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Abstract

Purpose: To improve building performance and meet statutory carbon reduction targets, a radical transformation of existing UK building stock is needed. Much previous research on building performance has focused on large-scale construction. However, retrofit of existing housing stock - which will contribute the majority of the requisite efficiency improvement - is carried out by practitioners in the Repair-Maintain-Improve (RMI) subsector. These practitioners are the sole traders and micro-firms who constitute two-fifths of employment in the construction sector. The study aims to examine the factors influencing these practitioners in RMI work to understand how better to engage them with improved building performance.

Design/Methodology/Approach: A total of 31 semi-structured interviews were conducted with RMI professionals from around the UK and analysed using template analysis.

Findings: The analysis identified capabilities of the practitioners who influence building performance, including knowledge and co-ordination of people and resources; opportunities including state action and customer demand; and motivations including pride in work, customer care and satisfaction, maintaining a viable business, and working relationships.

Originality: The study examined the attitudes and experiences of an under-researched sector who are essential to delivery of improved building performance. This study makes a novel contribution by applying an established psychological model of behaviour change, the Capability, Opportunity, Motivation – Behaviour (COM-B) model, for the first time in this domain.

Practical implications: For successful transition to high standards of building performance, modelling and measurement are not enough. Initiatives are needed to address the multiple factors which determine engagement in energy-efficient retrofit: capabilities, opportunities and motivations. The desire of RMI practitioners to meet customer expectations could be used to develop pragmatic building performance evaluation, guided by householder satisfaction criteria.

INTRODUCTION

Dissatisfaction with how buildings perform is a long-standing and well-documented issue in the UK (Derbyshire, 2001). From the oil-crisis of the 1970s, a particular research focus has been thermal loss from buildings. In the cool and damp UK winters, this results in increased use of energy for heating. Despite encouraging growth in renewable energy supply, fossil fuels remain predominant at 78% of supply (BEIS, 2020), with consequent significant

environmental impact through emissions of carbon dioxide and other greenhouse gases. Emissions from providing heat are the largest contributor to greenhouse gas (GHG) emissions in the UK, at 37% (BEIS, 2018). In order to meet national targets and international commitments to reduce emissions and mitigate the threat of a rapidly warming planet (HMG, 2020), significant improvements in buildings' thermal performance must be achieved.

Academic research has identified the critical role of residential retrofit, with over 3,000 journal papers in the domain over the past 20 years. Technological innovation and evaluation form a large part of the corpus, as do studies of historic and hard-to-treat buildings. There is extensive consideration of policy in addition. A noticeable weakness in earlier work has been the relative paucity of research on behaviour in the domain of energy-efficient retrofit, despite a rapidly growing literature on behaviour and practices relating to energy consumption (Delzendeh, Song, Lee & Zhou, 2017). However, this absence is now being addressed with an increased focus on human dimensions of retrofit. A recent review of research in North West Europe identified a theme on retrofit practice (Simpson, Whyte & Childs, 2020). The nature of situated creativity in retrofit has been explored (Lowe & Chiu, 2020) and the potential for community initiatives for retrofit are starting to be investigated (Putnam & Brown, 2021; Johnson, Bell, Borrion & Comber, 2020). It is not possible to address all research on retrofit but such studies represent a valuable additional dimension which adds to understanding and provides insights to guide more effective policy. The current study aims to contribute in this space.

While much research has treated building performance as synonymous with thermal or energy performance (Gupta, Gregg, & Cherian, 2019), some scholars have argued for a more comprehensive understanding. Taylor and colleagues (2018) sought to encompass indoor environmental quality (IEQ) and occupant satisfaction in evaluation of performance and noted the relative dearth of research on non-energy factors. However, they also argued that several factors in IEQ, such as ventilation and light, also influenced energy efficiency. Other discussion which positioned building performance as a broad construct has also tended to link back to energy consumption and climate change (Rogage, Clear, Alwan, & Lawrence, 2020).

For thermal and energy efficiency in particular, there is plentiful evidence for frequent and significant differences between the design expectations and the outcomes in use: "the infamous performance gaps" (Gorse, 2019, p. 1). Work in this domain has demonstrated that, despite technological improvement, increased understanding and better measurement, the gap remains stubbornly common, in both new build (Zero Carbon Hub, 2014a) and retrofit (Cholewa, Balaras, Nizetic, & Siuta-Olcha, 2020). In a longitudinal study over several heating seasons using actual energy consumption data, Cholewa *et al*. (2020) found that the energy consumption of 11 apartment blocks after a retrofit programme varied from 8% to 75% of predicted energy savings. In this case, different processes of retrofit were a partial reason for the wide range but other researchers have attributed the differences to challenges in modelling, occupant behaviour and issues in delivery (Taylor *et al*., 2018); regulation and policy failures and different priorities amongst large stakeholders

(Stevenson, 2019); and processual issues such as unclear responsibility and management issues such as inadequate communication (Zero Carbon Hub, 2014b). Focusing specifically on retrofit, performance gaps have been attributed to not only technical issues but also management failures and industry culture (Swan, Bayat, & Sheriff, 2018).

Much previous research has focused on large organisations and issues around management of large projects and teams. However, retrofit on existing housing stock, referred to as the Repair-Maintenance-Improvement (RMI) sector, contributes a financial value of £28.8bn, that is, 17% of all construction activity in Great Britain (ONS, 2020b). The sector is conducted primarily by micro-enterprise builders and tradespeople: 41% of workers in construction registered for value-added or employee tax are self-employed or work in businesses employing fewer than 10 people (ONS, 2020a). With an estimated 87% of UK residential building stock expected to be in use in 2050 (Boardman, 2007) and an estimated 25 million existing homes requiring energy efficiency measures in order to meet the target set in the Climate Change Act (2008, 2019) (Davies & Oreszczyn, 2012), research needs to attend to RMI practitioners and their engagement – or non-engagement – with improved energy performance.

RMI work includes all forms of construction and maintenance activity on existing homes, from roof repair to building a new extension. The RMI sector is not typically driven by energy-related factors (Wilson, Crane, & Chryssochoidis, 2015) and the individuals already making a living within repair and maintenance may not see benefit in expanding to cover energy-related retrofit, that is, the essential actors may not be motivated to engage with the actions necessary to deliver zero-carbon homes.

Improving energy efficiency, also referred to as conducting retrofit activities, encompasses upgrades to building fabric, heat provision, power, ventilation, and passive cooling (Committee on Climate Change, 2019) as well as changing user controls. For example, fabric measures, a recommended first priority, can include better thermal performance and air-tightness of the building envelope. Heat provision usually means replacing lower-efficiency boilers and moving away from gas or oil fuelled systems to heat pumps for example; or boosting water heating with solar thermal energy. Power can include provision of photovoltaic solar technology or other micro-generation technologies for electricity provision.

Low carbon builders and retrofit installers are often considered to be beyond the reach of policy (Owen, Mitchell, & Gouldson, 2014) due to the size and capacity of their organisations. For example, the Green Deal, launched as a flagship policy in 2013, failed to engage fully with existing small businesses (Rosenow & Eyre, 2016).The 'Each Home Counts' review (Bonfield, 2016) was consumer-focused and did not address the perspectives, attitudes or needs of the actors who are essential to delivery of energy-efficient retrofit.

Most academic research has also overlooked these practitioners. Studies on retrofit have focused on technology (Steadman *et al*., 2014) and performance (Webber, Gouldson, & Kerr, 2015). In the relatively few studies involving stakeholders, attention has been paid to building performance evaluation practitioners (Swan, Fitton, & Brown, 2015) and householders (Long, Young, Webber, Couldson, & Harwatt, 2015). While Fylan *et al*. (2016) included contractors in their focus groups examining barriers to energy efficiency retrofit, it

was not clear if these participants represented the micro- and small-enterprises which characterise the sector, and their experience and knowledge was not foregrounded.

Within that context, we address the gap in understanding these critical actors - people working in RMI who may choose to engage with or to ignore the techniques, technologies and standards that improve home energy efficiency. This understanding is vital to effective policy, knowledge dissemination and, ultimately, transformation of the sector.

Previous work on factors which may help or hinder the engagement of small RMI firms with retrofit has typically been without theoretical foundation, using a simplistic metaphor of 'barriers' and 'drivers'. But human and organisational actions, especially in a domain as multi-faceted as RMI, are far more complex. A system of interlocking factors – regulations, incentives, motivations, competition, markets, skills, and more – determines outcomes. Drawing from psychological understandings of human behaviour, COM-B (Capability, Opportunity, Motivation, Behaviour) is proposed as an appropriate theoretical framing with which to explore how RMI actors approach their work. First elaborated by Michie *et al*. (2011), the COM-B model has been applied widely on health and physical activity (Keyworth, Epton, Goldthorpe, Calam, & Armitage, 2020; Smaliukiene, Labutis, & Juozapavicius, 2020) as well as in environmental behaviour domains (Gainforth, Shields, Atkins, Jackson, & Michie, 2016).

Unlike many psychological theories of motivation, which focus wholly on internal factors, COM-B recognises the importance of factors both within and external to the individual. Personal factors including physical and psychological resources (such as strength, and knowledge and skills respectively) constitute Capability. Those aspects of the contextual setting which facilitate specific action (such as incentives) are encompassed by Opportunity. Opportunity and Capability contribute directly to behaviour in the model but, critically, also to Motivation. Motivation is the impetus to perform a behaviour and encompasses conscious processes, such as planning and decision-making, and automatic processes, such as habit. COM-B then offers a model of behaviour that recognises multiple factors within the person and their environmental context which actuate and guide the actions taken. In addition, the theory allows programmes to target behaviour change to be identified which align with the relevant factors of influence, and policies can be identified which align with the programmes.

In the current study, the COM-B framework was applied to individuals - the builder, tradesperson or other construction professional - active in the RMI market. The analysis aimed to address the questions: Why is this individual involved in this sector? What is important to them in their work? The research questions were targeted broadly on RMI rather than a narrower focus on retrofit or energy efficiency work for several reasons. The existing sector will – of necessity - form the basis for delivery of future policy. For a sector which needs to transform, the knowledge, skills and much of the resourcing will need to come from the current actors who will engage (or not) in alignment with their capability, motivations and their contextual opportunities. Introducing or increasing the level of energy efficiency into RMI work in most cases will be an extension of the work they are already doing. Thus the multiple factors driving their current work were examined in order to build understanding of relevant capabilities, opportunities and motivations for increased engagement in energy-efficiency retrofit for improved building performance.

RESEARCH METHODOLOGY AND METHOD

The dataset comprised three qualitative subsets, collected separately and independently by different research teams but addressing two very similar research questions: what drives construction practitioners involved in RMI? What are the factors influencing engagement with processes and technologies which can deliver greater energy efficiency and/or sustainability?

In each case, data collection proceeded via semi-structured interview. The method was chosen to gather a rich and broad dataset on what matters to RMI practitioners in their everyday professional activities. All three studies received prior ethical approval from an appropriate ethics body. Participant recruitment began with contacts from the researchers' personal networks and proceeded through a snowballing process. Sampling was purposive and sought practitioners in micro-enterprises or small-to-medium enterprises (SMEs) who were active in the RMI sector. In total, 31 interviews were conducted (Study A 20, Study B 5, Study C 6). Our final sample size of 31 was well above the number of 17 which has been suggested as necessary for data saturation (Francis *et al*., 2010). The interview schedules included questions on: project type and mix (A, B, C), supply chain relationships (A, C), motivation for involvement in the sector and with particular technologies (A, B, C), customer and market demand particularly for more sustainable solutions (B, C), access to information and knowledge (A, B, C), and a potential future sector with greater sustainability or energy efficiency (A, B, C). All interviews were audio recorded with participant permission and subsequently transcribed verbatim.

Participants

The participants were primarily sole traders (15) or working in SMEs (16) (see Table I). Almost all had an original trade but many combined roles or took different roles on different projects. Several combined a trade and project management role for a given project (10), carried out design and project management in addition to their trade (2) or were involved in materials supply as well as design and project management (3). All worked on residential projects, and many also worked on non-residential jobs such as schools, retail and commercial. Many operated fluidly with respect to supply chain positioning, being primary contractor on some projects and sub-contracting on others. Most used a varying network of co-workers, involving smaller or greater numbers of others as sub-contractors on projects as needed.

[Table I about here]

Data Analysis

Data analysis was conducted using template analysis, a form of thematic analysis. With template analysis, an initial thematic structure may be devised and applied to the data. As analysis proceeds, additional themes may be added and the original themes may be amended or deleted (Brooks, McCluskey, Turley, & King, 2015; King, 2004). We began with a three-part structure (Capability, Opportunity, Motivation) with six, eight and seven subthemes respectively, derived from the literature. The template was applied incrementally and the analysis proceeded in stages. In each stage, two researchers coded the themes for each case of a small set, typically five. The themes were discussed by all

three researchers which enabled greater clarity of meaning for each theme, and the template was revised by adding more subthemes. When all 31 interviews had been thematically coded, the template was simplified by deleting unused themes and aggregating similar themes. A total of 35 themes were identified (Capability 10, Opportunity 15, Motivation 10). To aid presentation, each was categorised on its prevalence across the participants: High where the theme was noted in over 20 participant accounts, Medium where the theme was noted in between 10 and 20 accounts, and Low where the theme was noted in fewer than nine accounts.

RESEARCH RESULTS

Table II summarises the themes and their categorisation as High/Medium/Low incidence. While there are valuable insights to be explored in the patterns of medium and low incidence themes, space precludes detailed discussion and the paper focuses on the high incidence themes. Table III presents a summary of the high prevalence themes, and indexes the extracts used in the text discussion below. Pseudonyms are used to protect anonymity.

[Insert Table II about here]
[Insert Table III about here]

Within the Capability theme, references to knowledge occurred in almost all cases. There was extensive evidence of the technical knowledge that the practitioners brought to their work. In Table III Extract 1, the practitioner describes a highly complex and technically challenging project on a heritage building located in a dense and high value urban area. He references the presence of adjoining neighbours, not only a technical challenge but also one of managing relationships and establishing trust. In passing, he mentions health and safety issues, pointing to knowledge on regulations as well as effective management and control of people, machinery and resources on a constrained site. The analysis showed that the practitioners knew not only what to do but how to do it: how to approach a problem, how to avoid problems developing and how to solve problems when they arose. Two of the participants specialised in PassivHaus, and could be described as underselling their expertise by describing it as "*only insulation and air tightness*" [Kal] while acknowledging the practical challenges.

A second prevalent capability was that of business management. Good organisational skills were seen as crucial – the ability to get materials and trades and finance all aligned (Extract 2). The subcontracted nature of much work meant having a good network of contacts and maintaining relationships and knowledge of trade skills. The numbers of subcontracted trades tended to vary by project and time and many had in place a panel of trusted subcontractors. Beyond the logistics of co-ordinating these highly flexible relationships, reciprocal trust was seen as important: the builders needed to trust the subcontractors to do high-quality work and deliver on time but recognised too that the subcontractors need to trust them to pay promptly. Maintaining strict control over quality and giving consideration to the motivation of all project members was valued. Several described actively developing the relationships and the importance of good skills in managing people: developing strong relationships, understanding how people work, communicating effectively and building trust within work networks.

Turning to Opportunity, that is, the factors external to the actors which influenced their approach to their work: there was an acceptance of legal requirements and of building regulations such as installation of energy efficient boilers. Practitioners described working in preparation for planned changes to regulations and of using the regulations as a source of reference and guidance. There was evidence of belief in the efficacy of the regulations and that they drove norms in the industry (Extract 3). Meeting the regulations was a source of satisfaction of a job properly done although "*there are still a lot of cowboys out there*" [Gavin] who may flout the regulations and, for some, "*the regs [regulations] are too loose, in my opinion ... ridiculous*" [Kal], indicating a desire for more ambitious regulation. One practitioner saw the risk that regulations constrained aspirations, with a common approach in the sector being to aim for minimum compliance (Extract 4).

Markets and customer demand represented a further opportunity which could encourage engagement with particular technologies, projects or approaches to construction. In many cases, the practitioners followed demand "*My client has whatever they want, if they're prepared to pay for the extra costs of the materials*" [Ash]. However, the risk of following the market was the absence of demand for greater energy efficiency or sustainability (Extract 5). This extract suggests an assumption that pursuit of higher energy efficiency is "*elitist*" and not for the sort of customers the practitioner deals with. The mainstream or non-specialist practitioners had seen customer interest in more energy-efficient boilers as part of improvement works but no demand for more extensive changes. There was some evidence of interest from knowledgeable self-build clients and from homeowners with moisture-related problems, so demand relating to energy efficiency – though limited – arose in a variety of settings. One PassivHaus business had developed their designs ahead of finding clients interested in the offering, and another business was started when the owner had to import products for his own home and then proceeded to import and grow the market for similar products in the UK. These represent examples of innovation, showing the potential within the sector for proactive creation of new products and approaches.

Within the Motivation dimension, pride in outcome was a prevalent theme. For many who expressed pride in their work, their comments related to the satisfaction of doing a good job, of working to the best of their ability and setting high standards (Extracts 6, 7). One said: "*I won't lower my standards to make money on a job*" [Matt], illustrating the relative priority for him of completing work of high quality. The practitioners described attention to detail and to quality of the work. Several also referred to the quality of the materials used as a factor in prideful work. One gave an example of walking away from a job rather than doing it as the customer wanted which he believed was wrong. There was a particular sense of accomplishment in complex or challenging jobs. The participants were also proud of the tangible end product: *"I'm proud that construction is an actual, tangible service and we make stuff*" [Ollie] and the longevity of the built product was a source of pride: "*knowing that you've put something in that's going to last 30/40 years*" [Gavin]. Although some participants noted that they knew of people in construction who would cut corners, use cheaper materials or take less time than needed, they emphasised their pride in the work they produced as a central motivation and source of satisfaction for them in their business.

An equally strong Motivation theme was customer focus. Most of the participants appeared strongly motivated to provide customer care in advance of work commencing and to achieve customer satisfaction on completion of projects. Although there were business benefits, with satisfied customers being prepared to act as reference projects and giving

recommendations, the personal satisfaction of delivering outcomes that customers praised was strongly in evidence "*the self-satisfaction of loving people being satisfied as well*" [Eddie]. For most, they actively worked to build the relationship with the customer (Extracts 8, 9) and this relates too to the capability discussed above of managing business relationships. Amongst other implications, a strong customer focus meant protecting the customers' money. Several participants mentioned returning to the project after completion: "*done it, finished it, looks really good, you go back there six months later and it looks as good as when you finished it, so yeah, that was quite rewarding*" [Harry] and maintaining long term relationships with some clients [Extract 9]. This suggests that RMI practitioners may take an interest in long-term occupant satisfaction, and see how at least some of their projects operate over time.

The participants' responses showed a prevailing concern with developing and maintaining a viable business as a strong motivation. There was evidence of attention to costs, ensuring low overheads, pricing carefully, trying to avoid borrowing, considering the impact of having to charge VAT on profit and of the extra expenditure involved in taking on employees. Perhaps surprisingly, relatively few of the participants prioritised profit for its own sake. In the example in Extract 10, for this practitioner, profit is "*a big thing*" but nevertheless, there is also the motivation of "*a sense of achievement*". This is not to suggest that businesses and individuals in the RMI sector are not motivated by profit: however, it shows that financial rewards are only one of many motivations. Earning enough to live on was a fundamental driver but was also linked to customer satisfaction, personal satisfaction in the quality of work and maintaining good relationships with other industry professionals.

Good working relationships were identified as another important motivational theme. Extract 11 shows how profit became less important than loyalty to employees. Many participants described the importance of good working relationships, enjoying working with the people in the industry (Extract 12). They acknowledged interdependence with others, complementary skills and co-operation: "*it's just working together like that, makes your day much easier because you've got someone who's there helping*" [Nick]. Teamwork on site was valued and also positive relationships with other actors in the sector including builders' merchants, architects and building inspectors. The mutual dependence meant that they actively sought to build strong relationships. Stan made it explicit: "*We're not only doing construction, we're trying to build a relationship with people*". Thus the relationships that the practitioners formed contributed to their enjoyment of and motivation for their work. This included others on site, in the industry more widely, and with customers.

DISCUSSION

The application of a template analysis based on COM-B to 31 interviews with RMI practitioners who worked primarily on residential stock resulted in 35 themes across Capability (10), Opportunity (15) and Motivation (10). The eight themes with high prevalence (that is, appearing in more than 20 accounts) are presented above (Capability 2, Opportunity 2, Motivation 4). The evidence demonstrates a complex set of factors influencing practitioners' involvement in RMI, including abilities and motivations specific to individuals as well as features of the political and economic landscapes in which they work.

The Motivation dimension had most high-incidence themes, covering intrinsic factors, particularly pride in work, and relationship factors with customers and co-workers. From the perspective of occupational psychology, this finding is unsurprising: meaningfulness at work

is long established as a factor in high work satisfaction and effectiveness (Hackman & Oldham, 1975) and social support has been shown to benefit workers' well-being and productivity (Park, Wilson, & Lee, 2004) . What is perhaps surprising is how little research attention has been paid to such fundamental determinants of engagement in key actors in construction. Understanding the basic drivers of motivation is critical so that policy initiatives and attempts within the industry and beyond to achieve transformation to high standards of building performance are in alignment with what drives construction practitioners in their day-to-day work. A further motivation was that of maintaining a viable business. This went beyond a profit motive and tapped a sense of achievement in running a successful business and a sense of loyalty to employees. This contrasts with common rhetoric around the objectives of business being the pursuit of profit and growth.

The emphasis the practitioners placed on customer satisfaction is particularly interesting. While none described systematic means of evaluating their work, the frequent references to customer satisfaction suggested that informal, qualitative assessment was common and several referred to visiting their projects after completion. This is effectively a form of ad hoc post-occupancy evaluation (POE), argued to be essential for improving building performance (Bordass & Leaman, 2005b). The findings contradict earlier research on larger-scale projects which found that designers and contractors rarely review how their projects work in use (Bordass & Leaman, 2005a). Comments made by customers can be assumed to convey overall occupant satisfaction, argued to be an essential measure of building performance (Taylor *et al*. 2016). The implication is that at the RMI end of the construction sector, informal post-occupancy evaluation is used by practitioners. However, again it must be noted that energy efficiency, as an invisible attribute (Hargreaves, Nye, & Burgess, 2010), is unlikely to form part of customers' assessment. There is scope for developing tools to allow householders to compare before and after energy use in a straightforward manner, and examine other ways in which energy performance could inform occupant satisfaction. Of particular relevance from the perspective of building performance was the pride that the participants took in their work and how important to them was the quality of what they produced. With previous research proposing quality of workmanship as an essential factor for good energy performance (Gupta *et al.,* 2019), the findings here suggest that there is an existing basis for development. However, again, the invisibility of energy efficiency may mean that it is not yet considered as part of a quality job by RMI practitioners.

Although the participants described the importance of work quality, the study methodology was not appropriate for evaluating such claims. The issue of quality intersects with that of knowledge – if practitioners are lacking in knowledge, their self-assessment of quality may also be lacking. It can be assumed that until energy performance is part of their focus, then self-assessed versus measured building performance may not match. Further work should examine what the concept of quality includes and excludes, and how RMI practitioners consider energy efficiency with respect to customer satisfaction. There is a need for wider energy literacy across the sector (Zero Carbon Hub, 2014b) and explicit linkage of quality of work in RMI and building energy performance. Further work is also needed on other critical behavioural dimensions such as approaches to risk. Such research could point to better ways to engage RMI practitioners with newer technologies.

Within the Capability dimension, the most prevalent themes were knowledge and the ability to manage and co-ordinate people and resources. The necessity of knowledge as a prerequisite for change is widely recognised. For example, the Each Home Counts review

recommended improved training (Bonfield, 2016). However, the skills pertaining to running a business and project managing from design to delivery have received less focus. Salient questions for greater energy efficiency as part of improved building performance include: Are specialist skills required and, if so, how available are people with these skills? Is the supply chain and procurement more complex? Does the technology or technique make planning and programming onsite work more difficult? In order for new technologies or processes for greater energy efficiency to become embedded into existing RMI, it is important that project management and co-ordination of workers and resources is not made more difficult.

Within the Opportunity dimension, the practitioners generally noted their support for regulation, for example, through building control. Some commented on the need for more demanding regulation, and expressed dissatisfaction with an assumption prevalent in the sector that regulations indicate the target rather than a minimum to be attained. They pointed to enforcement as an essential but frequently lacking complement to regulation. Equally there were some who lacked confidence in the technical standards behind policy and perceived compliance with regulations to be demotivating, hindering their engagement with products and processes of better building performance (ref to be inserted after review). The opportunities presented by customer demand were noted although most participants found little demand for energy-efficiency solutions. This points to the fallacy of expecting market demand to drive greater energy efficiency – practitioners saw little demand for improvements which may be intangible. There were a small number of examples of practitioners developing or supplying products in order to stimulate demand. This finding extends the conclusions of previous research which pointed to the need for greater knowledge and education within the industry (Zero Carbon Hub, 2014a; Stevenson, 2019) to argue for the need for greater knowledge within the general public. One route towards greater energy efficiency can be more knowledgeable and demanding home-owners.

While the study provided valuable insights into factors influencing RMI practitioners, there are limitations to be acknowledged. The qualitative approach does not make claims for statistical generalisability or representativeness of the findings. In particular, the participants were a small, mixed group in terms of firm size and specialisation. Future work could look to extend the findings with a statistically representative survey, to include retrofit specialists as well as general RMI practitioners, and to include RMI outside the residential sector.

CONCLUSION

The theoretical contribution of the paper is its application of an established framework on behaviour to the domain of energy-efficiency retrofit. Empirically it demonstrates the value of hearing the voices of participants active in this sector of construction which is of crucial importance to achieving zero carbon goals through improved building performance. The key conclusions are that initiatives to transform current housing towards high energy efficiency must consider the capabilities, opportunities and motivations of the central supply chain actors. Skills and expertise with new technologies and processes must be developed in the supply chain, but this can only be done effectively when embedded in the broader, non-technical motivations of undertaking RMI work. The implications of new ways of working must be considered with respect to the skills and abilities needed to manage and co-

ordinate such work. Sole traders and micro-organisations have little spare capacity so technologies and techniques requiring significant additional effort, co-ordination or knowledge are unlikely to be adopted. Regulation can help to drive engagement but will be of limited effectiveness if a robust assessment regime for compliance is not also in place. A culture shift is needed to ensure that regulation is seen as the baseline and not the ceiling for ambition. Market demand for energy efficiency has not happened and initiatives to increase customer interest amongst the general public are needed. There is scope to extend the ad hoc POE undertaken by committed RMI practitioners. Finally, personal motivations should be considered: successful practitioners take pride in their work, value their working relationships and are committed to maintaining their business. Initiatives on zero carbon should frame energy efficiency as best practice, as an expected offering by competent professionals, and as an essential component of high quality work.

To meet the transformation needed to achieve zero-carbon homes, policy, campaigns and initiatives must understand and address the many factors which determine engagement in energy-efficient retrofit, that is, the capabilities, opportunities and motivations of RMI practitioners.

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Table I. Characterisation of Participants

Company Size		**Trade**	
Sole trader	15	General builder	10
1-10 employees	12	Heating engineer/plumber	5
11-25 employees	2	Electrician	4
Over 50 employees	2	Bricklayer	3
		Plasterer/decorator	2
		Joiner	2
		Other	5
Total Participants	**31**		

Table II. Summary of Themes

Theme	H/M/L	Subthemes / Explanation
Capability		
Knowledge	H	(High incidence themes discussed in text below)
Manage and coordinate people and resources	H	
Individual characteristics	M	Problem-solving; resilience
Opportunity		
State action	H	
Markets and customer demand	H	
Innovation and diffusion	M	Technical feasibility; compatibility with existing systems and processes
Networks and relationships	M	Knowledge in supply chain; network trade associations; local availability; peer norms
Reputation	M	
Education and training	L	
Access to finance	L	
Motivation		
Pride in outcome	H	
Customer care and satisfaction	H	
A viable business	H	
Working relationships	H	
Personal commitment	M	Personal commitment to energy efficiency and/or environmental sustainability
Co-benefits	L	Comfort, warmth, avoidance of damp
Waste	L	Avoiding waste; recycling

Table III. Summary of High Prevalence Themes and Sample Quotations

Theme	Extract	Sample Quotation
Capability		
Knowledge	1	*What I take pride in is that we had a Georgian house, 300 year old … four storeys with four adjoining owners in the middle of Kensington, worth about five million quid and we excavated about 500 cubic metres of soil below and we kept the house up and we didn't have any health and safety issues* [Ollie]
Manage and coordinate people and resources	2	*My role mainly is joining up the dots, getting the team to put the frame up there on time, making sure the frames arrived on time, sorting out the finances of it all, that kind of thing* [Kal]
Opportunity		
State action	3	*A lot of this stuff we don't really think of energy efficiency, it just becomes the norm with the building regs and requirements…it's just this is what we have to do now to reach certain U values, certain criteria, so you don't really think of it as being green* [Alan]
	4	*The worst thing and one of the most common things we hear is, it's alright, we're just building to regulations, as if that is the zenith of... building regulations is where most people should start, not end* [John].
Markets and customer demand	5	*I think on your high end building work down south, you know, in the big cities or out in the country and you're building these bigger homes and EE [energy efficient] homes, that's more of an elitist job if you like…there is certainly no call for it in Scunthorpe* [Alan]
Motivation		
Pride in outcome	6	*I am foolishly keen on doing it the right way* [Mark]
	7	*I like seeing things done properly* [Eddie]
Customer care and satisfaction	8	*I think the most important things are meeting your customers expectation and understanding what their requirements are and making sure that what you do technically covers the requirements and also covers their expectations of what they want you to do and we always strive to make sure that at the end of every job, the customer's been satisfied and that's the main criteria [Eddie]*
	9	*It's a completely different house now, this transformation we made by adding features to the house and the family was really, really happy and then of course, if your clients are happy and you get positive feedback … and every time I go there,*

		every single time they make some sort of comment that it was a good idea. [Gavin]
A viable business	10	*It's mainly a sense of achievement and reward, financial reward is a big thing, if we get it right, we can make a decent living out of it* [Vinnie]
	11	*If you've built a company up for that amount of time, it doesn't really become just about money, … it sometimes becomes about the guys that have been working with you for that period of time, keeping them going* [Charlie]
Working relationships	12	*…decent blokes and nice people which is good for me, otherwise I don't know if I could do it* [Matt]