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Influencing the central heating technologies installed in homes: The role of social capital in supply chain networks

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HIGHLIGHTS

- Ethnography is used to investigate the relationships in heating supply chains.
- Social capital is seen to be an important part of these relationships.
- These relationships could help in the promotion of low carbon technologies.

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ABSTRACT

The likely installation of, and potential energy savings from, low carbon technologies in domestic buildings is not only dependent on those who fit them, but also the broader supply chains of which they are part. Despite this, the role of supply chain actors has been largely overlooked in strategies seeking to encourage the installation of more sustainable domestic heating technologies. With reference to central heating, this paper responds through an ethnographic analysis of how plumbers' merchants and sales representatives can influence the work of heating installers in the United Kingdom. It applies two dimensions of the concept of 'social capital': relational and structural. Relational social capital focuses on the trust, loyalty and reciprocity at play in relations, whilst structural social capital considers how the strength of tie can influence those to whom people turn for advice and support. Together, these ideas demonstrate how relationships amongst these groups can serve to influence product choice and facilitate information exchange. The paper concludes by discussing how these supply chains might be engaged with as a means of encouraging the installation of low carbon domestic technologies.

1. Introduction

The European Union (EU) has set a long-term goal of reducing its greenhouse gas emissions by 80–95% when compared with 1990 levels by 2050 (EC, 2011). Though hitting this target will require a concerted effort across a range of sectors, the existing building stock represents the biggest potential sector for energy savings. The energy consumed in buildings is responsible for approximately 40% of total EU consumption, with space heating being particularly significant (EC, 2012). In the UK, for example, space heating is the largest single contributor to domestic energy consumption, accounting for approximately 60% of this in 2011 (Palmer and Cooper, 2013). This value has also remained

persistently high over the last 40 years. This leads Palmer and Cooper (2013 p. 35) to argue that, if we are to "make serious inroads in cutting CO_2 from housing, reducing heating energy has to be part of any solution". Since 98% of homes in England and Wales were using gas central heating in 2011 (ONS 2011), this technology (or its replacement) should be a key focus.

In the UK, the Government's Low Carbon Plan aims for the installation of between 1.6 million and 8.6 million low carbon heat technologies by 2030 (HM Government, 2011 p. 40). To this end, the installation of alternative heating technologies is encouraged via Part L of the Building Regulations (HM Government 2013a). The Domestic Building Services Guide, written to assist compliance with this, includes heat pumps and micro-combined heat and power units as two such technologies (HM Government 2013b). Meanwhile, new forms of training and accreditation have been developed in the hope that a new workforce of low carbon technology installers should start to assemble as a consequence.

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For example, the Microgeneration Certification Scheme (MCS) seeks to ensure that those installing low carbon heating technologies are trained and certified to do so (MCS, 2016). It has been suggested that this should 'not be unachievable assuming the development of a robust supply chain and trained installers' (Rhodes, 2011 p. 8). However, a recent paper in this journal highlighted that installers and advisors involved in low carbon retrofit appear to be 'outside the influence' of policy interventions, which tend to focus instead on environmental performance and environmental accreditation schemes (Owen et al., 2014 p. 172).

Both policy makers and researchers have begun to acknowledge the role of installers. In particular, policy makers have outlined the provision of financial incentives, and the development of training and apprenticeship schemes for installing low carbon technologies (DECC, 2013). Meanwhile, academic research has recognised the role of technology installers in influencing householder practices in both UK (Darby and Liddell, 2015; Wade et al., 2016a) and international contexts (Gram-Hanssen et al., 2016). However, the role of supply chains has been largely neglected in both circles. This is despite the fact that Janda and Killip (2010 p. 121) position manufacturers and suppliers as 'key stakeholders' in meeting the low-carbon refurbishment agenda. Indeed, it has been suggested that in order to identify and define appropriate policy interventions to get low carbon technologies into homes, we need to more thoroughly consider the networks that influence microenterprise activity (Owen and Mitchell, 2015), namely the work of construction professionals, operating on a self-employed basis or in organisations of fewer than ten people (EC 2003). However, there is a current blind spot in terms of the interactions that take place in these networks and how they might feasibly be incorporated into policy.

It is with this in mind that this paper considers the plumbers' merchants and sales representatives with whom domestic heating installers[1] work. As an example of such 'micro-enterprise activity', heating installers are tasked with the selection, installation, and explanation of domestic central heating systems. Plumbers' merchants act as a supplier for heating installers, they stock the products and tools required for the installer's everyday work. Meanwhile, sales representatives are transient actors who are employed by manufacturers to encourage and manage the sales of their products. In this role, they move between plumbers' merchants and communicate regularly with heating installers. This paper proceeds by noting the limited academic attention that supply chains have thus far received by those hoping to understand and influence the potential uptake of low carbon heating technologies, before detailing the relational and structural social capital approaches that are used here to investigate them. This reveals a series of ways in which trust and loyalty inherent in relationships, along with weak and strong ties between different supply chain actors can influence heating installers' actions and the central heating technologies they install. The paper concludes by making suggestions about further research in this area, and outlining a series of policy recommendations about how supply chains might feasibly be harnessed in the promotion of low carbon domestic heating technologies.

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[1] In the UK context, those tasked with the installation of heating systems are known as heating installers or heating engineers. Heating engineers is a specific title allocated by Gas Safe Register to identify those that have the qualifications and training required to perform the installation of central heating systems (GSR 2011). Gas Safe Register are the organisation tasked with maintaining a database of those qualified and registered to work on domestic gas central heating systems. Their role is elaborated in Wade et al. (2016b).

2. Background

There has been very little investigation of construction supply chains, and how they influence energy consuming technologies in domestic buildings. The only research to have investigated heating installers' supply chains in any capacity was undertaken by Banks (2000a) (2000b). There are a handful of other studies looking at the role of construction industry supply chains in the low carbon building agenda, as detailed in the following section. Together, these suggest that supply chains have a role in influencing the products installed and the provision of information on which installers might draw when deciding what products to fit.

2.1. Supply chains influencing product selection

The construction professionals tasked with selecting and installing domestic technologies have been suggested to use an "informal but multi-faceted risk assessment" when determining what to fit in homes including, the cost, the potential for disruption if the technology went wrong, and their knowledge of the technology (Killip, 2013 p. 526). However, beyond operating "according to their own heuristics of risk and acceptability" (Owen et al., 2014 p. 176), it is likely that these actors might also be influenced by the broader supply chains through which these technologies are acquired. Killip (2013) has highlighted the 'self-perpetuating logic of conservatism within supply chains' whereby "conservatism tends to reinforce the strong position of established products and suppliers in product supply chains, and the difficulty of sourcing new products in turn becomes a barrier to greater uptake of new ideas" (p. 527). In this way, he (2013) suggests that the impetus for construction intermediaries to try installing new products loses momentum if it is not accompanied by a structural shift in the supply chain. Furthermore, the continued use of tried and tested products is also sustained by strong brand loyalties (Killip, 2013).

Banks (2000a, 2000b) used interviews with heating installers, manufacturers, housing developers and end users in the United Kingdom to make suggestions about the role of manufacturers and plumbers' merchants. Through this, he identified that boiler and controls manufacturers encourage loyalty through the use of "points schemes, sophisticated websites, [and] helplines offering advice and promotions […] at builders and plumbers merchants" (2000b p. C24). However, this is based on interview data alone and does not reveal how brand loyalties are established and sustained in reality, to influence the central heating technologies installed in homes. It is important to consider how these conservative practices and loyalties might limit the deployment of new or alternative technologies in buildings.

2.2. Supply chains as information sources

In addition to their influence on product selection, there is evidence that supply chains can act as avenues of information for those involved in the specification and installation of domestic technologies. In particular, Owen et al. highlight that supply chain networks may "provide a route to reach and influence individual practitioners where the dispersed nature of the [construction] trades makes finding effective communication channels difficult for policy makers" (2014 p. 178). A study of plumbers as potential water efficiency advocates highlighted that staff in the plumbers' merchant "communicate with plumbers, who in turn communicate to the public" making them important avenues for informing plumbers' actions (Bowden et al., 2012 p. 5). In this study, the plumbers' merchant was also identified as a location where plumbers spent time, which presented the opportunity for engaging them in information about water-saving products or advice

when they were most receptive (Bowden et al., 2012 p. 39).

This sits in contrast to Banks' findings with regard to heating installers, for whom he suggested that plumbers' merchants "simply act as a counter and distribution system for the manufacturers" (2000a p.8.8). This may be because Banks' finding is based on interviews with heating installers and manufacturers and did not therefore engage with plumbers' merchants in any capacity. Gathering the views of some industry representatives and not others in this way could have created a skewed picture. In particular, neglecting the perspectives and practices of plumbers' merchants themselves might have led to their role being downplayed. Further, this research was conducted fifteen years ago, so it is difficult to know how this network may have changed amidst shifting policies and technologies since then. In any case, in this context, the few studies that have investigated construction supply chains for the provision of information have produced ambiguous results. It is particularly important to investigate this in more depth because the limited engagement in low carbon retrofit schemes from the small and medium enterprises involved in repair, maintenance and improvement work has been attributed, in part, to a lack of access to information (O'Keeffe and Gilmour, 2014).

3. Method

3.1. Exploring supply chains using an ethnographic approach

It is only through the simultaneous consideration of people and technologies that effective policy to reduce the energy consumed in buildings can be designed and implemented (Rohracher, 2001; Skea, 2012). Although approaches from the social sciences can reveal how social processes can influence technologies and how they are used, they are often underutilised within energy and buildings research and policy (Sovacool, 2014; Sovacool et al., 2015). In particular, given its potential contribution, this project used ethnography with the aim of understanding how the social processes at play within heating installers' everyday work might influence the installation of central heating technologies.

Ethnography is a relatively unstructured means of exploring the social world (Atkinson and Hammersley, 1994). The method requires spending an extended amount of time with identified groups of participants, to understand why it is that they act in the ways that they do within identified social contexts. Rigour comes through the depth of engagement by, for example, spending time with relevant actors within their everyday context (Marshall and Rossman, 2006). This investigation took place across a variety sites where heating installers talked about and interacted with different supply chain actors, during which the role of the researcher was one of:

"Watching what happens, listening to what is said, and/or asking questions through informal and formal interviews, collecting documents and artefacts – in fact gathering whatever data are available to throw light on the issues that are the emerging focus of inquiry."
(Hammersley and Atkinson, 2007 p. 3)

Moments for data collection were established through opportunistic and 'snowball' sampling techniques. These included attending industry events, such as trade exhibitions, and approaching manufacturers and plumbers' merchants. Meanwhile, heating installers were recruited through attending manufacturer training days and building rapport with relevant individuals. In both cases, early participants were then asked to recommend additional participants. These introductions and endorsements

provided the "best ticket into the community" (Fetterman, 1989 p. 43). However, it should be acknowledged that they did influence the study sample by, for example, suggesting those that were trusted and highly regarded within the industry, amidst concerns about how the industry would be portrayed (Hammersley and Atkinson, 2007 p. 51). The sample included self-employed heating installers (or operating their own micro-enterprises with between 1 and 5 other employees), working primarily in private homes, and staff from several medium-sized organisations, who had contracts with Registered Social Landlords (RSLs) to perform heating installation and maintenance work across their housing portfolios. The heating installers that took part in this study were all male, and aged between 25 and 65 years old. They had a variety of backgrounds, qualifications and routes into the industry, but the majority had been working as heating installers for over 10 years. The plumbers' merchants and sales representatives were primarily male, but a few women in these roles also took part. They had a range of backgrounds, with some previously operating as heating installers, whilst others had moved from different sales positions.

In line with the ethnographic approach a range of data collection strategies were deployed according to what the participants were amenable to, and what seemed to yield the most relevant insights. This included 20 semi-structured interviews with heating installers, sales representatives and plumbers' merchants, shadowing heating installers 30 times as they fitted systems in homes, and observing installers in other social settings that included nine training sessions hosted by boiler and controls manufacturers. Plumbers' merchants emerged as potentially important actors through conversations with heating installers so, in keeping with the iterative nature of the ethnographic approach, time was subsequently allocated to understanding their role. This included spending a week in a branch of a national chain, and an independent organisation, along with incidental visits to both types of merchants with sales representatives and heating installers. Collectively, this resulted in approximately 400 hours spent with heating installers, plumbers' merchants and sales representatives in a variety of settings. The data presented in this paper draws on this whole dataset but particularly focuses on the time spent in plumbers' merchants and with sales representatives to build a picture of their role within the central heating installation supply chain.

The overt shadowing and observation resulted in the collection of detailed fieldnotes, with individual fieldwork events being written up as observations ranging from 4000 to 10,000 words in length. Interviews lasted between 45 min and 3 h in length; they were audio recorded and transcribed verbatim. Pseudonyms have been used throughout this paper to protect the anonymity of all participants, organisations, and brands. Analysis involved an incremental and iterative process of aligning relevant theories with emergent themes using qualitative analysis software (maxQDA) (Marshall and Rossman, 2006, p. 154). One of these theories related to the idea of 'social capital' that is used in this paper to explore the interpersonal dynamics that currently sustain central heating supply chains.

3.2. Understanding supply chain networks using social capital

Social capital is defined as "the resource[s] available to actors as a function of…their social relations" (Adler and Kwon, 2002 p. 18). Examples include loyalty, reciprocity, and trust. Social capital resources accrue to individuals by virtue of their social ties: they are delivered through social structures, and they facilitate the actions of actors within those structures (Coleman 1988 p. S98). With regard to the present project, this concept has already been used to understand the diffusion of household energy-efficiency information (McMichael and Shipworth, 2013), and shared

knowledge creation in construction firms (Bresnen et al., 2005). Two particular dimensions of social capital will be used in this paper: relational and structural. Relational capital focuses on the content and influences of relations, for example, trust and reciprocity, whilst structural capital refers to the type of network connections, for example strong and weak ties, and how these can shape relations, such as to whom you might turn for information (Nahapiet and Ghoshal, 1998).

3.2.1. Relational capital

In discussing the need to study supply chains from a social network perspective, Galaskiewicz (2011) notes the importance of understanding the relationships at play. He highlights the significance of the social meanings of relationships, in particular the trust and expectations inherent to them, for understanding how exactly supply chain networks "work" (Galaskiewicz, 2011 p. 7). Indeed, relational social capital focuses on the content and influences of peoples' relations, for example, trust and reciprocity. Trust can be defined as a willingness to be vulnerable to another party (Mishira, 1996). After conducting a literature review, Nahapiet and Ghoshal identified four aspects of belief in another that lead to trust: belief in their good intent; belief in their competence and capability; belief in their reliability and; belief in their perceived openness (1998 p. 254). Trust within relationships might help in ensuring efficient, timely interactions, bypassing the need for more formal measures (for example, written contracts) (Galaskiewicz, 2011). Meanwhile, expectations or social obligations "represent a commitment or duty to undertake some activity in the future" (Nahapiet and Ghoshal, 1998 p. 255). Whilst not explicitly using these terms, Coleman does highlight the role of social obligations in relationships, noting that "in some social structures, it is said that "people are always doing things for each other" " (1988 p. S102). He compares obligation to a credit slip such that when one person does something for another, the recipient has a debt to the donor, which is then recovered through future reciprocation (Coleman, 1988).

3.2.2. Structural capital

In addition to understanding the social meanings of installers' professional relationships, it is important to look at the patterns of linkages in place, that is the strengths of the relationships between different actors (Nahapiet and Ghoshal, 1998). Thus, whilst relational social capital is about the nature of relationships, structural social capital is about how strong individual bonds are. In particular, structural social capital reveals that tie strength can influence the routes to information that individuals might use. The strength of tie is defined by Granovetter as a "combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie" (1973 p. 1361). Network ties have generally been categorised as either strong or weak; it has been argued that successful networks have a collection of both (Uzzi, 1997). Strong ties are valuable for 'preserving or maintaining resources' (Lin, 1999 p. 34) i.e. maintaining the status quo and for the transfer of complex or tacit knowledge, particularly where trust is required (Krackhardt, 1992; Levin and Cross, 2004). However, strong ties are not the only way to gain useful resources. The benefits of weak ties, characterised by distant and infrequent interaction (Levin and Cross, 2004), have also been highlighted. Weak ties are particularly valuable in the delivery of non-redundant information (i.e. new knowledge) (Granovetter, 1973; Levin and Cross, 2004; Hansen, 1999). Within a closed network, or one with just strong ties, it stands to reason that actors are well known to one another, thus the only way that new information enters the group is through a weak tie to someone primarily operating in another group (Granovetter, 1973).

3.2.3. Considering relational and structural aspects together

The concepts of relational and structural capital will now be applied together to understand heating installers' supply chain networks. These different dimensions of social capital often work together in social networks, for example, where strong norms of trust and reciprocity have developed, strong social linkages are also likely to be found (Bresnen et al., 2005). The focus is on the relationships between heating installers, plumbers' merchants and sales representatives. Whilst the supply chain may extend beyond these actors, to include the manufacturers and policy makers influencing heating technologies for example, it is plumbers' merchants and sales representatives that emerged as most prominent in the everyday work of the heating installers in this study.

4. Results

4.1. The plumbers' merchant

Repeatedly emphasised in this fieldwork was that the merchant provides a 'hub' where heating installers, sales representatives and staff members regularly interact. On entering a plumbers' merchant there is a counter with plumbing products and tools lined up on display hooks and shelves behind it. Further behind that is an office space and an adjoining warehouse. Here, everything from bags of small copper elbow joints, to boilers and radiators are stored for sale to relevant tradespeople. As was apparent in this study, heating installers visit these merchants regularly, in some cases multiple times per day, for the products and parts required for their work. This makes the plumbers' merchant one of the most frequently encountered actors in the heating installer's network. Observation in these spaces revealed a friendly atmosphere, where conversations would readily flow between the personal (recent holidays, family news and golfing trips) and the professional (purchase orders, account payments and product enquiries). Indeed, with regular visits comes the potential for informal relationships:

> "I like to be on first name terms with people, so I like to go into my plumbing shop, 'hello Andy, Dave, George' whatever, I like to chat […] I don't like going into shops where you're a bit of an alien, y'know what I mean? […] I think blokes are creatures of habit, y'know they like…so of course, they don't like to go into different suppliers all the time, they like going' to the same suppliers, talk…"
> (Jack, self employed, interview)[2]

The majority of those taking part in this research exhibited a comparable familiarity with 'their merchant', expressing a preference for either a single business, or a small selection of local ones. Whilst the inception of these interactions can be based on locality or price, through regular informal interactions, installers would often develop strong relationships, featuring the relational social capital benefits of loyalty and reciprocity, with their merchant. Not everyone valued these relationships in the same way but this familiarity was nonetheless important; if the merchant does not know a heating installer they may experience a quite different service. For example, George noted that he was either ignored or 'treated like an imbecile' if unfamiliar to the staff. His comment demonstrates that without strong ties to the merchant, the installer may not have access to the same structural social capital benefits as those who do develop these relationships, in

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[2] The data presented in this paper are denoted according to how they were collected (through observation or interview), along with the type of participant (whether they were self-employed or working for an organisation).

this case a fast and friendly service. Regardless of tie strength, in the observed interactions between these two actors, the job of the merchant could often extend far beyond that of mere supplier. Indeed as the following examples show, social capital in the relationships between merchants and installers can serve to influence the technologies installed in homes.

4.1.1. Trusted ties influencing product decisions

In the fieldwork for this study, merchant knowledge emerged as particularly beneficial to heating installers for problem solving. During observation in merchants and incidental visits made with heating installers, these problem solving tasks appeared as routine procedure; a feature linked to the frequency of problem solving in both actors' work (Suchman and Wynn, 1984). In several cases, installers visited the merchant equipped with a picture of the problem part on their phone or with the part itself. Some of the experienced staff who took part in this research were able to identify these problems and recommend solutions quickly and with little explanation from the installer. This is an example of installers using a technology, which is not specific to their trade, to facilitate the exchange of social capital within their network. One merchant described this as 'a game of charades' since installers sometimes cannot articulate what exactly they need and he has to deduce a solution from the little evidence given (Seb, merchant-chain, fieldnotes). This is indicative of a key resource delivered by relational social capital: trust. In these moments, the installer is willing to reveal what he does not know, safe in the knowledge that exposure to the merchant will not have a detrimental impact on his professional standing. Furthermore, the installer demonstrates a belief in the competence and capability of the merchant.

However, fieldwork soon revealed how both national chains and independent merchants have product preferences. These are influenced by reputation, contractual obligations, informal rewards, profitability, and their relationships with sales representatives (as elaborated in the following section). For example, Doug discussed the 'terrible' relationship between Sableton, who produce boilers and Installer Spares, a national plumbers' merchant who will not stock their product (self-employed installer, interview). This is a 'real pain' for Doug, who sources Sableton products through a direct online company instead (self-employed installer, interview). In another example, Amir, an independent merchant, stocked only two types of control; a market leading brand and a cheaper alternative. He noted that '60%' of his customers do not ask for a specific brand; as a result, his customers get his preferred Stockman device (independent merchant, fieldnotes). Meanwhile Seb promotes an own-brand device, which he is incentivised to sell by the national chain of plumbers' merchants that he works for (national merchant, fieldnotes). Thus, whilst social capital, especially trust, might influence the products that installers fit, merchants' predilection for certain brands and parts, and the availability of particular products, no doubt influences the technologies that get fitted in homes. This is particularly true if neither the heating installer nor the end user specify the product they want, thus leaving it to the plumbers' merchant to select one.

Beyond suggesting particular brands, the merchant can also be involved in influencing the technical parameters of central heating systems, particularly through sizing. This is a process of determining the appropriate heat output of both the boiler and radiators for a particular property. Instead of following the formal sizing procedures stipulated in industry guidance and regulation for the selection of appropriate boilers and radiators, a heating installer may, for reasons of cost and convenience, select the products closest to his specification that are available in the merchant (merchant-chain, fieldnotes; manufacturer training, fieldnotes). This may even extend to plumbers' merchants performing sizing calculations on behalf of installers:

"Well if you give them the room size, wall content, window size, erm, whether it's been insulated with stuff, just the basic facts and they'll come back to you and say, y'know, you need about this size, or you need this capacity…"
(George, self employed, interview)

Arguably, it is owing to the trust inherent in relational capital that the installer has confidence in the merchant's ability to size a central heating system. Further, given that construction professionals can operate in particular geographic areas (Owen et al., 2014), it may be the case that heating installers are likely to form stronger relationships with local plumbers' merchants with whom they have developed strong ties that can verge on friendship (Granovetter, 1973). However, it was also apparent that the merchant's expertise might be recognised by those with weak ties, for example, infrequent visitors to a particular branch, suggesting that the merchant can provide information and influence central heating technologies, regardless of tie strength. In keeping with this, one participant noted how he re-visits his preferred plumbers' merchant because he recognises their 'product knowledge' which can support him in his work (George, self employed, interview). Either way, in their authoritative position, these individuals might be understood as being significant in determining the central heating technologies that are fitted in homes, particularly if installers do not have a firm idea of the products they are requesting. The role of social capital in supply chains is further demonstrated by the sales representative, whose use of both strong and weak ties in navigating between merchants and installers is detailed in the following section.

4.2. The sales representative

Gary: […] it's huge relationships, y'know. If you've got the relationship with the merchant and you can make them money, they're gonna back you and promote you, and then you rely on the relationship with the installer t-, to […] you want the relationship because you want them to use your product…
(Gary and Dale, sales reps, interview)

Gary and Dale are sales representatives, or 'reps', and, as they highlight above, an important part of their job is to establish relationships with both the merchant, who sells their product, and the heating installer, who buys and installs it. Sales representatives work for manufacturers, selling and promoting their products. Whilst they might receive commission for this activity, and heating installers might be aware of it, this motive for product recommendation was not brought to the fore during this fieldwork. When observing these actors, who are not necessarily identifiable by a uniform, their role was not always immediately clear. It was only through witnessing conversations as they switched from informal greetings and personal updates to recent sales and industry news that their task became apparent. Indeed, for success in their work sales reps prioritise the informal, friendly interactions yielded through relational social capital, rather than formal interactions underpinned by financial motivations. A large part of sales reps' job involves travelling between plumbers' merchants providing information about new products and communicating with the heating installers installing these products.

Heating installers might use sales reps in different ways. At interview, whilst some talked extensively about their relationship with the sales rep, others only mentioned this actor in passing. As James pointed out, "what you got to appreciate wi[th] reps is, some are arseholes, some are useful" (organisation, interview). Heating installers and sales representatives can have both strong and weak ties to one another. These ties of different strength can yield different structural social capital resources, for example, weak ties can be useful for gaining information (Ibrahim, organisation,

interview; Tom, self employed, interview; Martin, self employed, interview), whilst with stronger ties, the rep might provide expertise and support for the installer (James and Eddie, organisation, interview). The ties between sales representatives, plumbers' merchants, and heating installers are discussed in the following sections.

4.2.1. Imparting information and fostering loyalties

Sales reps (and the manufacturers they work for) have identified installers' frequent visits to the merchant as an opportunity for interaction:

> [Dennis] said that when the installers are in the merchant they have a bit of time on their hands, it was a great opportunity to talk to them because they will be stood waiting for an order to be run through or something, so you can have a chat to them then.
> (Dennis, sales rep, fieldnotes, industry event)

Here Dennis, a sales rep, identifies the plumbers' merchant as somewhere to find installers, but also crucially where installers have time to talk. This presents an important opportunity for the sales rep, which can be capitalised on by scheduling a 'breakfast morning' at the merchants, during which sales reps prepare bacon sandwiches for installers and inform them about new products. The merchant is busiest first thing in the morning (many branches open from 07:30), when installers visit to collect the equipment and materials they need that day. Breakfast mornings are popular; they were mentioned or witnessed several times during this fieldwork in a way that supports the potential of 'technical mornings' for the promotion of water-saving products to plumbers, as recognised by Bowden et al. (2012).

Amir noted that during these moments, the reps can "impart any information that they have" , and through these informal means he "gain[s] the knowledge" about new products and changes in the industry (Amir, merchant-independent, interview). Given the brevity of these meetings, it may be suggested that the structural ties between sales rep, installer, and potentially merchant are weak. However, as illustrated by Amir, they can still yield social capital, in particular *useful* information, that is new information or novel insights less likely to come from stronger ties (Levin and Cross, 2004). Furthermore, for the rep, these interactions can help to ensure product sales and may be used to encourage the development of stronger ties and brand loyalties from installers. These strong ties can also yield beneficial relational social capital resources to heating installers, as discussed in the following section.

4.2.2. Strong ties for specialist support

Installers develop product loyalties for various reasons, for example, the cost, quality and familiarity of certain products, along with manufacturer's incentives. However, there are also "a lot of relationships" (Gary and Dale, sales reps, interview), that can be used to encourage product loyalties. For example, if an installer "jump[s] from boiler manufacturer to boiler manufacturer" , they may miss out on the backup support (for example, technical assistance) that loyal customers receive (Eddie, organisation, interview). Conversely, if there is a stronger tie between installer and sales rep, access to specialist assistance for problems can follow:

> James: It's what you get brought in to, what they advise you and y'know, sometimes because you are with Ocipura, instead of ringin[g] the helpline to get the technician out we got a number which can get a bloke out now to change that part…
> (James and Eddie, organisation, interview)

Through building up a rapport with the Ocipura rep, James and Eddie are able to bypass the organisation's central technical helpline. Instead, they can go directly to the rep. Indeed, these strong ties can mean that heating installers turn to the sales representatives as their 'first port of call' (manufacturer training, fieldnotes) for solving problems. Reps may have efficient routes to access the manufacturer's central support on behalf of the installer, or they may be able to share their own technical expertise (this is particularly true where sales reps have previously operated as heating installers). Thus, through remaining loyal, and developing strong ties with particular sales reps, installers can gain a valuable relational social capital resource in the form of an efficient, specialised technical service.

The quality of rep support can sometimes also influence the product preferences of the merchant. For example, Amir, an independent merchant, cited three preferred boiler brands based on three things, the quality of the boiler, reliability and, "last but not least" , the support.

> "We get a lot more support out of them in terms of err, how they back customers up in terms of warranties, we have a bit more clout with their reps, erm we have erm a better sort of rapport with err the whole company overall, so when something doesn't go our way we get a bit more support out of [th]em in sorting things out without having to go through loads of red tape."
> (Amir, merchant-independent, interview)

With a strong relationship with the sales rep, Amir feels more attached to the whole company and is able to bypass "red tape" for problem solving. In keeping with this, a breakdown in a relationship with a sales representative might also result in a shift in product loyalty. This loyalty was discussed several times, as with their plumbers' merchants, heating installers noted switching their product loyalties if a particular individual with whom they had a strong relationship moved companies. In keeping with this, the 'rubbish' replacement for a rep who had recently left led Jack to use an alternative brand (industry event, fieldnotes). Building strong ties can clearly be beneficial for both installer and sales rep. The relational social capital resources available here include loyalty and repeated product sales for the representative, and access to a priority service and a high level of technical support for the installer.

4.2.3. Strong ties for insider information

Furthermore, strong ties with the merchant can particularly help the sales rep to keep abreast of who is buying and selling their products. With a strong tie, the rep might extend their visit to the merchant, staying for an informal chat over a hot drink. For example, a sales rep for Ocipura spent an hour with the branch manager of a plumbers' merchant, Seb, chatting over a cup of tea. During this time the two men discussed their families, recent holidays, a caravan renovation and a recent fishing competition. It was only towards the end of the conversation that the topic shifted:

> Brian asked 'who's fitting Bedlingtons?'. Seb mentioned to Brian that he had recently got a big new client that he might be interested in. He said that they were called First Class and that they'd spent £60,000 in a week and a half. I think Seb said that they were installing Bedlingtons. Brian said he'd like their name and number; Seb went to look it up and wrote it down for him. After this Brian left.
> (merchant-chain, fieldnotes)

Through this five-minute diversion, the sales rep has gained details of a potentially lucrative customer. It was after Brian's visit that Seb explained that he was the sales rep for Ocipura, but they

had known each other for years and he was 'more of a friend, really' (Seb, merchant-chain, fieldnotes). With the loyalty that emerges as a result of this relational social capital, Seb is willing to divulge the details of his customers to Brian who is then able to target those customers for future sales. Similarly, a sales representative might use strong ties with both customers and merchants to influence product sales. Another seemingly inconsequential exchange took place when Phil, a sales rep for Stockman, took one of his customers, Kelly, for lunch. Kelly is the buyer for a large contractor for social housing companies, it is her job to decide what products will be used on the company's contract to service 30,000 social housing properties over the next 5–10 years. During lunch, Kelly divulged that there was one new contract that would be having Ouseman instead of Stockman products fitted. Following this, Phil contacted Aaron, who manages accounts for Plumb Parts, and suggested that he contact Kelly to quote for the Stockman product, rather than the Ouseman one. Phil later explained that it was beneficial for him to encourage buyers to use Plumb Parts because Stockman have a deal with them, to sell a particular number of their products (sales rep, fieldnotes). Thus, this structural aspect of social capital: a strong tie to those buying products, can provide a valuable information channel which the sales rep can harness, ultimately influencing the central heating technologies installed in homes.

5. Discussion

The data presented has explored the relationships that make up heating installers' supply chains, and how they may influence domestic central heating technologies. Supply chains have been recognised as potentially important in influencing the technologies installed in buildings. However, the studies introduced at the beginning of this paper find contradictory evidence on the exact nature of how this influence is exerted (Banks 2000a, 2000b; Bowden et al., 2012), and had not yet examined the establishment and maintenance of relevant social relationships. As a response, this paper is part of a wider attempt, in the UK and internationally, to better understand the nature of supply chains and their influence. It represents the first investigation of the everyday interactions between heating installers, plumbers' merchants, and sales representatives. In this, social capital has provided a useful framework through which to understand these relationships by simultaneously considering the relational (nature of the relationships) and structural (strength of ties between individuals) aspects of social capital by which they can be characterised. The discussion now returns to the paper's earlier focus on how these supply chains might influence product choice and information provision.

5.1. Supply chains influencing product choice

Contrary to Banks' conclusion that plumbers' merchants "simply act as a counter and distribution system for the manufacturers" (2000a p. 8.8), they can influence heating installers' everyday work, and the technologies installed in homes. Some installers may prioritise cost and convenience over building strong relationships, reflecting Killip's (2013 p. 527) suggestion that for builders it is 'more normal' to use more than one supplier. However, through repeated informal communication, others develop strong ties to their merchant. In this, trust is the relational social capital resource that leads the installer to, at times, rely on the merchant's expertise by, for example, involving them in the sizing of central heating systems. However, the merchant is unlikely to have visited the property in which the system is installed, meaning that central heating systems might not be sized to reflect the thermal properties of the dwelling, as regulations and guidance

suggest they should be. This is particularly pertinent for strategies to encourage the installation of low carbon heating technologies since these devices can be more reliant on accurate technical specification and installation to function in an energy efficient way (this is particularly true for heat pumps: Gleeson (2015)). Moreover, in all of this, merchants do not act without their own agenda. Through interviews with heating installers and manufacturers, Banks concluded that merchants exhibit "no great brand loyalty" (2000a p. 8.8). However, by spending time in plumbers' merchants and talking with them about what they do, quite a different picture emerges. In particular, merchants' own affiliations and preferences, along with their contractual obligations and informal sales incentives can evidently play their part in influencing product choice. As others have argued, the social capital associated with this influence is not easily transferred or traded (Nahapiet and Ghoshal, 1998). For example, where structural ties develop between installer and merchant, relational social capital resources might include a fast, friendly service and brief interactions as a means of getting things done efficiently. Loyalty and reciprocity are inherent in these ties; with these features, the installer is 'looked after' by the merchant, whilst the merchant can guarantee repeat business. Thus, whilst it might initially appear that plumbers' merchants simply distribute products, when this is understood according to the social capital resources inherent in their relationships, these interactions are not necessarily so neutral.

Meanwhile, the sales representative might foster strong ties to the merchant, using this structural social capital as a rapid route to learn about, and subsequently influence, who is installing their products. These strong ties can be fostered through repeated interactions, but also the personalised incentives and favours that have featured throughout this discussion. These data provide key insights into how product decisions and preferences might be influenced by factors extending far beyond the person physically installing the central heating system. Meanwhile, sales representatives utilise the development of relationships with heating installers, and the relational social capital that can develop within them, to ensure loyalty in installers' product selections, and gather information about who is fitting different products. Where loyalty to an individual sales rep and, in turn their brand, prevails, heating installers may be reticent to fit alternative products.

Despite plumbers' merchants and sales representatives being involved in product selection, their role in disseminating information about product requirements (such as those detailed in the Domestic Building Services Compliance Guide) and installation standards (for example MCS) has, to date, been overlooked. This is something which policy-makers may prioritise when considering how to influence the heating technologies installed in homes. Further, closed social networks, consisting primarily of strong ties like those outlined above, can lead to exclusion, and reduce the flow of new ideas into the group (Adler and Kwon, 2002). For example, the rejection of new sources of knowledge and information from those outside of the existing network being deemed irrelevant (Bresnen et al., 2005). In this way, by persisting with 'tried and tested' products, and perpetuating associated (mis) understandings, the social relationships of the heating supply chain may hinder the uptake of low carbon heating technologies. Thus, it is essential that, when promoting the installation of alternative heating technologies in homes, policy makers consider how information about the energy benefits of these devices and their installation requirements could be disseminated through these tight social networks.

5.2. Supply chains for information

For the heating installer, strong ties to the plumbers' merchant are particularly important for problem solving and supporting

their expertise. Indeed, with the relational social capital developed through these ties, heating installers might turn to the merchant to help identify parts and solutions to problems, exposing limitations in their own expertise in doing so. This supports the suggestion that builders' or plumbers' merchants present an "opportunity to acquire and share knowledge in a non-competitive way" (Owen et al., 2014 p. 172). This is in keeping with Killip's (2011) suggestion that these intermediary actors might act as useful and reliable sources of information, in particular identifying suppliers and merchants as valuable 'allies' for Small and Medium Enterprises (SMEs) in the construction industry.

Meanwhile, through exhibiting loyalty to a particular manufacturer, and developing strong ties to a sales representative, heating installers secure a valued professional ally. In particular, relational social capital with sales representatives can provide specialist support and a priority service when they need help in problem solving. The existence of brand loyalties amongst SMEs and heating installers has previously been identified (Banks 2000a; Killip 2013). This research has revealed how these loyalties are partly sustained by the social capital that can develop between sales representatives and installers. Although, as noted by Banks (2000a), brand loyalties might develop at an early stage (for example, during early training and apprenticeships), these may shift depending on the relationship between installer and sales representative, and the quality of service and technical assistance that installers receive from particular representatives. Additionally, weak ties can be beneficial for the delivery of non-redundant information (Granovetter, 1973), particularly in a cost effective way (Hansen, 1999). With this structural social capital, in their transient role, the sales representative can act as a valuable channel for useful information, for example, providing details about new products during breakfast mornings and fostering future brand loyalties in the process.

5.3. Further supply chain investigations

This study has been limited to how plumbers' merchants and sales representatives feature in the social networks of heating installers. It would be beneficial to further map the structure of these networks, which would help to reveal the significance of different actors for different heating installers. For example, some participants of this research mentioned turning to the Internet, or family members working in the industry, if they had a query, whilst others might refer directly to manufacturers. Furthermore, these relationships are likely to vary according to the type of work the installer performs. For example, a self-employed installer might prioritise different relationships to one working for an organisation, or specialising in social housing contracts. More comprehensive observational studies at relevant points in the supply chain would be valuable for understanding additional variations in the roles played by particular actors and the nuances of the social relationships found at these points. This study has revealed the potential significance of the social capital processes found in the heating installers' supply chains. Whilst this reveals the need for further research in this area, as they stand, the current findings also have implications for future energy policy, as discussed in the following section.

6. Conclusions and policy implications

In efforts to influence installer practices in ways that reduce the energy consumed through domestic space heating, policy makers could make use of the strong ties that can evidently link heating installers, plumbers' merchants, and sales representatives. This investigation has revealed that the plumbers' merchant can be a

trusted source of information and expertise, and sales representatives can disseminate useful information during their visits to the merchants. Thus, these actors are well positioned to encourage the sale of low carbon heat technologies and provide energy efficiency advice that installers might then pass to their customers (see also Bowden et al. (2012)). Heating installers are likely to respond to messages from these individuals and, where relationships of trust and loyalty already exist, they are unlikely to be compromised by this new messaging. Further, the relationships between these actors develop over time, yielding social capital benefits including access to information, trust, loyalty, and reciprocity, which are not easily transferred or traded. Thus, it could be beneficial to target sales representatives and plumbers' merchants when thinking about who could act as effective avenues for the dissemination of information about low carbon heating technologies. In particular, policy makers might consider:

- Facilitating events like breakfast mornings, and working with industry to encourage installers to attend these, such that plumbers' merchants and sales representatives are able to communicate important policy information to them.
- Communicating strategies that form part of the energy efficiency agenda, such as MCS certification processes, to plumbers' merchants and sales representatives, who can, in turn, act to disseminate this information amongst heating installers.
- Ensuring that energy efficiency messaging features in sales strategies, such that plumbers' merchants and sales representatives are able to detail how products help in meeting the standards set out in the Building Regulations, and how they are to be effectively installed to this end.

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