.matrix(Afghanistan.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Afghanistan.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(Afghanistan.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Afghanistan.Type.Info.Tech.Net<-
set.edge.value(Afghanistan.Type.Info.Tech.Net,"Committees.Occ.VFreq.Ave",Afgh
```

```

anistan.Committee.Attendance.Occ.VF.Ave)
as.matrix(Afghanistan.Type.Info.Tech.Net,
attrname="Committees.Occ.VFreq.Ave")
Afghanistan.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(Afghanistan.Type.Info.Tech.Net,
attrname="Committees.Occ.VFreq.Ave")

Ukraine.Committee.Attendance.Occ.VF.Ave<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Ukraine", c(8:13)]
rownames(Ukraine.Committee.Attendance.Occ.VF.Ave)<-
AttributeData[AttributeData$X8GeneralInfoCountry == "Ukraine", c(3)]
Ukraine.Committee.Attendance.Occ.VF.Ave<-
as.data.frame(t(Ukraine.Committee.Attendance.Occ.VF.Ave))
Ukraine.Committee.Attendance.Occ.VF.Ave<-
crossprod(as.matrix(Ukraine.Committee.Attendance.Occ.VF.Ave),as.matrix(Ukraine.Committee.Attendance.Occ.VF.Ave))
diag(Ukraine.Committee.Attendance.Occ.VF.Ave)<-0
Ukraine.Committee.Attendance.Occ.VF.Ave.Net<-
network(Ukraine.Committee.Attendance.Occ.VF.Ave, directed=FALSE,
vertex.attrnames = TRUE, ignore.eval = FALSE, names.eval =
"Committee.Co.Attendance", matrix.type = "adjacency")
UkraineNetInfo<-
set.edge.value(UkraineNetInfo,"Committee.Co.Attendance",Ukraine.Committee.Attendance.Occ.VF.Ave)
Ukraine.Committee.Attendance.Occ.VF.Ave.Net2<-
as.matrix(UkraineNetInfo,attrname="Committee.Co.Attendance")
get.edge.attribute(UkraineNetInfo,
"Committee.Co.Attendance")
Ukraine.Type.Info.Pol.Net<-
set.edge.value(Ukraine.Type.Info.Pol.Net,

```

```

"Committee.Co.Attendance",Ukraine.Committee.Attendance.Occ.VF.Ave)
as.matrix(Ukraine.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Ukraine.Committee.Attendance.Occ.VF.Ave.Pol.Net2<-
as.matrix(Ukraine.Type.Info.Pol.Net,attrname="Committee.Co.Attendance")
Ukraine.Type.Info.Tech.Net<-
set.edge.value(Ukraine.Type.Info.Tech.Net,"Committees.Occ.VFreq.Ave",Ukraine.Committee.Attendance.Occ.VF.Ave)
as.matrix(Ukraine.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")
Ukraine.Committee.Attendance.Occ.VF.Ave.Tech.Net2<-
as.matrix(Ukraine.Type.Info.Tech.Net,attrname="Committees.Occ.VFreq.Ave")

#Stack diagonal matrices for institutional venues
##General network
Global.Committee.Attendance.Occ.VF.Ave.Mat<-
as.matrix(adiag(ElSalvador.Committee.Attendance.Occ.VF.Ave.Net2,
CostaRica.Committee.Attendance.Occ.VF.Ave.Net2,Guatemala.Committee.Attendance.Occ.VF.Ave.Net2,Panama.Committee.Attendance.Occ.VF.Ave.Net2,Honduras.Committee.Attendance.Occ.VF.Ave.Net2,
Malawi.Committee.Attendance.Occ.VF.Ave.Net2,Ethiopia.Committee.Attendance.Occ.VF.Ave.Net2,Ghana.Committee.Attendance.Occ.VF.Ave.Net2,
Afghanistan.Committee.Attendance.Occ.VF.Ave.Net2,
Ukraine.Committee.Attendance.Occ.VF.Ave.Net2))
Global.Committee.Attendance.Occ.VF.Ave.Mat.Net.NDir<-
network(Global.Committee.Attendance.Occ.VF.Ave.Mat, directed=F)
set.edge.value(Global.Committee.Attendance.Occ.VF.Ave.Mat.Net.NDir,
"Committee.Co.Attendance",

```

```
Global.Committee.Attendance.Occ.VF.Ave.Mat)
as.matrix(Global.Committee.Attendance.Occ.VF.Ave.Mat.Net.NDir,attrname="Committee.Co.Attendance")
##Technical network
Global.Committee.Attendance.Occ.VF.Ave.Tech.Mat<-
as.matrix(adiag(ElSalvador.Committee.Attendance.Occ.VF.Ave.Tech.Net2,
CostaRica.Committee.Attendance.Occ.VF.Ave.Tech.Net2,Guatemala.Committee.Attendance.Occ.VF.Ave.Tech.Net2,Panama.Committee.Attendance.Occ.VF.Ave.Tech.Net2,Honduras.Committee.Attendance.Occ.VF.Ave.Tech.Net2,

Malawi.Committee.Attendance.Occ.VF.Ave.Tech.Net2,Ethiopia.Committee.Attendance.Occ.VF.Ave.Tech.Net2,Ghana.Committee.Attendance.Occ.VF.Ave.Tech.Net2,

Afghanistan.Committee.Attendance.Occ.VF.Ave.Tech.Net2,
Ukraine.Committee.Attendance.Occ.VF.Ave.Tech.Net2))
Global.Committee.Attendance.Occ.VF.Ave.Tech.Mat.Net.NDir<-
network(Global.Committee.Attendance.Occ.VF.Ave.Tech.Mat, directed=F)
set.edge.value(Global.Committee.Attendance.Occ.VF.Ave.Tech.Mat.Net.NDir,
"Committee.Co.Attendance",
Global.Committee.Attendance.Occ.VF.Ave.Tech.Mat)
as.matrix(Global.Committee.Attendance.Occ.VF.Ave.Tech.Mat.Net.NDir,
attrname="Committee.Co.Attendance")
##Political network
Global.Committee.Attendance.Occ.VF.Ave.Pol.Mat<-
as.matrix(adiag(ElSalvador.Committee.Attendance.Occ.VF.Ave.Pol.Net2,
CostaRica.Committee.Attendance.Occ.VF.Ave.Pol.Net2,Guatemala.Committee.Attendance.Occ.VF.Ave.Pol.Net2,Panama.Committee.Attendance.Occ.VF.Ave.Pol.Net2,
Honduras.Committee.Attendance.Occ.VF.Ave.Pol.Net2,
```

```
Malawi.Committee.Attendance.Occ.VF.Ave.Pol.Net2,Ethiopia.Committee.Attendance.Occ.VF.Ave.Pol.Net2,Ghana.Committee.Attendance.Occ.VF.Ave.Pol.Net2,
```

```
Afghanistan.Committee.Attendance.Occ.VF.Ave.Pol.Net2,
Ukraine.Committee.Attendance.Occ.VF.Ave.Pol.Net2))
Global.Committee.Attendance.Occ.VF.Ave.Pol.Mat.Net.NDir<-
network(Global.Committee.Attendance.Occ.VF.Ave.Pol.Mat, directed=F)
set.edge.value(Global.Committee.Attendance.Occ.VF.Ave.Pol.Mat.Net.NDir,
"Committee.Co.Attendance",
Global.Committee.Attendance.Occ.VF.Ave.Pol.Mat)
as.matrix(Global.Committee.Attendance.Occ.VF.Ave.Pol.Mat.Net.NDir,attrname="Committee.Co.Attendance")
```

```
##### Stacking
matrices by country in one diagonalized
matrix
#General network of information
Global.Net.Info.List<-
list(ElSalvadorNetInfo,
CostaRicaNetInfo,GuatemalaNetInfo,PanamaNetInfo,HondurasNetInfo,
```

```
MalawiNetInfo,EthiopiaNetInfo,GhanaNetInfo,
AfghanistanNetInfo,
UkraineNetInfo)
Global.Net.Info.List.blockdiag <-
blockdiagonalize(Global.Net.Info.List,
"block_id")
##Technical network
Global.Net.Info.Tech.List<-
list(ElSalvador.Type.Info.Tech.Net,
CostaRica.Type.Info.Tech.Net,Guatemala.Type.Info.Tech.Net,Panama.Type.Info.Tech.Net,Honduras.Type.Info.Tech.Net,
```

```
Malawi.Type.Info.Tech.Net,Ethiopia.Type.Info.Tech.Net,Ghana.Type.Info.Tech.Net,
```

```
Afghanistan.Type.Info.Tech.Net,
Ukraine.Type.Info.Tech.Net)
Global.Net.Info.Tech.List.blockdiag <-
blockdiagonalize(Global.Net.Info.Tech.Lis
t, "block_id")
###Political network
Global.Net.Info.Pol.List<-
list(ElSalvador.Type.Info.Pol.Net,
CostaRica.Type.Info.Pol.Net,Guatemala.T
ype.Info.Pol.Net,Panama.Type.Info.Pol.Ne
t,Honduras.Type.Info.Pol.Net,
```

```
Malawi.Type.Info.Pol.Net,Ethiopia.Type.I
nfo.Pol.Net,Ghana.Type.Info.Pol.Net,
```

```
Afghanistan.Type.Info.Pol.Net,
Ukraine.Type.Info.Pol.Net)
Global.Net.Info.Pol.List.blockdiag <-
blockdiagonalize(Global.Net.Info.Pol.List,
"block_id")
```

```
##### ERGMs
Tests
### Stabilization tests geometrically
weighted degrees for the 3 networks
##Stabilizing the model with
geometrically weighted degrees
#General information network
Global.ERGMs.Stab1<-
ergm(Global.Net.Info.List.blockdiag ~
edges +
      gwodegree(0.5, fixed =
TRUE) +
      gwidegree(0.5, fixed =
TRUE),
      constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Stab1)
Global.ERGMs.Stab2<-
ergm(Global.Net.Info.List.blockdiag ~
edges +
      gwodegree(1, fixed =
TRUE) +
      gwidegree(1, fixed =
TRUE),
      constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Stab2)
```

```
Global.ERGMs.Stab3<-
ergm(Global.Net.Info.List.blockdiag ~
edges +
      gwodegree(2, fixed =
TRUE) + #Lower Bayesian Information
Criteria (BIC)
      gwidegree(2, fixed =
TRUE),
      constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Stab3)
screenreg(list(Global.ERGMs.Stab1,
Global.ERGMs.Stab2,
Global.ERGMs.Stab3))
#Technical information network
Global.ERGMs.Tech.Stab1<-
ergm(Global.Net.Info.Tech.List.blockdiag
~ edges +
      gwodegree(0.5, fixed
= TRUE) +
      gwidegree(0.5, fixed =
TRUE),
      constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Stab1)
Global.ERGMs.Tech.Stab2<-
ergm(Global.Net.Info.Tech.List.blockdiag
~ edges +
      gwodegree(1, fixed =
TRUE) +
      gwidegree(1, fixed =
TRUE),
      constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Stab2)
Global.ERGMs.Tech.Stab3<-
ergm(Global.Net.Info.Tech.List.blockdiag
~ edges +
      gwodegree(2, fixed =
TRUE) + #Lower Bayesian Information
Criteria (BIC)
      gwidegree(2, fixed =
TRUE),
      constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Stab3)
screenreg(list(Global.ERGMs.Tech.Stab1,
Global.ERGMs.Tech.Stab2,
Global.ERGMs.Tech.Stab3))
```

```
#Political information network
Global.ERGMs.Pol.Stab1<-
ergm(Global.Net.Info.Pol.List.blockdiag ~
edges +
          gwodegree(0.1, fixed =
TRUE) +
          gwidegree(0.1, fixed =
TRUE),
          constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Pol.Stab1)
Global.ERGMs.Pol.Stab2<-
ergm(Global.Net.Info.Pol.List.blockdiag ~
edges +
          gwodegree(1, fixed =
TRUE) + #Lower Bayesian Information
Criteria (BIC)
          gwidegree(1, fixed =
TRUE),
          constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Pol.Stab2)
Global.ERGMs.Pol.Stab3<-
ergm(Global.Net.Info.Pol.List.blockdiag ~
edges +
          gwodegree(2, fixed =
TRUE) +
          gwidegree(2, fixed =
TRUE),
          constraints = ~
blockdiag("block_id"))
summary(Global.ERGMs.Pol.Stab3)
screenreg(list(Global.ERGMs.Pol.Stab1,
Global.ERGMs.Pol.Stab2,
Global.ERGMs.Pol.Stab3))
```

```
##### ERGMs
Preference similarity Models
#####
#General network / Model 1 in Table 3
(paper)
GlobalQ9.Blockdiag.ERGMs.Pref.Sim <-
ergm(Global.Net.Info.List.blockdiag ~
edges +
          gwodegree(2,
fixed = TRUE) +
          gwidegree(2,
fixed = TRUE) +
```

```
nodecov("Self.Interest") +
nodecov("Pro.Social"),
          constraints = ~
blockdiag("block_id"),
control=control.ergm(seed=40))
summary(GlobalQ9.Blockdiag.ERGMs.Pr
ef.Sim)
#Tech network Model 3 in Table 3 (paper)
GlobalQ9.Blockdiag.Tech.ERGMs.Pref.Si
m <-
ergm(Global.Net.Info.Tech.List.blockdiag
~
edges +
          gwodegree(2, fixed = TRUE) +
          gwidegree(2, fixed = TRUE) +
nodecov("Self.Interest") +
nodecov("Pro.Social"),
          constraints =
~ blockdiag("block_id"),
control=control.ergm(seed=40))
summary(GlobalQ9.Blockdiag.Tech.ERG
Ms.Pref.Sim)
#Pol network Model 5 in Table 3 (paper)
GlobalQ9.Blockdiag.Pol.ERGMs.Pref.Sim
<-
ergm(Global.Net.Info.Pol.List.blockdiag ~
edges +
          gwodegree(1, fixed = TRUE) +
          gwidegree(1,
fixed = TRUE) +
nodecov("Self.Interest") +
nodecov("Pro.Social"),
          constraints =
~ blockdiag("block_id"),
control=control.ergm(seed=40))
summary(GlobalQ9.Blockdiag.Pol.ERGM
s.Pref.Sim)
```

```
#Comparative of results
screenreg(list(GlobalQ9.Blockdiag.ERGMs.Pref.Sim,

GlobalQ9.Blockdiag.Tech.ERGMs.Pref.Sim,

GlobalQ9.Blockdiag.Pol.ERGMs.Pref.Sim),
  custom.model.names = c("Global",
    "Technical", "Political"))

#Probabilities
plogis(coef(GlobalQ9.Blockdiag.ERGMs.Pref.Sim)[["edges"]])
plogis(coef(GlobalQ9.Blockdiag.Tech.ERGMs.Pref.Sim)[["edges"]])
plogis(coef(GlobalQ9.Blockdiag.Pol.ERGMs.Pref.Sim)[["edges"]])

##### ERGMs Complete Models
#####
#General network of information
GlobalQ9.Blockdiag.ERGMs.Complete <-
ergm(Global.Net.Info.List.blockdiag ~
      edges +
      odegree(0) +
      gwodegree(1,
fixed = TRUE) +
      gwidegree(5,
fixed = TRUE) +
      mutual +
      ttriple +
      twopath +
      dgwesp(1.5,
fixed = TRUE, type= "OTP") + #Filip 0.1
      dgwesp(1.5,
fixed = TRUE, type= "ITP") +
      dgwdsp(0.1,
fixed = TRUE, type= "OSP") +
      dgwdsp(0.1,
fixed = TRUE, type= "ISP") +
      edgecov(Global.Committee.Attendance.Occ.VF.Ave.Mat.Net.NDir,
"Committee.Co.Attendance") +
      nodecov("Influence.Indeg.Ave")+
      nodecov("Self.Interest") +
      nodecov("Pro.Social")+
      nodecov("Years")+
      nodematch("Sector", diff = F) +
      nodefactor("Sector"),
      constraints = ~
      blockdiag("block_id"),

      control=control.ergm(seed=40))
summary(GlobalQ9.Blockdiag.ERGMs.Complete)
#pending to test
#ddsp(d, type="OTP"); desp(d,
type="OTP")
#dgwdsp(decay, fixed=FALSE, cutoff=30,
type="OTP"); dgwesp(decay,
fixed=FALSE, cutoff=30, type="OTP")
#GOF
GlobalQ9.Blockdiag.ERGMs.Complete.GOF <-
gof(GlobalQ9.Blockdiag.ERGMs.Complete, nsim = 100,
      statistics
= c(odeg, ideg,
      esp, dsp, geodesic, triad.directed,
      walktrap.modularity))
plot(GlobalQ9.Blockdiag.ERGMs.Complete.GOF)
plot(GlobalQ9.Blockdiag.ERGMs.Complete.GOF$Outdegree)
plot(GlobalQ9.Blockdiag.ERGMs.Complete.GOF$Indegree)

#Tech network Model 4 in Table 3 (paper)
GlobalQ9.Blockdiag.Tech.ERGMs.Complete <-
ergm(Global.Net.Info.Tech.List.blockdiag ~
      edges +
```



```

gwodegree(0, fixed = TRUE) +
gwidegree(7, fixed = TRUE) +
    mutual +
    ttriple +
    twopath +
    dgwesp(1.5,
fixed = TRUE, type= "OTP") +
    dgwesp(1.5,
fixed = TRUE, type= "ITP") +
    dgwdsp(0.1,
fixed = TRUE, type= "OSP") +
    dgwdsp(0.1,
fixed = TRUE, type= "ISP") +
edgecov(Global.Committee.Attendance.Oc
c.VF.Ave.Tech.Mat.Net.NDir,
"Committee.Co.Attendance") +
nodecov("Influence.Indeg.Ave")+
nodecov("Self.Interest") +
nodecov("Pro.Social")+
nodecov("Years")+
nodematch("Sector", diff = F) +
nodefactor("Sector"),
constraints =
~ blockdiag("block_id"),
control=control.ergm(seed=40))
summary(GlobalQ9.Blockdiag.Tech.ERG
Ms.Complete)
#GOF
GlobalQ9.Blockdiag.Tech.ERGMs.Compl
ete.GOF <-
gof(GlobalQ9.Blockdiag.Tech.ERGMs.Co
mplete, nsim = 100,
statistics =
c(odeg, ideg,
esp,
dsp, geodesic, triad.directed,
walktrap.modularity))

#Pol network Model 6 in Table 3 (paper)
GlobalQ9.Blockdiag.Pol.ERGMs.Complet
e <-
ergm(Global.Net.Info.Pol.List.blockdiag ~
edges +
gwodegree(0, fixed = TRUE) +
gwidegree(7,
fixed = TRUE) +
    mutual +
    ttriple +
    twopath +
    dgwesp(1.5,
fixed = TRUE, type= "OTP") +
    dgwesp(1.5,
fixed = TRUE, type= "ITP") +
    dgwdsp(0.1,
fixed = TRUE, type= "OSP") +
    dgwdsp(0.1,
fixed = TRUE, type= "ISP") +
edgecov(Global.Committee.Attendance.Oc
c.VF.Ave.Pol.Mat.Net.NDir,
"Committee.Co.Attendance") +
nodecov("Influence.Indeg.Ave")+
nodecov("Self.Interest") +
nodecov("Pro.Social")+
nodecov("Years")+
nodematch("Sector", diff = F) +
nodefactor("Sector"),
constraints =
~ blockdiag("block_id"),
control=control.ergm(seed=40))
summary(GlobalQ9.Blockdiag.Pol.ERG
Ms.Complete)
GlobalQ9.Blockdiag.Pol.ERGMs.Complet
e.GOF <-
btergm::gof(GlobalQ9.Blockdiag.Pol.ERG
Ms.Complete, nsim = 100,
statistics = c(odeg, ideg,

```

```
esp, dsp, geodesic, triad.directed,  
walktrap.modularity))  
plot(GlobalQ9.Blockdiag.Pol.ERGMs.Co  
mplete.GOF)
```

```
#all networks  
screenreg(list(GlobalQ9.Blockdiag.ERGM  
s.Pref.Sim,
```

```
GlobalQ9.Blockdiag.ERGMs.Complete,
```

```
GlobalQ9.Blockdiag.Tech.ERGMs.Pref.Si  
m,
```

```
GlobalQ9.Blockdiag.Tech.ERGMs.Compl  
ete,
```

```
GlobalQ9.Blockdiag.Pol.ERGMs.Pref.Sim  
,
```

```
GlobalQ9.Blockdiag.Pol.ERGMs.Complet  
e),
```

```
custom.header = list("Global" = 1:2,  
"Technical" = 3:4, "Political" = 5:6))
```

APPENDIX G11: R CODES FOR CHAPTER 4

R-scripts for Chapter 4 "Collective-Action Risks
In Governance Networks:
Self-Organization Capacity And Structural
Functions For Innovation"

```
#Set up the working directory
rm(list=ls())
setwd("~/R/PhD")
```

```
#Packages
library(readxl) #install.packages("readxl")
library(dplyr) #install.packages("dplyr")
library(plyr) #install.packages("plyr")
library(psych) #install.packages("psych")
library(lattice) #install.packages("lattice")
library(texreg) #install.packages("texreg")
library(ggplot2) #install.packages("ggplot2")
library(tidyverse) #install.packages("tidyverse")
library(reshape) #install.packages("reshape")
library(reshape2) #install.packages("reshape2")
library(data.table) #install.packages("data.table")
library(cluster) #install.packages("cluste")
library(sjmisc) #install.packages("sjmisc")
library(ggpubr) #install.packages("ggpubr")
library(lmtest) #install.packages("lmtest")
library(arsenal) #install.packages("arsenal")
library(factoextra) #install.packages("factoextra")
library(tidytext) #install.packages("tidytext")
library(texreg) #install.packages("texreg")
library(sjPlot) #install.packages("sjPlot")
library(openxlsx) #install.packages("openxlsx")
library(ggrepel) #install.packages("ggrepel")
library(GPArotation)
#install.packages("GPArotation")
library(foreign) #install.packages("foreign")
library(multilevel) #install.packages("multilevel")
library(magic) #install.packages("magic")
library(UserNetR) #install.packages("UserNetR")
#Networks packages
detach(package: igraph)
#install.packages("igraph")
detach(package: intergraph)
#install.packages("intergraph")
library(sna) #install.packages("sna")
#detach(package:sna) #remove.packages("sna")
```

```
detach(package:igraph)
detach(package:intergraph)
library(network) #install.packages("network")
#detach(package:network)
#remove.packages("network")
library(statnet) #install.packages("statnet")
#detach(package:statnet)
#remove.packages("statnet")
#ERGMs
library(ergm) #install.packages("ergm")
#detach(package:ergm)
#remove.packages("ergm")
library(btergm) #install.packages("btergm")
#detach(package:btergm)
#remove.packages("btergm")
```

```
#Datasets 59
ElSalvadorQ9Info<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "ElSalvadorQ9", rowNames = T)
ElSalvadorQ9Coll<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "ElSalvadorQ9Symm", rowNames
= T)
ElSalvadorQ11Infl<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "ElSalvadorQ11", rowNames = T)
CostaRicaQ9Info<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "CostaRicaQ9", rowNames = T)
CostaRicaQ9Coll<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "CostaRicaQ9Symm", rowNames
= T)
CostaRicaQ11Infl<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "CostaRicaQ11", rowNames = T)
GuatemalaQ9Info<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "GuatemalaQ9", rowNames = T)
GuatemalaQ9Coll<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "GuatemalaQ9Symm", rowNames
= T)
```

⁵⁹ Datasets available upon request.

```
GuatemalaQ11Infl<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "GuatemalaQ11", rowNames = T)
HondurasQ9Info<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "HondurasQ9", rowNames = T)
HondurasQ9Coll<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "HondurasQ9Symm", rowNames
= T)
HondurasQ11Infl<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "HondurasQ11", rowNames = T)
PanamaQ9Info<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "PanamaQ9", rowNames = T)
PanamaQ9Coll<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "PanamaQ9Symm", rowNames =
T)
PanamaQ11Infl<-
read.xlsx("RawMatricesDichSymmQ9GT1ERGM
s.xlsx", sheet = "PanamaQ11", rowNames = T)
#Global Attributes
AttributeData<-
read.csv("AllCountriesCompleteDataset7.Org.Sec
.csv")

#Datasets to network format
ElSalvadorQ9Info.Mat<-
as.matrix(ElSalvadorQ9Info)
ElSalvadorQ9Info.Net<-
network(ElSalvadorQ9Info.Mat, matrix.type =
"adjacency", directed = T)
ElSalvadorQ9Coll.Mat<-
as.matrix(ElSalvadorQ9Coll)
ElSalvadorQ9Coll.Net<-
network(ElSalvadorQ9Coll.Mat, matrix.type =
"adjacency", directed = F)
ElSalvadorQ11Infl.Mat<-
as.matrix(ElSalvadorQ11Infl)
ElSalvadorQ11Infl.Net<-
network(ElSalvadorQ11Infl.Mat, matrix.type =
"adjacency", directed = T)
CostaRicaQ9Info.Mat<-
as.matrix(CostaRicaQ9Info)
CostaRicaQ9Info.Net<-
network(CostaRicaQ9Info.Mat, matrix.type =
"adjacency", directed = T)
```

```
CostaRicaQ9Coll.Mat<-
as.matrix(CostaRicaQ9Coll)
CostaRicaQ9Coll.Net<-
network(CostaRicaQ9Coll.Mat, matrix.type =
"adjacency", directed = F)
CostaRicaQ11Infl.Mat<-
as.matrix(CostaRicaQ11Infl)
CostaRicaQ11Infl.Net<-
network(CostaRicaQ11Infl.Mat, matrix.type =
"adjacency", directed = T)
GuatemalaQ9Info.Mat<-
as.matrix(GuatemalaQ9Info)
GuatemalaQ9Info.Net<-
network(GuatemalaQ9Info.Mat, matrix.type =
"adjacency", directed = T)
GuatemalaQ9Coll.Mat<-
as.matrix(GuatemalaQ9Coll)
GuatemalaQ9Coll.Net<-
network(GuatemalaQ9Coll.Mat, matrix.type =
"adjacency", directed = F)
GuatemalaQ11Infl.Mat<-
as.matrix(GuatemalaQ11Infl)
GuatemalaQ11Infl.Net<-
network(GuatemalaQ11Infl.Mat, matrix.type =
"adjacency", directed = T)
HondurasQ9Info.Mat<-
as.matrix(HondurasQ9Info)
HondurasQ9Info.Net<-
network(HondurasQ9Info.Mat, matrix.type =
"adjacency", directed = T)
HondurasQ9Coll.Mat<-
as.matrix(HondurasQ9Coll)
HondurasQ9Coll.Net<-
network(HondurasQ9Coll.Mat, matrix.type =
"adjacency", directed = F)
HondurasQ11Infl.Mat<-
as.matrix(HondurasQ11Infl)
HondurasQ11Infl.Net<-
network(HondurasQ11Infl.Mat, matrix.type =
"adjacency", directed = T)
PanamaQ9Info.Mat<-as.matrix(PanamaQ9Info)
PanamaQ9Info.Net<-
network(PanamaQ9Info.Mat, matrix.type =
"adjacency", directed = T)
PanamaQ9Coll.Mat<-as.matrix(PanamaQ9Coll)
PanamaQ9Coll.Net<-
network(PanamaQ9Coll.Mat, matrix.type =
"adjacency", directed = F)
PanamaQ11Infl.Mat<-as.matrix(PanamaQ11Infl)
```

```
PanamaQ11Infl.Net<-
network(PanamaQ11Infl.Mat, matrix.type =
"adjacency", directed = T)

##Set attributes only for Info & Coll networks
#Sector / Categorical
names(AttributeData[2])
head(AttributeData$X2Sector)
ElSalvadorQ9Info.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 2])
ElSalvadorQ9Coll.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 2])
CostaRicaQ9Info.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 2])
CostaRicaQ9Coll.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 2])
GuatemalaQ9Info.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 2])
GuatemalaQ9Coll.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 2])
HondurasQ9Info.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 2])
HondurasQ9Coll.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 2])
PanamaQ9Info.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 2])
PanamaQ9Coll.Net %v% "Sector" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 2])

#Meetings / Continuous
names(AttributeData[71])
head(AttributeData$X69Q7.1MeetingssAttendanc
e)
ElSalvadorQ9Info.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 71])
ElSalvadorQ9Coll.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 71])
```

```
CostaRicaQ9Info.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 71])
CostaRicaQ9Coll.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 71])
GuatemalaQ9Info.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 71])
GuatemalaQ9Coll.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 71])
HondurasQ9Info.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 71])
HondurasQ9Coll.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 71])
PanamaQ9Info.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 71])
PanamaQ9Coll.Net %v% "Meetings" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 71])

#Years / Continuous
names(AttributeData[80])
head(AttributeData$X78Q7.4LengthParticipation)
ElSalvadorQ9Info.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 80])
ElSalvadorQ9Coll.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 80])
CostaRicaQ9Info.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 80])
CostaRicaQ9Coll.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 80])
GuatemalaQ9Info.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 80])
GuatemalaQ9Coll.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 80])
HondurasQ9Info.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 80])
```

```
HondurasQ9Coll.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 80])
PanamaQ9Info.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 80])
PanamaQ9Coll.Net %v% "Years" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 80])
```

```
#Organisational sizes / Continuous
names(AttributeData[9])
head(AttributeData$Size)
ElSalvadorQ9Info.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 9])
ElSalvadorQ9Coll.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 9])
CostaRicaQ9Info.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 9])
CostaRicaQ9Coll.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 9])
GuatemalaQ9Info.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 9])
GuatemalaQ9Coll.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 9])
HondurasQ9Info.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 9])
HondurasQ9Coll.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 9])
PanamaQ9Info.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 9])
PanamaQ9Coll.Net %v% "Org.Size" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 9])
```

```
#Organisational Type / Categorical
names(AttributeData[804])
head(AttributeData$Type.Org)
```

```
ElSalvadorQ9Info.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 804])
ElSalvadorQ9Coll.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 804])
CostaRicaQ9Info.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 804])
CostaRicaQ9Coll.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 804])
GuatemalaQ9Info.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 804])
GuatemalaQ9Coll.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 804])
HondurasQ9Info.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 804])
HondurasQ9Coll.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 804])
PanamaQ9Info.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 804])
PanamaQ9Coll.Net %v% "Org.Type" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 804])
get.vertex.attribute(CostaRicaQ9Info.Net,
"Org.Type")
```

```
#Influence nominations / Continuous
names(AttributeData[674])
head(AttributeData$InDeg.Q11GT1DNetN)
ElSalvadorQ9Info.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 674])
ElSalvadorQ9Coll.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 674])
CostaRicaQ9Info.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 674])
CostaRicaQ9Coll.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 674])
```

```
GuatemalaQ9Info.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 674])
GuatemalaQ9Coll.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 674])
HondurasQ9Info.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 674])
HondurasQ9Coll.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 674])
PanamaQ9Info.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 674])
PanamaQ9Coll.Net %v% "Infl.Indeg.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 674])
```

```
#Influence Groups (Not used)
names(AttributeData[651:653])
ElSalvadorQ9Coll.Net %v% "Infl.Group.PubS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 651])
ElSalvadorQ9Coll.Net %v% "Infl.Group.PriS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 652])
ElSalvadorQ9Coll.Net %v% "Infl.Group.CS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 653])
CostaRicaQ9Coll.Net %v% "Infl.Group.PubS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 651])
CostaRicaQ9Coll.Net %v% "Infl.Group.PriS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 652])
CostaRicaQ9Coll.Net %v% "Infl.Group.CS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 653])
GuatemalaQ9Coll.Net %v% "Infl.Group.PubS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 651])
GuatemalaQ9Coll.Net %v% "Infl.Group.PriS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 652])
GuatemalaQ9Coll.Net %v% "Infl.Group.CS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 653])
```

```
HondurasQ9Coll.Net %v% "Infl.Group.PubS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 651])
HondurasQ9Coll.Net %v% "Infl.Group.PriS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 652])
HondurasQ9Coll.Net %v% "Infl.Group.CS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 653])
PanamaQ9Coll.Net %v% "Infl.Group.PubS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 651])
PanamaQ9Coll.Net %v% "Infl.Group.PriS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 652])
PanamaQ9Coll.Net %v% "Infl.Group.CS" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 653])
```

```
#Knowledge / Continuos
names(AttributeData[679])
ElSalvadorQ9Info.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 679])
ElSalvadorQ9Coll.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 679])
CostaRicaQ9Info.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 679])
CostaRicaQ9Coll.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 679])
GuatemalaQ9Info.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 679])
GuatemalaQ9Coll.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 679])
HondurasQ9Info.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 679])
HondurasQ9Coll.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 679])
PanamaQ9Info.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 679])
```

```
PanamaQ9Coll.Net %v% "Knowledge" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 679])
names(AttributeData[681])
ElSalvadorQ9Info.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 681])
ElSalvadorQ9Coll.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 681])
CostaRicaQ9Info.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 681])
CostaRicaQ9Coll.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 681])
GuatemalaQ9Info.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 681])
GuatemalaQ9Coll.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 681])
HondurasQ9Info.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 681])
HondurasQ9Coll.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 681])
PanamaQ9Info.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 681])
PanamaQ9Coll.Net %v% "Knowledge.Diff" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 681])
```

#Centrality Measures / Continuous

```
ElSalvadorQ9Info.Net %v% "deg"<-
degree(ElSalvadorQ9Info.Net, gmode="digraph",
diag=F, cmode="freeman", ignore.eval=T)
ElSalvadorQ9Info.Net %v% "outdeg"<-
degree(ElSalvadorQ9Info.Net, gmode="digraph",
diag=F, cmode="outdegree", ignore.eval=T)
ElSalvadorQ9Info.Net %v% "indeg"<-
degree(ElSalvadorQ9Info.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
ElSalvadorQ9Coll.Net %v% "deg"<-
degree(ElSalvadorQ9Coll.Net, gmode="graph",
diag=F, cmode="freeman", ignore.eval=T)
```

```
ElSalvadorQ9Info.Net %v% "between"<-
betweenness(ElSalvadorQ9Info.Net,
gmode="digraph", diag=F)
ElSalvadorQ9Coll.Net %v% "between"<-
betweenness(ElSalvadorQ9Coll.Net,
gmode="graph")
ElSalvadorQ11Infl.Net %v% "indeg"<-
degree(ElSalvadorQ11Infl.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
CostaRicaQ9Info.Net %v% "deg"<-
degree(CostaRicaQ9Info.Net, gmode="digraph",
diag=F, cmode="freeman", ignore.eval=T)
CostaRicaQ9Info.Net %v% "outdeg"<-
degree(CostaRicaQ9Info.Net, gmode="digraph",
diag=F, cmode="outdegree", ignore.eval=T)
CostaRicaQ9Info.Net %v% "indeg"<-
degree(CostaRicaQ9Info.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
CostaRicaQ9Coll.Net %v% "deg"<-
degree(CostaRicaQ9Coll.Net, gmode="graph",
diag=F, cmode="freeman", ignore.eval=T)
CostaRicaQ9Info.Net %v% "between"<-
betweenness(CostaRicaQ9Info.Net,
gmode="digraph", diag=F)
CostaRicaQ9Coll.Net %v% "between"<-
betweenness(CostaRicaQ9Coll.Net,
gmode="graph")
CostaRicaQ11Infl.Net %v% "indeg"<-
degree(CostaRicaQ11Infl.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
GuatemalaQ9Info.Net %v% "deg"<-
degree(GuatemalaQ9Info.Net, gmode="digraph",
diag=F, cmode="freeman", ignore.eval=T)
GuatemalaQ9Info.Net %v% "outdeg"<-
degree(GuatemalaQ9Info.Net, gmode="digraph",
diag=F, cmode="outdegree", ignore.eval=T)
GuatemalaQ9Info.Net %v% "indeg"<-
degree(GuatemalaQ9Info.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
GuatemalaQ9Coll.Net %v% "deg"<-
degree(GuatemalaQ9Coll.Net, gmode="graph",
diag=F, cmode="freeman", ignore.eval=T)
GuatemalaQ9Info.Net %v% "between"<-
betweenness(GuatemalaQ9Info.Net,
gmode="digraph", diag=F)
GuatemalaQ9Coll.Net %v% "between"<-
betweenness(GuatemalaQ9Coll.Net,
gmode="graph")
```



```
GuatemalaQ11Infl.Net %v% "indeg"<-
degree(GuatemalaQ11Infl.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
HondurasQ9Info.Net %v% "deg"<-
degree(HondurasQ9Info.Net, gmode="digraph",
diag=F, cmode="freeman", ignore.eval=T)
HondurasQ9Info.Net %v% "outdeg"<-
degree(HondurasQ9Info.Net, gmode="digraph",
diag=F, cmode="outdegree", ignore.eval=T)
HondurasQ9Info.Net %v% "indeg"<-
degree(HondurasQ9Info.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
HondurasQ9Coll.Net %v% "deg"<-
degree(HondurasQ9Coll.Net, gmode="graph",
diag=F, cmode="freeman", ignore.eval=T)
HondurasQ9Info.Net %v% "between"<-
betweenness(HondurasQ9Info.Net,
gmode="digraph", diag=F)
HondurasQ9Coll.Net %v% "between"<-
betweenness(HondurasQ9Coll.Net,
gmode="graph")
HondurasQ11Infl.Net %v% "indeg"<-
degree(HondurasQ11Infl.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
PanamaQ9Info.Net %v% "deg"<-
degree(PanamaQ9Info.Net, gmode="digraph",
diag=F, cmode="freeman", ignore.eval=T)
PanamaQ9Info.Net %v% "outdeg"<-
degree(PanamaQ9Info.Net, gmode="digraph",
diag=F, cmode="outdegree", ignore.eval=T)
PanamaQ9Info.Net %v% "indeg"<-
degree(PanamaQ9Info.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
PanamaQ9Coll.Net %v% "deg"<-
degree(PanamaQ9Coll.Net, gmode="graph",
diag=F, cmode="freeman", ignore.eval=T)
PanamaQ9Info.Net %v% "between"<-
betweenness(PanamaQ9Info.Net,
gmode="digraph", diag=F)
PanamaQ9Coll.Net %v% "between"<-
betweenness(PanamaQ9Coll.Net,
gmode="graph")
PanamaQ11Infl.Net %v% "indeg"<-
degree(PanamaQ11Infl.Net, gmode="digraph",
diag=F, cmode="indegree", ignore.eval=T)
```

```
#Attributes for visualisations for Info, Coll and
Influence networks
names(AttributeData[c(789,806)])
```

```
head(AttributeData$NodeShape2)
ElSalvadorQ9Info.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 806])
ElSalvadorQ9Coll.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 806])
ElSalvadorQ11Infl.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 806])
ElSalvadorQ9Info.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 789])
ElSalvadorQ9Coll.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 789])
ElSalvadorQ11Infl.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 789])
CostaRicaQ9Info.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 806])
CostaRicaQ9Coll.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 806])
CostaRicaQ11Infl.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 806])
CostaRicaQ9Info.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 789])
CostaRicaQ9Coll.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 789])
CostaRicaQ11Infl.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 789])
GuatemalaQ9Info.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 806])
GuatemalaQ9Coll.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 806])
GuatemalaQ11Infl.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 806])
GuatemalaQ9Info.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 789])
```

```
GuatemalaQ9Coll.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 789])
GuatemalaQ11Infl.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 789])
HondurasQ9Info.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 806])
HondurasQ9Coll.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 806])
HondurasQ11Infl.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 806])
HondurasQ9Info.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 789])
HondurasQ9Coll.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 789])
HondurasQ11Infl.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 789])
PanamaQ9Info.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 806])
PanamaQ9Coll.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 806])
PanamaQ11Infl.Net %v% "Shape" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 806])
PanamaQ9Info.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 789])
PanamaQ9Coll.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 789])
PanamaQ11Infl.Net %v% "Color" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 789])

#Activity in networks
#El Salvador Information
gden(ElSalvadorQ9Info.Net)
components(ElSalvadorQ9Info.Net)
gtrans(ElSalvadorQ9Info.Net, mode = "digraph")
```

```
centralization(ElSalvadorQ9Info.Net,degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "digraph")
lgc <-
component.largest(ElSalvadorQ9Info.Net,result="
graph")
gd <- geodist(lgc)
max(gd$gdist)

#El Salvador Collaboration
gden(ElSalvadorQ9Coll.Net)
components(ElSalvadorQ9Coll.Net)
gtrans(ElSalvadorQ9Coll.Net, mode = "graph")
centralization(ElSalvadorQ9Coll.Net,degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "graph")
lgc <-
component.largest(ElSalvadorQ9Coll.Net,result="
graph")
gd <- geodist(lgc)
max(gd$gdist)

#Costa Rica Information
gden(CostaRicaQ9Info.Net)
components(CostaRicaQ9Info.Net)
gtrans(CostaRicaQ9Info.Net, mode = "digraph")
centralization(CostaRicaQ9Info.Net,degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "digraph")
lgc <-
component.largest(CostaRicaQ9Info.Net,result="g
raph")
gd <- geodist(lgc)
max(gd$gdist)

#Costa Rica Collaboration
gden(CostaRicaQ9Coll.Net)
components(CostaRicaQ9Coll.Net)
gtrans(CostaRicaQ9Coll.Net, mode = "graph")
centralization(CostaRicaQ9Coll.Net,degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "graph")
lgc <-
component.largest(CostaRicaQ9Coll.Net,result="
graph")
gd <- geodist(lgc)
max(gd$gdist)

#Guatemala Information
```

```
gden(GuatemalaQ9Info.Net)
components(GuatemalaQ9Info.Net)
gtrans(GuatemalaQ9Info.Net, mode = "digraph")
centralization(GuatemalaQ9Info.Net, degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "digraph")
lgc <-
component.largest(GuatemalaQ9Info.Net, result="
graph")
gd <- geodist(lgc)
max(gd$gdist)
```

```
#Guatemala Collaboration
gden(GuatemalaQ9Coll.Net)
components(GuatemalaQ9Coll.Net)
gtrans(GuatemalaQ9Coll.Net, mode = "graph")
centralization(GuatemalaQ9Coll.Net, degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "graph")
lgc <-
component.largest(GuatemalaQ9Coll.Net, result="
graph")
gd <- geodist(lgc)
max(gd$gdist)
```

```
#Panama Information
gden(PanamaQ9Info.Net)
components(PanamaQ9Info.Net)
gtrans(PanamaQ9Info.Net, mode = "digraph")
centralization(PanamaQ9Info.Net, degree, diag=F,
cmode= "freeman", ignore.eval=FALSE, mode =
"digraph")
lgc <-
component.largest(PanamaQ9Info.Net, result="gra
ph")
gd <- geodist(lgc)
max(gd$gdist)
```

```
#Panama Collaboration
gden(PanamaQ9Coll.Net)
components(PanamaQ9Coll.Net)
gtrans(PanamaQ9Coll.Net, mode = "graph")
centralization(PanamaQ9Coll.Net, degree, diag=F,
cmode= "freeman", ignore.eval=FALSE, mode =
"graph")
lgc <-
component.largest(PanamaQ9Coll.Net, result="gra
ph")
gd <- geodist(lgc)
```

```
max(gd$gdist)
```

```
#Honduras Information
gden(HondurasQ9Info.Net)
components(HondurasQ9Info.Net)
gtrans(HondurasQ9Info.Net, mode = "digraph")
centralization(HondurasQ9Info.Net, degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "digraph")
lgc <-
component.largest(HondurasQ9Info.Net, result="g
raph")
gd <- geodist(lgc)
max(gd$gdist)
```

```
#Honduras Collaboration
gden(HondurasQ9Coll.Net)
components(HondurasQ9Coll.Net)
gtrans(HondurasQ9Coll.Net, mode = "graph")
centralization(HondurasQ9Coll.Net, degree,
diag=F, cmode= "freeman", ignore.eval=FALSE,
mode = "graph")
lgc <-
component.largest(HondurasQ9Coll.Net, result="g
raph")
gd <- geodist(lgc)
max(gd$gdist)
```

```
ElSalvador.Activity.Info<-
as.data.frame(get.vertex.attribute(ElSalvadorQ9In
fo.Net, "Sector"))
ElSalvador.Activity.Info<-
cbind(ElSalvador.Activity.Info,
as.data.frame(get.vertex.attribute(ElSalvadorQ9In
fo.Net, "outdeg")))
names(ElSalvador.Activity.Info) <- c("sector",
"outdeg")
ElSalvador.Activity.Info<-
ElSalvador.Activity.Info %>%
  group_by(sector) %>%
  summarise_each(funs(sum))
ElSalvador.Activity.Info<-
ElSalvador.Activity.Info %>% mutate(percentage
= paste0(round(outdeg/sum(outdeg)*100,2),"%"))
ElSalvador.Activity.Coll<-
as.data.frame(get.vertex.attribute(ElSalvadorQ9C
oll.Net, "Sector"))
```

```
ElSalvador.Activity.Coll<-
cbind(ElSalvador.Activity.Coll,
as.data.frame(get.vertex.attribute(ElSalvadorQ9Coll.Net, "deg")))
names(ElSalvador.Activity.Coll) <- c("sector",
"deg")
ElSalvador.Activity.Coll<-
ElSalvador.Activity.Coll %>%
  group_by(sector) %>%
  summarise_each(funs(sum))
ElSalvador.Activity.Coll<-
ElSalvador.Activity.Coll %>% mutate(percentage
= paste0(round(deg/sum(deg)*100,2),"%"))
sum(ElSalvador.Activity.Coll$deg)
ElSalvador.Activity.Infl<-
as.data.frame(get.vertex.attribute(ElSalvadorQ9Info.Net, "Sector"))
ElSalvador.Activity.Infl<-
cbind(ElSalvador.Activity.Infl,
as.data.frame(get.vertex.attribute(ElSalvadorQ11Infl.Net, "indeg")))
names(ElSalvador.Activity.Infl) <- c("sector",
"indeg")
ElSalvador.Activity.Infl<-
ElSalvador.Activity.Infl %>%
  group_by(sector) %>%
  summarise_each(funs(sum))
ElSalvador.Activity.Infl<-ElSalvador.Activity.Infl
%>% mutate(percentage =
paste0(round(indeg/sum(indeg)*100,2),"%"))

gden(CostaRicaQ9Info.Net)
CostaRica.Activity.Info<-
as.data.frame(get.vertex.attribute(CostaRicaQ9Info.Net, "Sector"))
CostaRica.Activity.Info<-
cbind(CostaRica.Activity.Info,
as.data.frame(get.vertex.attribute(CostaRicaQ9Info.Net, "outdeg")))
names(CostaRica.Activity.Info) <- c("sector",
"outdeg")
CostaRica.Activity.Info<- CostaRica.Activity.Info
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
CostaRica.Activity.Info<-CostaRica.Activity.Info
%>% mutate(percentage =
paste0(round(outdeg/sum(outdeg)*100,2),"%"))
gden(CostaRicaQ9Coll.Net)
```

```
CostaRica.Activity.Coll<-
as.data.frame(get.vertex.attribute(CostaRicaQ9Coll.Net, "Sector"))
CostaRica.Activity.Coll<-
cbind(CostaRica.Activity.Coll,
as.data.frame(get.vertex.attribute(CostaRicaQ9Coll.Net, "deg")))
names(CostaRica.Activity.Coll) <- c("sector",
"deg")
CostaRica.Activity.Coll<-
CostaRica.Activity.Coll %>%
  group_by(sector) %>%
  summarise_each(funs(sum))
CostaRica.Activity.Coll<-CostaRica.Activity.Coll
%>% mutate(percentage =
paste0(round(deg/sum(deg)*100,2),"%"))
sum(CostaRica.Activity.Coll$deg)
gden(CostaRicaQ11Infl.Net)
CostaRica.Activity.Infl<-
as.data.frame(get.vertex.attribute(CostaRicaQ9Info.Net, "Sector"))
CostaRica.Activity.Infl<-
cbind(CostaRica.Activity.Infl,
as.data.frame(get.vertex.attribute(CostaRicaQ11Infl.Net, "indeg")))
names(CostaRica.Activity.Infl) <- c("sector",
"indeg")
CostaRica.Activity.Infl<- CostaRica.Activity.Infl
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
CostaRica.Activity.Infl<-CostaRica.Activity.Infl
%>% mutate(percentage =
paste0(round(indeg/sum(indeg)*100,2),"%"))

gden(GuatemalaQ9Info.Net)
Guatemala.Activity.Info<-
as.data.frame(get.vertex.attribute(GuatemalaQ9Info.Net, "Sector"))
Guatemala.Activity.Info<-
cbind(Guatemala.Activity.Info,
as.data.frame(get.vertex.attribute(GuatemalaQ9Info.Net, "outdeg")))
names(Guatemala.Activity.Info) <- c("sector",
"outdeg")
Guatemala.Activity.Info<-
Guatemala.Activity.Info %>%
  group_by(sector) %>%
  summarise_each(funs(sum))
```

```

Guatemala.Activity.Info<-
Guatemala.Activity.Info %>% mutate(percentage
= paste0(round(outdeg/sum(outdeg)*100,2),"%"))
gden(GuatemalaQ9Coll.Net)
Guatemala.Activity.Coll<-
as.data.frame(get.vertex.attribute(GuatemalaQ9Co
ll.Net, "Sector"))
Guatemala.Activity.Coll<-
cbind(Guatemala.Activity.Coll,
as.data.frame(get.vertex.attribute(GuatemalaQ9Co
ll.Net, "deg")))
names(Guatemala.Activity.Coll) <- c("sector",
"deg")
Guatemala.Activity.Coll<-
Guatemala.Activity.Coll %>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Guatemala.Activity.Coll<-
Guatemala.Activity.Coll %>% mutate(percentage
= paste0(round(deg/sum(deg)*100,2),"%"))
sum(Guatemala.Activity.Coll$deg)
gden(GuatemalaQ11Infl.Net)
Guatemala.Activity.Infl<-
as.data.frame(get.vertex.attribute(GuatemalaQ9Inf
o.Net, "Sector"))
Guatemala.Activity.Infl<-
cbind(Guatemala.Activity.Infl,
as.data.frame(get.vertex.attribute(GuatemalaQ11I
nfl.Net, "indeg")))
names(Guatemala.Activity.Infl) <- c("sector",
"indeg")
Guatemala.Activity.Infl<- Guatemala.Activity.Infl
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Guatemala.Activity.Infl<-Guatemala.Activity.Infl
%>% mutate(percentage =
paste0(round(indeg/sum(indeg)*100,2),"%"))

gden(PanamaQ9Info.Net)
Panama.Activity.Info<-
as.data.frame(get.vertex.attribute(PanamaQ9Info.
Net, "Sector"))
Panama.Activity.Info<-
cbind(Panama.Activity.Info,
as.data.frame(get.vertex.attribute(PanamaQ9Info.
Net, "outdeg")))
names(Panama.Activity.Info) <- c("sector",
"outdeg")

```

```

Panama.Activity.Info<- Panama.Activity.Info
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Panama.Activity.Info<-Panama.Activity.Info
%>% mutate(percentage =
paste0(round(outdeg/sum(outdeg)*100,2),"%"))
gden(PanamaQ9Coll.Net)
Panama.Activity.Coll<-
as.data.frame(get.vertex.attribute(PanamaQ9Coll.
Net, "Sector"))
Panama.Activity.Coll<-
cbind(Panama.Activity.Coll,
as.data.frame(get.vertex.attribute(PanamaQ9Coll.
Net, "deg")))
names(Panama.Activity.Coll) <- c("sector",
"deg")
Panama.Activity.Coll<- Panama.Activity.Coll
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Panama.Activity.Coll<-Panama.Activity.Coll
%>% mutate(percentage =
paste0(round(deg/sum(deg)*100,2),"%"))
sum(Panama.Activity.Coll$deg)
gden(PanamaQ11Infl.Net)
Panama.Activity.Infl<-
as.data.frame(get.vertex.attribute(PanamaQ9Info.
Net, "Sector"))
Panama.Activity.Infl<-
cbind(Panama.Activity.Infl,
as.data.frame(get.vertex.attribute(PanamaQ11Infl.
Net, "indeg")))
names(Panama.Activity.Infl) <- c("sector",
"indeg")
Panama.Activity.Infl<- Panama.Activity.Infl
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Panama.Activity.Infl<-Panama.Activity.Infl %>%
mutate(percentage =
paste0(round(indeg/sum(indeg)*100,2),"%"))

gden(HondurasQ9Info.Net)
Honduras.Activity.Info<-
as.data.frame(get.vertex.attribute(HondurasQ9Info
.Net, "Sector"))
Honduras.Activity.Info<-
cbind(Honduras.Activity.Info,

```

```
as.data.frame(get.vertex.attribute(HondurasQ9Info
.Net, "outdeg"))
names(Honduras.Activity.Info) <- c("sector",
"outdeg")
Honduras.Activity.Info<- Honduras.Activity.Info
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Honduras.Activity.Info<-Honduras.Activity.Info
%>% mutate(percentage =
paste0(round(outdeg/sum(outdeg)*100,2),"%"))
gden(HondurasQ9Coll.Net)
Honduras.Activity.Coll<-
as.data.frame(get.vertex.attribute(HondurasQ9Col
l.Net, "Sector"))
Honduras.Activity.Coll<-
cbind(Honduras.Activity.Coll,
as.data.frame(get.vertex.attribute(HondurasQ9Col
l.Net, "deg")))
names(Honduras.Activity.Coll) <- c("sector",
"deg")
Honduras.Activity.Coll<- Honduras.Activity.Coll
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Honduras.Activity.Coll<-Honduras.Activity.Coll
%>% mutate(percentage =
paste0(round(deg/sum(deg)*100,2),"%"))
sum(Honduras.Activity.Coll$deg)
gden(HondurasQ11Infl.Net)
Honduras.Activity.Infl<-
as.data.frame(get.vertex.attribute(HondurasQ9Info
.Net, "Sector"))
Honduras.Activity.Infl<-
cbind(Honduras.Activity.Infl,
as.data.frame(get.vertex.attribute(HondurasQ11Inf
l.Net, "indeg")))
names(Honduras.Activity.Infl) <- c("sector",
"indeg")
Honduras.Activity.Infl<- Honduras.Activity.Infl
%>%
  group_by(sector) %>%
  summarise_each(funs(sum))
Honduras.Activity.Infl<-Honduras.Activity.Infl
%>% mutate(percentage =
paste0(round(indeg/sum(indeg)*100,2),"%"))

#Checks for betweenness
```

```
Data.Between<-read.xlsx("Betweenness
Analysis.xlsx", sheet = "Sheet1")
#By country & Sector
Data.Between.agg<- Data.Between %>%
  group_by(Country,Sector) %>%
  summarise_each(funs(sum))
#write.csv(Data.Between.agg,
"Data.Between.agg.csv")

get.vertex.attribute(ElSalvadorQ9Info.Net,
"vertex.names")
max(get.vertex.attribute(ElSalvadorQ9Info.Net,
"between"))
get.vertex.attribute(CostaRicaQ9Info.Net,
"vertex.names")
get.vertex.attribute(CostaRicaQ9Info.Net,
"between")
max(get.vertex.attribute(CostaRicaQ9Info.Net,
"between"))
get.vertex.attribute(GuatemalaQ9Info.Net,
"vertex.names")
get.vertex.attribute(GuatemalaQ9Info.Net,
"between")
max(get.vertex.attribute(GuatemalaQ9Info.Net,
"between"))
get.vertex.attribute(HondurasQ9Info.Net,
"vertex.names")
get.vertex.attribute(HondurasQ9Info.Net,
"between")
max(get.vertex.attribute(HondurasQ9Info.Net,
"between"))
get.vertex.attribute(PanamaQ9Info.Net,
"vertex.names")
get.vertex.attribute(PanamaQ9Info.Net,
"between")
max(get.vertex.attribute(PanamaQ9Info.Net,
"between"))

##### ERGM
MODELS #####

#El Salvador
#El Salvador Info
ElSalvador.Info.ERGM<-
ergm(ElSalvadorQ9Info.Net ~
  edges +
  #gwodegree(1, fixed = TRUE)

+
  #gwidegree(1, fixed = TRUE) +
```

```

mutual +
#ttriple +
twopath +
nodecov("between") +
#nodecov("indeg") +
#nodecov("Infl.Indeg.Ave") +
nodecov("Years"))
summary(ElSalvador.Info.ERGM)
coef.edges <-
as.numeric(coef(ElSalvador.Info.ERGM)['edges'])
exp(coef.edges)/(1 + exp(coef.edges))
ElSalvador.Info.ERGM.GOF <-
gof(ElSalvador.Info.ERGM, nsim = 100,
    statistics = c(odeg,
ideg, esp, dsp, geodesic, triad.directed,
walktrap.modularity))
plot(ElSalvador.Info.ERGM.GOF)

```

```

#Costa Rica Info
CostaRica.Info.ERGM<-
ergm(CostaRicaQ9Info.Net ~
    edges +
    #gwodegree(1, fixed = TRUE) +
    #gwidegree(1, fixed = TRUE) +
    mutual +
    #ttriple +
    twopath +
    nodecov("between") +
    #nodecov("indeg") +
    #nodecov("Infl.Indeg.Ave") +
    nodecov("Years"))
summary(CostaRica.Info.ERGM)
coef.edges <-
as.numeric(coef(CostaRica.Info.ERGM)['edges'])
exp(coef.edges)/(1 + exp(coef.edges))
CostaRica.Info.ERGM.GOF <-
gof(CostaRica.Info.ERGM, nsim = 100,
    statistics = c(odeg, ideg, esp,
dsp, geodesic, triad.directed,
walktrap.modularity))
plot(CostaRica.Info.ERGM.GOF)

```

```

#Guatemala Info
Guatemala.Info.ERGM<-
ergm(GuatemalaQ9Info.Net ~
    edges +
    gwodegree(1, fixed = TRUE) +
    gwidegree(1, fixed = TRUE) +
    mutual +

```

```

ttriple +
twopath +
nodecov("between") +
#nodecov("indeg") +
#nodecov("Infl.Indeg.Ave") +
nodecov("Years"))
summary(Guatemala.Info.ERGM)
coef.edges <-
as.numeric(coef(Guatemala.Info.ERGM)['edges'])
exp(coef.edges)/(1 + exp(coef.edges))
Guatemala.Info.ERGM.GOF <-
gof(Guatemala.Info.ERGM, nsim = 100,
    statistics = c(odeg, ideg, esp,
dsp, geodesic, triad.directed,
walktrap.modularity))
plot(Guatemala.Info.ERGM.GOF)

```

```

#Honduras Info
Honduras.Info.ERGM<-
ergm(HondurasQ9Info.Net ~
    edges +
    #gwodegree(1, fixed = TRUE) +
    #gwidegree(1, fixed = TRUE) +
    mutual +
    #ttriple +
    twopath +
    nodecov("between") +
    #nodecov("indeg") +
    #nodecov("Infl.Indeg.Ave") +
    nodecov("Years"))
summary(Honduras.Info.ERGM)
coef.edges <-
as.numeric(coef(Honduras.Info.ERGM)['edges'])
exp(coef.edges)/(1 + exp(coef.edges))
coef.ttriple <-
as.numeric(coef(Honduras.Info.ERGM)['ttriple'])
exp(coef.ttriple)/(1 + exp(coef.ttriple))
Honduras.Info.ERGM.GOF <-
gof(Honduras.Info.ERGM, nsim = 100,
    statistics = c(odeg, ideg, esp,
dsp, geodesic, triad.directed,
walktrap.modularity))
plot(Honduras.Info.ERGM.GOF)

```

```

#Panama Info
Panama.Info.ERGM<-ergm(PanamaQ9Info.Net ~
    edges +
    gwodegree(1, fixed = TRUE) +
    gwidegree(1, fixed = TRUE) +

```

```

mutual +
ttriple +
twopath +
nodecov("between") +
#nodecov("indeg") +
#nodecov("Infl.Indeg.Ave") +
nodecov("Years"))
summary(Panama.Info.ERGM)
coef.edges <-
as.numeric(coef(Panama.Info.ERGM)['edges'])
exp(coef.edges)/(1 + exp(coef.edges))
Panama.Info.ERGM.GOF <-
gof(Panama.Info.ERGM, nsim = 100,
    statistics = c(odeg, ideg, esp,
dsp, geodesic, triad.directed,
walktrap.modularity))
plot(Panama.Info.ERGM.GOF)

#Information Networks
screenreg(list(ElSalvador.Info.ERGM,
CostaRica.Info.ERGM, Guatemala.Info.ERGM,
Honduras.Info.ERGM, Panama.Info.ERGM),
    custom.model.names = c("El Salvador",
"Costa Rica", "Guatemala", "Honduras",
"Panama"))

#Collaboration
#El Salvador Coll
ElSalvador.Coll.ERGM<-
ergm(ElSalvadorQ9Coll.Net ~
    edges +
    degree(1, by=NULL,
homophily=FALSE, levels=NULL) +
    #twopath +
    nodematch("Org.Type", diff =
F) +
    #nodematch("Org.Type", diff =
T, levels = -c(3)) +
    nodematch("Sector", diff = F) +
    #nodematch("Sector", diff = T,
levels = -c(1,2,4)) +
    #nodecov("Knowledge") +
    nodecov("Knowledge.Diff") +
    #nodecov("Infl.Indeg.Ave") +
    nodecov("Meetings"))

summary(ElSalvador.Coll.ERGM)
ElSalvador.Coll.ERGM.GOF <-
gof(ElSalvador.Coll.ERGM, nsim = 100,

```

```

    statistics = c(deg, esp, dsp,
geodesic, triad.directed))
plot(ElSalvador.Coll.ERGM.GOF)

#Costa Rica Coll
CostaRica.Coll.ERGM<-
ergm(CostaRicaQ9Coll.Net ~
    edges +
    nodematch("Org.Type", diff = F)
+
    #nodematch("Org.Type", diff =
T, levels = -c(3)) +
    nodematch("Sector", diff = F) +
    #nodematch("Sector", diff = T,
levels = -c(1,2,4)) +
    #nodecov("Knowledge") +
    nodecov("Knowledge.Diff") +
    #nodecov("Infl.Indeg.Ave") +
    nodecov("Meetings"))
summary(CostaRica.Coll.ERGM)
#Guatemala Coll
Guatemala.Coll.ERGM<-
ergm(GuatemalaQ9Coll.Net ~
    edges +
    nodematch("Org.Type", diff = F)
+
    #nodematch("Org.Type", diff =
T, levels = -c(3)) +
    nodematch("Sector", diff = F) +
    #nodematch("Sector", diff = T,
levels = -c(1,2,4)) +
    #nodecov("Knowledge") +
    nodecov("Knowledge.Diff") +
    #nodecov("Infl.Indeg.Ave") +
    nodecov("Meetings"))
summary(Guatemala.Coll.ERGM)
#Honduras Coll
Honduras.Coll.ERGM<-
ergm(HondurasQ9Coll.Net ~
    edges +
    nodematch("Org.Type", diff = F)
+
    #nodematch("Org.Type", diff =
T, levels = -c(3)) +
    nodematch("Sector", diff = F) +
    #nodematch("Sector", diff = T,
levels = -c(1,2,4)) +
    #nodecov("Knowledge") +
    nodecov("Knowledge.Diff") +

```



```

#nodecov("Infl.Indeg.Ave") +
nodecov("Meetings"))
summary(Honduras.Coll.ERGM)
#Panama Coll
Panama.Coll.ERGM<-ergm(PanamaQ9Coll.Net ~
edges +
nodematch("Org.Type", diff = F)
+
#nodematch("Org.Type", diff = T,
levels = -c(3)) +
nodematch("Sector", diff = F) +
#nodematch("Sector", diff = T,
levels = -c(1,2,4)) +
#nodecov("Knowledge") +
nodecov("Knowledge.Diff") +
#nodecov("Infl.Indeg.Ave") +
nodecov("Meetings"))
summary(Panama.Coll.ERGM)
#Collaboration Networks
screenreg(list(ElSalvador.Coll.ERGM,
CostaRica.Coll.ERGM, Guatemala.Coll.ERGM,
Honduras.Coll.ERGM, Panama.Coll.ERGM),
custom.model.names = c("El Salvador",
"Costa Rica", "Guatemala", "Honduras",
"Panama"))

##### Visualizations of
networks #####

#Packages
detach(package: statnet)
detach(package: sna)
detach(package: statnet.common)
library(igraph)
library(intergraph)

#Igraph format
ElSalvadorQ9Info.Igra<-
asIgraph(ElSalvadorQ9Info.Net)
ElSalvadorQ9Coll.Igra<-
asIgraph(ElSalvadorQ9Coll.Net)
ElSalvadorQ11Infl.Igra<-
asIgraph(ElSalvadorQ11Infl.Net)
CostaRicaQ9Info.Igra<-
asIgraph(CostaRicaQ9Info.Net)
CostaRicaQ9Coll.Igra<-
asIgraph(CostaRicaQ9Coll.Net)

```

```

CostaRicaQ11Infl.Igra<-
asIgraph(CostaRicaQ11Infl.Net)
GuatemalaQ9Info.Igra<-
asIgraph(GuatemalaQ9Info.Net)
GuatemalaQ9Coll.Igra<-
asIgraph(GuatemalaQ9Coll.Net)
GuatemalaQ11Infl.Igra<-
asIgraph(GuatemalaQ11Infl.Net)
HondurasQ9Info.Igra<-
asIgraph(HondurasQ9Info.Net)
HondurasQ9Coll.Igra<-
asIgraph(HondurasQ9Coll.Net)
HondurasQ11Infl.Igra<-
asIgraph(HondurasQ11Infl.Net)
PanamaQ9Info.Igra<-
asIgraph(PanamaQ9Info.Net)
PanamaQ9Coll.Igra<-
asIgraph(PanamaQ9Coll.Net)
PanamaQ11Infl.Igra<-
asIgraph(PanamaQ11Infl.Net)

#Latam visualization
#Node sizes
rescale <- function(nchar,low,high) {
  min_d <- min(nchar)
  max_d <- max(nchar)
  rscl <- ((high-low)*(nchar-min_d))/(max_d-
min_d)+low
  rscl
}

#Canvas
#layout for info and coll
dev.off()
layout(matrix(c(1,2,3,4,5,11,
6,7,8,9,10,12), 2, 6, byrow = TRUE),
c(3,3,3,3,3,2),
c(8,8,8))
par(mar = c(0,2,2,0))
layout.show(12)

#layout for info and coll and influence
layout(matrix(c(1,2,3,4,5,17,
6,7,8,9,10,18,
11,12,13,14,15,16), 3, 6, byrow =
TRUE),
c(3,3,3,3,3,2),
c(8,8,8))
par(mar = c(0,2,2,0))

```

```
layout.show(18)

#Information
#1 El Salvador
set.seed(50)
par(mar = c(0,1.5,2,0))
plot(ElSalvadorQ9Info.Igra,
     layout=layout_nicely,
     vertex.size=
rescale(V(ElSalvadorQ9Info.Igra)$outdeg, 7,12),

vertex.shape=V(ElSalvadorQ9Info.Igra)$Shape,
vertex.color=V(ElSalvadorQ9Info.Igra)$Color,
vertex.label=NA,
edge.color="black",
edge.width=1.5,
edge.arrow.size=0.1,
main = "El Salvador")
box()
set.seed(50)
ElSalvadorCoords<-
layout_nicely(ElSalvadorQ9Info.Igra)
mtext("Information", side = 2, cex = 1.1)
#2 Costa Rica
set.seed(50)
par(mar = c(0,0,2,0))
plot(CostaRicaQ9Info.Igra, layout=layout_nicely,
     vertex.size=
rescale(V(CostaRicaQ9Info.Igra)$outdeg, 7,12),
     vertex.shape=V(CostaRicaQ9Info.Igra)$Shape,
     vertex.color=V(CostaRicaQ9Info.Igra)$Color,
     vertex.label=NA,
     edge.color="black",
     edge.width=1.5,
     edge.arrow.size=0.1,
     main = "Costa Rica")
box()
set.seed(50)
CostaRicaCoords<-
layout_nicely(CostaRicaQ9Info.Igra)
set.seed(50)
#3 Guatemala
set.seed(50)
par(mar = c(0,0,2,0))
plot(GuatemalaQ9Info.Igra, layout=layout_nicely,
     vertex.size=
rescale(V(GuatemalaQ9Info.Igra)$outdeg, 7,12),

vertex.shape=V(GuatemalaQ9Info.Igra)$Shape,
vertex.color=V(GuatemalaQ9Info.Igra)$Color,
vertex.label=NA,
edge.color="black",
edge.width=1.5,
edge.arrow.size=0.1,
main = "Guatemala")
box()
set.seed(50)
GuatemalaCoords<-
layout_nicely(GuatemalaQ9Info.Igra)
# 4 Panama
set.seed(50)
par(mar = c(0,0,2,0))
plot(PanamaQ9Info.Igra, layout=layout_nicely,
     vertex.size=
rescale(V(PanamaQ9Info.Igra)$outdeg, 7,12),
     vertex.shape=V(PanamaQ9Info.Igra)$Shape,
     vertex.color=V(PanamaQ9Info.Igra)$Color,
     vertex.label=NA,
     edge.color="black",
     edge.width=1.5,
     edge.arrow.size=0.1,
     main = "Panama")
box()
set.seed(50)
PanamaCoords<-
layout_nicely(PanamaQ9Info.Igra)
#5 Honduras
set.seed(50)
par(mar = c(0,0,2,0))
plot(HondurasQ9Info.Igra, layout=layout_nicely,
     vertex.size=
rescale(V(HondurasQ9Info.Igra)$outdeg, 7,12),
     vertex.shape=V(HondurasQ9Info.Igra)$Shape,
     vertex.color=V(HondurasQ9Info.Igra)$Color,
     vertex.label=NA,
     edge.color="black",
     edge.width=1.5,
     edge.arrow.size=0.1,
     main = "Honduras")
box()
set.seed(50)
HondurasCoords<-
layout_nicely(HondurasQ9Info.Igra)

#Collaboration
#Q11 El Salvador
set.seed(50)
par(mar = c(0,1.5,1,0))
```

```
plot(ElSalvadorQ9Coll.Igra,
layout=ElSalvadorCoords,
vertex.size=
rescale(V(ElSalvadorQ9Coll.Igra)$deg, 7,12),

vertex.shape=V(ElSalvadorQ9Coll.Igra)$Shape,
vertex.color=V(ElSalvadorQ9Coll.Igra)$Color,
vertex.label=NA,
edge.color="black", edge.arrow.size=0,
edge.width=1.5)
box()
mtext("Collaboration", side = 2, cex = 1.1)
#12 Costa Rica
set.seed(50)
par(mar = c(0,0,1,0))
plot(CostaRicaQ9Coll.Igra,
layout=CostaRicaCoords,
vertex.size=
rescale(V(CostaRicaQ9Coll.Igra)$deg, 7,12),

vertex.shape=V(CostaRicaQ9Coll.Igra)$Shape,
vertex.color=V(CostaRicaQ9Coll.Igra)$Color,
vertex.label=NA,
edge.color="black", edge.arrow.size=0,
edge.width=1.5)
box()
#13 Guatemala
set.seed(50)
par(mar = c(0,0,1,0))
plot(GuatemalaQ9Coll.Igra,
layout=GuatemalaCoords,
vertex.size=
rescale(V(GuatemalaQ9Coll.Igra)$deg, 7,12),

vertex.shape=V(GuatemalaQ9Coll.Igra)$Shape,
vertex.color=V(GuatemalaQ9Coll.Igra)$Color,
vertex.label=NA,
edge.color="black", edge.arrow.size=0,
edge.width=1.5)
box()
#14 Panama
set.seed(50)
par(mar = c(0,0,1,0))
plot(PanamaQ9Coll.Igra, layout=PanamaCoords,
vertex.size=
rescale(V(PanamaQ9Coll.Igra)$deg, 7,12),
vertex.shape=V(PanamaQ9Coll.Igra)$Shape,
vertex.color=V(PanamaQ9Coll.Igra)$Color,
vertex.label=NA,
```

```
edge.color="black", edge.arrow.size=0,
edge.width=1.5)
box()
#15 Honduras
set.seed(50)
par(mar = c(0,0,1,0))
plot(HondurasQ9Coll.Igra,
layout=HondurasCoords,
vertex.size=
rescale(V(HondurasQ9Coll.Igra)$deg, 7,12),
vertex.shape=V(HondurasQ9Coll.Igra)$Shape,
vertex.color=V(HondurasQ9Coll.Igra)$Color,
vertex.label=NA,
edge.color="black", edge.arrow.size=0,
edge.width=1.5)
box()

#Influence
#21 El Salvador
set.seed(50)
par(mar = c(0.5,1.5,1,0))
plot(ElSalvadorQ11Infl.Igra,
layout=ElSalvadorCoords,
vertex.size=
rescale(V(ElSalvadorQ11Infl.Igra)$inddeg, 5,10),

vertex.shape=V(ElSalvadorQ11Infl.Igra)$Shape,

vertex.color=V(ElSalvadorQ11Infl.Igra)$Color,
vertex.label=NA,
edge.color="black",
edge.width=1.5,
edge.arrow.size=0.1)
box()
mtext("Influence", side = 2, cex = 1.1)
#22 Costa Rica
set.seed(50)
par(mar = c(0.5,0,1,0))
plot(CostaRicaQ11Infl.Igra,
layout=CostaRicaCoords,
vertex.size=
rescale(V(CostaRicaQ11Infl.Igra)$inddeg, 5,10),

vertex.shape=V(CostaRicaQ11Infl.Igra)$Shape,
vertex.color=V(CostaRicaQ11Infl.Igra)$Color,
vertex.label=NA,
edge.color="black",
edge.width=1.5,
edge.arrow.size=0.1)
```

```

box()
#23 Guatemala
set.seed(50)
par(mar = c(0.5,0,1,0))
plot(GuatemalaQ11Infl.Igra,
     layout=GuatemalaCoords,
     vertex.size=
rescale(V(GuatemalaQ11Infl.Igra)$indeg, 5,10),

vertex.shape=V(GuatemalaQ11Infl.Igra)$Shape,

vertex.color=V(GuatemalaQ11Infl.Igra)$Color,
     vertex.label=NA,
     edge.color="black",
     edge.width=1.5,
     edge.arrow.size=0.1)
box()
#24 Panama
set.seed(50)
par(mar = c(0.5,0,1,0))
plot(PanamaQ11Infl.Igra, layout=PanamaCoords,
     vertex.size=
rescale(V(PanamaQ11Infl.Igra)$indeg, 5,10),
     vertex.shape=V(PanamaQ11Infl.Igra)$Shape,
     vertex.color=V(PanamaQ11Infl.Igra)$Color,
     vertex.label=NA,
     edge.color="black",
     edge.width=1.5,
     edge.arrow.size=0.1)
box()
#25 Honduras
set.seed(50)
par(mar = c(0.5,0,1,0))
plot(HondurasQ11Infl.Igra,
     layout=HondurasCoords,
     vertex.size=
rescale(V(HondurasQ11Infl.Igra)$indeg, 5,10),

vertex.shape=V(HondurasQ11Infl.Igra)$Shape,
     vertex.color=V(HondurasQ11Infl.Igra)$Color,
     vertex.label=NA,
     edge.color="black",
     edge.width=1.5,
     edge.arrow.size=0.1)
box()

#31 Labels
dummmynet <- network.initialize(8)
plot(dummmynet, displayisolates = F)

```

```

#32 Labels
dummmynet <- network.initialize(8)
plot(dummmynet, displayisolates = F)
legend("left",title = "Sectors", title.adj = 0.1,
text.font=4.5,
     col=c("red", "blue", "green", "orange",
"grey", "purple", "yellow", "gold"),
     legend =c("Public", "Private", "Civil society",
"Academia","Media", "Observer", "Assurance
team", "National secretariat"),
     pt.cex=2.5, pch=19, bty = "n")
dummmynet <- network.initialize(8)
plot(dummmynet, displayisolates = F)
legend ("left", title = "Administrative level",
title.adj = 0.1, text.font=4.5,
     pch=c(1,0, 20),
     legend =c("Local", "National",
"Supranational"),
     pt.cex=2, pt.bg = c(2,2,2), bty = "n")

#####
#####
#Collective action problems
CA.Problems<-
read.xlsx("RiskPerceptionDataset.xlsx", sheet =
"RiskAverages CA Problems")
CA.Problems<-dplyr::filter(CA.Problems,
X7GeneralInfoRegion == "Latin America")
CA.Problems[,c(1:10)]<- NULL
names(CA.Problems)
ElSalvador.CA.Problems<-
dplyr::filter(CA.Problems, X8GeneralInfoCountry
== "El Salvador")
CostaRica.CA.Problems<-
dplyr::filter(CA.Problems, X8GeneralInfoCountry
== "Costa Rica")
Guatemala.CA.Problems<-
dplyr::filter(CA.Problems, X8GeneralInfoCountry
== "Guatemala")
Panama.CA.Problems<-
dplyr::filter(CA.Problems, X8GeneralInfoCountry
== "Panama")
Honduras.CA.Problems<-
dplyr::filter(CA.Problems, X8GeneralInfoCountry
== "Honduras")
#Coordination
mean(ElSalvador.CA.Problems$Q12.3.Ind.Ave)
sd(ElSalvador.CA.Problems$Q12.3.Ind.Ave)

```

```
mean(CostaRica.CA.Problems$Q12.3.Ind.Ave)
sd(CostaRica.CA.Problems$Q12.3.Ind.Ave)
mean(Guatemala.CA.Problems$Q12.3.Ind.Ave)
sd(Guatemala.CA.Problems$Q12.3.Ind.Ave)
mean(Panama.CA.Problems$Q12.3.Ind.Ave)
sd(Panama.CA.Problems$Q12.3.Ind.Ave)
mean(Honduras.CA.Problems$Q12.3.Ind.Ave)
sd(Honduras.CA.Problems$Q12.3.Ind.Ave)

#Division
mean(ElSalvador.CA.Problems$Q10.1.Participati
ng.in.CoST.has.been.beneficial.Division)
sd(ElSalvador.CA.Problems$Q10.1.Participating.i
n.CoST.has.been.beneficial.Division)
mean(CostaRica.CA.Problems$Q10.1.Participatin
g.in.CoST.has.been.beneficial.Division)
sd(CostaRica.CA.Problems$Q10.1.Participating.i
n.CoST.has.been.beneficial.Division)
mean(Guatemala.CA.Problems$Q10.1.Participatin
g.in.CoST.has.been.beneficial.Division)
sd(Guatemala.CA.Problems$Q10.1.Participating.i
n.CoST.has.been.beneficial.Division)
mean(Panama.CA.Problems$Q10.1.Participating.i
n.CoST.has.been.beneficial.Division)
sd(Panama.CA.Problems$Q10.1.Participating.in.
CoST.has.been.beneficial.Division)
mean(Honduras.CA.Problems$Q10.1.Participatin
g.in.CoST.has.been.beneficial.Division)
sd(Honduras.CA.Problems$Q10.1.Participating.in
.CoST.has.been.beneficial.Division)

#Cooperation
mean(ElSalvador.CA.Problems$Q10.1.Solutions.c
onsensual.way.Cooperation)
sd(ElSalvador.CA.Problems$Q10.1.Solutions.con
sensual.way.Cooperation)
mean(CostaRica.CA.Problems$Q10.1.Solutions.c
onsensual.way.Cooperation)
sd(CostaRica.CA.Problems$Q10.1.Solutions.cons
ensual.way.Cooperation)
mean(Guatemala.CA.Problems$Q10.1.Solutions.c
onsensual.way.Cooperation)
sd(Guatemala.CA.Problems$Q10.1.Solutions.cons
ensual.way.Cooperation)
mean(Panama.CA.Problems$Q10.1.Solutions.con
sensual.way.Cooperation)
sd(Panama.CA.Problems$Q10.1.Solutions.consen
sual.way.Cooperation)
```

```
mean(Honduras.CA.Problems$Q10.1.Solutions.co
nsensual.way.Cooperation)
sd(Honduras.CA.Problems$Q10.1.Solutions.conse
nsual.way.Cooperation)
```

```
##### ERGMs Descriptives #####
#Stabilizing the model
#El Salvador
summary(ElSalvadorNetInfo,print.adj=FALSE)
centralization(ElSalvadorNetInfo, degree)
centralization(ElSalvadorNetInfo, betweenness)
summary(ElSalvadorNetInfo ~ edges + mutual)
summary(ElSalvadorNetInfo ~ triangle + twopath
+ ttriple + ctriple)
#Costa Rica
summary(CostaRicaNetInfo,print.adj=FALSE)
centralization(CostaRicaNetInfo, degree)
centralization(CostaRicaNetInfo, betweenness)
summary(CostaRicaNetInfo ~ edges + mutual)
summary(CostaRicaNetInfo ~ triangle + twopath
+ ttriple + ctriple)
#Guatemala
summary(GuatemalaNetInfo,print.adj=FALSE)
centralization(GuatemalaNetInfo, degree)
centralization(GuatemalaNetInfo, betweenness)
summary(GuatemalaNetInfo ~ edges + mutual)
summary(GuatemalaNetInfo ~ triangle + twopath
+ ttriple + ctriple)
#Panama
summary(PanamaNetInfo,print.adj=FALSE)
centralization(PanamaNetInfo, degree)
centralization(PanamaNetInfo, betweenness)
summary(PanamaNetInfo ~ edges + mutual)
summary(PanamaNetInfo ~ triangle + twopath +
ttriple + ctriple)
#Honduras
summary(HondurasNetInfo,print.adj=FALSE)
centralization(HondurasNetInfo, degree)
centralization(HondurasNetInfo, betweenness)
summary(HondurasNetInfo ~ edges + mutual)
summary(HondurasNetInfo ~ triangle + twopath +
triple + ctriple)
```

```
#####
#####DELETED
##### ANALYSES
#####
#####
```

```
##### Risk Factor Analysis
#####
#run factor analysis, see which items should
remain for the analysis and which ones do not.
#Set up the working directory
rm(list=ls())
setwd("~/R/PhD")
#data
Risk.data<-
read.xlsx("RiskPerceptionDataset.xlsx", sheet =
"RiskAverages")
Risk.data.CoST<-cbind(Risk.data[c(12:16)])
Risk.data.MSGs<-cbind(Risk.data[c(20:22)])

#FA CoST & MSG perceptions
Risk.data.CoST.MSG<-cbind(Risk.data.CoST,
Risk.data.MSGs)
Risk.data.CoST.MSG.FA<-
fa(Risk.data.CoST.MSG, nfactors = 1, fm = "pa",
rotate = "oblimin")
print(Risk.data.CoST.MSG.FA, digits = 3)
cronbach.alpha(Risk.data.CoST.MSG,CI=TRUE)
#alpha = 0.766
#FA Cost perceptions
Risk.data.CoST.FA<-fa(Risk.data.CoST, nfactors
= 2, fm = "pa", rotate = "oblimin")
print(Risk.data.CoST.FA, digits = 3)
cronbach.alpha(Risk.data.CoST,CI=TRUE) #
alpha = 0.68
Risk.data.CoST[,c(4:5)]<- NULL
Risk.data.CoST.2<-fa(Risk.data.CoST, nfactors =
1, fm = "pa", rotate = "oblimin")
print(Risk.data.CoST.2, digits = 3)
cronbach.alpha(Risk.data.CoST,CI=TRUE) #
alpha = 0.83
#Items 1,2,3 have high FAs
#FA MSG perceptions
Risk.data.MSGs.FA<-fa(Risk.data.MSGs,
nfactors = 1, fm = "pa", rotate = "oblimin")
print(Risk.data.MSGs.FA, digits = 3)
cronbach.alpha(Risk.data.MSGs,CI=TRUE) #
alpha = 0.8
#The three items have high FAs; the first one has
lower one (0.68)
Risk.data2<-
read.xlsx("RiskPerceptionDataset.xlsx", sheet =
"RiskAverages2")
Risk.data2[,c(1:5, 7:14, 18:20)]<- NULL
#Aggregate data
```

```
Risk.data2.Agg.Sum<- Risk.data2 %>%
  group_by(OrgCodeCountryN) %>%
  summarise_each(funs(sum))
Risk.data2.Agg.Ave<- Risk.data2 %>%
  group_by(OrgCodeCountryN) %>%
  summarise_each(funs(mean))
names(Risk.data2.Agg.Ave)
#Risk variables as covariates
Risk.data2.Agg.Sum<-Risk.data2.Agg.Sum %>%
mutate(Q10.1.Country.Ind.Diff.Risk =

case_when(Q10.1.Country.Ind.Diff < 0 ~ "Risk",

Q10.1.Country.Ind.Diff > 0 ~ "No Risk"))
Risk.data2.Agg.Sum<-Risk.data2.Agg.Sum %>%
mutate(Q12.3.Country.Ind.Diff.Risk =

case_when(Q12.3.Country.Ind.Diff < 0 ~ "Risk",

Q12.3.Country.Ind.Diff > 0 ~ "No Risk"))
Risk.data2.Agg.Ave<-Risk.data2.Agg.Ave %>%
mutate(Q10.1.Country.Ind.Diff.Risk =

case_when(Q10.1.Country.Ind.Diff < 0 ~ "Risk",

Q10.1.Country.Ind.Diff > 0 ~ "No Risk"))
Risk.data2.Agg.Ave<-Risk.data2.Agg.Ave %>%
mutate(Q12.3.Country.Ind.Diff.Risk =

case_when(Q12.3.Country.Ind.Diff < 0 ~ "Risk",

Q12.3.Country.Ind.Diff > 0 ~ "No Risk"))
#Global count of risks.
AttributeData.Latam<-dplyr::filter(AttributeData,
X7GeneralInfoRegion == "Latin America")
table(AttributeData.Latam$Q10.1.CoST.Country.I
nd.Diff.Sum.Risk)
table(AttributeData.Latam$Q10.1.CoST.Country.I
nd.Diff.Ave.Risk) #no difference between ave and
sum
table(AttributeData.Latam$Q12.3.MSG.Country.I
nd.Diff.Sum.Risk)
table(AttributeData.Latam$Q12.3.MSG.Country.I
nd.Diff.Ave.Risk) #no difference between ave and
sum
#Risk perceptions as attributes
names(AttributeData[796:799])
```

```
ElSalvadorNetInfo %v% "Risk.CoST.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 796])
ElSalvadorNetInfo %v% "Risk.MSG.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 797])
ElSalvadorNetInfo %v% "Risk.CoST.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 798])
ElSalvadorNetInfo %v% "Risk.MSG.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 799])
ElSalvadorNetInfo %v% "Risk.CoST.Sum.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 800])
ElSalvadorNetInfo %v% "Risk.MSG.Sum.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 801])
ElSalvadorNetInfo %v% "Risk.CoST.Ave.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 802])
ElSalvadorNetInfo %v% "Risk.MSG.Ave.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "El Salvador", 803])
CostaRicaNetInfo %v% "Risk.CoST.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 796])
CostaRicaNetInfo %v% "Risk.MSG.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 797])
CostaRicaNetInfo %v% "Risk.CoST.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 798])
CostaRicaNetInfo %v% "Risk.MSG.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 799])
CostaRicaNetInfo %v% "Risk.CoST.Sum.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 800])
CostaRicaNetInfo %v% "Risk.MSG.Sum.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 801])
```

```
CostaRicaNetInfo %v% "Risk.CoST.Ave.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 802])
CostaRicaNetInfo %v% "Risk.MSG.Ave.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Costa Rica", 803])
GuatemalaNetInfo %v% "Risk.CoST.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 796])
GuatemalaNetInfo %v% "Risk.MSG.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 797])
GuatemalaNetInfo %v% "Risk.CoST.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 798])
GuatemalaNetInfo %v% "Risk.MSG.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 799])
GuatemalaNetInfo %v% "Risk.CoST.Sum.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 800])
GuatemalaNetInfo %v% "Risk.MSG.Sum.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 801])
GuatemalaNetInfo %v% "Risk.CoST.Ave.Risk"
<-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 802])
GuatemalaNetInfo %v% "Risk.MSG.Ave.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Guatemala", 803])
PanamaNetInfo %v% "Risk.CoST.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 796])
PanamaNetInfo %v% "Risk.MSG.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 797])
PanamaNetInfo %v% "Risk.CoST.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 798])
PanamaNetInfo %v% "Risk.MSG.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 799])
PanamaNetInfo %v% "Risk.CoST.Sum.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 800])
```

```
PanamaNetInfo %v% "Risk.MSG.Sum.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 801])
PanamaNetInfo %v% "Risk.CoST.Ave.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 802])
PanamaNetInfo %v% "Risk.MSG.Ave.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Panama", 803])
HondurasNetInfo %v% "Risk.CoST.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 796])
HondurasNetInfo %v% "Risk.MSG.Sum" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 797])
HondurasNetInfo %v% "Risk.CoST.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 798])
HondurasNetInfo %v% "Risk.MSG.Ave" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 799])
HondurasNetInfo %v% "Risk.CoST.Sum.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 800])
HondurasNetInfo %v% "Risk.MSG.Sum.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 801])
HondurasNetInfo %v% "Risk.CoST.Ave.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 802])
HondurasNetInfo %v% "Risk.MSG.Ave.Risk" <-
as.vector(AttributeData[AttributeData$X8General
InfoCountry == "Honduras", 803])
get.vertex.attribute(PanamaNetInfo,
"Risk.CoST.Ave")
#Descriptive of variables
#Countries' count of risks.
table(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.CoST.Ave.Risk"))
table(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.CoST.Sum.Risk"))
table(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.MSG.Ave.Risk"))
table(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.MSG.Sum.Risk"))
table(get.vertex.attribute(CostaRicaNetInfo,
"Risk.CoST.Ave.Risk"))
table(get.vertex.attribute(CostaRicaNetInfo,
"Risk.CoST.Sum.Risk"))
```

```
table(get.vertex.attribute(CostaRicaNetInfo,
"Risk.MSG.Ave.Risk"))
table(get.vertex.attribute(CostaRicaNetInfo,
"Risk.MSG.Sum.Risk"))
table(get.vertex.attribute(GuatemalaNetInfo,
"Risk.CoST.Ave.Risk"))
table(get.vertex.attribute(GuatemalaNetInfo,
"Risk.CoST.Sum.Risk"))
table(get.vertex.attribute(GuatemalaNetInfo,
"Risk.MSG.Ave.Risk"))
table(get.vertex.attribute(GuatemalaNetInfo,
"Risk.MSG.Sum.Risk"))
table(get.vertex.attribute(HondurasNetInfo,
"Risk.CoST.Ave.Risk"))
table(get.vertex.attribute(HondurasNetInfo,
"Risk.CoST.Sum.Risk"))
table(get.vertex.attribute(HondurasNetInfo,
"Risk.MSG.Ave.Risk"))
table(get.vertex.attribute(HondurasNetInfo,
"Risk.MSG.Sum.Risk"))
table(get.vertex.attribute(PanamaNetInfo,
"Risk.CoST.Ave.Risk"))
table(get.vertex.attribute(PanamaNetInfo,
"Risk.CoST.Sum.Risk"))
table(get.vertex.attribute(PanamaNetInfo,
"Risk.MSG.Ave.Risk"))
table(get.vertex.attribute(PanamaNetInfo,
"Risk.MSG.Sum.Risk")) #um and ave have the
same results
#Countries' descriptive of risks.
##Institutional risk
get.vertex.attribute(HondurasNetInfo,
"Risk.CoST.Ave")
mean(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.CoST.Ave"))
sd(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.CoST.Ave"))
mean(get.vertex.attribute(CostaRicaNetInfo,
"Risk.CoST.Ave"))
sd(get.vertex.attribute(CostaRicaNetInfo,
"Risk.CoST.Ave"))
mean(get.vertex.attribute(GuatemalaNetInfo,
"Risk.CoST.Ave"))
sd(get.vertex.attribute(GuatemalaNetInfo,
"Risk.CoST.Ave"))
mean(get.vertex.attribute(HondurasNetInfo,
"Risk.CoST.Ave"))
sd(get.vertex.attribute(HondurasNetInfo,
"Risk.CoST.Ave"))
```



```
mean(get.vertex.attribute(PanamaNetInfo,
"Risk.CoST.Ave"))
sd(get.vertex.attribute(PanamaNetInfo,
"Risk.CoST.Ave"))
#Governance model risk
mean(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.MSG.Ave"))
sd(get.vertex.attribute(ElSalvadorNetInfo,
"Risk.MSG.Ave"))
mean(get.vertex.attribute(CostaRicaNetInfo,
"Risk.MSG.Ave"))
sd(get.vertex.attribute(CostaRicaNetInfo,
"Risk.MSG.Ave"))
mean(get.vertex.attribute(GuatemalaNetInfo,
"Risk.MSG.Ave"))
sd(get.vertex.attribute(GuatemalaNetInfo,
"Risk.MSG.Ave"))
mean(get.vertex.attribute(HondurasNetInfo,
"Risk.MSG.Ave"))
sd(get.vertex.attribute(HondurasNetInfo,
"Risk.MSG.Ave"))
mean(get.vertex.attribute(PanamaNetInfo,
"Risk.MSG.Ave"))
sd(get.vertex.attribute(PanamaNetInfo,
"Risk.MSG.Ave"))

#####
VISUALISATIONS
#####
##### Individual Value
Networks preparation for Chord Diags
#####
ElSalvador.Dat.Val<-
read.csv("ElSalvador.RawMatricesR.New.csv")
CostaRica.Dat.Val<-
read.csv("CostaRica.RawMatricesR.New.csv")
Guatemala.Dat.Val<-
read.csv("Guatemala.RawMatricesR.New.csv")
Panama.Dat.Val<-
read.csv("Panama.RawMatricesR.New.csv")
Honduras.Dat.Val<-
read.csv("Honduras.RawMatricesR.New.csv")
##Global attributes
Global.Attributes<-
read.csv("AllCountriesCompleteDataset6.Org.Sec
.csv")
```

```
ElSalvador.Attr<-dplyr::filter(Global.Attributes,
X8GeneralInfoCountry == "El Salvador")
CostaRica.Attr<-dplyr::filter(Global.Attributes,
X8GeneralInfoCountry == "Costa Rica")
Guatemala.Attr<-dplyr::filter(Global.Attributes,
X8GeneralInfoCountry == "Guatemala")
Panama.Attr<-dplyr::filter(Global.Attributes,
X8GeneralInfoCountry == "Panama")
Honduras.Attr<-dplyr::filter(Global.Attributes,
X8GeneralInfoCountry == "Honduras")

##Information exchange value networks
#El Salvador
ElSalvador.Info.Val<-
dplyr::filter(ElSalvador.Dat.Val, Question ==
"Q9.2InfoShared")
ElSalvador.Info.Val<-
dplyr::filter(ElSalvador.Info.Val,
Network.Validation != c("Aggregation - Max",
"Aggregation - Average", "Aggregation - Sum"))
##remove unnecessary columns
ElSalvador.Info.Val[,c(1:4, 6:10, 21:76)]<- NULL
##Adjusting names
ElSalvador.Info.Val <-
dplyr::rename(ElSalvador.Info.Val,
"Assurance.Team" = "CoST.Assurance.Team")
ElSalvador.Info.Val <-
dplyr::rename(ElSalvador.Info.Val,
"National.Secretariat" =
"CoST.National.Secretariat")
ElSalvador.Info.Val$RaterOrg[which(ElSalvador.
Info.Val$RaterOrg == "CoST Assurance Team")]
<- "Assurance Team"
ElSalvador.Info.Val$RaterOrg[which(ElSalvador.
Info.Val$RaterOrg == "CoST National
Secretariat")] <- "National Secretariat"
##Re-ordering of column names and rows
ElSalvador.Info.Val<-
ElSalvador.Info.Val[base::order(colnames(ElSalv
ador.Info.Val))]
ElSalvador.Info.Val<- ElSalvador.Info.Val %>%
dplyr::select(c("RaterOrg"), everything())
##Aggregate responses by sum
ElSalvador.Info.Val.Agg.Sum<-
ElSalvador.Info.Val %>% #step to chek names
are ordered
      group_by(RaterOrg) %>%
      summarise_each(funs(sum))
##Add names of sectors
```

```
ElSalvador.Info.Val.Aggr.Sum<-
as.data.frame(ElSalvador.Info.Val.Aggr.Sum)
rownames(ElSalvador.Info.Val.Aggr.Sum)<-
ElSalvador.Attr$OrgCode
ElSalvador.Info.Val.Aggr.Sum$RaterOrg<-NULL
ElSalvador.Info.Val.Aggr.Sum<-
as.data.frame(t(ElSalvador.Info.Val.Aggr.Sum))
rownames(ElSalvador.Info.Val.Aggr.Sum)<-
ElSalvador.Attr$OrgCode
##Reshape with melt long format
ElSalvador.Info.Val.Aggr.Sum.Edge<-
reshape2::melt(as.matrix(ElSalvador.Info.Val.Aggr
.Sum, value.name = "value"))
#Change names of sector to aggregate them / gsub
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1 <-
gsub('[0-9.]', '',
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1)
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2 <-
gsub('[0-9.]', '',
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2)
#Final aggregation by sector
ElSalvador.Info.Val.Aggr.Sum.Edge<-
ElSalvador.Info.Val.Aggr.Sum.Edge %>%
  group_by(Var1,Var2) %>%
  summarise_each(funs(sum))
#Add complete names of sectors
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"CS"]="Civil society"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"PrivS"]="Private sector"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"PriS"]="Private sector"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"PubS"]="Public sector"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"NS"]="National Secretariat"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"AT"]="Assurance Team"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"Aca"]="Academia"
```

```
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"Med"]="Media"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var1[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var1 ==
"Obs"]="Observers"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"CS"]="Civil society"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"PrivS"]="Private sector"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"PriS"]="Private sector"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"PubS"]="Public sector"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"NS"]="National Secretariat"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"AT"]="Assurance Team"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"Aca"]="Academia"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"Med"]="Media"
ElSalvador.Info.Val.Aggr.Sum.Edge$Var2[ElSalv
ador.Info.Val.Aggr.Sum.Edge$Var2 ==
"Obs"]="Observers"
##Transformation to edgelist format
library(statnet)
ElSalvador.Info.Val.Aggr.Sum.Net <-
network(ElSalvador.Info.Val.Aggr.Sum.Edge,
vertex.attrnames = TRUE, ignore.eval = FALSE,
loops = TRUE, matrix.type = "edgelist")
summary(ElSalvador.Info.Val.Aggr.Sum.Net,
print.adj = T)
##add attributes
ElSalvador.Info.Val.Aggr.Sum.Net %v% "color"<-
c("orange", "gold", "green", "yellow", "blue",
"red")
get.vertex.attribute(ElSalvador.Info.Val.Aggr.Sum.
Net, "vertex.names")
##Chord Diagrams
```

```
ElSalvador.Order.ChordD<-data.frame(Sector =
get.vertex.attribute(ElSalvador.Info.Val.Agg.Sum.
Net, "vertex.names"),
                                Color =
get.vertex.attribute(ElSalvador.Info.Val.Agg.Sum.
Net, "color"))
ElSalvador.Order.ChordD<-
arrange(ElSalvador.Order.ChordD, desc(Sector))
ElSalvador.Order.ChordD.Sector<-
dplyr::pull(ElSalvador.Order.ChordD, Sector)
ElSalvador.Order.ChordD.Grid.Col<-
dplyr::pull(ElSalvador.Order.ChordD, Color,
Sector)
chordDiagram(ElSalvador.Info.Val.Agg.Sum.Edge,
              order = ElSalvador.Order.ChordD.Sector,
              grid.col =
ElSalvador.Order.ChordD.Grid.Col,
              transparency = 0.5,
              directional = 1,
              direction.type = c("arrows", "diffHeight"),
              diffHeight = -0.04,
              link.arr.type = "big.arrow",
              annotationTrack = c("grid", "name",
"axis"),
              annotationTrackHeight = c(0.02, 0.05),
              link.sort = TRUE,
              link.largest.ontop = TRUE)
```

```
#Costa Rica
CostaRica.Info.Val<-
dplyr::filter(CostaRica.Dat.Val, Question ==
"Q9.2InfoShared")
CostaRica.Info.Val<-
dplyr::filter(CostaRica.Info.Val,
Network.Validation != c("Aggregation - Max",
"Aggregation - Average", "Aggregation - Sum"))
##remove unnecessary columns
CostaRica.Info.Val[,c(1:4, 6:10, 26:81)]<- NULL
##Adjusting names
CostaRica.Info.Val <-
dplyr::rename(CostaRica.Info.Val,
"Assurance.Team" = "CoST.Assurance.Team")
CostaRica.Info.Val <-
dplyr::rename(CostaRica.Info.Val,
"National.Secretariat" =
"CoST.National.Secretariat")
```

```
CostaRica.Info.Val$RaterOrg[which(CostaRica.In
fo.Val$RaterOrg == "CoST Assurance Team")] <-
"Assurance Team"
CostaRica.Info.Val$RaterOrg[which(CostaRica.In
fo.Val$RaterOrg == "CoST National
Secretariat")] <- "National Secretariat"
##Re-ordering of column names and rows
CostaRica.Info.Val<-
CostaRica.Info.Val[base::order(colnames(CostaRi
ca.Info.Val))]
CostaRica.Info.Val<- CostaRica.Info.Val %>%
dplyr::select(c("RaterOrg"), everything())
CostaRica.Info.Val$Colegio.Federado.de.Ingenier
os.y.Arquitectos<-NULL
CostaRica.Info.Val$Laboratorio.Nacional.de.Mate
riales.y.Modelos.Estructurales<-NULL
##Aggregate responses by sum
CostaRica.Info.Val.Agg.Sum<-
CostaRica.Info.Val %>% #step to chek names are
ordered
              group_by(RaterOrg) %>%
              summarise_each(funs(sum))
##Add names of sectors
CostaRica.Info.Val.Agg.Sum<-
as.data.frame(CostaRica.Info.Val.Agg.Sum)
rownames(CostaRica.Info.Val.Agg.Sum)<-
CostaRica.Attr$OrgCode
CostaRica.Info.Val.Agg.Sum$RaterOrg<-NULL
CostaRica.Info.Val.Agg.Sum<-
as.data.frame(t(CostaRica.Info.Val.Agg.Sum))
rownames(CostaRica.Info.Val.Agg.Sum)<-
CostaRica.Attr$OrgCode
##Reshape with melt long format
CostaRica.Info.Val.Agg.Sum.Edge<-
reshape2::melt(as.matrix(CostaRica.Info.Val.Agg.
Sum, value.name = "value"))
#Change names of sector to aggregate them / gsub
CostaRica.Info.Val.Agg.Sum.Edge$Var1 <-
gsub('[0-9.]', "",
CostaRica.Info.Val.Agg.Sum.Edge$Var1)
CostaRica.Info.Val.Agg.Sum.Edge$Var2 <-
gsub('[0-9.]', "",
CostaRica.Info.Val.Agg.Sum.Edge$Var2)
#Final aggregation by sector
CostaRica.Info.Val.Agg.Sum.Edge<-
CostaRica.Info.Val.Agg.Sum.Edge %>%
              group_by(Var1, Var2) %>%
              summarise_each(funs(sum))
#Add complete names of sectors
```

```
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"CS"]="Civil society"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"PrivS"]="Private sector"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"PriS"]="Private sector"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"PubS"]="Public sector"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"NS"]="National Secretariat"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"AT"]="Assurance Team"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"Aca"]="Academia"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"Med"]="Media"
CostaRica.Info.Val.Agg.Sum.Edge$Var1[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var1 ==
"Obs"]="Observers"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"CS"]="Civil society"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"PrivS"]="Private sector"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"PriS"]="Private sector"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"PubS"]="Public sector"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"NS"]="National Secretariat"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"AT"]="Assurance Team"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"Aca"]="Academia"
```

```
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"Med"]="Media"
CostaRica.Info.Val.Agg.Sum.Edge$Var2[CostaRi
ca.Info.Val.Agg.Sum.Edge$Var2 ==
"Obs"]="Observers"
##Transformation to edgelist format
CostaRica.Info.Val.Agg.Sum.Net <-
network(CostaRica.Info.Val.Agg.Sum.Edge,
vertex.attrnames = TRUE, ignore.eval = FALSE,
loops = TRUE, matrix.type = "edgelist")
summary(CostaRica.Info.Val.Agg.Sum.Net,
print.adj = T)
##add attributes
CostaRica.Info.Val.Agg.Sum.Net %v% "color"<-
c("gold", "green", "yellow", "purple", "blue",
"red")
get.vertex.attribute(CostaRica.Info.Val.Agg.Sum.
Net, "color")
##Chord Diagrams
CostaRica.Order.ChordD<-data.frame(Sector =
get.vertex.attribute(CostaRica.Info.Val.Agg.Sum.
Net, "vertex.names"),
Color =
get.vertex.attribute(CostaRica.Info.Val.Agg.Sum.
Net, "color"))
CostaRica.Order.ChordD<-
arrange(CostaRica.Order.ChordD, desc(Sector))
CostaRica.Order.ChordD.Sector<-
dplyr::pull(CostaRica.Order.ChordD, Sector)
CostaRica.Order.ChordD.Grid.Col<-
dplyr::pull(CostaRica.Order.ChordD, Color,
Sector)
chordDiagram(CostaRica.Info.Val.Agg.Sum.Edge
,
order = CostaRica.Order.ChordD.Sector,
grid.col =
CostaRica.Order.ChordD.Grid.Col,
transparency = 0.5,
directional = 1,
direction.type = c("arrows", "diffHeight"),
diffHeight = -0.04,
link.arr.type = "big.arrow",
annotationTrack = c("grid", "name",
"axis"),
annotationTrackHeight = c(0.02, 0.05),
link.sort = TRUE,
link.largest.ontop = TRUE)
```

```
#Guatemala
Guatemala.Info.Val<-
dplyr::filter(Guatemala.Dat.Val, Question ==
"Q9.2InfoShared")
Guatemala.Info.Val<-
dplyr::filter(Guatemala.Info.Val,
Network.Validation != c("Aggregation - Max",
"Aggregation - Average", "Aggregation - Sum"))
##remove unnecessary columns
Guatemala.Info.Val[,c(1:4, 6:10, 26:81)]<- NULL
##Adjusting names
Guatemala.Info.Val <-
dplyr::rename(Guatemala.Info.Val,
"Assurance.Team" = "CoST.Assurance.Team")
Guatemala.Info.Val <-
dplyr::rename(Guatemala.Info.Val,
"National.Secretariat" =
"CoST.National.Secretariat")
Guatemala.Info.Val$RaterOrg[which(Guatemala.I
nfo.Val$RaterOrg == "CoST Assurance Team")]
<- "Assurance Team"
Guatemala.Info.Val$RaterOrg[which(Guatemala.I
nfo.Val$RaterOrg == "CoST National
Secretariat")] <- "National Secretariat"
##Re-ordering of column names and rows
Guatemala.Info.Val<-
Guatemala.Info.Val[base::order(colnames(Guatem
ala.Info.Val))]
Guatemala.Info.Val<- Guatemala.Info.Val %>%
dplyr::select(c("RaterOrg"), everything())
Guatemala.Info.Val$Ministerio.de.Comunicacion
<-NULL
Guatemala.Info.Val$World.Bank<-NULL
##Aggregate responses by sum
Guatemala.Info.Val.Aggr.Sum<-
Guatemala.Info.Val %>% #step to chek names are
ordered
  group_by(RaterOrg) %>%
  summarise_each(funs(sum))
##Add names of sectors
Guatemala.Info.Val.Aggr.Sum<-
as.data.frame(Guatemala.Info.Val.Aggr.Sum)
rownames(Guatemala.Info.Val.Aggr.Sum)<-
Guatemala.Attr$OrgCode
Guatemala.Info.Val.Aggr.Sum$RaterOrg<-NULL
Guatemala.Info.Val.Aggr.Sum<-
as.data.frame(t(Guatemala.Info.Val.Aggr.Sum))
rownames(Guatemala.Info.Val.Aggr.Sum)<-
Guatemala.Attr$OrgCode
```

```
##Reshape with melt long format
Guatemala.Info.Val.Aggr.Sum.Edge<-
reshape2::melt(as.matrix(Guatemala.Info.Val.Aggr
.Sum, value.name = "value"))
#Change names of sector to aggregate them / gsub
Guatemala.Info.Val.Aggr.Sum.Edge$Var1 <-
gsub('[0-9.], ', ',
Guatemala.Info.Val.Aggr.Sum.Edge$Var1)
Guatemala.Info.Val.Aggr.Sum.Edge$Var2 <-
gsub('[0-9.], ', ',
Guatemala.Info.Val.Aggr.Sum.Edge$Var2)
#Final aggregation by sector
Guatemala.Info.Val.Aggr.Sum.Edge<-
Guatemala.Info.Val.Aggr.Sum.Edge %>%
  group_by(Var1,Var2) %>%
  summarise_each(funs(sum))
#Add complete names of sectors
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"CS"]="Civil society"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"PrivS"]="Private sector"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"PriS"]="Private sector"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"PubS"]="Public sector"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"NS"]="National Secretariat"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"AT"]="Assurance Team"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"Aca"]="Academia"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"Med"]="Media"
Guatemala.Info.Val.Aggr.Sum.Edge$Var1[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var1 ==
"Obs"]="Observers"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatem
ala.Info.Val.Aggr.Sum.Edge$Var2 ==
"CS"]="Civil society"
```

```
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "PrivS"]="Private sector"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "PriS"]="Private sector"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "PubS"]="Public sector"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "NS"]="National Secretariat"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "AT"]="Assurance Team"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "Aca"]="Academia"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "Med"]="Media"
Guatemala.Info.Val.Aggr.Sum.Edge$Var2[Guatemala.Info.Val.Aggr.Sum.Edge$Var2 == "Obs"]="Observers"
##Transformation to edgelist format
Guatemala.Info.Val.Aggr.Sum.Net <-
network(Guatemala.Info.Val.Aggr.Sum.Edge,
vertex.attrnames = TRUE, ignore.eval = FALSE,
loops = TRUE, matrix.type = "edgelist")
summary(Guatemala.Info.Val.Aggr.Sum.Net,
print.adj = T)
##add attributes
Guatemala.Info.Val.Aggr.Sum.Net %v% "color"<-
c("gold", "green", "yellow", "purple", "blue",
"red")
get.vertex.attribute(Guatemala.Info.Val.Aggr.Sum.
Net, "color")
##Chord Diagrams
Guatemala.Order.ChordD<-data.frame(Sector =
get.vertex.attribute(Guatemala.Info.Val.Aggr.Sum.
Net, "vertex.names"),
Color =
get.vertex.attribute(Guatemala.Info.Val.Aggr.Sum.
Net, "color"))
Guatemala.Order.ChordD<-
arrange(Guatemala.Order.ChordD, desc(Sector))
Guatemala.Order.ChordD.Sector<-
dplyr::pull(Guatemala.Order.ChordD, Sector)
```

```
Guatemala.Order.ChordD.Grid.Col<-
dplyr::pull(Guatemala.Order.ChordD, Color,
Sector)
chordDiagram(Guatemala.Info.Val.Aggr.Sum.Edge,
order = Guatemala.Order.ChordD.Sector,
grid.col =
Guatemala.Order.ChordD.Grid.Col,
transparency = 0.5,
directional = 1,
direction.type = c("arrows", "diffHeight"),
diffHeight = -0.04,
link.arr.type = "big.arrow",
annotationTrack = c("grid", "name",
"axis"),
annotationTrackHeight = c(0.02, 0.05),
link.sort = TRUE,
link.largest.ontop = TRUE)

#Panama
Panama.Info.Val<-dplyr::filter(Panama.Dat.Val,
Question == "Q9.2InfoShared")
Panama.Info.Val<-dplyr::filter(Panama.Info.Val,
Network.Validation != c("Aggregation - Max",
"Aggregation - Average", "Aggregation - Sum"))
##remove unnecessary columns
Panama.Info.Val[,c(1:4, 6:10, 24:79)]<- NULL
##Adjusting names
Panama.Info.Val <-
dplyr::rename(Panama.Info.Val,
"Assurance.Team" = "CoST.Assurance.Team")
Panama.Info.Val <-
dplyr::rename(Panama.Info.Val,
"National.Secretariat" =
"CoST.National.Secretariat")
Panama.Info.Val$RaterOrg[which(Panama.Info.Val$RaterOrg == "CoST Assurance Team")] <-
"Assurance Team"
Panama.Info.Val$RaterOrg[which(Panama.Info.Val$RaterOrg == "CoST National Secretariat")] <-
"National Secretariat"
##Re-ordering of column names and rows
Panama.Info.Val<-
Panama.Info.Val[base::order(colnames(Panama.Info.Val))]
Panama.Info.Val<- Panama.Info.Val %>%
dplyr::select(c("RaterOrg"), everything())
Panama.Info.Val$Assurance.Team<-NULL
##Aggregate responses by sum
```

```
Panama.Info.Val.Agg.Sum<- Panama.Info.Val
%>% #step to chek names are ordered
  group_by(RaterOrg) %>%
  summarise_each(funs(sum))
##Add names of sectors
Panama.Info.Val.Agg.Sum<-
as.data.frame(Panama.Info.Val.Agg.Sum)
rownames(Panama.Info.Val.Agg.Sum)<-
Panama.Attr$OrgCode
Panama.Info.Val.Agg.Sum$RaterOrg<-NULL
Panama.Info.Val.Agg.Sum<-
as.data.frame(t(Panama.Info.Val.Agg.Sum))
rownames(Panama.Info.Val.Agg.Sum)<-
Panama.Attr$OrgCode
##Reshape with melt long format
Panama.Info.Val.Agg.Sum.Edge<-
reshape2::melt(as.matrix(Panama.Info.Val.Agg.Su
m, value.name = "value"))
#Change names of sector to aggregate them / gsub
Panama.Info.Val.Agg.Sum.Edge$Var1 <-
gsub('[0-9.]', '',
Panama.Info.Val.Agg.Sum.Edge$Var1)
Panama.Info.Val.Agg.Sum.Edge$Var2 <-
gsub('[0-9.]', '',
Panama.Info.Val.Agg.Sum.Edge$Var2)
#Final aggregation by sector
Panama.Info.Val.Agg.Sum.Edge<-
Panama.Info.Val.Agg.Sum.Edge %>%
  group_by(Var1,Var2) %>%
  summarise_each(funs(sum))
#Add complete names of sectors
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 == "CS"]="Civil
society"
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 == "PrivS"]="Private
sector"
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 == "PriS"]="Private
sector"
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 == "PubS"]="Public
sector"
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 == "NS"]="National
Secretariat"
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 ==
"AT"]="Assurance Team"
```

```
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 ==
"Aca"]="Academia"
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 == "Med"]="Media"
Panama.Info.Val.Agg.Sum.Edge$Var1[Panama.In
fo.Val.Agg.Sum.Edge$Var1 ==
"Obs"]="Observers"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 == "CS"]="Civil
society"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 == "PrivS"]="Private
sector"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 == "PriS"]="Private
sector"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 == "PubS"]="Public
sector"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 == "NS"]="National
Secretariat"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 ==
"AT"]="Assurance Team"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 ==
"Aca"]="Academia"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 == "Med"]="Media"
Panama.Info.Val.Agg.Sum.Edge$Var2[Panama.In
fo.Val.Agg.Sum.Edge$Var2 ==
"Obs"]="Observers"
##Transformation to edgelist format
Panama.Info.Val.Agg.Sum.Net <-
network(Panama.Info.Val.Agg.Sum.Edge,
vertex.attrnames = TRUE, ignore.eval = FALSE,
loops = TRUE, matrix.type = "edgelist")
summary(Panama.Info.Val.Agg.Sum.Net,
print.adj = T)
##add attributes
Panama.Info.Val.Agg.Sum.Net %v% "color"<-
c("green", "yellow", "purple", "blue", "red")
get.vertex.attribute(Panama.Info.Val.Agg.Sum.Ne
t, "color")
##Chord Diagrams
```

```
Panama.Order.ChordD<-data.frame(Sector =
get.vertex.attribute(Panama.Info.Val.Agg.Sum.Ne
t, "vertex.names"),
      Color =
get.vertex.attribute(Panama.Info.Val.Agg.Sum.Ne
t, "color"))
Panama.Order.ChordD<-
arrange(Panama.Order.ChordD, desc(Sector))
Panama.Order.ChordD.Sector<-
dplyr::pull(Panama.Order.ChordD, Sector)
Panama.Order.ChordD.Grid.Col<-
dplyr::pull(Panama.Order.ChordD, Color, Sector)
chordDiagram(Panama.Info.Val.Agg.Sum.Edge,
  order = Panama.Order.ChordD.Sector,
  grid.col =
Panama.Order.ChordD.Grid.Col,
  transparency = 0.5,
  directional = 1,
  direction.type = c("arrows", "diffHeight"),
  diffHeight = -0.04,
  link.arr.type = "big.arrow",
  annotationTrack = c("grid", "name",
"axis"),
  annotationTrackHeight = c(0.02, 0.05),
  link.sort = TRUE,
  link.largest.ontop = TRUE)
```

```
#Honduras
Honduras.Info.Val<-
dplyr::filter(Honduras.Dat.Val, Question ==
"Q9.2InfoShared")
Honduras.Info.Val<-
dplyr::filter(Honduras.Info.Val,
Network.Validation != c("Aggregation - Max",
"Aggregation - Average", "Aggregation - Sum"))
##remove unnecessary columns
Honduras.Info.Val[,c(1:4, 6:10, 22:69)]<- NULL
##Adjusting names
Honduras.Info.Val <-
dplyr::rename(Honduras.Info.Val,
"Assurance.Team" = "CoST.Assurance.Team")
Honduras.Info.Val <-
dplyr::rename(Honduras.Info.Val,
"National.Secretariat" =
"CoST.National.Secretariat")
Honduras.Info.Val$RaterOrg[which(Honduras.Inf
o.Val$RaterOrg == "CoST Assurance Team")] <-
"Assurance Team"
```

```
Honduras.Info.Val$RaterOrg[which(Honduras.Inf
o.Val$RaterOrg == "CoST National Secretariat")]
<- "National Secretariat"
##Re-ordering of column names and rows
Honduras.Info.Val<-
Honduras.Info.Val[base::order(colnames(Hondura
s.Info.Val))]
Honduras.Info.Val<- Honduras.Info.Val %>%
dplyr::select(c("RaterOrg"), everything())
##Aggregate responses by sum
Honduras.Info.Val.Agg.Sum<- Honduras.Info.Val
%>% #step to chek names are ordered
  group_by(RaterOrg) %>%
  summarise_each(funs(sum))
##Add names of sectors
Honduras.Info.Val.Agg.Sum<-
as.data.frame(Honduras.Info.Val.Agg.Sum)
rownames(Honduras.Info.Val.Agg.Sum)<-
Honduras.Attr$OrgCode
Honduras.Info.Val.Agg.Sum$RaterOrg<-NULL
Honduras.Info.Val.Agg.Sum<-
as.data.frame(t(Honduras.Info.Val.Agg.Sum))
rownames(Honduras.Info.Val.Agg.Sum)<-
Honduras.Attr$OrgCode
##Reshape with melt long format
Honduras.Info.Val.Agg.Sum.Edge<-
reshape2::melt(as.matrix(Honduras.Info.Val.Agg.
Sum, value.name = "value"))
#Change names of sector to aggregate them / gsub
Honduras.Info.Val.Agg.Sum.Edge$Var1 <-
gsub('[0-9.]', "",
Honduras.Info.Val.Agg.Sum.Edge$Var1)
Honduras.Info.Val.Agg.Sum.Edge$Var2 <-
gsub('[0-9.]', "",
Honduras.Info.Val.Agg.Sum.Edge$Var2)
#Final aggregation by sector
Honduras.Info.Val.Agg.Sum.Edge<-
Honduras.Info.Val.Agg.Sum.Edge %>%
  group_by(Var1,Var2) %>%
  summarise_each(funs(sum))
#Add complete names of sectors
Honduras.Info.Val.Agg.Sum.Edge$Var1[Hondura
s.Info.Val.Agg.Sum.Edge$Var1 == "CS"]="Civil
society"
Honduras.Info.Val.Agg.Sum.Edge$Var1[Hondura
s.Info.Val.Agg.Sum.Edge$Var1 ==
"PrivS"]="Private sector"
```



```
Honduras.Info.Val.Agg.Sum.Edge$Var1[Honduras.Info.Val.Agg.Sum.Edge$Var1 ==
"PriS"]="Private sector"
Honduras.Info.Val.Agg.Sum.Edge$Var1[Honduras.Info.Val.Agg.Sum.Edge$Var1 ==
"PubS"]="Public sector"
Honduras.Info.Val.Agg.Sum.Edge$Var1[Honduras.Info.Val.Agg.Sum.Edge$Var1 ==
"NS"]="National Secretariat"
Honduras.Info.Val.Agg.Sum.Edge$Var1[Honduras.Info.Val.Agg.Sum.Edge$Var1 ==
"AT"]="Assurance Team"
Honduras.Info.Val.Agg.Sum.Edge$Var1[Honduras.Info.Val.Agg.Sum.Edge$Var1 ==
"Aca"]="Academia"
Honduras.Info.Val.Agg.Sum.Edge$Var1[Honduras.Info.Val.Agg.Sum.Edge$Var1 ==
"Med"]="Media"
Honduras.Info.Val.Agg.Sum.Edge$Var1[Honduras.Info.Val.Agg.Sum.Edge$Var1 ==
"Obs"]="Observers"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 == "CS"]="Civil
society"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"PrivS"]="Private sector"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"PriS"]="Private sector"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"PubS"]="Public sector"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"NS"]="National Secretariat"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"AT"]="Assurance Team"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"Aca"]="Academia"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"Med"]="Media"
Honduras.Info.Val.Agg.Sum.Edge$Var2[Honduras.Info.Val.Agg.Sum.Edge$Var2 ==
"Obs"]="Observers"
##Transformation to edgelist format
```

```
Honduras.Info.Val.Agg.Sum.Net <-
network(Honduras.Info.Val.Agg.Sum.Edge,
vertex.attrnames = TRUE, ignore.eval = FALSE,
loops = TRUE, matrix.type = "edgelist")
summary(Honduras.Info.Val.Agg.Sum.Net,
print.adj = T)
##add attributes
Honduras.Info.Val.Agg.Sum.Net %v% "color"<-
c("gold", "green", "yellow", "blue", "red")
get.vertex.attribute(Honduras.Info.Val.Agg.Sum.
Net, "color")
##Chord Diagrams
Honduras.Order.ChordD<-data.frame(Sector =
get.vertex.attribute(Honduras.Info.Val.Agg.Sum.
Net, "vertex.names"),
Color =
get.vertex.attribute(Honduras.Info.Val.Agg.Sum.
Net, "color"))
Honduras.Order.ChordD<-
arrange(Honduras.Order.ChordD, desc(Sector))
Honduras.Order.ChordD.Sector<-
dplyr::pull(Honduras.Order.ChordD, Sector)
Honduras.Order.ChordD.Grid.Col<-
dplyr::pull(Honduras.Order.ChordD, Color,
Sector)
chordDiagram(Honduras.Info.Val.Agg.Sum.Edge,
order = Honduras.Order.ChordD.Sector,
grid.col =
Honduras.Order.ChordD.Grid.Col,
transparency = 0.5,
directional = 1,
direction.type = c("arrows", "diffHeight"),
diffHeight = -0.04,
link.arr.type = "big.arrow",
annotationTrack = c("grid", "name",
"axis"),
annotationTrackHeight = c(0.02, 0.05),
link.sort = TRUE,
link.largest.ontop = TRUE)
```