BUILDINGS & CITIES

SPECIAL COLLECTION: RETROFIT AT SCALE: ACCELERATING CAPABILITIES FOR DOMESTIC BUILDING STOCKS

RESEARCH

Domestic retrofit: understanding capabilities of micro-enterprise building practitioners

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ABSTRACT

To deliver effective domestic retrofit at scale, it is essential to understand the current and required capabilities of building practitioners working in the repair, maintenance and improvement (RMI) of existing buildings. Capability research in the construction sector has previously focused on large projects, but small, and particularly, micro-firms that undertake RMI and form 77% of workers in construction, are under-researched. This gap is addressed by the present study on the capabilities of the practitioners and the contextual opportunities to deploy capabilities. The study analysed data from interviews (n = 27) with micro-enterprise building practitioners working in the UK's RMI sector. Template analysis was conducted by applying an established model of behaviour change: Capability, Opportunity, Motivation—Behaviour (COM-B). Under Capability, three main themes were identified: knowledge, business management and individual characteristics. Under Opportunities, the main themes were state action, market and customer demand, technology diffusion, networks and business management. Under Motivation the themes were pride in work, good working relationships, maintaining a viable business and customer satisfaction. Practitioners are continually learning and problem-solving, developing trust and creating positive professional relationships. Working with these existing capabilities, experiential learning on-site and peer-to-peer training are recommended to scale up capability. For capabilities to be deployed, policy must enable opportunities across the multiple contexts micro-enterprise practitioners operate within, including training and incentives across the supply chain network and in stimulating demand.

POLICY AND PRACTICE RELEVANCE

Policy-driven retrofit programmes, such as those providing government funding for retrofit, must work from existing practitioner capability to accelerate capacity and allow delivery at scale. Practitioner knowledge, built over generations, is used to solve problems

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encountered with existing buildings. Practitioners minimise risk by avoiding unfamiliar technologies and practices. Practitioners develop capability on-site, experientially, so policy must enable practical experience for practitioners. One aspect of capability that needs enhancement to deliver effective retrofit at scale is understanding the building as an integrated system. While learning about individual technologies is important, integrated knowledge of multiple technologies and how they work together is required. To develop industry capability, policy needs to recognise the essential role micro-enterprise practitioners play in delivering retrofit and to harness their existing capabilities in knowledge, problem-solving and business management. Opportunities are needed to develop retrofit capability through peer-to-peer learning, knowledge-sharing between older and younger practitioners, and influential sector networks.

1. INTRODUCTION

Creating capability in a workforce to deliver energy-efficiency retrofit at scale is an enormous undertaking, according to Clarke *et al.* (2020). One of the biggest challenges in delivering an energy-efficiency programme is the availability of skilled professionals (Gross *et al.* 2020). Retrofit may include fabric improvements to increase energy efficiency, as well as measures to decarbonise heat, power and the water supply (CCC 2019), requiring an approach that considers the building as an integrated whole (Clarke *et al.* 2020). An integrated approach includes technically challenging activities that cut across different professional domains, such as external wall insulation, increased air-tightness, ventilation upgrades and low-carbon heating such as heat pumps, alongside the decarbonisation of the electricity system (Lowe & Chiu 2020). To date, such integrated, whole-house, or deep, retrofit has been undertaken by relatively few building practitioners (Fawcett & Topouzi 2020), limiting the opportunity for the majority of micro-enterprise practitioners to develop the necessary capability.

Micro-enterprise building practitioners deliver most repair, maintenance and improvement (RMI) activities in owner-occupied homes and are essential to accelerate energy-efficiency retrofit (Murtagh *et al.* 2021). Micro-enterprises, with seven employees or fewer, represent 92% (more than 300,000) of all construction firms in the UK (ONS 2018), and comprise 77% of the total construction workforce (BEIS 2019). Retrofit activities shape, and are shaped by, a system of policies, programmes and agents (Karvonen 2013). Yet practitioners delivering retrofit activity are often overlooked in retrofit policy design (Owen *et al.* 2014), with little or no consideration of developing their capability to support delivery at scale.

Alongside technological capability, economic incentive and political will, changes in practitioner behaviours are required for energy transitions (Komendantova 2021). Both psychological and physical capability are needed for an individual to engage with an activity (Michie *et al.* 2011). Michie *et al.* (2011) describe how capability, interacting with motivation and opportunity, generates behaviour. To scale up retrofit, practitioners need capabilities to deliver the systemic technological and social changes required and access to the opportunities to deploy that capability (Dixon & Eames 2013; Janda & Parag 2013). Micro-enterprise practitioners have previously been described as having two distinct areas of capability: technical, based on their knowledge, and adaptive, based on how they can use that knowledge in different situations—together, these influence practitioner ability to install energy-efficiency technologies (Owen *et al.* 2014).

The paper is structured as follows. A literature review of retrofit, energy efficiency, the RMI sector, capability and the theoretical model, Capability, Opportunity, Motivation—Behaviour (COM-B), are presented next. This is followed by the method adopted for the current research. The results are then presented highlighting an array of capabilities that match the needs of large-scale retrofit, followed by insights into how practitioners view the opportunities to deploy retrofit-relevant capability. These findings are discussed in the context of policy.

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2. BACKGROUND

2.1 RETROFIT AND ENERGY-EFFICIENCY

Retrofit creates complex projects encompassing multiple stakeholders, uncertainties, hidden risks and challenges in the allocation of responsibilities (Topouzi *et al.* 2017). Practitioners need both technical knowledge and project management capabilities to undertake effective retrofit (Killip 2013). They need to be able to adapt their standard procedures because fitting new technologies and products into existing buildings requires creativity and practical intelligence; projects rarely go exactly to plan. For example, there are often unforeseen complexities that cannot be identified until work is underway (Topouzi *et al.* 2017). Retrofit capability challenges usual practices by integrating new and unfamiliar energy-efficiency technology (Lowe & Chiu 2020) into a range of existing buildings, often with layers of multiple changes added over a building's life-cycle.

One of the UK's biggest projects intending to develop industry capability for energy-efficiency retrofit was the Retrofit for the Future (RftF) Programme, launched in 2009. In RftF, practitioners were found to 'confront problems, and re-think and re-negotiate solutions' to overcome complexity in delivering innovative domestic retrofit (Lowe & Chiu 2020). In a project report for a previous UK policy to stimulate energy-efficiency retrofit (Gorse *et al.* 2017), the practitioner perspective was found to have a substantial bearing on retrofit outcomes and the practitioner's approach was fundamental to realising energy savings. Additionally, the 'just-in-time' nature of funding for retrofit by previous policy schemes was considered to lead to a lack of time for research, early involvement of practitioners or team reflection on processes and outcomes (Gorse *et al.* 2017). More recently, place-based retrofit has required coalitions of practitioners in cities, from private businesses as well as voluntary organisations and local authorities, to experiment during times of particularly challenging policy conditions (Ince & Marvin 2019). Ince & Marvin (2019) suggest that a preparation phase allowing networks to be developed before delivery, could help 'normalise' retrofit demonstrator projects. This normalising is considered to be important as people are influenced by what others, both peers and wider societal networks, do (Nolan *et al.* 2008).

2.2 RMI RETROFIT PRACTITIONERS AND CAPABILITY

RMI retrofit practitioners involved in a retrofit programme influence others in their networks, for example, sideways from one to another (Janda & Parag 2013), within the community of practice in which they operate (Wade *et al.* 2016) and in supply chain networks (Owen 2015). In retrofit, subcontracting is often used to provide labour and skill flexibility for specific projects or particular regulatory requirements (Killip 2013). However, a shortage of capabilities can lead to increased time, and costs, on projects (Foxon 2011; Jagger *et al.* 2013), especially if finding specialists is time-consuming or they are simply not available.

To be effective, Clarke *et al.* (2020) suggest capability development for low-energy construction needs to move away from narrow capabilities and specific tasks and to take more standards-focused approaches with broad occupational profiles. In the UK, the measures intended to drive change in retrofit, stemming from the Clean Growth Strategy and Energy Performance Certificates, need to be more widely understood, not remaining the preserve of specialists alone (Fawcett & Topouzi 2020). As technical building standards progress, they can drive innovation, potentially as part of a group of policies aiming to improve building performance (Gann *et al.* 1998). This approach to standards can enable top-down implementation to meet bottom-up problem-solving capability (Winch 1998). Skills development should include how individual technologies work together as a system (Clarke *et al.* 2020) and how they are used in practice (Killip *et al.* 2018). However, enabling a training approach that integrates systems across multiple traditional practitioner training programmes may require a reconfiguration in professional domains to deliver an integrated service (Janda *et al.* 2014). This integrated delivery could be enabled via broad occupational profiles that enable multiple skills training (Clarke *et al.* 2020), as opposed to single-trade-practitioner training.

The capabilities effective retrofit practitioners require include knowledge, communication, problem-solving, coordination and project management (Clarke *et al.* 2020). Knowledge can be

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partitioned between individual knowledge and social knowledge (De Long & Fahey 2000). Social knowledge exists between individuals and groups and structured knowledge which is embedded in organisational practice. Individual knowledge includes both tacit and explicit knowledge and encompasses knowledge in the body, such as how to ride a bike or cognitive knowledge, which may be more theoretical or abstract. Problem-solving, in contrast, is a cognitive process that makes use of existing knowledge applied to new challenges. The transfer and communication of knowledge can be between practitioners, within firms or supply chains or with external industry bodies. Social learning theory placed role models as an important factor enabling vicarious learning, that is, learning from others (Bandura & McClelland 1977). Occupational settings, such as RMI work, offer valuable spaces for informal learning (Kersh 2017) that can enable peer-to-peer knowledge exchange.

While RMI practice and large construction projects differ in many ways, the literature relating to capability development in large construction projects can offer insights in terms of how practitioners come together to combine capabilities for project delivery. Studies have explored bottom-up capability development, for example, project-based learning when a firm moves into a new market or technology, including an exploratory project, then project-to-project application of new capability, embedding new knowledge (Brady & Davies 2004) and avoiding losing that knowledge on the next project (Davies & Brady 2016). Brady & Davies (2004) describe a top-down approach led by strategic decisions, with examples primarily in large companies seeking to exploit company-wide resources.

Organisations involved with complex projects deal with uncertainty and require a range of innovation, knowledge and expertise, usually embodied within individuals. The construction industry has been described as a loosely coupled system with tight couplings for individual projects and loose couplings of the wider network of practitioners (Dubois & Gadde 2002). Project-based firms operating on large complex projects build project capability at the interface between the project and the firm (Lobo & Whyte 2017). As part of this, a balance is struck between developing one-off solutions and applying previously used solutions in novel ways (Grabher & Ibert 2011).

The retrofit sector within RMI operates in a similar way to large complex projects in terms of teams coming together for individual projects with looser connections to wider practitioner teams, but usually with smaller teams working on individual projects and engaging with their wider networks across multiple projects. RMI has previously been described as a set of co-evolving systems of practitioners, user practices and business strategies (Killip *et al.* 2018) alongside ecosystems and institutions (Foxon 2011). Trust is central to the interactions between practitioners and across the supply chain, for successful project delivery (Khalfan *et al.* 2007). This trust is developed over time and experience working within the practitioner network.

Having reviewed the relevant literature on retrofit, energy efficiency, the RMI sector and capability, the focus now turns to the theoretical basis for this study.

2.3 THE BEHAVIOUR CHANGE MODEL

While other research has explored institutional aspects of retrofit, such as finance and warranties, the unit of analysis in this study is the individual practitioner. An established psychological model of behaviour change, the Capability, Opportunity and Motivation—Behaviour (COM-B) model (Michie *et al.* 2011) is applied here to the working experiences of RMI practitioners. In this behavioural framework, capability interacts with opportunity and motivation to generate behaviour. The COM-B model can be used to design interventions that change one or more aspects of a system and encourage behaviour change.

Capability is defined as both the psychological and physical capabilities of an individual, including having the necessary knowledge and skills and being able to engage in the necessary thought processes (Michie *et al.* 2011). The opportunity aspect concerns the factors outside the individual that make the behaviour possible, including institutional factors such as finance. Motivation is the internal energising of behaviour, including emotional responses, habitual processes and analytical decision-making.

To present the study's findings in appropriate depth, the results relating to motivation are given elsewhere (Murtagh *et al.* 2021). In summary, key motivations for RMI practitioners included pride in work, good working relationships, maintaining a viable business and customer satisfaction, while demotivating factors leading to lack of engagement with retrofit include a perception of increased cost, lack of confidence in technical standards and a perception of an increased burden of compliance with those standards. Important findings included that RMI practitioners were not motivated simply by profit: reputation amongst clients and others in the sector mattered to them. A strong focus on customer satisfaction related to taking pride in the quality of work, but could also lead to 'over-protection' of the customer and failure to offer higher cost, but more energy-efficient, outcomes.

The current paper focuses on capability, with additional insights into the external opportunities enabling or disabling capability as appropriate.

3. METHODS

The analysis presented here is based on three qualitative datasets from different research studies across England with similar aims: to understand building practitioners' experiences and perspectives on energy-efficient or sustainable construction and retrofit. The sampling strategy in each study was purposive and participant recruitment made use of personal networks, snowballing and gathering respondents through a builders' merchant. In each study, the researcher had links to industry extending beyond their academic role, which benefitted the study while also positioning the researchers with some prior knowledge and experience of the construction industry.

The total number of interviews conducted was 31. Excluding four interviews from practitioners in larger firms, the final aggregated data set was 27 interviews. This included study A (17 interviews from 2015 to early 2016), study B (four interviews, 2018) and study C (six interviews, 2015). The practitioners' reported roles are summarised in ***Table 1***; however, in practice, many were found to work across trades. The practitioners were working around the UK (study A: London and adjoining counties; study B: Bristol and North Lincolnshire; and study C: West Yorkshire). The three interview protocols included questions on: the type of work carried out, how they operate their business, sources of information for work, experiences or ambition towards sustainability and energy efficiency.

Table 1: Participant and business characterisation.

BUSINESS DETAIL	CATEGORY	NUMBER OF PARTICIPANTS
Company size	Sole trader	15
	1–10 employees	12
Trades (core business, though many work across trade boundaries)	General builder	8
	Heating engineer/plumber	4
	Electrician	4
	Bricklayer	3
	Plasterer/decorator	2
	Joiner	2
	Other	4
Total	Participants	27

The participants operated in networks of other sole traders and micro-enterprises. While subcontracting was common, it took different forms, from long-term co-working over years to the provision of specialist skills on a specific project. These networks meant that the practitioners offered a variety of services that could change according to project needs. Core trades were usually complemented with project management, sometimes with design services and, in some

instances, with product supply. An attempt was made to categorise the interviewees by trade or service offering, but it was found that any categorisation lost the richness of the fluid networks offered by the practitioners in the sector. Hence, an indicative summary is shown in ***Table 1***, but individual pseudonyms are reverted to in the presentation of the findings.

3.1 ANALYSIS

Template analysis, a form of thematic analysis, was adopted as this allows both structure and flexibility in the analysis process (King 2004; Brooks *et al.* 2015). The *a priori* template structure was Capability, Opportunity and Motivation (COM), in line with COM-B theory (Michie *et al.* 2011). The initial analysis included three transcripts, one from each dataset. Each transcript was analysed independently by two researchers to identify themes relating to COM, then discussed as a team to check the relevance of the suggested theme, consistency in how themes were understood and to agree further sub-themes. The template was then revised, and the same process repeated for further small sections of the transcripts until all were analysed. Towards the end of the analysis process, the themes were clustered in an iterative process where the clusters were re-examined following the final rounds of analysis. In the presentation of findings below, themes with fewer than two occurrences are omitted for clarity.

4. FINDINGS

The findings are presented on capability, followed by opportunities that can enable or hinder whether capability is deployed. The capability clusters and themes are presented in ***Table 2***. Prevalence is indicated by categories of high (over 20 interviews included the theme), medium (between 10 and 20 interviews) and low (nine or fewer interviews). Each cluster is then discussed with supporting extracts.

Table 2: Capability: clusters, themes and prevalence.

CLUSTER (AND CATEGORY)	THEME	PREVALENCE
Knowledge	Knowing and knowing how	High
	Ability to work across trade boundaries	Medium
	Ability to access knowledge	Medium
	Ability to keep learning and developing	Low
Business management	Manage and coordinate people and resources	High
	Develop and manage positive client relationships	Medium
Individual characteristics	Problem-solving	Medium
	Resilience	Low

4.1 KNOWLEDGE

4.1.1 Knowing and knowing how

Of the themes in this cluster, 'knowing' and 'knowing how' were identified frequently. 'Knowing' is the knowledge of an individual about how to do something in theory, and 'knowing how' includes the practical element, for example, knowing what is required to complete the task physically. This quotation, referring to various roles within a family business, illustrates this:

> My dad is 75, he still works for the company. His skills are the fact that he's got unbelievable experience, he's built everything it's possible to build and any detail he can look at and say 'do it like this'. His experience is unparalleled really and my brother, Steve, runs the site side of things, he's just very kind out of the box thinking, he can get round any problem.
>
> (Kal)

Here there is a reference to how the father's knowledge has been developed across decades and a variety of projects. This implies that some knowledge cannot be gained quickly or without experience. Therefore, there is a time element and a need for practical experience alongside. The brother is very much a problem-solver, while it is not clear whether this is natural or a learned ability, it is recognised, and considered valuable, by the practitioner. Both 'knowing how' and 'knowing' the products are described here:

> the technical side of making sure we understand how to do things, making sure they're done right and solving the issues of architects who've got no idea what they're looking at and making sure that we're using the right product and that side of it.
>
> (Vinnie)

Here Vinnie describes solving problems believed to be caused by the architects' designs. In addition, there is reference to mistrust or even lack of respect between practitioners. Therefore, the differing knowledge between 'knowing' and 'knowing how' between different practitioners may cause friction. The lifetime of experience was shared by many, for example:

> I know every tradesmen because I was brought up in the building trade and so I know a bit about everybody's [role].
>
> (Dave)

This long-standing experience appeared to contribute to the knowledge of how the industry operates and the practitioner roles involved.

4.1.2 Ability to work across trade boundaries

The ability to work across trade boundaries was recognised as a strength by participants for practitioners' own work and an aspect that they saw in others. For example, practitioners shared insights of where they have adapted and covered other roles to get a job completed:

> That was everything from start to finish, plumbing, the drains, heating. We even did the guttering on that job I think because the roofer pulled out, so they were [asking] 'Can you do the guttering?'
>
> (Frank)

The capability of working across trade boundaries was seen as a positive and something that can be overlooked by others who might not realise building practitioners, such as bricklayers, not only have a skill in the area in which they perhaps initially trained, but also over time learn and develop capabilities across other trades.

4.1.3 Ability to access knowledge

The ability to access knowledge included insights into where information was accessed by practitioners, as well as the times when new information was needed, and attitudes to learning. The practitioners frequently referred to the need for continuous learning. In some cases, this acknowledgement was driven by building regulation changes. However, in some cases, clients were keen to exceed minimum building regulation standards. In relation to meeting client demand for energy efficiency, participants noted the need to keep learning about new products:

> if someone said to me 'I want this as green as possible,' I would have to go out, scour the internet to try and find the products, then source the product.
>
> (Alan)

Finding information takes time and can entail risk for practitioners if they are learning about new technologies. Sources of information for the practitioners included co-workers, project partner companies, manufacturers' representatives, manufacturers' training courses, trade magazines, trade associations' materials (*e.g.* the National Housing Building Council), wholesalers, builders' merchants, suppliers' websites, architects, specialist internet sites (*e.g.* the Planning Portal for

Building Regulation Approved Documents) and general internet searches. Some recognised the limits of finding information and the informality of gaining knowledge:

> We've got a rule as a company [...] if we don't understand something, we don't do it until we do understand it. [...] Two ways [to access knowledge], one is by talking to people—it comes up in conversation, over a cup of coffee and the other way is by pure chance, there's no formal way and probably, that would be a very good way forward for the industry [...].
>
> (Vinnie)

The nature of knowledge-sharing between practitioners over daily interactions such as coffee breaks highlights how information flows between practitioners. The learning by chance, especially in relation to changes to mandated requirements such as building regulations, is important to note as this impacts the ability of practitioners to meet evolving standards. This informal learning of standards implies that voluntary standards would face even greater challenges penetrating the sector. The ability to access knowledge and invest time into this as a small company was considered limited for some, which is perhaps why some favour informal knowledge exchange. However, others commented on the availability and their control of time, to pay attention to detail, compared with employees working on large construction sites. This suggests there may be differing capabilities relating to time and learning that relate to the size of firm involved in retrofit.

4.1.4 Ability to keep learning and developing

The ability to keep learning was referred to by a few participants in terms of both learning on each job and the attitude to learning:

> some of them are like 'ooh, I don't wanna do this' and some of them are like 'how do I work with this?' So that varies a little bit, their attitude.
>
> (Kal)

While some could be enthusiastic about learning, others were perhaps more risk averse. The option to continue learning was a motivating factor for some who valued project variety:

> you could hang doors all day long if you wanted to, but that just wouldn't motivate me, it has to be something that's a little bit different, that stretches the grey matter.
>
> (Barry)

This implies that, for Barry, too many routine tasks are not favourable and being faced with a challenge to overcome is positive. While some were excited about learning, others noted this may not be the norm:

> My dad's good 'cos he's always looked in the magazines at new products that are coming out, he's always been interested in innovating. He's unusual in that way 'cos most builders learn a certain way of doing things and then they kind of stick to that, he didn't.
>
> (Kal)

This statement also shows a perception of a common discourse of reluctance to change in the industry, perhaps due to a need to ensure competence and to be time efficient.

4.2 BUSINESS MANAGEMENT

4.2.1 Manage and coordinate people and resources

The variety of work and scale of projects required flexibility from the participants and many shared detail on contracting and subcontracting for specific projects to enable this, while ensuring practitioners would be equipped with materials and the work would be sequenced accordingly. A few of the participants subcontracted directly and spoke of coordinating others:

> Probably about 15 [subcontractors], it rises and falls. [...] Typically, today [...] two, but yesterday, there was probably 18, but it just rises and falls as trades move in, trades move out. [...] We try to build a relationship with the people, using people we rate as good. [...] you're only as good as your contractors. So we tend to stick with the same panel of subcontractors.
>
> (Vinnie)

This emphasises the trust needed between building practitioners in terms of both lead practitioners trusting the competence of those contracted and the subcontracted practitioners trusting the person organising the project. In addition to the practicalities of ensuring the right people and capabilities were deployed, many spoke of the need to develop good working relationships. This related to taking on work that is deliverable to enable a positive reputation: 'we take a job that we can finish' (Stan). Taking on work that is achievable, as stated here, was a recurrent theme. The ways in which participants ensured projects delivered in terms of managing people, resources and developing positive client relationships are described in the following subsections. To build the trust required for people to employ or be employed as subcontractors, good working relationships need to be cultivated over time.

4.2.2 Develop and manage positive business and client relationships

Many participants spoke of the need to cooperate, in relation to developing good relationships: 'you're not gonna get anywhere if you don't get on with people' (Thomas), demonstrating an awareness of the importance of strong relationships. In addition, they recognised the need to understand client drivers: 'you have to understand what motivates them' (Barry) and their needs. Earning trust from the client was mentioned frequently, with the recognition of the value of the work and the risks involved for a client requesting work on their own home:

> If someone's gonna take you on to do a project, then they are trusting you with their money, which has taken them a lot of time and effort to acquire and then they're gonna give it to you to work on their house, which is their most valuable asset, so there are some pretty big things there.
>
> (Thomas)

Here there is a recognition of the trust placed by clients in their practitioners. In addition to reputation with the client, the participants noted the need to develop good relationships with the companies supplying building materials: many used the same merchants regularly and developed a long-term relationship. Relationships between building practitioners were seen as a valuable resource in terms of finding information, or checking whether something was technically feasible:

> I'll ring up a plasterer and say, 'There's this new damp proof plaster, is it right?' And then I'd go along and say, 'Oh yeah, you're right, we'll do that.'
>
> (Dave)

Trust and reputation between parties was paramount. In addition to this trust among colleagues, many participants spoke of close friends and relatives they worked with regularly, some of whom they grew up with or were the children of their friends and now in the building industry: 'although we're technically in competition, we're all friends—it's strange one' (Andy).

This section has presented insights into the strength of capability that participants described expressed in relation to developing good working relationships with clients, other professionals in their network and fellow practitioners.

4.3 INDIVIDUAL CHARACTERISTICS

Practitioners demonstrated capabilities through what are termed here individual characteristics. These were psychological characteristics that appeared to vary between individuals, and in line with almost all psychological characteristics they are likely to have developed through the interaction between predispositions and lived experience.

4.3.1 Problem-solving ability

Solving problems, such as overcoming tricky detailing and dealing with unforeseen challenges once the work started, were themes that appeared repeatedly, for example, through showing 'initiative' (Nick) and being 'creative' (Thomas), often to 'fix the problems up as quickly as possible' (Leo):

> Problem solving, that is my job, problem solving. From the moment I wake to the moment I go to sleep, it is problem solving. The problem may well be a mis-delivery or a product that's been delivered that's not suitable or fit for purpose, or a tradesman not coming in, or uncovering something in a building that's an unforeseen and you then have to come up with a solution whilst thinking on your feet—that is my key skill.
>
> (Dee)

Here, as with many other practitioners, problem-solving was seen as an essential capability required within many aspects of delivering work, especially in existing buildings. The practitioners' attitude to solving problems appeared to be important:

> [...] I believe that every problem is solvable [...] someone who specialises in designing couldn't really understand what the client wanted [...] with our construction knowledge [...] we managed to solve the problem.
>
> (Stan)

Here the practitioner mentions the differing roles between designers and practitioners, as referred to above, and appears to value the ability to apply existing practical construction knowledge learned through experience in his capability to solve problems.

4.3.2 Resilience

Resilience was noted as a capability theme during analysis. It encompassed being able to adapt to change, negotiate tricky interactions or deal with physically demanding work, sometimes in unpleasant environments. Overall, there was a sense that: 'you've also got to be very thick skinned, determined' (Dee). In terms of keeping a project going smoothly, there was sometimes a need to: 'have stiff words with people [...] which is the unpleasant side of it' (Thomas), demonstrating the capability to manage the working environment. In addition, the need to be physically resilient was stated by some:

> small builders, they have a lot to do—it's a difficult job—and [...] it's a very physically demanding job and you've got guys who work really hard [...], they're dealing in an unpleasant environment, cold, wet sometimes; they're dealing with power tools, noise, pollution, so it's not an easy job.
>
> (Thomas)

This demonstrates hard work and ability to persevere in environments that may be less than ideal, despite doing what appears to be complex work and deploying knowledge developed over generations. The next section explores the opportunities relating to practitioner capability.

4.4 OPPORTUNITY

Opportunity refers to external factors influencing the practitioners' potential to exercise their capability. The opportunity clusters and themes identified are presented in ***Table 3***. As with the capability themes, the prevalence of high (over 20), medium (between 10 and 20) and low (nine or fewer) represent frequency in the 27 interviews from which content was coded. Each cluster is then discussed and sample extracts presented.

CLUSTER	THEME	PREVALENCE
State action	Building regulations and standards	Medium
	National policy grants and education	Medium
Customer and market demand	Specific customer demand	Medium
	Customer knowledge	Low
	Market demand	Medium
Technology diffusion	Technology feasibility	Medium
	Compatibility with existing building systems	Low
	Compatibility with work structure	Low
Networks and industry relationships	Knowledge (or lack of)	Medium
	Networks and trade associations	Medium
	Local availability of products	Low
	Peer and professional	Low
Business management	Reputation	Medium
	Education and training	Low
	Access to finance	Low

Table 3: Opportunity: clusters, themes and prevalence.

4.4.1 State action

There was a variety of responses in relation to state action and whether regulation, policy and education were effective in terms of energy efficiency. In relation to regulation, responses were mixed between some who felt the building regulations (such as Part L for energy conservation in England and Wales) were too relaxed and were frustrated at those who saw them as a target rather than as a baseline, in contrast to others who felt they had become very stringent and struggled to meet them. Some worked with the local building control surveyor, who has authority to check and enforce building regulation adherence in the UK, to find ways to meet them. Overall, the regulations were seen by the participants to contribute to industry change, though there was concern about whether the regulations were ambitious enough or understood and enacted by all. The communication of building regulation changes was patchy, with many turning to colleagues to hear about changes. As micro-enterprise practitioners, their capability to keep up to date was *ad hoc* at best.

In relation to experience with previous national policy initiatives such as the UK Boiler Scrappage Scheme, some had positive experiences, but others felt such schemes tended to favour large businesses, even where micro-practitioners were accredited to do the work by bodies such as Gas Safe in the UK. Considering education, it was noticeable that training for policy schemes was not discussed by any participant: there appeared to be a lack of expectation that policy changes would include training opportunities. While there was acknowledgement of the need for training on new energy-efficiency technology, 'None of those products work unless you have the education, and the informing of the household and the contractor' (Craig), training referenced by participants was that offered by manufacturers on their own products. This demonstrates an awareness of the limitations of only focusing on specific technologies rather than an integrated approach to consider the building as a whole system and how it is used in practice.

Overall, there was a sense that while energy efficiency had become more of a focus, it was still not a priority beyond meeting minimum standards on regulations for many.

4.4.2 Customer and market demand

Customer and market demand were reported to vary. Some saw energy efficiency as adding cost to the standard work they do which could run over the client's budget. While some participants

stated that householders were unaware of pioneering technologies, others actively sought energy efficiency. Some participants reported this as a niche market for those able to pay, with certain geographical locations in the UK being favourable to this type of work. In contrast, comfort was seen as universal:

> everybody wants a warm, cosy house, don't they, that they can afford to run, but they usually want something green in some way I suppose.
>
> (Carl)

The means to provide the comfort and the definition of 'green' here might not be specific enough to drive industry change. Some found interest from landlords, particularly in government schemes where there were grants and financial incentives available. The ability of micro-enterprises to work flexibly and to accommodate the requests of clients was seen as positive to enable bespoke retrofit and renovation. Client demand and meeting their expectations were noted as important in the domains of opportunity, capability and motivation, underling the criticality of the relationship between customer and RMI practitioner. Some participants stated smaller companies have the opportunity to meet specific customer and market demands and ensure the detail of delivery within bespoke retrofit projects, beyond what bigger companies can provide, based on their experience.

4.4.3 Technology diffusion

The reliability of new technology for energy efficiency was found to be a concern for some participants. This concerned the ease of operation and maintenance, and ultimately customer satisfaction and the reputation resulting from their work. Practitioners shared experiences of feeling competent and having trust in technologies they regularly install. Where participants had worked with specific retrofit products, some, such as certain types of internal insulation, were found to be unpleasant to work with, but led to good results. Others observed problems in the building system after introducing improved energy-efficiency measures, such as increased damp following reducing air leakage. Some had found ways to overcome this and allow technology compatibility by considering ventilation and taking a more integrated approach, in line with standards such as Passive House they had developed their business within:

> Windows have always been the core of the business. [...] We introduced the ventilation because that was part of the package, we couldn't see how we could promote Passive House without offering a good ventilation solution; and then we also introduced the air-tightness products.
>
> (Carl)

In relation to the sub-theme of compatibility with work structure, practitioners subcontracted other practitioners at times to access the necessary capabilities and get projects finished. There was a recurrent theme around micro-enterprise practitioners having the opportunity to allocate sufficient time to complete quality work, which was also considered to create a positive working environment, in terms of allowing practitioners to enjoy their work. This links back to the ability to manage time and enable this. In contrast, large sites were perceived as not allowing sufficient time for quality work due to tight timescales and a focus on high output, such as large volumes of new houses.

4.4.4 Networks, industry relationships and business management

The networks of building practitioners and connected professionals were a source of information, reassurance, trust, recommendations and often friendship. Trusted colleagues offered the opportunity to gather information on the feasibility of products or proposed solutions, and on necessary regulations and how to meet the regulatory requirements. In addition, these networks often provide new work, via either subcontracting or recommendations based on the reputation the practitioners held with others:

> if you lose trust, it's over [...] it's really upsetting [...] builders don't want to get a bad reputation and all it takes is one job [...] you've done 20 good projects [...] but the bad project is what people bring up.
>
> (Thomas)

The concern of losing trust and reputation could lead to practitioners avoiding risks with new products, or that could lead to customers' perception of poor-quality work. Builders' merchants were a main source of information and, of course, materials. Where products needed to complete an energy retrofit were not supplied by them, this created a real challenge in completing the work. One practitioner was keen to see the development of greater opportunities with merchants who were more committed to ethically sourced building materials:

> We could do with a Waitrose type supplier almost. You need a supplier who is seen to be actually properly committed and some are to some extent.
>
> (Carl)

In this statement, Carl reflects on the need for suppliers to be committed to providing ecologically sound building materials, which was considered to be currently lacking in the industry.

5. DISCUSSION

Having presented the empirical data describing practitioners' capabilities, and the opportunities that can enable or constrain their capabilities, this discussion synthesises the findings into three strands: the nature of practitioner capability and how it changes over time; the aspects of capability that need enhancement to create an industry which can deliver retrofit at scale; and the value of practitioner networks. Taken together, these strands offer ideas to help develop industry, education and policy approaches that meet the enormous need for retrofit activity.

Practitioners were found to develop their capability over time and with experience, often over decades in the industry, many with initial learning via parents and grandparents. Salient capability themes included the participants' ability to solve problems while working across a variety of projects, trade boundaries and house types. In some cases, practitioners turn their hand to other trades to complete work. This was reported in the context of delivering the agreed project and meeting customer expectations. However, training for existing practitioners was mainly reported in relation to product manufacturers sharing insights on specific technologies within specific trades, yet understanding how they work with existing buildings and systems was lacking from this free training designed to promote individual products. A suggestion was made by one participant for an accreditation process through which building practitioners should be registered to demonstrate compliance with standards, which could be a route to developing integrated building expertise.

Training only within trade boundaries will limit future capability, as discussed by Clarke *et al.* (2020), who suggest post-age-16 training should enable practitioner development with a focus on the standards that need to be achieved. Participants described a lack of clear communication and understanding over building regulation requirements and changes. This was found to create a sense of instability and mistrust among some practitioners in the standards, with negative consequences for engagement and adherence to such legislation. Developing knowledge of standards takes time and regulations were considered to be confusing to understand; this adds risk in terms of whether practitioners can meet standards in practice. Furthermore, some participants found the regulations too lenient, with little enforcement and low penalties for failure to comply. As the building regulations in relation to energy efficiency are changing rapidly in recent years, providing training at differing levels of energy efficiency could be one route. For example, training to meet minimum standards, plus training to exceed these to meet likely future standards, in addition to highly stringent energy efficiency standards to achieve net zero, over three or more tiers, could better prepare the workforce than only training to meet current building regulation standards as a target. It is ineffective if the standards required to meet zero-carbon targets are only understood by specialists (Fawcett & Topouzi 2020).

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Beyond technical capabilities, the capabilities required to manage resources and people effectively were salient in the data. Such capabilities included taking on work that was achievable, managing the timescale to complete work to an agreed deadline, monitoring to ensure a high level of quality, sourcing appropriate materials and products, and gaining knowledge on subcontracting specialist work where necessary. This theme speaks to a wide set of capabilities, including task, resource and financial planning, materials logistics, organisation, negotiation, technical knowledge, management of people, and commercial knowledge. Therefore, practitioners are already multi-skilled in ways that can enable them to take advantage opportunities to develop and deploy skills in energy-efficiency retrofit. Previous research on pioneering retrofit programmes found that practitioners actively confront problems and develop solutions to overcome challenges (Lowe & Chiu 2020): having the opportunities to work on progressive projects is therefore vital in developing capability and experience over time.

Practitioners' networks were often built upon personal relationships with trust as a core characteristic. Trust occurs in multiple ways and in various professional relationships the practitioners held and was identified across capability and opportunity within the COM-B framework. One aspect was to protect reputation as this was a vital means to gaining work and for assessing others' credibility to complete quality work. This meant the careful avoidance of risks that might damage this trust, such as the use of unfamiliar technology that could harm a practitioner's reputation. Participants placed a great deal of trust in fellow practitioners. Trust has previously been proposed as essential to construction project success (Khalfan *et al.* 2007) and this view appears to be shared by practitioners who participated within the current study.

To develop effective capability to deliver retrofit at scale, recognising the strength and value of practitioner networks is essential. This influence among practitioners has been previously recognised for informal knowledge-sharing (Janda & Parag 2013; Wade *et al.* 2016), and should not be overlooked. Role models have previously been found an important factor in learning from others (Bandura & McClelland 1977), with occupational settings being valuable places for informal learning (Kersh 2017). Theory on experiential learning has emphasised the importance of experience (Kolb 2014), as well the necessity for pragmatic active experimentation (Morris 2020). Therefore, there is potential to work with the grain of how practitioners typically learn on-site, in practice. However, care must be taken to consider how this can assist practitioners gain trust in technologies, processes and in fellow practitioners to turn to for potential later advice.

As a result of this research, the following six recommendations are made to enable the development of capabilities and provide the opportunities for these to be deployed, in line with the COM-B model of behaviour change (Michie *et al.* 2011):

- To enable consistent and effective policy, policymakers must establish engagement with micro-enterprise practitioners to inform policy design and delivery. Representation of micro-enterprise practitioners should enable the standards to be developed and communicated in ways with which the practitioner can actively engage and can trust. While not all practitioners are likely to want to engage in developing policy, improving accessibility to this can encourage wider input.
- Whether via formal vocational training or on-site, developing existing capability experientially (learning through doing) could be an effective way to validate existing capability and allow the integrated delivery of multiple retrofit measures. To extend capability, the focus cannot be too narrow; there should be recognition that a broader skill base is important.
- In providing opportunities for capabilities to be deployed, the lack of demand noted by the participants must be addressed. Practitioners stated that some householders were unsure about retrofit options, others avoiding the associated costs and the market being considered as niche. Both education and incentivisation of homeowners will be necessary.
- The desire for government-supported opportunities was mentioned by participants specifically in relation to regulations, education and stimulation of customer and market

demand. Without the alignment of these aspects, capabilities to deliver retrofit at scale cannot be deployed.

- Enabling learning via peers is recommended. This can enable situated communication of how to meet the required retrofit standards, with specific consideration of the existing building and challenges faced on site. The nature of knowledge-sharing between families and practitioners, often from older team members to those younger, could be a route to develop and disseminate knowledge. For example, if the older, experienced practitioners were incentivised, they could develop and inform capability development in relation to energy-efficiency retrofit. The ageing workforce that could otherwise constrain the future industry as their knowledge is lost could instead by drawn in as an invaluable resource with which to collaborate, to influence and to train their colleagues. However, this will only be effective if this group were willing to upskill and share expertise.
- The nature of funding for retrofit schemes could be designed to include practitioner engagement, monitoring and reflection on the process, rather than the 'just-in-time' nature of previous funding (Gorse *et al.* 2017). This can then enable the preparation of the practitioners (Ince & Marvin 2019), as well as the supply chain (Osmani & O'Reilly 2009).

This research considered the capabilities described in the practitioners' accounts. However, in terms of limitations, the approach was not suitable for assessing the range of technical capabilities that may be required for successful retrofit. Further work is needed to evaluate the additional specific capabilities necessary and how widespread these skills are in RMI practitioners. In addition, the participants' educational and training background was not systematically explored, and this could be included in future studies. As with any research involving participants, there is always a chance that those who respond are more favourable to education and research. This is challenging to overcome but could have led to more interest from those involved for state action relating to energy efficiency; however, there was a mix of attitudes in relation to this. Although the studies were carried out between 2015 and 2018, the findings are still very relevant as there is an urgent need to consider the practitioners' perspective in policy design, particularly in relation to their capability development and enabling opportunities for them to engage in retrofit.

6. CONCLUSIONS

This article presents insights from the perspectives of micro-business practitioners on their work, which included energy efficiency retrofit, analysed using the Capability, Opportunity, Motivation—Behaviour (COM-B) framework. The practitioners described multiple capabilities and were found to value their knowledge of what they do and their professional reputation. Capabilities including problem-solving, managing businesses, managing resources and developing good relationships were essential to their work. Providing on-site opportunity to develop practitioner capability is recommended. Peer-to-peer learning could enable effective communication and knowledge exchange, potentially allowing longer term relationships to be developed for informal, ongoing information-sharing.

To accelerate the uptake of retrofit and increase capability within the subsector of micro-enterprise building practitioners, developing the existing strengths of the current workforce is essential. This workforce, which comprises more than three-quarters of workers in construction in the UK, represents a wealth of knowledge that could be used to inform the successful retrofit of the existing buildings on which they have spent a lifetime working. To achieve this, working with, and progressing, existing routes of knowledge-sharing could be trialled. Enabling the opportunity to develop skills through retrofit-delivery schemes that allow time for practitioner engagement and reflection is recommended.

An approach for capability development via existing routes of knowledge-sharing could include experienced members of the workforce engaging in finding retrofit solutions to meet the client's requirements or project's goals, enabling problem-solving and experiential learning. These experienced members of the industry could potentially upskill and share knowledge with more junior team members as they often do with general construction work. A long-term plan is needed to ensure practitioners can develop trust in processes and practices, in addition to working within an equipped supply chain network. Opportunities through customer and market demand can allow the capable practitioners to practise and develop their skills. As the practitioners place a high value on their reputation, with both clients and their professional networks, trade and industry bodies should investigate the widescale rollout of recognition or accreditation for good practice and experience of retrofit.

Further research could learn from the practitioners' capability development experiences and stimulate the pragmatic design of local retrofit delivery. In addition, research can learn more about the success of retrofit delivery from the practitioner perspective pre- and post-retrofit, or via an action or participatory approach. As part of this, consideration of how design-and-build stages occur and how the information flows across these activities and between practitioners for domestic retrofit would be valuable to inform routes to advance this. RMI practitioners work with an array of existing dwellings and households on a daily basis, and the development of their capabilities is a critical consideration in designing effective policy to deliver retrofit at scale.

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