DETECTING DEFECTS IN THE UK NEW-BUILD HOUSING SECTOR: A LEARNING PERSPECTIVE

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House builders play a key role in controlling the quality of new homes in the UK. The UK house building sector is, however, currently facing pressures to expand supply as well as conform to tougher low carbon planning and Building Regulation requirements; primarily in the areas of sustainability. There is growing evidence that the pressure the UK house building industry is currently under may be eroding build quality and causing an increase in defects. It is found that the prevailing defect literature is limited to the causes, pathology and statistical analysis of defects (and failures). The literature does not extend to examine how house builders individually and collectively, in practice, collect and learn from defects experience in order to reduce the prevalence of defects in future homes. The theoretical lens for the research is organisational learning. This paper contributes to our understanding of organisational learning in construction through a synthesis of current literature. Further, a suitable organisational learning model is adopted. The paper concludes by reporting the research design of an ongoing collaborative action research project with the National House Building Council (NHBC), focused on developing a better understanding of house builders' localised defects analysis procedures and learning processes.

Keywords: action research, defects, house builders, new homes, organisational learning.

INTRODUCTION

The delivery of high quality homes in the United Kingdom (UK) rests predominantly with the house builder (e.g. Sommerville and McCosh, 2006). The house building sector is under pressure to deliver 240,000 homes per year to meet demand (e.g. Holmans, 2013). It is argued that the one of the principal reasons for the decline in house building in the UK is local councils withdrawing from production from the late 1970s onwards (e.g. KPMG and Shelter, 2014). The withdrawal of local council housing supply has placed further pressure on private house builders to bridge the gap. Private house builders have responded to the need for more homes by rapidly up-scaling supply, with a 23% increase in new housing starts for the year 2013-14 compared to 2012-13 (DCLG, 2014). At the same time as increasing housing supply the UK house building industry is also under a further pressure to meet new requirements, such as the target for all new houses to be 'zero carbon standard' from 2016 (UK Government, 2012). The zero carbon standard agenda has resulted in the introduction of tougher Building Regulations, for example, changes to part L

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'Conservation of Fuel and Power' (DCLG, 2013), which has resulted in house builders incorporating new technologies to achieve compliance (e.g. Lees and Sexton, 2014).

A review of current literature has highlighted that the pressures the UK house building industry is currently under may be having a negative impact on build quality, causing an increase in defects (e.g. Hopkin *et al*., 2014). There is growing evidence that the inclusion of new technologies can adversely impact new-home quality (e.g. Gill *et al*., 2010). Moreover, it has long been advocated that an increase in housing supply can reduce build quality as tightened delivery dates cause supply chains, skills and site management to become over stretched (e.g. Sommerville *et al*., 2004). The strain caused by an increase in supply is evident with the UK house building sector currently reporting materials, skills and workforce shortages (e.g. HBS, 2013). Further evidence of the increase new housing defects is in the Home Builders Federation survey results (HBF, 2015), which show that in 2015, 93% of home owners reported defects within their new-build house, the second year in a row that this figure has increased.

A review of UK new-build housing defect literature has identified that learning from defects experience is a potentially useful approach for house builders to reduce defects in new homes. The extant literature is, however, silent on how house builders actually learn and make improvements based upon past defect experience. This paper presents the theoretical framework used to guide the ongoing collaborative action research project with the National House Building Council (NHBC) which is focused on developing a better understanding of how UK house builders learn from defects.

LITERATURE REVIEW

Research into new-build housing defects in the UK is limited when compared to the wider construction sector (e.g. Love and Li, 2000), non-new-build housing (e.g. Page and Murray, 1996), and international new-build housing (e.g. Macarulla *et al*., 2013). Hopkin *et al*. (2014) provided a review of the UK new-build housing defect literature, identifying that research into new housing defects in the UK can be generally grouped into three aspects: the stage in which the housing project is studied; the level of analysis; and, the findings, and how the findings are used. Building upon this review, this paper will further explore the recommendations being made within the literature.

Recommendations within the UK new-build housing defect literature

A number of recommendations to reduce defects have also been given within the literature, including: training for trades, standardised processes and products, predefined quality criteria, and learning from defects. Each will be discussed in turn.

Training for trades

It is argued that a mandatory training requirement resulting in the granting of a licence to carry out building works would improve the levels of skill and knowledge, and increase the ability for trades to achieve the desired levels of workmanship and ultimately reduce defects (e.g. Baiche *et al*., 2006). For example, gas engineers in the UK are required to be qualified and on a register to legally work on boilers, fires and all other gas appliances (e.g. Gas Safe, 2015). Despite the mandatory qualification and registration requirements for gas engineers, Craig (2007) extracted a number of defects related to gas installations from a leading snagging company’s database, for example, boilers and flues. The defects identified suggest that a licence to carry out building work is unlikely to eradicate defects on its own.

Standardised processes and products

The adoption of standardised processes and products in the building process has been argued as a potential solution to reduce defects. Baiche *et al*. (2006), for example, point out that the adoption of standard details would reduce complexity within the building process and increase familiarity from one site to the next, and ultimately would achieve defect reductions within the current construction environment. Lees and Sexton (2014) have established that house builders currently utilise standardised design and production plans and practices which are repeated from development to development. The combination of standardisation and repetition currently employed within the house building industry and high defect levels suggests that standardised processes and products may not be a viable solution to eradicating defects.

Predefined quality criteria

It has been recommended that house builders should establish a set of quality criteria to deliver to their customers on a consistent basis. Customers should be made aware of these criteria, and as such they can judge the finished product, the home, against that predefined criteria. This approach is argued to reduce the level of subjectivity with regards to defects and ultimately reduce their incidence (e.g. Auchterlounie, 2009). Under the terms of most new home warranties, the house builder is required to build to the warranty provider's requirements. Any deviation from the warranty provider's predefined criteria would constitute a defect (e.g. NHBC, 2012) [Note: NHBC provide a warranty on 80% of UK new homes]. As circa 95% of new homes in the UK will be covered by a warranty (e.g. Sommerville and McCosh, 2006; DCLG, 2014; NHBC, 2013) the majority of new homes are already being constructed to a prescribed set of quality criteria, which the home buyer will be able to access. Despite the *"predefined"* quality criteria in place there are still high numbers of defects in new homes.

Learning from defects

Learning from defects is considered as a means for solving the persistent defect problems in the new-build housing sector nationally and internationally. In the international context, Macarulla *et al*. (2013) for example, argue that if house builders analyse their defect performance they can gain an understanding of the nature of defects occurring and develop strategies to reduce them in Spain. In the UK context, Auchterlounie (2009) states that the UK house building industry should implement a feedback system to enable the builders to assess their current systems and their outputs. Roy *et al*. (2005) emphasise that re-examining and modifying working practices has the potential to reduce quality failures. Baiche *et al*. (2006) conclude the above ideas by arguing continuous review, research and feedback as a means of reducing housing defects in the UK. Davey *et al*. (2006) further advise that sharing good practice and the developments of others has the potential to improve processes to aid defect reduction. A number of government and industrial reports have been published to guide how house builders can improve their new-build housing performance. The 'Home building' report, published by the National Audit Office (NAO, 2007) suggests that by tracking and measuring the performance of different construction techniques and processes year on year, house builders can compare one technique against another in order to make improvements in performance. The NAO (2007) further recommend that a house's quality performance assessment should include analysing the number of warranty claims and number of defects within the property. The 'Management of post-completion repairs' report, published by the NHBC Foundation (2011), advocates an approach of: recording and analysing defect data, feeding the outcomes of the analysis in to the design and construction of a home to amend procedures and ultimately make improvements based upon what has been learnt. Together these ideas suggest that the 'learning perspective' has been recognised as a means of reducing defects in new homes. The extant new-build housing defect literature, however, is silent on how house builders actually learn and make improvements based upon past experience (Hopkin *et al*., 2014).

Organisational Learning (OL)

Organisational learning (OL) has been recognised as a source of company competitive advantage and is a term frequently utilised within the general management literature. Argyris (1977) argues OL to be a process of detecting and correcting error. Fiol and Lyles (1985) develop the concept to go beyond detecting and correcting errors arguing that OL considers organisations to be cognitive units which contain cognitive systems and memories, capable of observing their actions, investigating to discover the effects of alternative actions, and modifying their actions to improve performance. The definition is further expanded by Neilson (1997) who adds a requirement for producing higher level assets by arguing OL to be the continuous process of creating, acquiring, and transferring knowledge accompanied by a modification of behaviour to reflect new knowledge and insight; and produce higher level assets.

The construction literature relating to OL tends to draw upon the general literature as the basis of their OL definitional discussions. For example, Opoku and Fortune (2011) adopt Lopez's *et al*. (2005) definition describing OL as a dynamic process of creation, acquisition and integration of knowledge aimed at the development of resources and capabilities that contribute to organisational performance. The suitability of OL in a construction setting has, however, often been questioned due to the largely project-based nature of the construction industry. Gann and Salter (2000) assert that project-based methods of production in construction create a strong requirement to understand knowledge flows to help facilitate the integration of experiences from an organisation's projects in to its continuous business processes. Winch (1998), however, argues that most construction project problem-solving techniques are adapted using tacit knowledge and applied to a situation to meet specific client needs, and therefore it is difficult for them to be learned, codified and applied to future projects. Furthermore, the way in which many construction firms acquire and make use of knowledge is often poorly developed, resulting in firms gaining experience at an individual level, yet are unable to translate that to an organisational level (Barlow and Jashapara, 1998). Barlow and Jashapara (1998) go on to argue that those involved in construction projects are not afforded sufficient opportunity to feed experience they have gained from previous projects in to future ones. It is suggested that existing feedback systems in place within the construction industry are unstructured and informal, and as a result, ineffective (e.g. Scott and Harris, 1998). In order to provide structured and formal knowledge sharing mechanisms to enable previous experiences of the project co-workers to be exchanged and assist in enabling OL, Knauseder *et al*. (2007) argue that construction companies should look for opportunities to bridge project boundaries and enhance the tacit knowledge base of the workforce (and organisation) to promote learning and organisational memory (OM). OM is defined as *"the means by which knowledge from the past is brought to bear on present activities"* (Stein and Zwass, 1995:89). Huber (1991:107) further stresses the critical role of OM as *"the basic processes that contribute the occurrence, breadth, and depth of organisational learning."* OM may be stored in a range of repositories, both human and artefact (Robbey *et al*., 2000). For example, OM may consist of computer-based OM for storing and retrieval of information by individuals (e.g. Huber, 1991). OM can also be held and updated through codifying modifications within company processes in order to enable the transmission of the new routines (e.g. Berkhout *et al*., 2006). Ozorhon *et al*. (2005) further stress the need for construction firms to develop the necessary skills and systems to ensure that explicit knowledge is formed and committed to OM.

The potential for OL to achieve defect reduction in construction is further evidenced through its application to successfully detect and reduce errors in a number of project-based industries, such as: reducing surgical errors in the health sector (e.g. Vashdi *et al*., 2007) and reducing errors in aircraft maintenance in the aviation industry (e.g. Federal Aviation Administration, 2009).

In the construction literature, a number of OL models have been presented. For example, Chan *et al*. (2005) propose a multi-facet conceptual model of OL to help understand OL challenges at the construction project level. This model is made up of five facets. First, 'contextual facets' are the external factors that management have either indirect control or no control over. Second, 'policy facets' distinguish formal and informal steps taken by senior management to promote OL. Third, 'psychological facets' are the shared beliefs that a team is safe for interpersonal risk taking and the commitment to an organisation. Fourth, 'cultural facets' are the norms that are likely to create valid information and the commitment to take corrective action. Finally, 'structural facets' are the organisations learning mechanisms. This model however has not been empirically tested. Knauseder *et al*. (2007) move away from offering a conceptual model and take a broader approach to demonstrate evidence of different learning approaches based on quantitative empirical data drawn from 51 construction projects. Three learning approaches for enhancing OL are identified. First, 'organising for learning' to enable the exchange of experiences to expand individual knowledge bases. Second, 'experimenting' with new materials and working styles. Finally, 'networking' for sharing experiences between others to bridge boundaries and enhance learning. Berkhout *et al*. (2006) propose that OL can be seen as a cycle that can be modelled from four constructs: (see Figure 1). First, 'signal recognition and interpretation' is where an occurrence is recognised as a novel situation which indicates that existing organisational routines are inappropriate or ineffective. It is argued that organisations are more likely to recognise a signal as a need for change the more frequent, clear and relevant it is to the organisation. Second, 'experimentation and search' is the process of initiating adaptation of organisational routines. Adaptation typically occurs in two forms: trial and error to modify existing actions and observe their impact on a small scale, and searching internal and external sources for relevant experience and knowledge that can be applied to the given situation. Third, 'knowledge articulation and codification' is the process of exposing potential adaption options to an evaluation process in order to select the option most suitable to the organisation. Upon selection of an appropriate option the modified routines are codified in company documentation, processes, software, targets etc. in order to transmit the new routine throughout the organisation. Fourth, 'feedback' from experience will be sought to validate that the proposed alternative routine remains viable, finally returning to the beginning of a new cycle by way of a new stimulus.

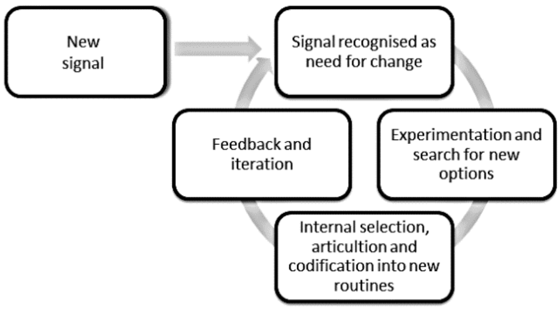

Figure 1: Organisation learning (adopted from Berkhout et al., 2006)

As this project seeks to understand how house builders individually and collectively, in practice, collect and learn from defects experience in order to reduce the prevalence of defects in future homes (see 'research aims and objectives' section) Berkhout's *et al*. (2006) OL model has been identified as the most suitable. The justifications for this model's adoption are as follows. First, the adopted OL model has previously been tested within a construction environment, more specifically, to guide and analyse interviews from a range of functional departments within two housing associations and three house builders. Moreover, the model has been shown to be successful in determining how the housing industry responds to climate change impacts that are recognised as significant, for example to analyse a house builders technical innovation in response to persistent problems. Second, for OL to begin a signal needs to be recognised as a novel situation which indicates a need for change to existing organisational routines (e.g. Berkhout *et al*., 2006). The starting point of this model is to identify a signal as significant. Third, it has been argued that there are a lack of structures, incentives and opportunities for project members to communicate and share knowledge and experience (e.g. Barlow and Jashapara, 1998; Scott and Harris, 1998; Knauseder *et al*., 2007), the second stage of the adopted OL model involves internal and external scanning for relevant experience and knowledge to respond to a novel situation. Finally, the need for the storage of, and access to, OM by construction firms is highlighted (e.g. Ozorhon *et al*., 2005). The adopted model identifies a clear logic for codifying new routines in organisational documentation, and transmitting the new information/knowledge throughout the organisation.

RESEARCH AIM AND OBJECTIVES

The overall aim of this action research project is to better understand how UK house builders' individually and collectively, in practice, collect and learn from defects experience in order to reduce the prevalence of defects in future homes. In order to achieve the stated aim a number of objectives will need to be satisfied:

1. Understand house builders' localised defects analysis procedures, and their current knowledge feedback loops to inform future practice.

2. Establish the impact of individual defects on key stakeholders in the defect detection and remediation process for house building.

3. Design and test action research interventions to develop a new defects assessment tool kit and learning systems to reduce targeted defects.

This paper has identified OL as a theoretical concept which can help on developing a better understanding of how UK house builders learn from defects. The next section presents the research methodology used to address the research aims/objectives.

RESEARCH METHODOLOGY

Research Approach

An action research (AR) approach is considered appropriate for this research as this research aims to empirically investigate how house builders learn from defects experience in general; and, more specially, to induce change (new defect assessment tools and learning systems) in a social setting (a house builder) in order to reduce targeted defects. AR is understood to be an approach which *"simultaneously assists in practical problem solving and expands scientific knowledge, as well as enhances the competencies of the respective actors, being performed collaboratively in an immediate situation using data feedback in a cyclical process aiming at an increased understanding of a given social situation, primarily applicable for the understanding of change processes in social systems and undertaken within a mutually acceptable ethical framework"* (Hult and Lennung, 1980:247). A cyclical process view of AR is resonated by Susman and Evered (1978) in the general literature and by Lu and Sexton (2009) in the construction literature who further differentiate the five-phase process of: problem/opportunity diagnosis, action planning, action taking, evaluating and specifying learning. First, the 'problem diagnosis' phase involves identifying an improvement opportunity. Second, the 'action planning' phase specifies the organisational actions to advance the intervention. Third, the 'action taking' phase is the implementation of the action plan. Fourth, the action evaluation phase is an activity to determine whether the applied interventions have been successful, in comparison to the criteria set out in the action planning stage. The final phase, 'specifying learning' is to reflect on the gained knowledge from the action research.

Research Design

This section presents the overall design for the research (Figure 2).

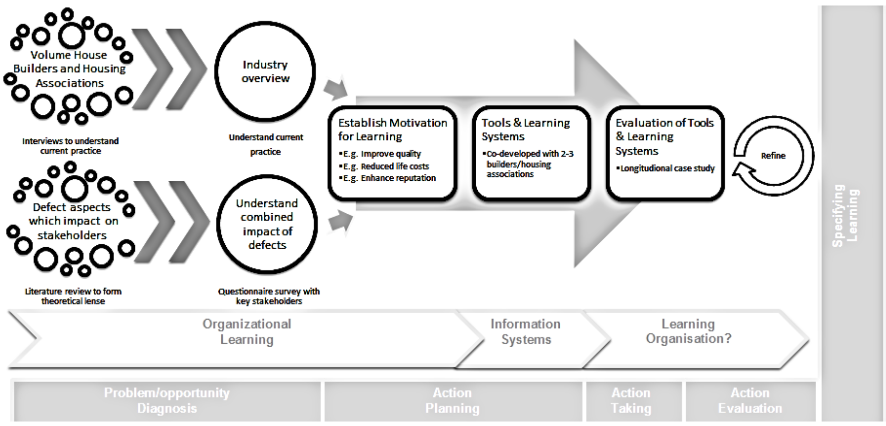

Figure 2: Overall research design

This research project is currently in the diagnosis phase of the AR cycle. There are two tasks being carried out in the diagnosis phase. The first task is to 'understand house builders' localised defects analysis procedures, and their current knowledge feedback loops to inform future practice' (objective 1). Data collection for task one will involve semi-structured interviews with senior management and customer care departments of five volume house builders and housing associations, in order to understand their current processes and therefore identify the problem/improvement opportunity. The house builders and housing associations are targeted on an output basis (volume of properties built). Customer care departments have been selected due to their involvement in the post-completion defect remediation process while senior management for their anticipated level of influence within the organisation. The second task is to 'better understand the impact of defects on key stakeholders within the new house building defect detection and remediation process' (objective 2). Data collection for task two was through an electronic questionnaire survey targeted at the four key stakeholders in the house building detection and remediation process: home occupant, house builder, warranty provider and building inspector. The aim of the survey was to establish what impacts of defects are the most important to the four stakeholder groups by asking the respondents to prioritise a number of pre-determined impact factors on a scale of 1 (Not a priority) to 5 (Essential). The survey was distributed via a web link with a covering email which set out the purpose of the survey and research ethics safeguards. The survey was distributed to 2003 people drawn from the NHBC's database, including 817 home occupants who have had a defect rectified under their NHBC warranty during the financial year 2013-14; 161 members of the same warranty provider's staff; 209 building inspectors from the UK's largest approved independent building inspection service, and 816 active house builders on the NHBC's register. The duration of the survey was one month with three follow-up email reminders. The overall response rate was 15% with a total of 292 responses (18% of home occupants; 6% of house builders, 34% of warranty provider; and 21% of building inspectors). The interview and survey phases contribute towards to the first two research objectives. In addition, the two phases will inform objective three 'Design and test action research interventions to develop new defect assessment tools and learning systems to reduce targeted defects.'

DISCUSSION AND CONCLUSION

What has become clear from a further review of the UK new-build housing defect literature is that a number of commentators have made consistent recommendations to reduce defect prevalence. The recommendations, in particular, for the training of trades, standardised processes and products, and predefined quality criteria are an on-going priority for the UK house building industry, yet the persistent problem of defects remains. It was found that the one remaining recommendation 'learning from defects', in this case, the process of how house builders currently learn from defects, remains under-researched. Learning at an organisational level (i.e. organisational learning) is often argued as a means of enabling organisations to produce higher level assets and gain competitive advantage. The translation of OL principles have, however, not been fully achieved in the new-build housing sector. The potentiality of OL to provide a framework for house builders to learn from and reduce defects is under-developed area. The review of literature relating to the suitability of OL in a construction setting has identified a suitable model for the theoretical basis of the upcoming interview process of the ongoing collaborative action research project with the NHBC to better understand house builders' defects analysis procedures and learning processes to reduce defects.

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