

MAPPING SUSTAINABILITY RELATED KNOWLEDGE OF CONSTRUCTION PLANNED WORKS: A SOCIAL HOUSING CASE STUDY

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Evidence suggests that the awareness amongst construction practitioners of the sustainability concept and its implications is growing, although changes in practice remain relatively slow. In the UK, the government has launched several initiatives to improve the situation and a plethora of sustainable guidelines and frameworks have been developed for construction practitioners. This research argues that despite this, insufficient emphasis has been placed on the management of sustainability related knowledge which is currently readily available and held in practice. To fill this gap, a doctoral research based at Glasgow Caledonian University aims to develop a framework to help construction practitioners to manage the flow of sustainability related knowledge available during the course of their projects. As part of this wider research, this paper presents a case study of a kitchen renewal project by a small urban Scottish housing association exploring the dynamics and complexities of sustainability related knowledge flow. A seven step knowledge mapping methodology analysing semi-structured interviews with practitioners involved in the project delivery is presented. The case study findings indicate that Housing Association (HA) practitioners possess economic, environmental and social goals and the knowledge associated but no formal system or mechanism to manage it. Next it appears that practitioner relationships influence the exchange of sustainability related knowledge. Also it was observed that implicit and tacit knowledge influence practitioners' decisions. Finally it seems that practitioners acquire sustainability related knowledge from practice rather than policies. The case study findings provide a base to develop practical advices and solutions for HAs' practitioners during planned works to improve the management of sustainability related knowledge based on an understanding of sustainability issues and communication mechanisms.

Keywords: knowledge management, social housing, sustainability.

INTRODUCTION

Given its many environmental, economic and social impacts the construction industry has a central role to play in the delivery of sustainable development. During the last fifteen years many UK governments' initiatives such as the Egan (1998) report encouraged reforms to make the construction industry more competitive and sustainable. However, many argue that government strategy based primarily on encouraging rather than compelling regulations has failed to embed sustainability practices throughout the construction industry (Pickvance and Chautard, 2006). Although government incentives and recommendations may have implications for all sectors of the industry, most mandatory directives remain focused primarily on the

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new build sector which contributes, at most, an additional 1% per year to the existing stock. It can therefore be argued that the government's current target of delivering Zero Carbon new houses by 2016 only regulates a microcosm of the building stock. The remaining 99% of (existing) buildings are not currently targeted by such compulsory regulations. To achieve the government's overall targets for carbon emission reduction over the next decade, the existing building stock must be refurbished in a sustainable manner.

Social housing being a significant client to the construction industry it provides a valuable focus as it is recognised for its innovation capacity and coverage of sustainability dimensions given its role in society (Egan, 1998). Social housing practitioners managing the existing stock have to implement government sustainability policies into practice. In Scotland since 2003 HAs must have a sustainability policy and an action plan based on the Scottish sustainable development policy that sets out the principles to be promoted and the sustainability objectives to be met by a HA applying for funding. However, there is a lack of understanding of the implications or actions required to deliver these sustainability policies and practitioners have difficulties to apply the sustainability concepts to context specific projects such as planned works (Hall and Purchase, 2006).

This lack of clarity around the sustainability focuses can be attributed to the complexity of the sustainability concept adding to organisations' traditional economically based strategy, social and environmental issues. Increasingly an efficient management of knowledge is being seen as an important part of developing sustainable practices (Hamel and Prahalad, 1994; Nonaka and Takeuchi, 1995). However, it is not clear how to efficiently manage this knowledge referred to as 'sustainability-related knowledge' (Malone and Yohe, 2002). Knowledge management strategies and solutions have been developed over the years helping organisations to become knowledge centred. For example Renukappa and Egbu (2007) highlighted the key challenges associated with mapping sustainability related knowledge and developed a framework to manage change and knowledge associated with sustainability initiative for the benefit of organisations. However, frameworks such as these provide broad guidance but are potentially difficult to apply in practice. In fact many researchers argue that managing sustainability related knowledge is an integrated and complex process and that to be successful a knowledge management strategy must be suited to specific organisations context and integrated to practitioners practices (Lichtenstein and Swatman, 2003; Renukappa and Egbu, 2007). As a result of this lack of specificity and despite the large amount of literature on sustainability and knowledge management, HA practitioners do not possess specially developed mechanisms or systems allowing them to share and transfer the existing sustainability related knowledge created during good practices.

This paper presents an important step of a doctoral research which aims to develop a knowledge management framework to facilitate and improve the sharing of sustainability related knowledge between social housing practitioners during a planned work (Leblanc *et al.*, 2010). The first section of the paper presents the research methodology for developing such a framework and provides the background of an empirical case study considered to establish the requirements for its development. This is followed by a description of the seven steps taken to knowledge mapping and its analysis. The paper concludes with a presentation of some initial case study findings articulated from the knowledge maps.

RESEARCH METHODOLOGY

Case studies were identified as an effective approach to investigate the complex interactions between social housing planned works practitioners. As a comprehensive research strategy the case study allows to the researchers to develop an understanding of a real life context project (Yin, 2003) in order to examine in situ the dynamics and complex flow of sustainability related knowledge within a planned work project. This section firstly presents the doctoral research case study selection methodology and secondly introduces the case study presented in this paper.

The knowledge management framework aims to address all type and size of Scottish HAs. In this qualitative research the number of case studies is governed by the principles of saturation (Strauss and Corbin, 1990) with the level of saturation determined through the understanding of how the type and size of a HA influence the management of sustainability related knowledge hence how the framework must adapt to these attributes. In order to facilitate the selection of case studies and reach the saturation point a classification of Scottish HAs based on the amount of home managed and the Scottish Housing Regulator (SHR, 2008) HAs classification was developed and is shown in table 1. In order to provide a representation of the various Scottish HAs type and size a case study from each category will be selected. Finally to identify the most common planned programme of works a survey² of Scottish HAs was conducted and analysed revealing that heating (16%) and kitchen renewals (15%) represented the highest levels of investment and the highest numbers of planned works.

Table 1: Number and percentage of Scottish HAs according to the type and size

	Specialist	Rural	Urban	Stock transfer
Small <2,000 units	12 (8%)	15 (9%)	78 (49%)	21 (13%)
2,000<Medium<8,000 units	3(2%)	2(1%)	14 (9%)	12 (8%)
Large>10,000 units				2 (1%)

This paper presents the findings of a case study representing a planned kitchen renewal project realised by a small urban HA near Glasgow. This case study was selected for focus as it represents nearly half of Scottish HA's (see table 1) and from the survey was one the two most common types of planned works. Many of its characteristics are representative of HA's of this size with a limited number of staff, a varied housing stock mainly (71%) acquired during the 1990s from the government and the rest built or acquired since then. Regarding the planned works the HA has been using partnering agreements with the contractor, consultant and manufacturer for the last 8 years and considers it as an advantageous solution compared to one-off contracts. The selected project was a typical kitchen renewal in 58 homes including the removal of previous kitchen elements, installation of kitchen units and worktops, plumbing and electrical works as well as room finishes (floor, walls, ceiling decoration and tiles).

KNOWLEDGE MAPPING

In the process of developing a knowledge management framework to improve the sustainability of social housing planned works knowledge mapping was identified as a

² The researchers refer to an email survey send to all Scottish HAs and realised in a previous stage of the doctoral research. 2008/09 planned works planning and budget from 23 HAs were collected and analysed

suitable method from which to capture the sustainability related knowledge and its flow between practitioners. Knowledge maps provide the opportunity to describe the relationship between practitioners during the various activities of a planned work, the knowledge they hold and its nature (explicit, implicit or tacit) and the mechanisms of its exchange. In order to reflect the focus on sustainability, the mapping technique includes a triple bottom line approach to identify knowledge related to social, economic and environmental aspects. This section describes the application of the knowledge mapping methodology developed in this research divided into seven steps. This methodology applied to this case study will also be applied to other case studies as part of the wider research.

The knowledge mapping methodology

Semi structured interviews were conducted with practitioners involved in the kitchen renewal project. Interviews were analysed under the grounded theory principles in order to minimise the researchers' preconceptions and allow the theory to emerge from the data (Strauss and Corbin, 1990). As a research design the knowledge mapping analysis aims to link the information collected during interviews to the development of a knowledge management framework to improve the sustainability of planned works (Yin, 2003). The mapping approach reflects the context and dynamics of social housing planned works. It covers Eppler (2008) knowledge transfer and application maps categories and is inspired from the social network mapping described by Plumley (2003). It also builds upon Thomson et al. (2009) work on mapping the knowledge during a sustainability assessment and Egbu's (2006) work by specifying to which sustainability pillar the knowledge relates to.

Step 1: Data collection

The first step consisted of identifying which practitioners involved in the kitchen renewal project had an impact on the project sustainability hence should be interviewed. Following the grounded theory principles HA practitioners were asked to cite internal or external practitioners influencing the sustainability of the kitchen renewal. The process started by asking the HA director who indicated that the Technical Services Manager (TSM) was the kitchen renewal project manager and as such was responsible for kitchen renewal projects. Next the TSM was asked the same question and stated that the contractor and the consultant currently in partnership with the HA were the main external practitioners involved in the project. The TSM and the director added that other practitioners were involved in the kitchen renewal projects such as the finance manager for the budget and the maintenance inspector for advice on the stock condition but only the consultant and contractor were directly involved in the process and could influence its sustainability. As a result the TSM, contractor and consultant were identified as main project practitioners having an impact on the project sustainability and asked to identify and describe for each activity what sustainability aspect was important, what related knowledge was required, its nature, source and communication method.

Step 2: Interviews transcript and coding

First, interviews were digitally recorded and transcribed for analysis. Next, the text was divided into manageable parts with the aid of an Excel table. These meaningful parts of text were assigned a code title and a code reference. This methodology is based on the open coding principles described by Corbin and Strauss (1990) that allows codes to be compared and grouped together to form categories and subcategories. The code title briefly described the text with the respondent's

vocabulary and the code reference is composed of the respondent abbreviation (Technical Services Manager: TSM, Consultant: CS, Contractor: CT) and a number.

Step 3: Classification of codes according to project phases and activities

To reflect the context of the project the TSM, consultant and contractor were asked to review a generic planned work process model previously developed by the researchers following a grounded theory approach³. Following this review two sets of planned work activities were distinguished: ‘Mainstream’ and ‘Occasional’ activities (see table 2 below). Mainstream activities are part of every kitchen project and are repeated every year while occasional activities are not necessarily carried out during every project and based on 3 or more years’ cycles. An example of occasional activity is the stock condition spread over three years, every ten years. The codes were then classified according to the mainstream and occasional activities.

Table2: Case study mainstream and occasional activities and corresponding project phases

Phase	Mainstream activity	Phase	Occasional activity
All	Committee meeting		
Planning	Stock condition information management	All	Sustainability policy revision Stock condition survey Innovative project decision Consultant selection Contractor selection Manufacturer selection
	Work prioritisation		
	Budget draft Budget approval		
Contract preparation	Project details and works specification		
Site preparation	Housing survey and tenants’ consultation		
	Asbestos removal assessment		
	Pre-start meeting		
On site work	Work execution	Post contract	Component replacement
	Tenants’ satisfaction survey		
Post contract	Sign-off		
	Contractor evaluation		

Step 4: Categorisation of codes

From the analysis a set of code categories emerged reflecting the dynamics to develop the knowledge maps: goal (describes a practitioner goal during an activity), sub-activity (describes a sub-activity within an activity), knowledge (refers to information or knowledge hold by a practitioner), relationship (refers to the relationship between practitioners), barrier (refers to a sustainability barrier) and driver (refers to a sustainability driver). For example the TSM described that during the housing survey and tenants’ consultation activity, the contractor explains the work to be carried out to the tenants and advices them on how to fit a maximum number of units in the kitchen design. The corresponding code is therefore classified as a goal.

³ The researchers refer to a process model for social housing planned work developed in a previous phase the doctoral research. The model consists of 7 phases and 20 activities and is based on semi-structured interviews followed of a validation process respectively involving 11 and 7 social housing practitioners.

Step 5: Classification of codes according to sustainability aspects

The relevant codes were then classified according to the three sustainability pillars: social, environmental and economic. Some codes were observed to cover the three sustainability aspects while others were focused on only one or two. For example, the contractor’s explanation of the work to be carried out to the tenant during the housing survey and tenants’ consultation is classified as a social issue. In fact ensuring that tenants values are included in the decision making process potentially increases tenants’ satisfaction with new kitchen hence improves their quality of life (Vanegas *et al.*, 1996).

Step 6: Analysis of knowledge flow surrounding the activities

This step consisted of firstly providing a short description as described in the interviews of the interaction between practitioners (or tenants) during which knowledge is transferred. This was followed by specifying the explicit (books, documents, reports, white papers, spreadsheets, memos and databases), implicit (values and requirements of stakeholders, expert knowledge) or tacit (expert knowledge acquired through past experiences) nature of the knowledge being transferred (Thomson *et al.*, 2010). Table 3 presents practitioners’ social goals (which stimulates the need for knowledge) during the housing survey and tenants consultation activity (site preparation phase) as an example of the knowledge mapping analysis to explore the nature of knowledge being transferred and transformed (Nonaka and Takeuchi, 1995).

The first column describes to which sustainability pillar the goal is associated to (in this case social). The second column presents the titles of the codes associated to practitioners’ social goals. The third column describes the interactions between practitioners and tenants associated to the codes. The fourth column describes the nature of the knowledge being shared during the interaction.

Table3: Example of the knowledge mapping analysis for practitioners’ social goals during housing survey and tenants’ consultation

Sustainability aspect	Code title	Knowledge transfer description	Nature of knowledge transferred
Social	Contractor explanation of work	Contractor explaining work to be done to tenants and write their preferences	Discussion: Implicit Notes: Explicit
	Collection of tenants’ preferences		
	Contractor advises tenants on the new kitchen layout	The contractor aims to maximise the amount of units fitted in the kitchen by advising tenants.	Discussion: Implicit

Step 7: Graphic knowledge map

The last step of the knowledge map analysis consisted of developing a graphical representation of the tables for each activity. The figure 1 below illustrates a part of the knowledge map developed for the housing survey and tenants’ consultation activity. More precisely it illustrates table 3 of step 6, plus the goals and tacit knowledge of the contractor. The map highlights the nature and the flow of knowledge exchanged between the contractor and the tenants. It also shows to what sustainability pillar(s) the knowledge is associated to. In this case, for example the knowledge map shows that this part of the activity is strongly focused on the social

aspect with the contractor collecting tenants' preferences and advising for the new kitchen layout.

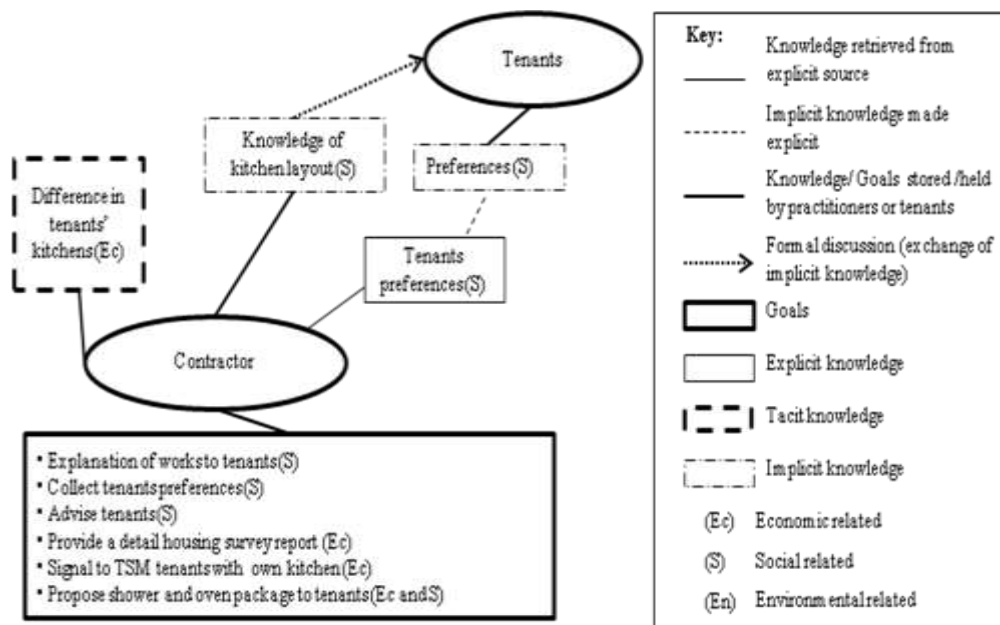


Figure 1: Knowledge map for the housing survey and tenants' consultation activity

FINDINGS

The knowledge maps allow the researchers to examine the nature and flow of sustainability related knowledge between practitioners during each activity, and some preliminary findings are explored in this section.

Sustainability activities

This section presents three activities which were found to have an impact on the sustainability project. The first activity named 'innovative solution' is linked to the fact that by 2015 the HA stock will have to reach the Scottish Housing Quality Standards (SHQS). The TSM stated that for a majority of the stock achieving the SHQS was not very challenging but for a few problematic houses, innovative solutions were required. These problematic houses hence become laboratories for environmentally friendly pilot projects such as renewable heating:

"We should pass easily enough. The major issue is the 12 properties that are electric heated with no gas in the area. What you will find is every electric property you have got is failing because it is not reaching the SAP of energy rate. So at the moment this is what I am looking at, trying to source a sustainable heating system for electric properties." (TSM).

The second activity is the 'work execution' with the practitioners' economic and social objective of delivering finished rooms to tenants. The TSM explained that the HA provides a professionally finished job instead of giving decoration allowances. The social aspect lies in the fact that the HA ensure that the tenants do not spend their decoration allowance on other things and the HA economic argument is to achieve value for money since they ensure that the job is done at a professional standard:

"To a certain extent it saves us because we used to give out a decoration / disturbance allowance every time we were doing a kitchen or bathroom. But it made more sense to get the contractor to do a quality job and then we do not need to pay any additional funding. And also the argument was that if you give tenants money they would spend it on drink. You give them vouchers they would sell them down the pub and then you would go back once they leave"

the house and you would just see that it has not been decorated and stuff like that. We spend all the money in a finish product now.” (TSM).

The last presented activity is the ‘manufacturer selection’. This process is key in a kitchen renewal project since all the sustainability aspects are taken into consideration. The economic objective shared by the practitioners is to select kitchen elements that achieve value for money and with minimum maintenance. The environmental aspect is managed by the consultant:

“...in all the contracts that we do there is scope for sustainability using sustainable products, where it comes from. In the kitchens they are the source for the timber for the kitchens. We can check that. The source is from a sustainable forest or whatever.”(CS).

The social aspect is considered with the HA aiming to hire a local manufacturer, also managed by the consultant:

“There is a local that we actually use for these contracts and that has a bearing on it as well, you know keep it into the local community, trying to give some local employment.”(CS).

It should be noted that the consultant words “We can check that” ,” whatever” and “as well” shows that the environmental and social aspect are not the priority but are recognised as part of the process.

Practitioners' sustainability knowledge rooted in practice

Although the knowledge maps clearly identified that practitioners considered economic, social and environmental factors; none of them referred to a sustainability policy or any theoretical document for guidance or knowledge. This shows that practitioners have some knowledge of sustainability principles and intend to apply them into practice but do not follow any theoretical policy view of sustainability. This situation was highlighted when the researchers requested a copy of the HA sustainability policy and the TSM realised that the policy was out of date since 2003.

The importance of practitioner's implicit and tacit knowledge

The source of information or knowledge for many activities is explicit but practitioners also attach importance to informal and formal discussions where implicit knowledge is shared. During the ‘innovative project decision’ activity the TSM explained that after checking internet and magazines, discussions with peers was the normal following step. In addition, the exchange of practitioners' implicit knowledge offers improvement opportunities. For example during the ‘manufacturer selection’ activity the contractor suggested a local manufacturer to the TSM:

“I know all the kitchen companies anyway but I had not heard of them because they are local contractors and it was talking to X (contractor) that they mentioned that it is who they used and we put them on the list and they got it (the contract.)” (TSM).

The case study shows that the exchange of implicit knowledge based on tacit knowledge between practitioners is anchored in practice and influence project decisions. Currently both implicit and tacit knowledge are not being formally managed and mechanisms helping practitioners within HAs or between HAs to improve tacit and implicit knowledge exchange should be developed further.

The importance of practitioner relationship on the flow of knowledge

The partnership agreement in place between the HA, contractor and consultant during the last few years created an environment of trust between practitioners almost permanently in contact:

“If I am being honest I would say that 90% of the time when we do work because we have worked together since 5 years there is a level of trust here as well. So when we do a job X (TSM) knows it is done because he has seen the other jobs...” “...Every one of us will have a mobile phone where we have the contacts and see for instance if I have an email and we want a response or something like that we pick up the phone.” (CT)

Practitioners’ closeness potentially increases the exchange of implicit knowledge such as the contractor local manufacturer suggestion to the TSM (described earlier) that might not happen between practitioners without partnership agreement.

CONCLUSIONS

This paper presented a sustainability knowledge mapping analysis of a small urban Scottish HA as a part broader research to develop a knowledge management framework. The knowledge maps identified that practitioners have economic, social and environmental goals and hold or have access to the related knowledge. It was also observed that practitioners’ sustainability related knowledge is mainly rooted in practice highlighting the gap between theoretical policies and practice. Finally, it was found that implicit and tacit knowledge influence practitioners’ and tenants’ decisions. This corroborates Thomson et al. (2010) conclusions of a knowledge mapping exercise highlighting the importance of implicit and tacit knowledge exchange through advice from experts or those with past experiences of sustainability.

This case study served as a pilot around which the methodology and the knowledge mapping technique were developed. The methodology presents limitations inherent to the nature of sustainability knowledge and the selected knowledge management approach. In fact knowledge and especially sustainability related knowledge is dynamic and the mapping exercise of limited value in time since sustainability related knowledge validity constantly evolve. Regarding the knowledge management approach consisting of classifying knowledge through categories (functionalism) it has been criticised for its inability to capture the complexity around knowledge creation (Venters, 2002).

Despite these limitations the case study highlighted the need to explore the complex and dynamic nature of sustainability related knowledge in situ and presented findings rooted in realities of practice. Based on these findings this research provides the potential to provide HAs with advice relating to the management of their sustainability knowledge through practical solutions during planned work. For example the planning of meeting between internal or external practitioners focusing on the exchange of implicit knowledge might be beneficial prior activities mainly based on practitioners’ tacit knowledge acquired through practice and discussion with peers such as manufacturer selection or innovative decisions. The practical advices only providing opportunities for practitioners to share and acquire sustainability related knowledge without adding to the workload.

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