WHO ARE THE 'MIDDLE ACTORS' IN SUSTAINABLE CONSTRUCTION AND WHAT DO THEY NEED TO KNOW?

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Abstract

This paper explores what knowledge and skills are needed, and how those skills and knowledge might be gained, in order to deliver more sustainable outcomes from construction, using the concept of “middle actors”. “Middle actors” are the individuals who occupy the space between ‘top down’ policy and instruction, and ‘bottom up’ norms. In construction, 'middle actors' with influence on building performance include clerks of works, project managers, tradespeople and technical advisers.

There is a relentless drive for more sustainable buildings that use less energy, generate less waste during construction and use, and provide healthy environments for people to live and work in. This direction of travel can no longer be considered “new” and yet it remains far from the mainstream. To create buildings which are sustainable, we need to consider not only technology and design changes, but how to alter the wider system of construction. We use middle actors as the lens through which to examine these non-technical changes, and the skills and knowledge required to achieve them.

A review of the concept of middle actors as it has been applied to construction and an overview of skills and knowledge needs for sustainable construction is followed by identifying middle actors in new build and retrofit, commercial and domestic projects currently under way with one developer in Leeds, UK. The skills and knowledge needed by ‘middle actors’ to deliver more sustainable outcomes from their projects are described, based on empirical data gathered from project teams, and further structured by considering when in the project cycle they are needed, and what routes to gaining the required skills and knowledge might be most effective. This analysis reinforces that there is no single route to achieving more sustainable buildings and instead the activities, responsibilities and networks of individuals need to be carefully considered in developing training programmes for construction teams.

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Introduction

The challenge of transforming our built environment, and how we create buildings, to be fit for a sustainable future remains significant. There is a relentless drive, supported by policy and regulation, for more sustainable buildings that use less energy, generate less waste during construction and use, and provide healthy environments for people to live and work in. The pressures are acute for both homes and non-domestic buildings, and for both new build and the existing building stock. New build processes are being driven to change (in the UK) through a "Transforming Construction" priority in the UK's Industrial Strategy which seeks to improve the quality and consistency of buildings, while also reducing costs and build time, through huge deployment of off-site and module construction. These forms of construction still require knowledge and skills to support sustainable outcomes. However the distribution of *who* has the knowledge and skills and *when* they are deployed must change from the traditional forms of knowledge within individual professional domains developed through vocational training and onsite experience.

Transforming existing buildings, with their histories and multiple functions in terms of shelter and local character, poses a different set of challenges compared to creating new sustainable buildings; a set of challenges that the UK is currently failing to address (CCC, 2019). There are a range of design and technical advances that could be used in existing buildings, from novel space heating, to radical energy conservation or whole house 'Energiesprong' approaches. However, implementing these innovations relies on the variety of people involved in working on existing buildings developing and using new skills, working across traditional trade boundaries and reconfiguring construction work processes. We refer here to the "variety of people working on existing buildings" rather than solely "the construction industry" because the repair, maintenance and improvement, including renovation, of buildings, particularly homes, is not an entirely professional project. Work on homes can be carried out by home owners with a series of projects over time (Fawcett, 2013) and there is a large element of the homeowners themselves driving towards more or less sustainable construction outcomes (Fawcett & Killip, 2014) as well as a significant DIY element in the delivery of projects. In some cases householders have also equipped themselves to guide builders on technical details for low-energy retrofit (Thomsen & Huage, 2014; Simpson, 2017). However, to provide some focus to this paper we map only the construction professionals involved in work on existing buildings.

The required direction of travel to more sustainable construction and building performance can no longer be considered "new" and yet it remains far from the mainstream. To create buildings which are sustainable, we need to consider not only technical and design changes, but how to alter the wider system of construction (Thunshelle et al., 2018). This means we have to understand the relationships that shape construction outcomes, understanding construction as a set of co-evolving actors (Killip et al., 2018), operating in networks (Owen,

2015) and as part of a complex supply network, rather than a linear supply chain (Killip et al, in press).

Questions which guided our data collection and analysis for this paper are:

1 - Who shapes construction activity towards more or less sustainable outcomes?

2 – What kinds of skills and knowledge do different team members say they need, and are there any additional skills/knowledge gaps not explicitly recognised by those individuals?

3 – When in the project cycle do the skills and knowledge that lead to more sustainable outcomes need to be deployed, and by whom?

These questions are answered in the 'emergent findings' section below, while a fourth question guides the 'discussion' section:

4 – Do the answers to questions 1, 2 and 3 help to identify preferred methods and routes for professional development?

To provide some focus in differentiating between individuals and roles in different teams, we use the concept of 'middle actors'.

Who are the 'middle actors' in construction, and why do they matter?

Social and technological innovations are commonly seen as either being induced from the 'top-down' - e.g., by policymakers - or evolving from the 'bottom-up' - e.g. by citizens. A 'middle-out' perspective focuses instead on agents of change that can promote transition and which are located in the middle, in between the state and its citizens. The Middle-Out Perspective (MOP) developed by Janda and Parag (2013) and Parag and Janda (2014) shows that middle actors can affect change in several different directions: upstream to policymakers, downstream to clients or members and sideways to other middle actors (often by enabling and sharing new professional norms and working practices). By linking the top and bottom, the MOP is both an alternative and complementary to existing 'bottom-up' and 'top-down' efforts to implementing low-carbon innovations and practices in society.

Middle actors are distinct from intermediaries who have been researched in the construction industry (Kivimaa & Martiskainen, 2018) because middle actors have agency, they are not conduits, more or less effective in the transfer of information; middle actors actively shape the decisions and actions taken by others through their own information filtering and interpretation. Middle actors in a construction project are diverse. Between the top down policy and regulation, including carbon and building regulation, and the bottom up builder user demands, a range of individuals carrying out diverse roles coax a construction project into fruition.

The MOP is a relatively new and evolving approach to understanding socio-technical energy transitions. It aims to find new ways of approaching existing or wicked problems (Rittel & Webber, 1973). As such, the MOP has attracted a diverse range of research analyses. The initial work of Parag and Janda described how middle actors include (but are not limited to)

such groups as building professionals, religious congregations, and commercial property owners (Janda & Parag, 2013; Parag & Janda 2014). In recent years, these and other authors have further applied and developed the MOP to address a number of other middle actor groups, including: providers of housing refurbishment (Janda, Killip & Fawcett, 2014), heating engineers (Wade, et al., 2016), community-based organizations (Hamilton et al., 2014), facilities managers (Goulden & Spence, 2015), social housing providers (Cauvain & Karvonen, 2018), and actors involved in energy storage (Devine-Wright et al., 2017).

Previous research shines a light on how individual professional groups interrelate and how they deploy their skills and knowledge to shape the outcomes of a construction project. Architects seek to interpret standards in a way that allows them to meet client needs and their own professional interests (Fischer and Guy, 2009). Heating engineers use information from others in their professional networks to develop their advice to customers (Wade et al, 2016). Both these groups define areas of legitimacy for their advice, or areas of 'professional jurisdiction (Abbott, 1988; Wade et al, 2018). More broadly, professional groups also work in together in what Abbott (1988) calls a "system of professions" where different groups claim ownership of particular aspects of socially accepted problems. These then become their "professional jurisdiction" which they need to defend in the public eye to keep their mastery of the niche, even while they share the work terrain with others. In the construction industry, for example, Janda (1998, 1999) has used Abbott's framework to examine how architects, engineers, and energy efficiency advocates pursue their own professional objectives whilst working on the same project; how a new profession might be needed to enhance residential retrofits (Janda & Killip, 2013); how architects, engineers and builders excel in different ways in high profile buildings (Janda, 2017).

What do middle actors need to know to deliver sustainable construction, and how do they learn?

In the UK, the Construction Leadership Council produced a Sustainable Training Guide (2017), which includes recommended learning outcomes for sustainable building, aimed at construction trades, building services engineering trades, managers, supervisors and designers. The construction trades section is divided into: Low energy/ low carbon building, Sustainable products, Waste, reuse and recycling, Water and whole build processes. The low energy section (CLC, 2017) includes: principles of building performance and associated costs, Principles of air-tightness, Effective insulation, Ventilation and air quality and Overheating. Similarly, the Builders Books (ZCH, 2015), the Services Guide (ZCH, 2016A) and the Thermal Bridging Guide (ZCG, 2016b), all developed by the Zero Carbon Hub (ZCH) explain principles such as thermal bridging with illustrated examples of technical solutions for building site use. This work followed the ZCH's work identifying factors contributing to the building performance gap between designed as as-built energy use, which installation detailing was one contributing factor (ZCH, 2014). Previous work with construction teams in Leeds, UK identified that delivering sustainable construction relies on knowledge of technical detailing for building performance, lean principles of minimising waste and social relations and value involved in construction processes and products (Simpson et al. 2018).

The present UK vocational education training system pursues a top-down management approach, characterised by a task-based system and a lack of self-management for trainees (Clarke et al., 2017). This has major consequences for enabling middle actor agency. In the UK, 73% of construction companies have been found to have no training plan, 81% no training budget and only 19% investing in training (BIS, 2013). Previous studies from across Europe confirmed a lack of energy literacy, plus an increasing demand for multi-skilled actors within areas critical to achieving energy efficiency (ZCH 2014) but current vocational training is inadequate to this task. For example, for National Vocational Qualifications (NVQ) 2 and 3 in bricklaying, trainees learn about the installation of cavity wall insulation with particular care for junction detailing but there is no mention of air tightness or thermal bridges (Clark et al., 2017). Similar challenges exist in plastering NVQ Level 2. For groundwork, window installation, loft insulation and labouring no formal vocational training exists. BTEC Pearson released a new specification for courses such as the Level 4 Construction and the Built Environment in 2017 (BTEC, 2017), which does encompass sustainability within units such as Construction Technology and Construction Information, but if students are to gain a full understanding of the issues, their tutors and their sources of information will need to take this integrated view.

Approach

The empirical data used in this paper's exploration of middle actors' skills and knowledge needs were gathered during two projects in Leeds, UK. To allow a flexible and exploratory research approach, research questions were not set at the outset of these projects and we are not presenting the results of a formally designed research inquiry.

The first project acted as a catalyst, gathering interest from local construction stakeholders, including middle actors, with expertise in sustainable building, city wide planning and development or training and skills, from research, public and private sector organisations. The aim was to co-identify the sustainable construction skills required for both retrofit and new-build. The skills needed were identified through a series of telephone conversations with stakeholders ahead of a workshop which gathered insights responding to three questions: what are the benefits of sustainable construction, what are the challenges, and what are the solutions?

The second project further engaged some of those attendees, particularly a local developer of two sites in Leeds and the specialist construction College, also in Leeds. This engagement took place around the completed new office build on one site, which was used as an exploratory case study, and alongside a second office which was at design stage at a second site. Both offices aimed to exceed minimum standards on energy efficiency and the second aimed to become an exemplar of Design for Performance approach for new office buildings, adopted from Australian NABERS programme. The teams engaged through these developments were initially suggested by the developer with some further suggestions made during each meeting, creating a snowball sample.

The developer has a stated interest in sustainability, which encompasses site accessibility, building use and community support, environmental impact, as well as climate change

mitigation and adaptation. The city's further education College specialising in construction training is working in partnership with apprenticeship providers on one of the sites. The initial provision is for 12 Construction Contracting Operation apprentices who are also completing a Level 3 BTEC course in Construction and the Built Environment

During the second project, informal meetings were held to explore perspectives of the network of middle actors involved in the office developments. To fit the short exploratory project the meetings were unstructured and informal. At the start of each meeting the project was explained, ensuring openness and transparency whilst allowing meeting attendees the opportunity to ask questions or choose to opt out. The meetings focused on sustainable skills required in the sector and gaps the teams had noticed for their peers or others involved in the design and build process. The discussions included aspects of training and development the teams felt were useful and effective, or otherwise.

As the first case study office build was recently completed and the second was at design stage, this allowed teams to reflect on recent or current experiences. The meetings were held within the café situated on the ground floor of the first completed office build providing further authenticity to discussions and allowing particular junction or detail challenges to be pointed out in the structure. This enabled construction practice and site realities to move our previous research beyond theorising and provide reflections with empirical grounding. There is a growing literature using ethnographic methods to understand construction practices (Pink et al, 2013) and while not proceeding as far as autoethnography (Grosse 2018), this paper recognises the positionality of the researchers as influencers within the construction project system and offers insights from reflective practice within the system, synthesising new primary data with previous experience in order to answer a series of linked questions. In addition, researchers visited training sessions ran by the College, taking place in portakabins on the site. This allowed conversations with the trainers, apprenticeship providers and 12 trainees as a group.

Emergent findings

Middle actors were found to operate as a network. An ecosystem analogy might be useful here as different actors occupied different niches defined by their skills, knowledge and practical influence (Simpson & Owen, in press). Middle actors identified in these projects were:

- Designers – both architects and structural engineers, who see their purpose as delivering on the architect's vision.
- Designers at the level of delivery – particularly M&E designers who seek to deliver on the architect's vison but also meet other parameters in terms of standards and practice.
- Project Manager – working on behalf of the client or lead contractor and tying together many threads.
- Clerk of Works – also working on behalf of the client, the Clerk of Works lies at the heart of an efficient and effective project once on site. Usually using a background in quantity surveying, the Clerk of Works monitors whether the design drawings and

specifications are being implemented correctly. Clerks of Works became less common as a role, often replaced by trade foremen, as cost pressures increased in the construction sector. However, the advent of Building information Management (BIM) has led to the role re-emerging, albeit with a slightly different profile.

- Tradespeople - construction workers including general builders and specific trades such as electrician, roofer, plasterer, joiner, heating engineer, glazier.
- Technical advisers – for mechanical and electrical (M&E) services, and for innovative sustainability approaches in building performance, particularly when a building requires accreditation e.g. BREEAM or WELL or EnergyStar. Advice tends to be framed by the standard that has caught the attention of the client or designer, or has been previously trialled by the advisers. Technical advisers typically work to advise designers and the project manager; they have limited connections to tradespeople or onsite work, but were found to directly liase with the clerk of works, often on a daily basis during the construction phase. Where the clerk of works needed to clarify a M&E or building performance detail they would photograph the issue and send it to the consultants for advice on an informal basis

We now turn to the question "How does middle actors' influence vary?" looking at interest and influence by topic, as a bridge to then considering when they need knowledge.

- Waste management and resource efficiency – driven by regulation and the need for a site waste management plan, but also a visible source of cost and improving resource efficiency in construction and use contributes effectively to a business case for change based on cost and payback. However, reducing waste at source requires thought and care from both designers and the trades who implement design.
- Low energy in use – often considered by designers, in response to regulatory pressures such as compliance with Building Regulations, but realising design intent is dependent on the skills and knowledge of the tradespeople who carry out work. Two areas of skills and knowledge were identified by our project partners within this sphere. First, a range of people across the project team needed to know about the technologies that might enable lower energy use, and second, construction workers, and those evaluating and signing off construction work, needed to understand how individual tasks fitted together into the whole picture of building performance. There was a particular emphasis on the need to understand detailing and the reasons for paying attention to interfaces between materials and different trades' work.
- Low embodied carbon may be considered as a useful benefit by designers, once other performance criteria such as strength and weight have been achieved (Giesekam et al 2016) but embodied carbon impacts are near invisible to most other construction middle actors.
- Resilience and adaptability – while these terms are most often used in connection with the need to be resilient to the impacts of climate change, particularly flood impacts in the geography of our case study projects, they might also refer to the

potential to change building function over time e.g. allowing flexible partitioning of space to accommodate changing occupants, or mixing live/work space.

- Health and well-being – health and safety at work is, with good reason, a high priority for construction sites and all those who work on them. Health and safety in site construction practices is regulated, and carefully monitored with performance scrutinised. However, clients and architects now also consider how the building will contribute to the health and wellbeing of its users, although there are few explicit connections between this consideration and the onsite practices that deliver the designs.
- Social value – a requirement from all public sector procured construction projects in the UK, social value refers to impacts generated by the project such as employment, skill development and community building. Social value was identified by a range of stakeholders in these construction projects (Simpson et al, 2018) but since it arises both from the building design, and from the project management approach and decisions made about procurement and recruitment, it is the most difficult to grasp of the skills areas identified.

Table 1 summarises what skills and knowledge these actors told us that they needed i.e. their conscious knowledge needs. The suggestions of when those needs are most acute have been organised by the researchers into stages of the project cycle as defined in the RIBA Workplan (RIBA, 2013).

Table 1, Middle actors and their skills / knowledge needs for sustainable construction

Middle actor	**Sustainable construction skills/knowledge needs**	**When in the project cycle is that need manifest? RIBA workplan stages**	**Preferred learning routes**
Designers – architects / structural engineers	Impact of design decisions – during construction and during building use Efficient building form Material selection Junction detailing Design for re-use Location of plant rooms Building modelling software and links to accurate input variables	Stage 0 – Strategic Definition Stage 1 – Preparation and Brief Stage 2- Concept Design Stage 3 - Developed Design Stage 4 – Technical Design Stage 7 – post occupancy evaluation	Formal training, CPD accredited Mentoring/sponsorship of innovation and practical learning, informal through project discussions
Designers – M&E	M&E Systems and links to accurate input variables Building modelling software Building Management Systems Building physics and how that translates into materials, fabric and configuration of Communication with on-site project team How users interact with buildings	Stage 3 - Developed Design Stage 4 – Technical Design Stage 6 – Handover and close out Stage 7 – post occupancy evaluation	Formal training, CPD accredited, informal through project discussions
Clerks of works	Technical details to be installed Knowledge of all construction contract operations Mechanical and Electrical knowledge (or specialist employed) Relationship between design and sustainable outcomes	Stage 4 – Technical Design Stage 5 – Construction Stage 6 – Handover and Close Out	Formal, on the job – or sponsored by client, informal through project discussions

Project Managers	Interaction of decisions and how they affect project outcomes in terms of a range of measures: cost, waste, energy etc.	Stage 3 - Developed Design Stage 4 – Technical Design Stage 5 – Construction Stage 6 – Handover and Close Out	On the job – or sponsored by client. Must be integrated with project manager role and skills i.e. not a standalone subject, informal through project discussions
Tradespeople	Know what (to do) Know how (to do something) Understanding how their work interacts with others – particularly around detailing and interfaces.	Stage 5 – Construction Stage 6 – Handover and Close Out	On the job. Training delivered by individuals with experience and credibility Accreditation only beneficial if supported, required and credible, informal through project discussions
Technical advisers – BREEAM	Technical knowledge related to standards and measures Building modelling software Also require process skills to communicate, persuade, encourage, problem solve etc.	Stage 2- Concept Design Stage 3 - Developed Design Stage 4 – Technical Design Stage 5 – Construction Stage 6 – Handover and Close Out Stage 7 – post occupancy evaluation	Formal and accredited (to lend value to the work) for technical knowledge. Informal learning for process skills

Discussion

Our mapping shows that the variety of middle actor roles leads to a diverse set of skills and knowledge needs. Talking to construction teams reinforced that both knowing *what* to do, and also knowing *how* to do things are important. In addition, there are a number of softer, process skills that also need to be developed. These blur the boundaries between roles and expertise, requiring construction project team members to be aware of the implications of their decisions on others' work, and also on the eventual building created.

Diverse training needs can only be met through diverse training methods. The UK construction industry's Supply Chain Sustainability School is an example of allowing construction firm employees and project workers to select e-learning modules at a time and location to suit their circumstances. While the School has been able to track activity, i.e. number of e-learning modules completed, it cannot easily track the impact of those modules and this approach, in isolation, leads to a compliance-based approach to knowledge. This is familiar to construction workers (and others) from health and safety knowledge and certification systems. Such an approach may be appropriate for ensuring compliance with, for example, waste management standards. The other approach observed in Leeds is onsite training for apprentices (Simpson and Owen, in press), which allows trainees to study elements of construction as it takes place in practice. Where contractor teams are communicating well with the trainers such training can provide a route to communicating technical details clearly, while ensuring an understanding of the whole building system and also inspiring apprentices. This could be particularly useful for communicating thermal and air-tightness factors, building services systems and minimising waste through on-site operations, among other areas where flexible, responsive deployment of knowledge is needed.

Only the technical advisors on the projects in Leeds recognised that the knowledge gained through previous formal education needed to be continually updated in light of changing information and project needs. They used literature, professional fora, webinars and other means as a way of developing competence in their selected standard. The technical consultants considered it vital that those involved in design have a comprehensive knowledge needs of carbon or energy literacy. However, in translating this knowledge into building performance, other knowledge needs were identified related to the processes which led to sustainable outcomes, e.g. the value and rationale for quality and detailing and, interestingly, how construction might contribute to sustainable outcomes beyond the immediate physical impact of the project, such as generating social value (Simpson, et al 2018).

Working with a specific certification in mind and potentially becoming a benchmark 'base build' was a motivational factor for the developer. However, such standards also make new demands of the knowledge and skills in the construction teams delivering the project. For a small number of middle actors, sustainable construction outcomes is a primary concern. This can be driven by a cocktail of motivations from personal "green" beliefs and values to commercial value generation or exploiting a niche market opportunity (Killip et al, in press). For many others, sustainable outcomes are not their main focus. However, there may be

other motivating factors which lead to more sustainable outcomes. For example, a focus on accuracy and detailing is important in delivering in practice the intentions and potential of a design. Similarly, sharp attention to avoiding waste and managing effectively within resource constraints may be driven by financial interests but has the effect of reducing waste.

Innovation in methods such as offsite and module construction may be shifting the locus of where skills are deployed, but there are still needs for specialist knowledge. With one construction firm who have moved their entire operation to a purpose-built 'lean' manufacturing unit, they had broken down boundaries between trades and required each member of a multi-trade team to have detailed knowledge of each other's' work and skills both so that they could step in and support each other during the whole construction process, but also so that they understood the implications of their decisions and actions on others' areas of responsibility.

Current training focuses narrowly onto design and technical inputs, responding effectively to drivers for accuracy and resource / finance constraint. However, this means that training can easily miss whole building issues such as detailing and quality, and project process issues such as the interaction between different trade activities.

Conclusion

Using the lens of middle actors reveals roles in a construction project beyond the traditional roles of project manager, surveyor and trade. There are many middles in a construction project, as Reindl (2017) found in her study of the retrofit system within Swedish housing companies. Once we have recognised middle actors, and their importance, we must also avoid assuming they are a homogenous group. Beyond the professional roles described here, there are a range of other informal influential roles played by owners and their trusted networks, who will bring their own skills, knowledge and motivation into the conversations about what works needs to be done and how it should be done. Middle actor activities, influencing more or less sustainable construction activities, can arise from being part of a formal role, such as the focus on detailing that a Clerk of Works might provide, or from a personal motivation, such as a technical adviser's commitment to eliminating the performance gap. Either way, seeing these various actors through the lens of the 'middle-out perspective' emphasises that they are not automatons simply performing services demanding of them by others. Instead, they have both agency (the ability to make decisions) and capacity (the ability to enact them). Moreover, they can influence other actors around them, either *up* the supply chain or *down* to their clients, or *sideways* to other actors on the construction team.

The mixture of skills needed for sustainable construction - hard and soft, technical and process - leads to the unsurprising conclusion that training and development routes for sustainable construction need to be more diverse, offering options other than formal college-based learning. Allowing construction team members to develop personalised curricula or learning pathways, which respond to their motivations and project-specific needs could work well, and different modes of learning such as peer learning, supply chain

training, and experiential, site-based learning would all have a place in this kind of personalised approach. However, at present only those roles which have an expectation of continuing professional development in support of certification, or chartered status, are likely to take up such opportunities.

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