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The multiplicity of value in the front-end of projects: The case of London transportation infrastructure

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ABSTRACT

There is growing interest in the ways that value is understood in the context of projects and within project-based settings. Recent studies emphasise the multiplicity of project value in various project settings as perceived by different project actors. Drawing on previous work on project value and project front-end, this study expands on the idea of multiplicity of project value in the early project definition phase. To this end, the study draws from empirical data on infrastructure projects provision, including semi-structured interviews with a set of highly experienced and senior level informants with extensive knowledge and familiarity of infrastructure project planning and front-end decision making. The study is bounded with a focus on London, UK as an example of a complex, highly established global city with a great reliance on its infrastructure and a well-established projects ecology. Through inductive qualitative data analysis the study explores the role of infrastructure projects as solutions to policy problems, the multiple and complex nature of value in project definition and identifies three value levels, which are instrumental for project definition: local value, sector value and user value. The multi-level value framework in the project front-end extends and complements early decision making in planning and setting up of infrastructure projects.

Introduction

It has been widely acknowledged that the justification of a project should be based on long-term benefits that will be realized after the project is delivered (Morris and Hough, 1987; Morris, 2013). These arguments are often discussed in the context of 'value', which will accrue in different forms as a result of the project being undertaken (Laursen and Svejvig, 2016). Moreover, it has been increasingly acknowledged that the value for the project is established in the project's front-end where key decisions on project execution, operations and use outcomes are made (Artto et al., 2016; Edkins et al., 2013; Samset and Volden, 2016). Value has been receiving increasing attention in project scholarship (Fuentes et al., 2019; Green and Sergeeva, 2018; Riis et al., 2019) through an emergent body of work suggesting different facets of value, such as 'value as worth' and 'value as ideals' (Martinsuo et al., 2019a). However, a clear articulation of the understanding of value and its role in the definition of projects is very scarce. This is surprising, because justifications of project value drive project definition and initiation, a key point in the realisation of any project. The value argument is usually based on the anticipated future benefits that will materialise out of the project (Laursen and Svejvig, 2016). This argument is often promoted and enacted by actors in the project front-end who play an important role in mobilizing the support and stakeholders to get the project off the ground (Flyvbjerg et al., 2018).

This understanding of value is particularly relevant for infrastructure projects (supporting, for example, transportation, energy, water, waste and ICT systems) that are planned and delivered through a project-based organisation working with diverse groups of stakeholders, typically spanning public and private sector. Infrastructure projects can be seen as a class of policy interventions that provide wide groups of users and the public with essential services. The establishment and understanding of value in the project front-end is critical to justify the investment and obtain stakeholder commitment, which allows the infrastructure project to be initiated.

Existing research broadly addresses some aspects of value in infrastructure projects, mainly focusing on either poor performance (downside) or positive externalities (upside) in the form of learning and innovation for specific organisations in the project delivery stage. Performance studies of infrastructure projects propose 'survival of the unfittest' (e.g., Flyvbjerg, 2009), where projects that look best on paper are sanctioned for execution, invariably leading to underperformance in the latter execution phases due to optimism bias and strategic misrepresentation by project promotors (Flyvbjerg et al., 2009). Conversely, a stream of research drawing on organisational capabilities and strategic

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management literature addresses direct outcomes and positive externalities, focusing on the opportunities for capability building, learning and innovation that projects bring to their participants (Davies et al., 2009). In this setting, the scale, temporal complexity (Brookes et al., 2017), practices (Chang et al., 2013) and pluralistic decision-making (Gil and Pinto, 2018) amongst a number of contesting stakeholders and groups, compounded with public funding, will mean that value in infrastructure projects will be defined based on the anticipated use value that the asset will create in its operation. Of particular relevance for this topic is a recent study by Martinsuo et al. (2019b) that used a multi-case approach to understand aspects of value at the front-end of transportation infrastructure projects in Finland, suggesting the benefits of a lifecycle-oriented framing that stakeholders adopt in the front-end of infrastructure projects. In their work, they distinguish between financial, social, ecological, regional, and comparative value and suggest future studies to further extend findings from the empirical setting of transportation projects and to unpack specific forms of value that were found in the study (Martinsuo et al., 2019b).

In this study we particularly focus on the importance of the *multiplicity of value*, as previously emphasised by Ahola (2008) and Martinsuo and Killen (2014), as an empirical phenomenon describing many considerations of value in the setting of infrastructure projects. Infrastructure project value is created when the use of infrastructure assets enable a variety of commercial and social activities, which feed into the broader economy (Frischmann, 2012). Following Martinsuo et al (2019b), this paper contributes to the growing literature on project value by further exploring and unpacking the multiple dimensions of project value beyond the conventional *triple bottom line* of economic, social and environmental value. Similar to Martinsuo et al (2019b), we specifically focus on transportation infrastructure projects and their specific forms of value creation and delivery. Moreover, we focus on project actors who act within the policy domain of decision making and shape project front-end, and we select the analytical level of the London of infrastructure projects ecology (Davies, 2017; Whyte and Nussbaum, 2020) to obtain insights beyond a single project or a small selection of projects.

The principal research question is: *How does multiplicity of value manifest itself in front-end decision making and definition of infrastructure projects?*

To understand the value in the front-end and definition of projects, we conduct a phenomenon-based interpretive research (Sandberg, 2005; Silverman, 2015) in the setting of London's infrastructure projects ecology (Davies, 2017; Whyte and Nussbaum, 2020) as a *habitat* for our informants and as a significant, established and coherent institutional and organisational field combining the market, policy mandates and regulatory arrangements. This research setting combines the organizational features of projects with the multifaceted notion of value for a variety of groups of stakeholders, which is embedded in the infrastructure class of assets. Within this setting, we selected ten *elite informants* (Aguinis and Solarino, 2019) that represent the influential project front-end actors to inform the study with their views and interpretations of value in project front-end.

The remaining sections of the paper are structured as follows. We first introduce a selected body of research on value and the front-end of projects. We continue by introducing the empirical setting of the London infrastructure projects ecology and interviews with the elite informants who informed this research, before presenting findings focusing on the multiple levels of project value we identified in the data.

Value in Infrastructure, Projects and Project Front-end

In our argument about multiplicity of value and the front-end of infrastructure projects, we draw on literature from economics and public administration. This complements project studies on value and helps to understand the nature of value arguments as they are proposed by actors in the front-end definition of infrastructure projects.

Infrastructure Value

The value of infrastructure projects to society is challenging to measure. The potential transformative value of projects typically goes beyond the valuations generated through appraisal methodologies such as cost-benefit analysis. However, insights into the value of infrastructure can be gained from public administration literature on the notion of value as *public value,* broadly defined as the 'added value' that accrues to the broader populace, beyond the simple aggregation of benefits to private individuals or firms (Jørgensen and Bozeman, 2007). Extending this further, the concept of value is variously defined as the appreciation or desire for a particular outcome, related to individual or collective needs or preferences (Meynhardt, 2009). Similarly, literature acknowledges the role of infrastructure projects as a class of policy intervention, with a purpose to create not only its immediate economic outputs that can be captured through market transactions, but also a host of positive externalities - such as non-market and public goods (Frischmann, 2012).

It is not only the built infrastructure but also their operational characteristics that generate value, such as service quality, accessibility and affordability (Koppenjan et al., 2008). Fisher (2014) emphasises the importance of integrative thinking to deliver value across different dimensions, such as public safety, quality of life, and environmental sustainability. Regarding transport infrastructure, the ongoing expansion of networked infrastructures, reduction of travel times, increased connectivity and circulation reflect broader expectations on how modern society should function and intrinsic links between mobility across and between metropolitan areas, and economic development (McArthur, 2019). Whilst theoretical work on value is an established stream of enquiry in economics and public administration literature, we next discuss how do those ideas translate and apply to the project organisational setting.

Project Value

The value of projects for societies and economies has historically been understood as one of development and enabling (for example as in aerospace and military contexts) and the economic valuation rationale for projects is a comparison of the project benefits and notional ratio of costs compared with project long term anticipated benefits (Morris, 2013). While project value can be thought of as notional ratio of utility (satisfaction of needs) to the use of resources, it should include a comparison between costs and value achieved over the project lifecycle compared to original value expectations for various stakeholders (Martinsuo et al., 2019a). However, the certainty of costs will become known much sooner than the certainty of benefits, which tend to accrue over a much longer period of time. As a result, practice methodologies and decision-making guidebooks tend to focus on costs as the single more readily available indicator of value (Laursen and Svejvig, 2016).

In an effort to address this issue, project scholarship has recently started exploring and theorising various manifestations of project value. As a result, project value studies began gaining considerable traction as a stream of inquiry (Brady et al., 2005; Martinsuo and Killen, 2014; Matinheikki et al., 2016; Martinsuo et al., 2019a; Laursen and Svejvig, 2016). Value is recognised as a multifaceted concept that occurs across different temporal scales (project vs operations), amongst a variety of actors and can be observed at various levels of analysis such as individuals, organisations, groups and even entire societies (Lepak et al., 2007). Project participants, whether core or fringe stakeholders (Hart and Sharma, 2004), operate on their own value definitions and equations to rationalise sustaining or terminating their involvement in the project pointing towards the various facets that value can acquire in different project phases and for different project stakeholders.

Recent research has covered various phenomena of project value emerging, for instance, in the form of narratives addressing the wider context of market competition and industry policies (Green and Sergeeva, 2018), the dichotomy between the temporary project and per-

manent organisations (Riis et al., 2019) and the temporal context of the project decommissioning whereby value is created by project's termination (Invernizzi et al., 2019). Similarly, recent research has also looked at value co-creation whereby the client organisation engages with market partners (Liu et al., 2019), customers (Fuentes et al., 2019) or delivery partners (Pargar et al., 2019), and generate value in the process. Similarly, research has acknowledged that value in projects can be generated through the use of management approaches and methods, such as risk management (Willumsen et al., 2019) or acceleration to fast-track projects to completion (Svejvig et al., 2019). Value has similarly been approached from a firm-level perspective, in the context of value capture from a portfolio of projects to address the value slippage that occasionally occurs beyond individual projects (Bos-de Vos et al., 2019).

Value in Project Front-end

The front-end of projects is where early ideas on project value will be established, negotiated and consolidated, as a means to justify the case for the project prior to its sanctioning (Edkins et al., 2013). While existing literature acknowledges the importance of the project front-end and suggests that early project decisions will determine the faith of the project (Morris, 2013; Samset and Volden, 2016; Artto et al., 2001), a recent systematic literature review on the topic of project front-end suggests uncertainty and lack of information as the main feature of the front-end decisions (Williams et al., 2019). In their review, Williams et al (2019) summarise preliminaries, defining the project purpose, analyses of the scenarios and alternatives and selecting the project concept as the main activities of the project front-end. Despite the importance of the project front-end processes for the value creation, there is scant literature that explicitly links the two areas. For example (Matinheikki et al., 2016) suggest that the value creation in the front-end of projects occurs through the coordination and mutual alignment of parties in inter-organisational networks. Similarly, Liu et al (2019) focus on the activities in the project front-end where the client is co-creating value in use together with market partners and suggest the creation of commercial, intellectual and collaborative value as a result of the process.

While these studies begin providing useful insight into the value at the project front-end, they are both focusing on the inter-organisational activities after the formation of the inter-organisational networks that will shape the delivery of the project. While useful, existing studies do not unpack value arguments which are used to define the project by decision makers in the embryonic stages of project front-end. Those early stages of project definition are key for shaping the justification for the project. Understanding value in project front-end is particularly important when the project is based on the complex and socially constructed ideas of value, as is typically the case in infrastructure projects. To inform this enquiry, we engage with the setting of stakeholders that typically inhabit the front-end of projects. They represent policy actors who promote or oppose projects and in such a way frame early ideas about value of projects.

Research Design

This study reports on a segment of our collective programme of research on value in infrastructure projects between 2014 and 2017 following phenomenon-based (Von Krogh et al., 2012) research approach. For this study, we specifically focused on the research setting of the London infrastructure projects ecology (Davies, 2017) as coherent institutional and organisational field involved in the planning, delivery and operation of infrastructure projects in a globally significant city. To obtain deeper familiarity with the research setting within which the empirical phenomenon of interest is situated, we reviewed a wide range of the publicly available material about London infrastructure projects such as *King's Cross Central Redevelopment, St. Pancras International Station, Heathrow T2 and T5, London Olympic Games 2012, Crossrail, Crossrail 2, Thameslink 2000, High Speed 2, and Jubilee Line Extension.* We similarly reviewed private sector and government reports including the *National Infrastructure Plan* and *HM Treasury 'Green Book'* which detail the methodology for the appraisal of UK public sector projects. Over a period of several years, we collectively participated in and supported a variety of industry and policy events in the context of the London infrastructure projects ecology broadly following the engaged scholarship approach (Van de Ven, 2007). Whilst our research was focusing on value in infrastructure delivery the research design was partially serendipitous as the focus was not initially guided by theory but empirical phenomenon of interest (Von Krogh et al., 2012)- planning and decision-making in the front end of infrastructure projects. For this reason, our theoretical framing in the data analysis evolved from the initial focus on strategic value to final conceptual angle (as presented in this paper) on the multiplicity of value in the definition of infrastructure projects. The empirical phenomenon-based and emergent research design strategy allowed us to gather rich and diverse data including interviews and other relevant documentation relating to the definition of projects and, in particular, value arguments that are employed to justify/or oppose the investment into the project. This creation of this large data-pool was critical to the subsequent refinement exercises conducted.

The study of multiplicity of value in project definition presented in this paper reports on an interpretive analysis (Sandberg, 2005) of interviews with elite informants (Aguinis and Solarino, 2019; Mikecz, 2012; Harvey, 2011) comprising senior industry and public sector individuals significantly involved in the planning and investment decisions for infrastructure projects. These actors' views were sought as they occupy central positions in front-end planning and project identification stages and we saw their first-hand experience as both a reliable and credible source of the rationale behind the value definition.

Data collection and analysis

Informants were individuals with senior decision-making experience at the interface of urban planning, policy and the delivery of major infrastructure programmes (Table 1). Specifically, all informants possess experience in infrastructure planning and delivery at a senior management or leadership level and considerable depth of experience in the London context. In such a way, the group of informants brought together experience across a diverse range of infrastructure projects over the past two decades. To ensure that the experience of the informants aligns well with the projects in the London ecology of infrastructure projects we researched independently through secondary sources. Our data collection strategy was emergent, drawing from emergent insights arising from successive interviews to inform future interviews (Silverman, 2015). It is important to say that the elite informants were chosen for their experience to capture the views of typical stakeholder groups on both the supply and demand side of infrastructure projects definition.

Interviews were framed with exploratory questions about planning challenges for urban infrastructure developments. As interviews progressed, data collected were developed into a preliminary framework of insights that helped inform the questions in subsequent interviews. Our purposive sampling sought to capture a diversity of views (Silverman, 2015) that exist amongst front-end project actors about London's infrastructure project ecology as we progressed in locating interviewees. This variation would come from different organisational and institutional settings that our informants were embedded in, acknowledging that most informants have worked in both public and private sector roles across their working life. Table 1 gives details of participants' profiles.

Following Sandberg (2005), we strived to achieve communicative, pragmatic and transgressive validity during data collection and analysis. To strengthen the communicative validity of data collection, the first two authors of the paper attended all but two interviews to emphasize reflection in real time and support each other with additional questions if a new avenue of interest would open up. In a similar vein, we strived

Table 1
List of elite informants representing the London ecology of infrastructure projects with their roles

Informant	Relevant role and expertise	Date of interview	Duration of interview
1	Director-level manager in an international professional services firm specialising in engineering and the built environment (14,000+ employees globally).	1 Jun 2016	01:09:26
2	Director-level manager for a major global professional services provider for the built environment (14,000+ employees globally).	2 Jun 2016	00:48:54
3	Director-level official for major events (transport)	6 Jun 2016	01:00:49
4	Lead practitioner in planning and urban development for a major global professional services provider for the built environment (1,800 employees internationally).	5 Jul 2016	00:50:11
5	Senior borough council official, specialising in smart technologies and procurement	13 Jul 2016	01:19:59
6	Former Chief Executive Officer of a global engineering and design consultancy (15,000+ employees internationally)	14 Jul 2016	00:49:07
7	Senior Programme Manager at a metropolitan public transportation agency (25,000+ employees)	7 Aug 2016	00:50:03
8	University professor, advisor for national infrastructure bodies and former senior civil servant	7 Oct 2016	01:14:05
9	Vice President of a major international telecommunications infrastructure provider (120,000+ employees globally)	10 Apr 2017	00:28:32
10	Economic Policy Manager of a major management, engineering and development consultancy (15,000+ employees internationally)	8 May 2017	00:48:44

to achieve pragmatic validity by asking follow-up questions about specific examples whenever informants would describe what seemed as a generic principle of practice. Finally, we sought to obtain transgressive validity by actively seeking out the contradictions and tensions during the data analysis process. It is important to mention that the validity procedures focused on reporting on the empirical phenomenon (planning and front-end decision-making of infrastructure projects), and not the analysis including the theoretical focus on multiplicity of value, which only emerged later in the analysis process. After each interview, we compared notes amongst the two interviewers and conducted a preliminary comparison with other interviews to validate the direction of the data collection and assess the comprehensiveness of the emerging findings. Whilst we were not aiming to achieve the condition of formal theoretical saturation, through our interviews it became clear that the main insights were quickly emerging, especially as interview data was triangulated with the insights from publicly available reports on the projects being captured in the data analysis.

All interviews were audio recorded and transcribed. Data was coded using Atlas.ti software inductively to develop a hierarchical data structure with first order concepts, second order themes and aggregate dimensions (Gioia et al. 2013). The first step applied open coding, identifying first order categories that emerged across the initial interviews. As the research continued, these categories were sifted and sorted to identify similarities and emergent themes, resulting in second order categories. Based on further reflection and consulting emerging stream of literature of value in infrastructure and project studies we refined the second order categories distilled this set of concepts further to aggregate dimensions reported in the paper. Findings draw from this data structure to examine the inter-relationships between the themes and develop new insights about value in project definition. It is also important to mention that whilst we draw on Gioia et al (2013), our intent was not to follow a formal grounded theory building approach but to use the method as an analytical device to code the data for the interpretive study. The data structure is illustrated in the Appendix.

Findings: Multiplicity of Value in Project Definition

Through our analysis of interview data, we found distinct themes that unpack the multiplicity of value in project definition. We present the findings by first elaborating upon the overall value argument justifying the project and its complexity. We then unpack this complexity by proposing the three spatial-economic-organisational configurations of where and how project value accrues as distinct analytical levels that emerged from our qualitative thematic analysis of the data. Whilst we wanted to maintain individuality and give voice to each of the respondents, we still report them as anonymous accounts, for confidentiality purposes. This method allowed us to systematically code the data and iteratively derive categories and themes.

Infrastructure projects as solutions for policy problems

The analysis suggests that that the initial step in defining the value in project initiation is to justify the need for the infrastructure project as a solution to a problem. This process of problem formulation is often in the policy domain, suggesting a project solution to solve transport problems such as congestion, for example in the form of network upgrades or capacity expansion. While there are instances where projects requiring building of an asset are necessary and justified, other times the project could entail policy interventions or applications of technologies as equally effective solutions to problems.

> "The best infrastructure are those that have associated policy changes… or, we use policies instead of infrastructure – quite often, as individuals we think the solution must be to build something. The reality is that probably we're better of actually trying to avoid doing it in the first place, or using new technology to avoid doing it."

Therefore, an important question in the project definition is to intentionally question the need for capital projects to meet long-term objectives, against the merit of alternative interventions in operating models or technology-based solutions, or a combination or all three. This suggests exploring alternative 'solution sets' that apply a combination of project interventions that may improve capacity, actively manage demand for certain users or times, and mitigate the environmental impacts of travel in conjunction with each other. This requires a wider set of stakeholders to participate in the shaping of the project:

> 'One of the challenges for the infrastructure industry going forward is how you blend policy, as well as the infrastructure interventions and new technology to get more sophisticated and higher value solution sets – rather than always thinking that banging in a new railway must be the solution'

In London, the congestion charge introduced in 2003 is one of the most effective solutions of this type:

> '*London's big success story has been the congestion charge, it did involve some infrastructure but it was basically a behavioural macro-tool to tackle it, with low-emissions zones.*'

New technological innovations enabling the congestion charge to be monitored and enforced were a necessary precondition, and its introduction dramatically improved road congestion without necessitating any capacity upgrades or the use of additional urban land to accommo-

date traffic. Transport infrastructure interventions can be as simple as reallocating street space for different transport modes and uses, which reflects the priority assigned to different kinds of travel activities:

> 'If you move the kerb, you change the priorities. If you change the bus lanes, you change the priorities. If you put in a tram, you've change the priorities… you are implicitly making value judgements of balance every time you put in transit or a motorway or a traffic light or a pedestrian crossing.'

The most common way to justify infrastructure projects as a solution for policy problems is to address the issue of *future growth* often described in terms of population increase, however, this is a result of interdependent urban economic and migration systems. Local populations, labour and property markets, determine the level and distribution of growth, and ultimately the demands for transport services, conditioned by demographic trends and technological change. For example upgrading mobility services to support future population growth is critically important for urban areas, and long-term planning is essential for timely delivery of transport upgrades. An important aspect of the future growth aspect of value is that its beneficiaries do not yet exist in the location where they will benefit from planned projects, and so it incorporates an intergenerational dimension and the responsibility of local governments to plan for future generations' needs. The interconnected mobility needs arising from urban growth are exemplified by the Thameslink 2000 project:

> 'It was predicated against population growth, which has almost happened by now, and the growth in traffic movements to [Gatwick and Luton] airports, and commuting flows into London, along the way… It provided [for] three different objectives simultaneously – two airport-city links, commuter traffic, and in the centre, a north-south rail service… so those three objectives were somewhat in tension with each other, with regard to some of the parameters for which the engineered system was thought about.'

This emphasises the tensions in meeting different needs: the travel flows across multiple spatial scales that Thameslink 2000 supported brought tensions between the imperative to reduce journey times while including enough stops to serve both local and regional travel. Given the complex impacts of urban growth on travel demand, the informants recounted the need for an overarching, cohesive 'vision' for the total and relative levels of accessibility provided within cities, particularly as it relates to different transport modes. This goes beyond projections and extrapolations of existing travel patterns, to a broader and more deliberate plan for the prioritisation and provisions made for different travel needs and related transport modes:

> 'That's what has been materially missing from many situations – is a vision statement for how you want your city to behave'

Creating value by supporting future growth requires speculative assumptions, to anticipate a future growth scenario that may or may not arise. The factors influencing population growth or decline are complex and difficult to predict, and the level of infrastructure provision itself has some influence on the rate of growth. This implies that the 'predict and provide' approach of business cases to project future demand and develop an investment strategy to meet that need, has limited scope to actively shape the desired future outcomes for accessibility and travel services in a city:

> 'You can't make a business case "fact-driven". The problem is, if we do it on business case, you've already manifested a problem you're now solving – as opposed to anticipating a problem and living in hope that something will happen… we have a government policy now for evidence-based decisions. [But] your transit stuff, by and large, it isn't evidence based – it's self-fulfilling scenario based'

In this context, decisions are taken under high uncertainty, with the knowledge that the 'do nothing' option is likely as risky as over-investing in infrastructure. At the same time, continuing to adopt the '*self-fulfilling scenario based'* approach should be scrutinized in light of other value creation opportunities around user experience, shaping travel behaviour and treating mobility as a sequence of interconnected travel activities. To develop a vision on '*how you want your city to behave*', utilising these complementary forms of value creation can shape the city's desired growth trajectory and augment value creation at the metropolitan scale.

The ultimate beneficiaries of infrastructure projects as solutions for policy problems are expected to be those with the highest propensity to use the infrastructure installed, expanded or otherwise improved, such as future residents and those operating in the local economic sectors that will gain from a larger, more diverse labour market.

The complexities of assessing the different project options suggest that an argument for various dimensions of the project benefits and value is complex and multifaceted, which cannot be reduced to a single variable or number. For example, a more efficient transport system creates a potential range of secondary benefits for those directly and indirectly affected, such as quicker journey times, but also less pollution and fewer accidents.

Complex notions of value in infrastructure projects

Whilst at the highest level of consideration and sanction, infrastructure projects are justified as solutions to policy problems, project value is complex and multidimensional as it is realised in different time scales and takes different forms for different project actors – the delivery organisation, direct users of the service as well as various other project stakeholders. In this way decision-making to decide on the planning and implementation of new projects should be able to accommodate diverse types of value.

From those expert informants that contributed to this research, in the case of London the high-level priorities for the transport planning and development are set out in the London's *Mayor's Transport Strategy* document outlining long-term plans *"to transform London's streets, improve public transport and create opportunities for new homes and jobs.* This official and strategic document sets out high-level objectives that provide a framework for the prioritisation and selection of infrastructure projects that will support the long-term strategy.

> "Increasingly now we're moving to a pretty robust top-down approach to say, so these are the outcomes we want to drive across London... and this is the size of our investment programme and these pressures are coming on in terms of growth and performance – how do we best spend our money??"

The prioritisation of projects happens based on a value rationale – especially driven by funding requirements. For public sector funding with significant requirements for transparency in decision making, a strong rationale is needed of whether the project is worth the investment.

> "It's just trying to find a way maybe of, not necessarily codifying, that sort of common sense view that people have of,:' that feels like a project that was worth that investment of public money'."

However, in defining the temporary project organisation, there is a considerable level of fragmentation of the ideas of value as they are interpreted and acted on by the various project actors. For example, fragmentation of value notions happens along the junction or fault lines of disciplinary siloes in the planning and design of infrastructure projects. As different design disciplines have historically evolved to solve particular kinds of domain problems and optimise solutions from their perspective, this leaves very little space to consider project options outside of the traditional disciplinary domains and that may involve the wider consideration of value types.

> "Because we think in one dimension … you've got a transportation tribe, a rail tribe, a road tribe, an aviation tribe - each tribe just does its own thing, so it'll give you turnout geometries, and high speed

tunnels, switches and crossings – but it won't ever ask the question of, why don't you walk instead. And there's a paucity of thinking in the broadest context."

Allocation of value priorities between costs and benefits which materialise over different time scales. Whilst benefits are likely to accrue over a long time horizon, costs are incurred in the present and therefore short-term cost focus can drive the prioritisation and valuation more strongly than long-term benefits.

"I can never discount 50 years of benefit because the way I think as an individual on that time horizon means I will always value, or disvalue, my immediate grief much more."

A common response to the tension between long-term and short-term and fragmentation of ideas on project value is to fall back into the project management optimisation mindset focusing on time, cost and specifications only.

"We're trying to make sure that the project manager, who's always focused on cost-time-quality, isn't in trying to optimize those things, compromising the benefits of why we set out to do the project in the first place"

It becomes clear that unpacking the value rationale of an infrastructure project to solve a transportation planning and policy problem is not straightforward, as the value argument has different time-scales, different beneficiaries, stakeholders and other parties with very different priorities and interests. To extend our understanding of this 'value unpacking' and based on our analysis of both secondary sources and interviewee insights, we next present the three proposed discrete value levels linked to the front-end definition of infrastructure projects: *local value, sector value and user value*.

Levels of Value in infrastructure project initiation

4.3.1. Local value

The first level of value we identified articulates the project benefits that will accrue at a local scale. Enabling local regeneration is typically nested within the broader process of supporting growth, however it creates a distinct form of value at the local scale. Regeneration is the re-development of specific areas to improve the amenity and quality of the built environment, and increase capacity for residential and employment populations. Regeneration operates within the broader process of expanding accessibility to support future growth, however it is characterized by distinct place-based interdependencies between property development and transport improvements. Improvements in transport accessibility and the amenity of the built environment stimulate growth in the residential and/or employment populations. Transport infrastructure creates value by stimulating redevelopment of property proximate to stations or nodes with service improvements. In cities with severe undersupply of housing, such as London, this value is heightened due to the strong imperative to increase housing stock:

'[Infrastructure] plays a key enabler in terms of allowing a lot of development work to take place, and now you need to flip the thinking to a degree… social sustainability will become really important over the next 10–15 years, part of it driven by the real challenge that London is facing in housing accommodation, and the ability to find affordable places for people… It's a slight change in thinking, it's no longer that the potential is there around transport nodes, we have to create those links and nodes to enable developments to function properly'.

As described by one of the informants, transport creates value not just to keep pace with demand, but actively stimulates targeted growth areas and shape the structure of the city. Value creation is not solely through capital expansion; changes to the service frequency and quality can also dramatically enhance transport's value to stimulate regeneration in specific locations:

'I'm working on an area in London – on the map it looks like a highly connected place… but then you realize that the station has one train an hour at peak times, possibly two. It's one of the most deprived places in Britain – the reason it can be, is that the service is operated on a farebox basis, it's bringing in passengers from commuter towns… there's no reason for the rail company to stop in this area because no one there can pay a fare – but it won't ever be regenerated if that train doesn't stop there either.'

This example reiterates the tension between accessibility at the regional and local scale, as commuter lines pass through outer boroughs of London but do not provide adequate services to these populations, compared to the outlying commuter towns they primarily serve. Reliance on the farebox model that requires user fees to cover the cost of serving a given area revealed how delivery models overlooked this source of potential value creation, inferring from low ridership that the service did not provide value, when in fact the combination of low service quality and high prices suppressed ridership growth. Creating value to enable local regeneration hinges on the interdependence between land development and transport provision: the actual development capacity of an area – determined by planning permissions and zoning – is critical, and transport services must provide accessibility to labour markets and key public services to optimise the stimulatory effect on redevelopment. The specific beneficiaries of local regeneration are determined by planning regulations that shape the distribution of benefits between across existing residents and business benefit, and whether they are displaced as a result of redevelopment and associated growth in property values. However, in the instance that planning regulations account for equitable distribution of benefits, the value created can benefit current and future residents and local businesses in regenerated areas. This value is realized at the local scale, proximate to areas with improved amenity and transport connectivity.

4.3.2. Sector value

The second level of value is the sector that the infrastructure project is supporting, in our case it is transportation sector where value arises from the optimization of service provision. Specifically it is about mobility going beyond individual trips to treat travel as a process of interlinked activities supported by various infrastructures, both for private individuals and commercial users. From this perspective, integration across transport modes and consideration of the impacts of upgrades on an end-to-end journey – such as a daily commute or delivery route – are critical opportunities to enhance value. This perspective grounds the conception of transport with the user, and their specific needs and capabilities to move efficiently across multiple modes and scales.

'The point you're making is process design of transportation – and, classically we don't think about transport as a process, and certainly not an end-to-end process. We think about it as a series of bits of physical interventions, it's asset based – so we'll have a train station, we'll have bike racks, we'll have a railway line, not actually, how do you make the whole thing work, and how does that work differently under new technologies'

Conceptualising the project's contribution to its respective sector challenges the dominant model of using calculations of travel-time savings and agglomeration benefits in front-end project planning to estimate project benefits and the merit of different design options. From the user perspective, treating travel as an end-to-end process includes the reliability and frequency of services, first- and last-mile trips, trip-chaining and individual travel needs. Alongside faster travel, regularity and ease of transfers are also important:

'Traditionally it has been improving journey time – and the cost value of time equation was the simple driver. But it's not journey time, it's also reliability – accessibility in predictable time – acknowledging that the dis-incentive curve of extra journey time is not linear'

The non-linearity of travel-time savings is particularly pertinent, showing that from the user perspective, a marginal improvement in

travel time may be of little real value if the service provided is not reliable or sufficiently frequent. The process design of transport is just as important for commercial travel and logistics, for which reliable transport is a key factor to business efficiency. Urban freight services in London are a current issue as increased congestion is a growing issue, spurred by an increase in online shopping and the consequent home deliveries:

> 'Freight now forms a large part of the traffic in central London, it's needed, we know it has to be there to service the shops and things we need, but we can look at consolidation, putting it into larger vehicles, or retiming of freight deliveries.'

Reconsidering solutions from the perspective of sector value shows that catering specifically to the transport needs of freight providers can leverage complementary options to adjust the timing and storage of freight. This exploits the fact that freight can be stored and kept to a deliver at a set time - giving more flexibility for scheduling travel than is possible with the movement of people. This domain suggests the positioning of the project benefits along the lines of the technology and engineering paradigm of project planning and delivery. This rationale ultimately draws upon the user beneficiaries who will drive the demand for the development of a new asset.

4.3.3. User value

The third and last level of value in the front-end of transportation infrastructure project we identified centres on the individual experience of infrastructure users. In the case of transportation infrastructure, travel is an individual activity with experiential value depending on reliability, comfort and convenience, as well as a means to access different locations within a city. The experiential quality of transport is an important form of value for users. Generating value for the user's experience operates along three dimensions: (1) the experiential quality of travel arising from convenience and ease of navigation, crowding, noise and air pollution; (2) the diversity of individual user needs for different demographics, trip purposes and individual mobility needs; (3) the potential trade-offs between providing mobility and quality of 'place' in urban environments. Since most transport infrastructure has a dual purpose as public space, and is the dominant common area in a city, it is important for quality of life to ensure that users of these spaces can navigate them safely and easily:

> 'It's partly, how pleasant is this area to pass through, in terms of ease of movement or clutter, easy road crossings, less noise, better air quality… and then there's a further one, is this space so nice that I actually want to stop here and absorb it and sit on this bench overlooking this nice view/landscaped area or whatever – and dwell a bit more in the space.'

Public spaces are used by a large number of people, with diverse needs that influence the experience. City streets have growing importance for place-making, which improves their experiential value and also generates benefits for business owners in attracting greater pedestrian activity.

> 'We break it down, appreciating that some people experience the transport system as a bus passenger, some as a pedestrian, some as a cyclist – moving away from just seeing the road network as something to move vehicles around, and seeing it as a more holistic transport network.'

Taking direct consideration of the impacts of a transport project on the full range of users draws attention to trade-offs between different users, and the capabilities of different users to safely and easily navigate through multi-modal infrastructures. Creating value through this mechanism can face trade-offs between other forms of value:

> 'Some of our schemes, in order to provide better liveability, actually slow people down – and as soon as you start slowing it down, the number of people and the value that's placed on their time usually far outweighs the safety, health, ambience and other benefits.'

The imperative to support the flow of traffic across different modes, against the need to slow down traffic to improve safety and amenity, gives rise to tensions between objectives for faster travel and vehicle speeds and the value of safety and amenity.

Discussion: Towards a multi-level concept of value at the front-end of infrastructure projects

This study aimed to explore how the multiplicity of value occurs in the in front-end decision making and definition of infrastructure projects. Our findings show that value in the front-end of project decision making manifests as a rationale communicated for the project based on its framing as a complex solution to a policy problem. In this context, the value of infrastructure projects is envisioned to materialize through benefits for multiple segments of the economy and groups of beneficiaries. The multiplicity of value is a multi-level rationale justifying benefits that an infrastructure project will generate across multiple time scales. Our findings also suggest that the initiation of an infrastructure project is based on the articulation of local, sector, and user value as defined by those forming the project decision-making elite.

We can summarise these findings by proposing the following multi-level framework that distinguishes between the different concepts of value (Table 2). This framework helps to make sense of and differentiate between the complementary arguments that are used to justify the initiation of an infrastructure project, all based on the project's envisioned future value.

Local value represents the contribution that an infrastructure project makes to the local community and its economy by enabling, facilitating or accelerating social and economic activities which would not have occurred without the project. In the context of transportation infrastructure, this concept is often summarised with the argument for the economies of agglomeration to justify urban transportation infrastructure.

Sector value describes the contribution of the infrastructure project to the specific economic sector that it is supporting – e.g., transportation. In this way, the project develops an improved technology or process that enhances the sector through the development, upgrade or maintenance of assets that, for instance add new capability to the sector. Capacity upgrade projects that increase effectiveness or innovation projects that increase efficiency of the infrastructure operations are good illustrations of increasing sector value.

User value considers the contribution of the infrastructure project to its intended beneficiary groups and individual users. There are multiple ways in which this can happen, for instance by incorporating users in the design and development process of the new project, through mechanisms such as public consultations or more directly having users co-produce the design with project teams. Value is created through the design process of not just the project, but also on the maintenance and operational regimes, by focusing on user experience in design decisions.

The multi-level value framework for the initiation of infrastructure projects helps to develop both a categorical and a more nuanced understanding of project value. This complements the existing research on project value with a further focus on the project front-end and its important role in the project justification and initiation. Our findings reinforce the idea of project value as a multiple and multifaceted phenomenon, contingent on both the phase of the project and the perspective of the stakeholder in line with Martinsuo et al (2019a). The proposition to recognize the discrete role of local value validates previous work, while the analytical levels of industry sectors and user beneficiaries extend the thinking on multiplicity of value at the front-end of projects, in line with Martinsuo et al (2019b). Specifically, we begin to reveal the individual elements of the value justification argument in the project front-end as they are shaped by the project decision makers. Notions of local, sector,

Table 2
Multi-level value framework for the initiation of infrastructure projects

Level of project value	*Transportation infrastructure setting*	*Value argument for an infrastructure project*	*Mechanism of value creation*
Local Value	Transportation assets will bring connectivity to local areas and generate a variety of downstream activities.	Project will create local benefits by contributing to social and economic activity and boosting the wider economy of the metropolitan area	Positive spill-overs, network effects.
Sector Value	Optimising travel as a process within urban transport planning frameworks.	Project will contribute to the value of its sector through the addition of new or upgraded transportation assets.	Efficiency and effectiveness through process optimisation, capacity upgrades, etc.
User Value	Designing infrastructure to accommodate travel behaviours and enhance passenger experience.	Project will enhance the use experience of individual users and groups of beneficiaries.	Design, operational and maintenance regime to ensure positive user experience.

and user value suggest distinct arenas for the discussion and negotiation of different forms of value between the actors representing the project (promotor, sponsor, etc) on the one hand, and various groups of project stakeholders on the other. In this way, the multi-level value framework in project initiation can be seen as a cognitive dissonance model to distinguish amongst interests of different actors whose support is necessary for an infrastructure project to be sanctioned.

The multi-level value framework also contributes to our current understanding of the ways in which infrastructure projects are shaped and initiated. The multi-level focus of our findings about value in the project front-end reinforces the view espoused in literature on the social value of infrastructure, emphasising difficulties in clearly articulating the benefits of the project and identifying the proxy indicators for its demand. The key mechanisms for value creation are thus defined as positive externalities whereby a project intervention is an intermediary input catalysing a wide range of downstream social and economic activities, creating spill-overs through network effects across a large number of users (Frischman 2012). Our study begins to define various areas in which these downstream benefits (sometimes expressed as positive externalities) will materialise as outcomes of the infrastructure project for different groups of actors and stakeholders over a range of timescales that can last into the longer-term future..

Finally our multi-level value framework helps disentangle some of the "fuzziness" often attributed to the front-end of projects in line with Williams et al (2019). It does so by proposing an analytical structure to help understand how the strategic and policy priorities that lead to the project's creation then go on to shape the direction for the front-end decision making. Our findings suggest that subjective stakeholder interpretation and discursive efforts about the different forms of value they are focussed on contribute to the "fuzziness" of the front-end of projects. Our study proposes that the front-end of infrastructure projects is a space where priorities are justified and defined by key decision makers. This then creates the conditions for stakeholder legitimation and contestation in a deliberative process that will ultimately lead to the infrastructure project being sanctioned for execution, delayed, or rejected.

We therefore propose that the value argument mobilised in the project front-end definition has a key legitimizing role in gaining the commitment of key stakeholders and other key parties (Gil and Pinto, 2018) who will have a say in justifying the project investment as well as the different disciplinary fields active in the cost and benefit analysis stage. For example, in the project definition stage, uncertainty can be treated as an opportunity to be maximised when justifying the project's potential value, whereas in the project realisation stage it can be seen as risk to be minimised. In transportation infrastructure settings, expertise from economics and economic geography underpin the calculation of local value, whereas the technology and engineering design mindset underpins the sector value and the user value.

The three distinct value levels are mutually complementary in that they feed upon and complement each other and are combined into a wider argument on value in the front-end of infrastructure projects. The interrelationships between the levels of value for transportation infrastructure are created through physical networks, governance and institutional structures, operating models and funding mechanisms. In this way our multi-level value argument helps to understand how projects are framed as a response to a problem that both precedes the project and is solved or alleviated by the project.

Conclusions, Limitations and Avenues for Future Research

This research focuses on the multiplicity of value in the definition of infrastructure projects as a class of technologies and policy interventions that create benefits for the local economy, its sectors, and various groups of stakeholders and users. This paper reports on an in-depth qualitative study in the empirical setting of the ecology of London infrastructure projects as it emerges in project definition stage. Findings present an argument about infrastructure projects as a response to policy problems and this includes the complex notion of value which we have investigated in further detail from the interview data from a set of expert informants, as a sample of the project decision-making elite. From this we have identified three distinct levels of value: local value, sector value and user value that help clarify the complexity of project value and, further, provides an important argument for what is involved in the initiation of the project.

Our work adds to the recent conversations on project value (e.g., Laursen and Svejvig, 2016; Martinsuo et al., 2019a; Bos-de Vos et al., 2019; Vuorinen and Martinsuo, 2019) and studies on the project front-end emphasising the strategic importance of early project decisions to shape benefit realization in operations (Morris, 1994; Edkins et al., 2013; Artto et al., 2016; Davies et al., 2006). More specifically, the study contributes to ideas on project value (Martinsuo et al., 2019a) by extending the conventional 'triple bottom line' approach into a multi-level framework differentiating between distinct contributions of an infrastructure project to its local community and economy, industry sector and groups of beneficiaries and individual users.

These findings further add to the call to continue expanding project practices onto the strategic phases of project decision-making and benefit realization in operations as outlined in previous studies by, for example, Davies et al. (2006), Morris (2013) and Artto et al. (2016). By identifying the multiple levels for understanding project value, we strengthen the argument that project initiation decisions in complex stakeholder settings are often a product of politically-mediated negotiation processes that is based on value arguments. The multi-level value framework proposed in this paper can be used as the first stage of a heuristic tool that helps explain how different stakeholders in the project front-end and other project actors can find common ground focusing on the value of the transformational potential of the project rather than its execution efficiency. As such, the multi-level value framework has several implications for the practice of projects and their management. First, it emphasises opportunities for problem-solving that the project can unlock as distinctly different from the conventional project execution parameters of time, cost and quality. Because in their front end, projects have not yet materialised in any substantive form and the uncertainty level is

high, value in project definition can be focused more on long-term benefits and effectiveness of the measure implemented rather than efficiency considerations related to time and cost. As such front-end value is much more about the desirable and possible than it is about the factual.

Having discussed the utility of the findings from this study, we next turn to the limitations. The qualitative data presented in the findings section draws from a relatively limited number of interviews. However, this limitation is mitigated by the narrow focus of the research inquiry, which was bounded in both geographical terms and application type in that we analyse the London transportation infrastructure projects ecology and had a data quality emphasising the 'elite' status of the informants. This then allows the range of experience-informed insights to provide a robust representation of our research question seeking to uncover the argument on multiplicity of value in the definition of infrastructure projects. To provide further confidence in the results derived from the focus on the 10 informants for interviews that were specifically referred to in this paper, and from which quotes have been drawn, the data presented here represents a segment of much broader engagement with a large number of project and policy practitioners in the UK context that we have undertaken between 2014 and 2017 along the lines of engaged scholarship (Van de Ven, 2007). Although this wider engagement was instrumental for the development of this inquiry, we did not formally report all the activities within this effort not to compromise the clarity of focus and transparency of the data collection and analysis underpinning this study. Moreover, the findings and our propositional model suggest an emphasis on transportation infrastructure. Whilst transportation infrastructure comprises a large part of the London infrastructure projects ecology, it is visible in the public eye and often contested, we appreciate that some of the aspects of the findings would might look differently for different classes of infrastructure projects (for example energy, water and waste or IT). Future studies should focus on different sectors of infrastructure and other classes of projects in a research journey to uncover project definition decision-making processes.

Findings also suggest that, while value ideas draw from established knowledge within disciplines such as engineering, economics, public administration and policy, they also rely on the shared cognitive and discursive spaces of actors who define it. Drawing on this insight future studies can focus on the processes whereby the early stakeholders involved in the front-end definition of projects construct value through rhetorical devices that play a role at those early stages. Understanding the processes of value construction in the front-end definition of projects can also be extended to include the alignment with the societal and political processes of infrastructure project selection.

Specifically, the discursive dimension is critically important for infrastructure projects, where early planning stages require imagining how new or upgraded physical infrastructures will contribute to the economic and social systems they are embedded in. Whilst it was beyond the scope of this work to address the specific discursive features of the shaping of value in project definition, this should be addressed further.

With this in mind, we suggest that future studies could apply critical discourse analysis to uncover the power structures embedded in language use, viewing language use as a social practice that constitutes and reinforces power structures. One of the interesting angles would be to understand how the stakeholders that inhabit the project front-end encourage and motivate project selection which inherently disempower some of those most negatively affected by the project for the majority of citizens (and themselves). Such studies can look for example into not only the different (desirable) aspects of project value with the aim of justifying the project, but the broader ramifications of the discourses, such as their undesirable connotations. To illustrate, consider that an emphasis on one value level can unravel an entire host of positive and negative externalities that the project is likely to produce. Examples include the impact on climate change through the encouragement or discouragement of the production of greenhouse gases, or the social cost arising from infrastructure's impact on land values, which in turn drives gentrification process and the displacement of vulnerable or marginalised socio-economic groups.

Similarly, future studies can address the multi-stakeholder dynamics of value based on which actors they enrol. The key feature of the value domains and their interactions is that each level is represented by a particular group of actors. As different actors get involved in different points in time, future work can address the stakeholder dynamics that contributes to their value discourse and its legitimisation. Whilst local value is based around local and national scale populations, sector value involves enrolling the business and expert communities, who have a vested interested in the generation of new assets. Finally, the user value is centred around the ultimate beneficiary of large scale schemes embodied in infrastructure development. We conclude with a call for more research on the project front-end of inception, definition and initiation especially focusing on the neglected but important area of value creation, emergence, delivery and capture.

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Appendices

Table 3

Table 3
Data structure.

Aggregate Dimension	2nd order theme	1st order concept	Illustrative quote
I Infrastructure as a solution to policy problem	I.1. Simultaneously shaping and estimating future travel demand	I.1A. Uncertainty around return on investment	"I'll take the traffic model, I'll take the population growth, I'll take the ethnicity mix of that which have different habits, I'll take the gender makeup and age makeup which have different travel habits, I'll take the average income or the distribution of income and project them all forward ten years and I've no idea what's going to happen. It's like, well, any one of those could be off by 20% and change the answer. So why pretend?"
		I.1B. Valuation and appraisal are spending public money on a wish	"You need to submit a credible scenario with a sort of, it's a bit naïve, but a reasonable scenario with a minimum and maximum scenario and you'll probably still be wrong, because cities tend to be a bit unpredictable. And you know, how do you spend public money on a wish? Well actually, you are."
		I.1C. The business case already manifests the problem you're solving, rather than anticipating a problem	"That's the problem, if we do it on business case, the problem is already, you've already manifested a problem you're now solving. As opposed to anticipating a problem and living in some hope that something will happen."
		I.1D. You can't make a business case fact-driven, it's always predicated on estimates	"Heseltine – what he will say is that you can't make a business case, fact-driven. So, I want to build an East London river crossing that's predicated upon a population growth, and economic mix, an underlying GDP growth for the next fifty years."
		I.1E. Value appraisal isn't evidence-based, it's self-fulfilling scenario based	"Your transit stuff, by and large, isn't evidence based, it's self-fulfilling scenario based"
	I.2. Interdependent value creation with land re/development	I.2A. Land value capture as funding - it always pays for the next line	"Hong Kong never paid for a metro line from real estate income; now let me say the opposite – what it did was create land over its stations, after it built the station or the depot, which it then sold. Its balance sheet is actually a real estate developer that has – so what they did, they created land, sold it, it didn't pay for that metro line, it paid for the next metro line"
		I.2B. Areas where London is growing provide funding streams from developers	"A reasonable amount of my programme is influence by where London is growing, and therefore we have that engagement with – usually this flows through the boroughs, because they're the ones who secure from the developers the contribution, so we work with the boroughs and funding agreements basically redirect Section 106/CIL towards the projects, and we've been quite successful on a number of projects"
		I.2C. Creating or stimulating mobility solutions generate value for commercial activities	"In a similar mindset, would be if we could create or stimulate the arrival of a fast mobility transport solution in the broader sense, then we could have more chance of generating value and we've got some sites in mind for the industrial parks and stuff where that's key to their success"
		I.2D. Economics of land value capture - enabling more development or taxing future income?	"And you've just financed your tube line Mr Mayor, on the basis of this tax that's going to be in place after the upgrade is in operation, because there's no value before it's working, it opens in five years, your property values are going through the floor, you're now taxing all you prime real estate with the supertax. Bit tough – and you made that decision at the beginning to borrow money, which is going to get paid back by these property developers in seven years' time."
		I.2E. Funding improvements through taxes on development	"So we would give people extra development, tax free periods, because we wanted them there for future tax base, not have a future tax base that was taxed, but actually giving them tax-free for ten years, on the basis that in ten years' time the city would have a big tax base, and we'd have created employment, we'd now be healthy, they could afford to pay the tax."
	I.3. Imperative to support future capacity increase	I.3A. Growth-driven projects are heavily supported by external funding	"Where projects are almost totally growth-driven, facilitating housing or something, then we'd seek to fully fund them. So yes, while – the more money we can secure externally, the further our money goes"
		I.3B. Business model for next generation smart infrastructure	"They're all hoping to get out of this, some sort of business model for next generation smart infrastructure, which can look for evidentially at what the before and after state is, in terms of ROI"
		I.3C. Overall vision for how the city 'behaves'	"That's what has been materially missing from many situations – is a vision statement for how you want your city to behave"
II Complex notion of value	II.1 Fragmentation of value	II.1A. Paucity of thinking in the broadest context	"Because we think in one dimension – if you go into most consultancies – Aecom, Atkins, Buros, Arup, whatever – you've got a transportation tribe, a rail tribe, a road tribe, an aviation tribe - each tribe just does its own thing, so it'll give you turnout geometries, and high speed tunnels, switches and crossings – but it won't ever ask the question of, why don't you walk instead. And there's a paucity of thinking in the broadest context."
		II.1B. Valuation of benefits across different time scales	"The way we value time as an irrational human being, I feel much more pain now because the long term benefit even though it might be slight, I can never discount 50 years of benefit because it's not… so, the way I think as an individual on that time horizon I will always value, or disvalue, my immediate grief much more"
		II.1C. Optimising benefits - ensure that project manager, optimising time-cost-quality, doesn't compromise overall benefits of project	"We're trying to make sure that the project manager, who's always focused on cost-time-quality, isn't in trying to optimize those things, compromising the benefits of why we set out to do the project in the first place"

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Table 3 (*continued*)

Aggregate Dimension	2nd order theme	1st order concept	Illustrative quote
		II.1D. Shift in process from bottom-up local projects to strategy-driven prioritization	"Increasingly now we're moving to a pretty robust top-down approach to say, so these are the outcomes we want to drive across London... and this is the size of our investment programme and these pressures are coming on in terms of growth and performance – how do we best spend our money?
	II.2 Codification of value	II.2A. Project specification flexible to allow design choices and stakeholder consultation	"One of the big problems is our current planning process requires a level of definition for the project, that defines the project in detail, before you've designed it. Which means your ability to value engineer it when you are designing it, you're now designing everything to a fixed parameter rather than an envelope, and that is just absurdity. "
		II.2B. Codifying the 'common sense view' of whether a project was worth investment	"It's just trying to find a way maybe of, not necessarily codifying, that sort of common sense view that people have of, yeah that feels like a project that was worth that investment of public money."
		II.2C. Value appraisal tools work better for small to medium sized projects	"The bigger the project/infrastructure investment, the more holistic question that's necessary, and being brave to say actually you need to do something different"
		II.2D. Value judgements in technical decisions	"You are implicitly making value judgements of balance every time you put a transit system or a motorway system or a traffic light system or a pedestrian crossing system"
		II.2E. Value proposition of how you use the streetscape - big variable is where you put the kerbs	"I think the vision issue, and I use that word deliberately – so the value issue – your value proposition of how you use streetscape – and the big variable is where you put kerbs. That changes your city. All you have to do is move a 6" kerb"
III Local value	III.1. Benefits capitalised into land values	III.1A. Value of improved connectivity between communities	"Crossing the Thames twice with a new subway line is kind of obvious. You connect two communities, two bus services, it's sort of, it's like, you don't need a planning model. You only need a felt tip. That's a good idea right, it will always pay for itself by connecting two parts of the existing city.
		III.1B. Value creation between mobility and land-use intensification creates a virtuous cycle	"It works if you've got enough density of population – in effect you've captured the exogenous benefits from transportation, converting it to build, which then drives in money, so it's a way of capturing the virtuous cycle"
		III.1C. Transport upgrades about economic regeneration impacts, not flow	"They fought very very hard to get that tube line to come over here, because they realized that it wasn't about flow at that time, it was about the economic regeneration impacts"
	III.2. Creation of shared, common value	III.2A. Historic infrastructure shaped by engineering for social good, over economic or financial benefit	"If you look at a lot of the really spectacular engineering, that was done in the 19th century in this country and then into the 20th century in the United States, it wasn't dominated by finance at all, it was dominated by engineering and social good. And only in the past half century have we allowed economists and financiers and accountants, and lawyers, to dominate the way we do things"
		III.2B. Responding to housing development areas to improve transport	"There's an Overground station there – so, and that's responding to a housing development and saying what we're going to do about it. Clearly, it's better if you can actually target the housing areas where you have got the potential for the transport"
		III.2C. Value creation for residential growth and value capture through business rates is misaligned	"In London, and a lot of places, because it depends on business rates whereas actually a lot of the planning of some of our rail routes is all residential driven, so it doesn't quite stack up, doesn't quite work"
		III.2D. Urban infrastructure improvements remake existing infrastructure	"Streets, you don't get new streets – these have been here a long time, they don't move"
		III.2E. Everyone has an interest in projects in the public space	"You do something in the public space – and everybody has an interest in it – whether they're a freight user, a bus passenger, a utility company, a frontager, someone who just walks through there, somebody who's never been there, but thinks that it's an iconic space – and in a way that's one of the challenges"
		III.2F. Unclear identification of long term purpose/s of an asset	"A fundamental characteristic of urban infrastructure which is different – and I put it as a characteristic rather than a problem – is that it is rarely possible that a government or the public sector has been able to articulate with any real clarity the long term purpose of the asset."
IV. Sector value	IV.1. Travel as a process	IV.1A. Predict and provide gives a different solution when considered across modes	"Predict and provide only worked if you were looking at single modes. It was predict and provide for traffic, predict and provide for trains, it wasn't predict and provide for mobility in a city – which is a fundamentally different question. And I think that we've run out of money and space so predict and provide is just gone from most urban options."
		IV.1B. London's transport is so deeply meshed in the city, if one [route] fails you can still get around	"At the moment we're using public transport for that, of course, that's why the tube is so successful because it is so deeply meshed in the city, it's not in a lot of other cities, that's why people love London, because whatever happens, you can get from a to b by at least six different routes, and if one of them fails you can still get around, it's slightly more irritating but it's not catastrophically awful"
		IV.1C. Focus on process-based mechanisms for value creation	"The point you're making is process design of transportation – and, classically we don't think about transport as a process, and certainly not an end-to-end process. We think about it as a series of bits of physical interventions, it's asset based – so we'll have a bike station, we'll have bike racks, we'll have a railway line, not actually, how do you make the whole thing work, and how does that work differently under new technologies. "

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Table 3 (*continued*)

Aggregate Dimension	2nd order theme	1st order concept	Illustrative quote
		IV.1D. Intersection between technologies, mobility, pollution, value of transport	"In the future that's an equation which we don't, we haven't solved the old one, this is the new one that's coming up with new technologies – actually it's a different game"
		IV.1E. Valuation of projects lacks a cohesive understanding of the purpose	"The friction is, you argue for insular projects, there is usually no need or mandate or requirement to have a cohesive view of why you're doing it"
		IV.1F. Significant urban projects come down to capital expenditure and journey time capacity	"All the approval process about significant city projects, particularly light rail, heavy rail, is about capex and journey time capacity. Journey time capacity we just dealt with, the capex issue, is purely political – what any mayor wants is to get the capital sum in his budget, because once it's built, no one's going to close it."
		IV.1G. Transport providers equate value with time saved	"Traditionally, it was improving journey time, and that was, cost value of time equation was the simple driver, the quicker the journey therefore I had saved three hours of my time, times a million people, times 6.50, therefore that was the cost-benefit, which is, phenomenally crude"
		IV.1H. Private taxi-cabs are convenient but pump traffic onto the road network	"Other one would be taxi private-hire, the expansion of Uber is exacerbating the current problems we have with congestion in central London, it's great for us as punters – but it's pumping a lot more vehicles onto the road network"
		IV.1I. Shared mobility schemes to improve connectivity to transit nodes	"Whether we put a scheme of shared electric scooters, initially, to get people over from the overground station, so that we can get people into the waterfront, because we haven't got the express connectivity that we need, and so we would promote those sorts of schemes"
	IV.2. Value to support commercial activities	IV.2A. Physical mobility and digital connectivity support economic value-added activity	"There's scope to put more economic value-added activity on that site, if we can sort out both physical mobility and digital connectivity, which are both a bit under-performing, in relation to where we would want them to be."
		IV.2B. Equations for appraising value aren't good enough	"The classical method of evaluating is journey time savings and congestion relief. You could eliminate those virtually altogether, and go to, and argue that it's accessibility in predictable time, with a non-straight line time value curve."
		IV.2C. Protecting freight functions while optimising timing and space allocated to vehicles	"Freight, for instance – if we're talking about central London, freight now forms a large part of the traffic in central London, it's needed, we know it has to be there to service the shops and things that we need, but can we look at consolidation, putting it into larger vehicles, retiming of freight deliveries"
		IV.2D. Treating value as willingness-to-pay underestimates actual value potential	"That [rail] service is operated on a farebox basis, it's bringing commuters into London every day, they're paying the fares, and there's no reason for the rail company, effectively, to stop at this station on the way, because the modelling suggests there's no one there willing to pay a fare; but it won't ever be regenerated if that train doesn't stop there either."
V. User value	V.1. Diversity of user needs and expectations	V.1A. Oxford Street crossing system for pedestrians, with vehicles	"It used to be, all the traffic lights were done for vehicles. With crossing. Rapidly we're moving, like at Oxford Street, Atkins designed a crossing system for pedestrians, with vehicles"
		V.1B. Seeing the road network as a more holistic network	"We're moving away from just seeing the road network as something to move vehicles around, and seeing it as a more holistic transport network"
		V.1C. It's not precisely the journey time but time (within bounds) plus predictability that matters	"It's not journey time, it's predictability, and that's true of all journeys. The classical method of evaluating is journey time savings and congestion relief. You could eliminate those virtually altogether, and go to, and argue that it's accessibility in predictable time, with a non-straight line time value curve."
		V.1D. Appreciating the different people experience transport infrastructure in different ways	"We do try now and break it down, appreciating that people experience – like Old Street – some people experience it as a bus passenger, some as a pedestrian, some as a cyclist, and we try and give it from their perspective"
		V.1E. Value creation and fairness for different users	"You get into the inequality of fare policy, and congestion pricing, and off-peak travel and peak travel, which means that cleaners can't travel to work in the rush hour, because they can't afford it. Is that valid?"
		V.1F. Value creation occurs across different groups and temporal, spatial scales	"At the heart of the conundrum, the reason you're doing this scheme isn't just for locals who live on the line of the route, it's the wider societal benefits, exogenous benefits to do with pollution, and they can't handle that either – so it's a dispersed raft of benefits to society at large, versus some micro-benefits for themselves a long time in the future, vs a huge amount of upfront pain when you can't walk down the pavement, can't cross the road, there's dust and grief"
		V.1G. Benefits mapped against ten principal outcomes for surface transport	"We tend to map them against our own – surface transport has ten principal outcomes, reliable roads, better bus network, cycling, walking"
	V.2. Experiential quality of travel	V.2A. Need to improve the liveability as well - people have high expectations	"Nearly all of our schemes go through this balancing act of, we still need to move people around the city, but actually we need to improve the liveability as well – people have high expectations"
		V.2B. Urban transport all occurs in public space	"Cities, usually, what's fantastic about your urban transit – it all occurs in public space. Even metro entrances come out in public space."
		V.2C. Changing the landscape of stakeholder engagement to include the passengers	"So, there's an example of where the stakeholder engagement was insufficiently complete at critical times... I said, we really have to talk to the people, and we have to model how people get on and off trains, and as a result, other work was done, also at UCL, with TfL on the modernization of various tube lines, we didn't quite get to Crossrail in time, but there's still work being thought about in Crossrail, and it's certainly being thought about in Crossrail 2. as a result we changed the landscape of stakeholder engagement, to include, the passengers – which after all is what train systems are being created for.

(*continued on next page*)

Table 3 (*continued*)

Aggregate Dimension	2nd order theme	1st order concept	Illustrative quote
		V.2D. Attractiveness is a mix of attributes including public spaces	"It's partly, how pleasant is this area to pass through, in terms of ease of movement or clutter, easy road crossings, less noise, better air quality – as against, and then there's a further one, is this space so nice that I actually want to stop here and absorb it and sit on this bench overlooking this nice view/landscaped area or whatever – and dwell a bit more in the space"
		V.2E. BCR doesn't adequately reflect some of the liveability aspects	"One of our main responsibilities is to justify the project, in terms of the business case, and we have a fixed methodology within TfL which broadly follows DfT guidelines, and my view is that our methodology in terms of benefit-cost ratio doesn't really adequately reflect some of the liveability aspects"

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