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Detecting defects in the UK new-build housing sector: a learning perspective

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Rapid growth in the production of new homes in the UK is putting build quality under pressure as evidenced by an increase in the number of defects. Housing associations (HAs) contribute approximately 20% of the UK's new housing supply. HAs are currently experiencing central government funding cuts and rental revenue reductions. As part of HAs' quest to ramp up supply despite tight budget conditions, they are reviewing how they learn from defects. Learning from defects is argued as a means of reducing the persistent defect problem within the UK housebuilding industry, yet how HAs learn from defects is under-researched. The aim of this research is to better understand how HAs, in practice, learn from past defects to reduce the prevalence of defects in future new homes. The theoretical lens for this research is organizational learning. The results drawn from 12 HA case studies indicate that effective organizational learning has the potential to reduce defects within the housing sector. The results further identify that HAs are restricting their learning to focus primarily on reducing defects through product and system adaptations. Focusing on product and system adaptations alone suppresses HAs' abilities to reduce defects in the future.

Keywords: Defects; housebuilding; housebuilders; housing associations; organizational learning.

Introduction

The UK housebuilding sector is under pressure to deliver upwards of 200 000 new homes per year to meet demand (Holmans, 2013). One of the principal reasons for the decline in housebuilding in the UK is local councils withdrawing from production from the late 1970s onwards, which has placed further pressure on private housebuilders and housing associations (HAs) to bridge the supply gap (KPMG and Shelter, 2014). Private housebuilders, for example, have responded to the need for more homes by a rapid upscaling of supply, with a 23% increase in new housing starts for the year 2013–14 compared to 2012–13 (Department for Communities and Local Government, 2015). The accelerated upscaling of supply has caused strain in the UK housebuilding sector in the form of acute materials, skills and workforce shortages following the 2008 economic downturn (UK Commission for Employment and Skills, 2012; Home Building Skills, 2013). Further evidence of strain is the increase in new housing defects. The Home Builders Federation survey results (Home Builders Federation, 2015a), for example, show that in 2015, 93% of home owners reported defects within their new-build house, the highest this figure has been in the last five years.

HAs contributed circa 20% of the UK's supply of new housing in 2014 (Department for Communities and Local Government, 2015). In recent years HAs have experienced a decline in funding from the UK government (KPMG and Shelter, 2014), and from

April 2016 have to reduce social housing rents by 1% each year for the next four years (Her Majesty's Treasury, 2015). It is anticipated by the HAs that these funding and rental income reductions will further constrain their ability to meet the ambition shared by themselves and the UK government to increase housing supply (National Housing Federation, 2015).

HAs, in response to the dual considerations of the funding squeeze and the increase in the number of defects in new homes, are seeking to improve the way they learn from defect data to reduce defects in the future. The reduction of defects through better learning processes is a common, normative prescription in the UK new-build housing defects literature. The extant literature is, however, silent on how HAs *actually* learn and make improvements based upon past defect data. The aim of this explorative research is to better understand how UK HAs, in practice, learn from past defects in an effort to reduce the prevalence of defects in future new homes.

Case study results are reported which provide empirical support for the potential value of effective organizational learning (OL) systems within HAs to reduce defects within new-build houses. The results reveal that HAs tend to adopt an integrated approach of targeting the reduction of the prevalent defects (as identified from structured defect data collection and analysis systems) through appropriate design and construction process improvements. The source of build quality improvement tends to be internal to the HAs. There is evidence of explicit resistance to absorb relevant experience and knowledge from outside the organization to apply to build quality improvement initiatives.

The structure of this paper is organized as follows. First, the salient key features of the UK new-build housing association sector are set out. Second, the UK new-build housing defect literature is reviewed, which leads to the identification of the importance of learning from defects. Third, organizational learning theory and the adopted conceptual model are discussed. Fourth, the adopted research methodology is outlined. Fifth, the empirical data is presented. Finally, a discussion is given and conclusions are drawn.

Key features of the UK new-build housing association sector

Housebuilding in the UK accounts for 30% of the UK's construction output by cost (Home Builders Federation, 2015b). Despite this fiscal contribution there is a considerable shortfall in the number of dwellings available in the UK and it is claimed that an additional 200 000 plus new homes a year will be required to meet demand and needs (Holmans, 2013). Over the past decade, on average, approximately 160 000 new homes have been completed per year with private housebuilders and HAs contributing 70% and 20% of this volume respectively (Department for Communities and Local Government, 2015). One of the fundamental reasons for the housing shortage is the reduction of houses being built by local authorities, with HAs now supplying the majority of the UK's affordable housing (KPMG and Shelter, 2014). HAs are not for-profit organizations that can use any profit they make to maintain existing homes and help finance new ones and are typically financially regulated and funded by the government (National Audit Office, 2005). HAs have experienced a reduction in funding from the UK government in recent years (KPMG and Shelter, 2014), and as of April 2016 they will have to reduce social housing rents by 1% each year for the subsequent four years (Her Majesty's Treasury, 2015). The reduction in central government funding has in some cases made HAs cautious in planning new developments (KPMG and Shelter, 2014) and has resulted in a number of HAs reviewing their processes to maximize profit as they prepare to build with limited or no grants (Chevin, 2013).

Learning from new-build housing defects: a review of the literature

Our understanding of a defect is 'the breach of any mandatory National House Building Council (NHBC) Requirement by the Builder or anyone employed by or acting for the Builder' (National House Building Council, 2012, p. 3). The NHBC's definition has been adopted because upwards of 80% of new homes in the UK need to be built in accordance with NHBC standards to receive warranty cover (National House Building Council, 2015). The NHBC is the UK's leading standard-setting body and provider of warranties for new homes. The NHBC warranty typically offers 10 years of post-completion cover (in addition to certain cover before completion) and is split into two sections: cover during the first two years (builder's liability period) and cover during years 3–10 (National House Building Council, 2012). Under the terms of the warranty the housebuilder is responsible for rectifying any breach of the requirements within the builder's liability period and any breach that may result in a warranty claim in years 3–10 will ultimately affect the builder's premium rating (renewal fee) (National House Building Council, 2011).

Learning from defects to reduce the occurrence of recurring defect problems in the new-build housing sector is commonly advocated as a normative prescription, both nationally and internationally. In the international context, Macarulla *et al*. (2013), for example, argue that if housebuilders in Spain analyse their defect performance they can gain an understanding of the nature of defects occurring and develop strategies to reduce them. In the UK context, Auchterlounie (2009) states that the UK housebuilding industry should implement a feedback system to enable the builders to assess their current systems and their outputs. Roy *et al*. (2005) emphasize that the process of housebuilders re-examining and modifying their working practices has the potential to reduce quality failures. Baiche *et al*. (2006) synthesize a number of learning prescriptions in their argument that continuous review, research and feedback are means of reducing housing defects in the UK. Davey *et al*. (2006) further advise that the development and sharing of good practice have the potential to reduce defects.

A similar learning prescription can be found in a number of government and industrial reports which have been published to guide how housebuilders can improve their new-build housing performance. The 'Homebuilding' report, published by the National Audit Office (2007), for instance, suggests that by tracking and measuring the performance of different construction techniques and processes year-on-year, housebuilders can compare one technique against another in order to make improvements in performance. The National Audit Office (2007) further recommends that houses' quality performance assessment should include analysing the number of warranty claims and number of defects within properties. Industry bodies offer similar guidance. The 'Management of Post-Completion Repairs' report, for example, published by the National House Building Council Foundation (2011), advocates an approach of recording and analysing defect data, and feeding the outcomes of the analysis into the improvement of the design and construction of future homes.

Government and industry guidance share a common position that the 'learning perspective' is an important approach to the reduction of defects in new homes. The prevailing literature, however, provides very little empirical insight into how housebuilders learn from defects in practice.

Organizational learning

Argyris (1977) argues organizational learning (OL) to be a process of detecting and correcting errors. Fiol and Lyles (1985) develop the OL concept to go beyond detecting and correcting errors with the argument that organizations are cognitive units that are capable of observing their actions, investigating the effects of alternative actions, and modifying their actions to improve performance. Neilson (1997) extends the concept further to add a knowledge dimension to articulate OL to be the continuous process of creating, acquiring, and transferring knowledge accompanied by a modification of behaviour to reflect new knowledge and insights.

Research into OL in construction tends to directly draw upon the general literature. Opoku and Fortune (2011), for example, adopt Lopez *et al*.'s (2005) definition to describe OL as a dynamic process of creation, acquisition and integration of knowledge aimed at the development of resources and capabilities that contribute to organizational performance. The suitability of OL in construction settings has, however, been questioned by commentators on the basis of the project-based nature of the construction industry. Barlow and Jashapara (1998) argue that those involved in construction projects do not have sufficient opportunity to feed experience they have gained from previous projects into future ones. Scott and Harris (1998) go on to explain that feedback systems in the construction industry are unstructured and informal and, as a result, ineffective. The project-based characteristics of the construction sector have led to research that has found that different types of construction projects tend to develop different learning approaches that recognize local conditions and idiosyncratic challenges (Knauseder *et al*., 2007). Housebuilding is a specific type of construction activity which is quite distinct from other forms of construction in terms of the types of market, the resource inputs, and the organization of the process (Gann, 1996). Egan (1998) argues that housebuilding is essentially a set of repeat products and processes which can be continually improved but, more importantly, the process of construction is itself repeated from project to project.

Berkhout *et al*.'s (2006) OL process resonates with the housebuilding industry's process-oriented characteristics. The OL process is a cycle that consists of four main constructs (see Figure 1). First, 'signal recognition and interpretation' is where an occurrence is recognized as a novel situation which indicates that existing organizational routines (Nelson and Winter, 1982) are inappropriate or ineffective. Second, 'experimentation and search' is the process of initiating adaptation of organizational 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 adaptation options to an evaluation process in order to select the option most suitable to the organization. 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 organization.

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Finally, '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.

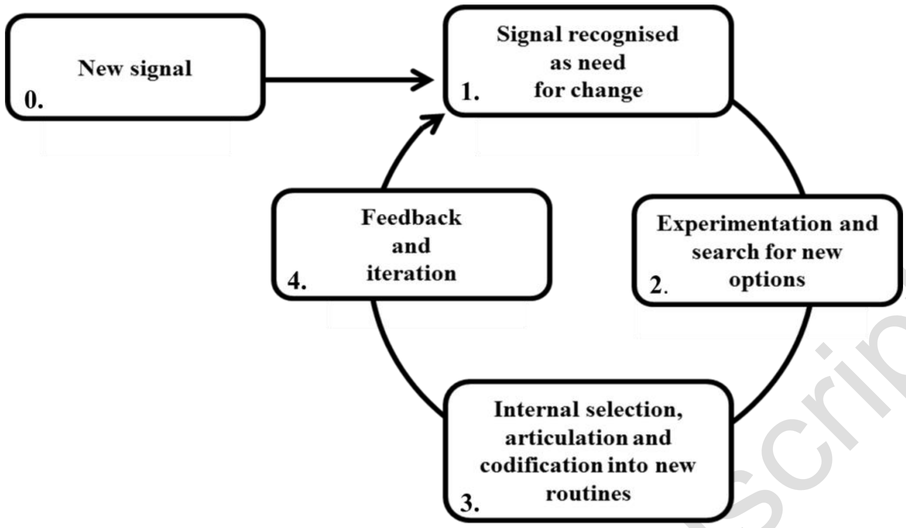

Figure 1: *Organisation learning model in housebuilding (adopted from Berkhout et al., 2006)*

Research methodology

The case study approach is considered appropriate for this research, which aims to empirically investigate how HAs, in practice, learn from past defects to reduce the prevalence of defects in future new homes. A case study offers a fruitful method for detailed investigation and research of a specific real-life setting (in this case, HAs learning from defects) which enables the researcher to offer underlying explanations from the case (Widdowson, 2011). The case study results cannot be generalized with complete confidence beyond the case study firms. This research adopts the position set out by Yin (2009) in that the results are generalized to theory (which is analogous to the way in which scientists generalize from experiments to theory) rather than to the whole population of HAs.

Twelve HA case studies were self-selected by the participants themselves. HAs tend to either rent their homes out at affordable rates or sell them through low-cost home ownership schemes (Fuller *et al*., 2010). Table 1 below outlines the profile of the HAs and interviewees. The smallest two HAs develop up to 500 new homes per year, four HAs between 500 and 1000, two HAs between 1000 and 1500, three HAs between 1500 and 2000, and the largest HA develops between 2000 and 3000 homes per year. The HA sample set provides geographical coverage for the whole of England with eight HAs developing homes in the south of England, four in the midlands, one in the north of England, three in London, and one HA develops homes nationwide.

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Table 1: Profile of HAs and interviewees

No.	Description	Participant(s) role(s)
HA 01	Developer of between five hundred and one thousand new affordable homes per year in the London area	New Homes Manager
HA 02	Developer of between five hundred and one thousand new affordable homes per year in the south of England	Administrator Head Clerk of Works Quality Manager Asset Manager
HA 03	Developer of between fifteen hundred and two thousand new affordable homes per year in the south of England and midlands	Quality Manager
HA 04	Developer of between five hundred and one thousand new affordable homes per year in the south of England and midlands	Customer Care Manager Development Director
HA 05	Developer of between five hundred and one thousand new affordable homes per year in the London area	Customer Care Manager
HA 06	Developer of between two and three thousand new affordable homes per year in the south and north of England	Head of Quality
HA 07	Developer of between zero and five hundred new affordable homes per year in the London area	Head of Strategy
HA 08	Developer of between one thousand and fifteen hundred new affordable homes per year in the south of England	Development Manager
HA 09	Developer of between one thousand and fifteen hundred new affordable homes per year in the south of England and midlands	Customer Care Manager
HA 10	Developer between fifteen hundred and two thousand new affordable homes per year in the south east of England and midlands	Head of Quality
HA 11	Developer of between zero and five hundred new affordable homes per year in London and the south east of England	Head of Quality New Homes Manager Development Director
HA 12	Developer of between fifteen hundred and two thousand new homes per year nationwide	Asset Manager Customer Care Manager

Data was collected through semi-structured interviews with 19 interviewees, including senior management and teams responsible for undertaking the defects management process in order to understand their current processes. The interviewees were selected for their expert knowledge of and involvement in the defects management process, and their involvement in introducing change within their respective organizations. The interviews were arranged via an e-mail which set out the premise of the interviews along with research ethics safeguards. The interviews lasted around one hour and took place between June and September 2015. Table 2 outlines the OL constructs based on Berkhout *et al*. (2006), and the interview questions asked to gain insight into the HAs defect management and learning processes.

Table 2: Summary of interview schedule

OL Constructs	Interview questions
0. New signal	Can you provide me with an overview of your defects management process? Do you record post-completion defect data? At what level of detail is the data captured? Do you use any categories to classify defects? If so, what categories are chosen?
1. Signal recognized as need for change	Do you analyse defect data? If so, what do you analyse? How frequently is the analysis undertaken? Why do you analyse defect data? How do you decide that the findings present a need for a change?
2. Experimentation and search for new options	If a change is needed, how do you identify adaptation options?
3. Internal selection, articulation and codification into new routines	How are adaptation options decided and selected, and by who? Once selected, how are the new processes communicated around the organisation?
4. Feedback and iteration	When implemented, how do you monitor the new processes to make sure they are viable and remain viable?

During the interviews field notes were taken, as consent for audio recording was not given by the participants. Upon completion of the interviews the field notes were typed up and sent back to the participants for them to verify and update as necessary. In addition to the interviews, further data was obtained through the analysis of relevant organizational documents, e.g. defects management procedures and defect records. The data was thematically analysed. Thematic analysis is a method of identifying, analysing and reporting themes within datasets which are largely qualitative in nature (Braun and Clarke, 2006). The themes identified to analyse the data were positioned around the OL constructs and the questions related to those. For example, for the 'new signal' construct the question of 'at what level of detail is the data captured?' identified a number of recurrent themes including: 'address' (the address of the property experiencing the defect), 'completion date' (the date that the property was completed), 'scheme ID' (the identification number for the scheme in which the property is), and 'contractor' (the name of the contractor responsible for the build). The results and identified themes are presented in the next section.

Results

This section presents the research results, structured around the constructs of the adopted organizational learning (OL) model: new signal; signal recognized as need for change; experimentation and search for new options; internal selection, articulation and codification into new routines; and feedback and iteration.

New signal

The key findings indicate that all 12 of the HAs recorded defect data, typically through a central team which deals with the defects management process. However, the defect data was captured in a variety of systems, with varying detail, extent, and classification. In regard to systems used, three HAs recorded post-completion defect data in a standard spreadsheet, whereas the remaining nine HAs used bespoke defects management information systems to both capture data and manage the repair process. A defects management information system allowed a HA to look up property records for their existing build stock. After identifying the property, the HA could: create a new defect record, input customer details (e.g. name, telephone number); arrange an investigation (if deemed necessary); assign a repair to a contractor; and document and track progress along the way. The volumes of defect data captured within the respective systems per year ranged from a low of 85 records held in HA02's spreadsheet to 585 records contained in HA07's bespoke system.

In respect of detail and extent of data captured, all 12 HAs captured seven core fields of information: (1) the property address, (2) the property completion date, (3) the associated scheme ID, (4) the name of the contractor responsible for the build, (5) the details of the customer reporting the defect, (6) the date the defect was reported/logged, and (7) a free-text field for a description of the defect and any damage reported. Outside these seven core fields the data captured differed significantly between the HAs; for example, two HAs recorded construction type, two HAs recorded the warranty provider's policy number for the property, one HA recorded estimated cost savings (typically when a warranty claim had been successfully made) and three HAs kept a record of the status of a repair (e.g. closed, ongoing). Further, divergent levels of data accuracy between respective HAs were evident. HA11 suggested that inaccurate defect data was hampering their learning capabilities when they explained that 'we are hoping to reduce inaccurate defect recording which will provide a more in-depth understanding of what needs to be changed or improved on our future projects'. One instance of potential poor data accuracy was in HA10, who place significant emphasis on redirecting defects straight to the main contractor to rectify and record their data based upon home occupants' reported descriptions of the defects. HA10 is in stark contrast to HA02 who has a Clerk of Works who investigates all defects and then adds notes in their system to outline the cause established from those detailed investigation findings. HA02's defect log contained significantly fewer defects compared to the other HAs and they were one of the HAs who could outline specific instances of how they had achieved defect reduction through OL.

In terms of defect classification, 10 of the 12 HAs used categories to classify defects while the remaining two HAs did not attempt to categorize defects (instead, relied upon the free-text descriptions for capturing defect data). When classifying defects, the categories used in rank order were: 'building area' (the area of the building in which they had occurred, e.g. doors and windows, electrics, heating) (seven HAs), 'trade' (the trade responsible for their occurrence, e.g. plumber, joiner, electrician) (five HAs), 'repair priority' (the priority of the repair, e.g. emergency, urgent, or routine) (three HAs), 'damage' (the damage caused as a result of the defect's occurrence) (one HA), and 'extent' (the level in which the defect was affecting the property, e.g. whole house) (one HA). Further, the defect classification adopted by the

10 HAs varies, from the use of the 'trade' category only (two HAs) to the use of four categories (building area, trade, repair priority and extent) (one HA).

Signal recognized as need for change

The HAs relied upon analysing defect data as the catalyst for their learning processes. The need to analyse defect data in order to identify the need for change was evident in 11 of the 12 HAs. HA02, for example, confirmed that analysing defect data enabled them to '… identify areas of strength or weakness and potential areas that require change …'. In contrast, the only HA who did not undertake any analysis reported that they could not identify trends and improvement opportunities to reduce defects.

Where HAs undertook defect data analysis, the 'frequency' and 'areas' analysed varied considerably. In terms of frequency of analysis, 10 HAs analysed defect data based on one particular frequency: a 'monthly' basis was used by six HAs, a 'weekly' basis by two HAs, an 'ad hoc' basis by one HA, and one HA analysed on a 'quarterly' basis. Only one HA undertook the analysis on both an 'ad hoc' and 'quarterly' basis.

In respect of what HAs analyse, there were two consistent features: the frequency of defects within the organization's build stock (10 of the 11 HAs), and the number of defects within the organization's build stock sorting by type/category (eight HAs). Other common aspects analysed were: the number of defects occurring sorting by the key actor responsible for the build: typically the contractor (seven HAs), the number of defects per unit built over a given time period (six HAs), the total repair cost for the analysed time period (four HAs); and whether the repair had achieved its target completion date (four HAs). In contrast to the common analysis approaches one HA analysed the type/category of defects occurring separating by the key actor responsible for the build (typically the contractor), two HAs analysed the customers' levels of satisfaction with the repair and service, HA12 analysed the cost of defects occurring by type/category of defects; and HA08 analysed the number of defects sorting by geographical regions.

Experimentation and search for new options

The identification of new adaptation options was found mainly through 'invitation' to relevant internal and external people, followed by the review of data relating to projects performing well, review of customer feedback, and piloting alternatives to gauge viability on a small scale. First, it was found that all of the HAs who analysed defects data exploited the knowledge and experience of co-workers by openly inviting proposals to solve a given problem through internal communication, such as formal meetings and discussions. HA04, for example, described how alternative options were generated '… via [formal] meetings and discussions with our finance, maintenance and development teams …'. Further, external discussion was advocated by five HAs, with HA12 promoting '…discussions with manufacturers and contractors involved …'. Second, three HAs were in favour of reviewing products, systems and personnel in schemes that are performing well when compared to their peers. HA06 encouraged '… looking at the past performance of the alternative products/systems …' as a means of determining the long-term viability of alternative options. Third, in addition to discussions with those actors involved in the construction process, HA11 considered feedback from residents via satisfaction surveys when identifying changes. Finally, HA11 piloted potential changes on a small scale prior to mass introduction and suggested that ‘when something new is reported as an improvement it is rolled out on other projects and incorporated in updated future standards’.

Internal selection, articulation and codification into new routines

It was found that selecting and approving an adaptation option was made through review panels at an organizational level and informal communication at an individual/unit level. First, review panels were conducted by seven HAs to consider change proposals and determine whether the proposed changes were in alignment with the organizational strategy. A review panel was typically the leadership group which consisted of senior management from the organization. Second, the remaining four HAs were reliant on the department who could make the change. This was captured by HA12 who stated that ‘… the construction department has the final say in whether a change [to specification] is made …’.

Once a change has been selected, changes were captured and codified into new routines by 11 HAs, primarily through updating their ‘employers’ requirements’ (specification to be used for all builds). Five of the 11 HAs further updated their ‘design guides’ in light of accepted changes. Nine of the HAs had strategies in place to communicate the implemented changes to key stakeholders including e-mails to key internal stakeholders, posting updates on a staff intranet, feedback to contractors, feedback to manufacturers, internal meetings, updating of a lessons log, and providing internal training groups for stakeholders directly affected by a change.

In four out of the 11 HAs where new lessons that had been identified did not result in ‘adaptation’ to formal routines (i.e. updates to the HAs ‘employers’ requirements’ or ‘design guides’), the HAs would share these new lessons with colleagues by ‘networking’. HA10 remarked that ‘… defects are typically [in their experience] related to workmanship rather than design …’. With the workmanship concerns in mind four HAs had internal informal discussions (networking) with site teams to raise awareness of problem areas of construction. This was evident in HA02 where the Head Clerk of Works (who was largely office based and focused on defects post-completion) arranged regular team meetings with his clerk of works (who were typically site based inspecting new-builds) which required them to provide examples of typical defects they felt they were seeing frequently on site for discussion. The Head Clerk of Works would also provide an overview of particular problems identified through their defects log. Through these discussions the clerk of works were further aware of potential problem areas on site. In addition to networking with site teams to share experience and knowledge, HAs also advocated ‘networking’ with departments responsible for procurement and development. This was clear from HA03 who undertook quality improvement discussions with senior management in a bid to guide future decision-making; and two further HAs who discussed contractors’ long-term performance and general problems with their development department to influence their future awarding of contracts.

Feedback and iteration

The feedback on the implemented changes was monitored through three mechanisms: anecdotal feedback, ongoing performance monitoring, and review panels. Two HAs relied solely upon feedback from anecdotal channels to gauge the success of a change. Two HAs conducted review panels to formally review progress since the implementation of a change. Two HAs trusted the continuous review of data and ongoing monitoring to determine the success of a change. The remaining five HAs exercised a combination of the approaches. For example, HA02 advocated an approach of using anecdotal feedback to evaluate the early feeling around the implemented change. HA02 would then take an approach of continuously monitoring and reviewing performance to observe progress (as well as identify new signals).

Example of learning from defects in a housing association environment

In order to further understand how HAs learnt from defects, where possible, participants were asked to describe a specific event of defect reduction. The process was mapped on to the OL framework. Figure 2 below shows the learning process in HA12 to reduce shower tray failures.

0. New signal. New signals were entering the organization through the HA's customer care department via reports of shower tray failures.

1. Signal recognized as need for change. A member of the customer care team along with the Customer Care Manager analysed data for trends and found a comparatively large number of shower tray failures. Due to the high volume of shower tray failures, the Customer Care Manager brought this to the Asset Manager's attention and they believed this may be something that warrants change. More detailed analysis was undertaken by the Customer Care Manager. The analysis showed that the failures typically related to one manufacturer's shower tray.

2. Experimentation and search for new options. The Customer Care Manager had discussions with the manufacturer over the product performance and came to an agreement with the manufacturer that the manufacturer would provide a higher specification shower tray for the same price as the original.

3. Internal selection, articulation and codification into new routines. The Customer Care Manager and Asset Manager then proposed this to the senior manager within the construction department, who approved the change (as it was at no extra cost) and codified the change into organizational routines by way of updating the HA's 'employers' requirements' (specification to be used on all builds) documents.

4. Feedback and iteration. After the new specification was implemented for some time, long-term analysis/continuous performance review (undertaken by the Customer Care Manager), identified that the alternative shower tray had reduced the number of shower tray failures (comparatively) since its introduction.

HA12 replaced their entire stock of a product (shower trays) across the whole organization without initially piloting the change to test its effectiveness.

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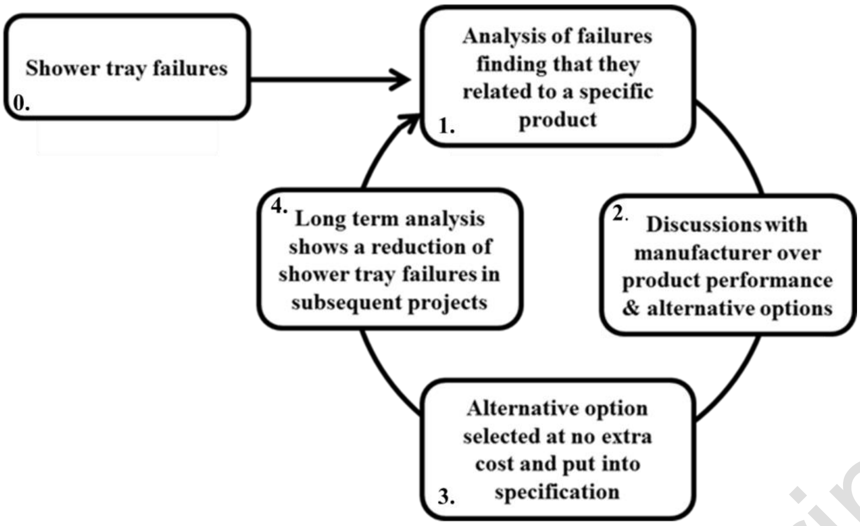

Figure 2: *OL to reduce shower tray failures in HA12*

Discussion and conclusions

Learning from defects is a frequent normative recommendation to reduce defects within the government, industry and academic literatures. There is, however, very little empirical data on how housing associations (HAs) actually learn from defects in practice. This explorative research contributes to our understanding by case study results of how HAs collect and learn from defects. Organizational learning (OL) was the theoretical lens to understand HAs' localized defects analysis procedures, and their current knowledge feedback loops to inform future practice. This section discusses the empirical contributions, theoretical contributions, and implications for policymakers and practitioners.

Empirical contributions

The findings provide four empirical contributions. First, HAs record and analyse significant volumes of defect related data within a centralized unit, captured through a combination of different actors and systems. The data recording and analysis provide the platform for the subsequent stages of the learning process. The recording and continuous review of data act as both a process of identifying new signals and a feedback mechanism for implemented changes. Without this continuous review, HAs would be limited to unstructured feedback and signals received through anecdotal channels alone. One logic within some HAs is of redirecting defects straight to the contractor responsible (for the repair) without seeking to understand or record the true nature and cause of the defects at any point. The redirecting logic raises empirical questions regarding the defect data accuracy because there is potential for a number of defects to exhibit themselves in the same way, and without understanding the true cause and keeping accurate records then the HA may be (unknowingly) focusing on an unproblematic aspect.

Second, a harmonized logic of reducing defects with a primary focus on product and system focused improvements and broad changes throughout the organization is identified. The broad organizational changes to integrate product and system modifications are evident in the majority of the HAs who consistently codified and introduced changes into new organizational routines through updates to their ‘employers’ requirements’ (the specification to be used on all builds). The product and system improvement focus further manifests itself with five HAs updating their ‘design guides’. Prior to the introduction of broad organizational changes there was little evidence of experimentation of changes on a small scale.

Third, the importance of sourcing and sharing knowledge is emphasized. It was found that HAs typically relied on sourcing knowledge from internal staff when searching for new adaptation options, and in some cases networking to generally share knowledge. Networking tends to be a secondary informal task which does not result in a ‘routine’ change, with HAs continuing to work within standard procedures and guidelines. However the networking is believed to result in the modification of an individual’s working practices in light of new knowledge. Further, there is an indication that HAs were reluctant to invite knowledge from outside the organization. Only five of the HAs sought to invite solutions from external sources compared to all inviting solutions from internal sources.

Finally, the significance of a review panel for linking individual learning and organization learning is emphasized. The need for review panels to translate the identification of a problem situation to a change in organizational routine is identified. Where no review panel (to impartially assess a change’s suitability and concordance with existing organizational objectives and strategies) is in place, reliance falls upon one individual for selecting changes. As such, learning processes took place at different rates dependent on the individuals and their communication network.

Contribution to organizational learning theory

A number of the empirical contributions provide associated theoretical contributions. The contribution that HAs consistently capture, record and analyse defect related data to recognize signals which indicate a need for a change to current practice corroborates Berkhout *et al*.’s (2006) assertion that novel situations are usually identified through continuous monitoring of signals. The structured approach to defect data capture and analysis as a feedback mechanismis in contrast to Barlow and Jashapara’s (1998) and Scott and Harris’s (1998) suggestions that feedback systems in place within the construction industry are unstructured and informal, and as a result, ineffective. One reason for the contrast to Barlow and Jashapara (1998) and Scott and Harris (1998) is the unique nature of the housebuilding industry when compared to the wider construction sector. For example, HAs typically have a centralized team within the organization that are responsible for the defects management process and provide the link between project-level and organizational-level activities. The contribution, however, further identifies thatHAs use continuous monitoring of signals to establish the success of previously implemented changes. The contribution that HAs primarily look to reduce defects via the introduction of broad product and system changes (with limited experimentation on a small scale) further emphasizes that learning in housebuilding is characterized by its focus on, and introduction of new policies, processes and routines (e.g. Berkhout *et al*., 2006;Knauseder *et al*., 2007).The contribution that HAs have a primary focus also supports Knauseder *et al*.’s (2007) argument that housing organizations mainly apply one learning approach. The contribution that HAs openly invite proposals for adaptation options from internal staff contradicts the perception of workers within HAs that they are unlikely to have an influence on decisions within their organizations because managers are less encouraging and open to ideas for change from the workforce as presented in Knauseder *et al*. (2007). Furthermore, HAs tended to advocate an approach of changes being reviewed by an impartial review panel, to overcome problems of individual bias.

Whilst the OL model adopted offered explanatory power in understanding how HAs created, acquired, and transferred knowledge, how they modified their behaviour to reflect that new knowledge, and how they produced higher level assets as a result, the empirical findings indicate a modification to the existing model towards one specific for learning from defects. Figure 3 below represents the adapted learning from defects model for HAs which classifies a five stage OL cycle. The learning process for a HA starts with defect data recording; because of this the incoming signals concept within the existing model has been adapted to explicitly outline the need to capture defect data, thus promoting the recording of all new signals (defects) entering the organization. Following on from incoming signals, defect data analysis is found to be the primary enabler to recognizing a need for a change to organizational routines and the catalyst to that subsequent change taking place within HAs. The signal recognized as need for a change construct within the model has been modified to ensure that the direct link between structured periodic analysis and the capability that analysis generates to identify problem areas and key signals of a need for change is recognized. After the periodic analysis process two potential streams of action resulting from the identified need for change were identified. These two streams are in the form of procedural changes (codification) (the primary approach to reducing defects), or knowledge sharing (personalization) (the secondary approach). Since broad changes throughout the organization via updates to 'employers' requirements' is the advocated approach to learning from defects within the HA environment, the model has been updated to acknowledge this. The model has also been further updated to recognize that there was very little evidence of experimentation of changes on a small scale within HAs. Furthermore, the model has been modified to accommodate the recognized process of sharing knowledge and experience in order to improve the tacit knowledge base of the workforce along with the modification of individual behaviour this may cause. Finally, the model has been updated to acknowledge the concurrent processes of 'feedback' and 'continuous review of performance/data analysis' to both determine the success of a change and identify new improvement opportunities. Although these five stages of OL from defects are listed in progressive order, learning is perceived as a cyclical, dynamic process.

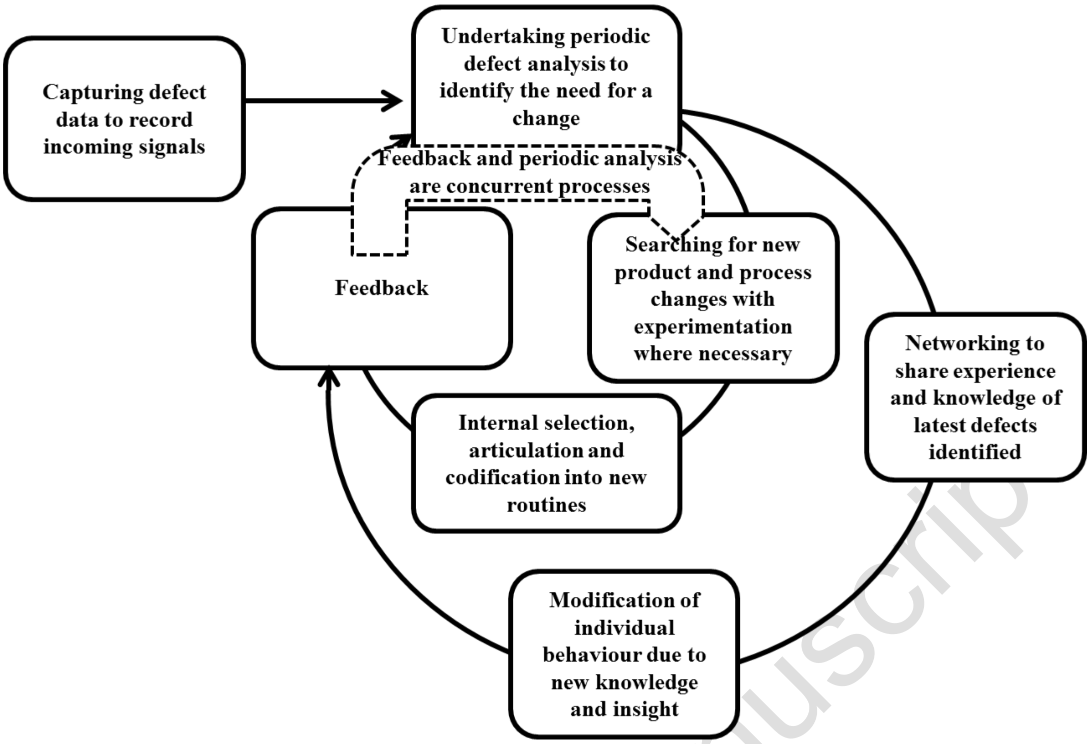

Figure 3: *Organisational learning from defects model for HAs*

Implications for policy and practice

The UK HAs appear to be restricting themselves to the short-term solution of primarily attempting to “design out defects” through organisational wide product and system based improvements, without fully acknowledging the issues of onsite workmanship as a factor that contributes to defects in new homes (a secondary concern identified in four HAs only). The product and system improvement solutions have achieved success for HAs to reduce defects in the short-term; however, overtime the approach may become a restriction for HAs that hampers them in effectively reducing defects. HAs need to design and implement appropriate learning systems that both continue to reduce defects through product and system improvements, but at the same time acknowledge that onsite workmanship is a contributing factor to driving down defects in future projects. The implication for policy is how to encourage the ongoing learning from and reduction of defects within the house building sector. As the UK house building industry increases volume to contribute to reducing the housing shortage and achieving government production targets, there is potential for quality to suffer (evident in the increase in defects over the previous few years of recovery since 2008). The UK Government could tackle the problem of increasing defects, and the UK house building industry may benefit from a sector-wide change initiative to encourage the implementation of OL systems.

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