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Reducing Defects through Organizational Learning within a Housing Association Environment

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***Abstract*—**Housing Associations (HAs) contribute circa 20% of the UK's housing supply. HAs are however under increasing pressure as a result of funding cuts and rent reductions. Due to the increased pressure, a number of processes are currently being reviewed by HAs, especially how they manage and learn from defects. Learning from defects is considered a useful approach to achieving defect reduction within the UK housebuilding industry. This paper contributes to our understanding of how HAs learn from defects by undertaking an initial round table discussion with key HA stakeholders as part of an ongoing collaborative research project with the National House Building Council (NHBC) to better understand how house builders and HAs learn from defects to reduce their prevalence. The initial discussion shows that defect information runs through a number of groups, both internal and external of a HA during both the defects management process and organizational learning (OL) process. Furthermore, HAs are reliant on capturing and recording defect data as the foundation for the OL process. During the OL process defect data analysis is the primary enabler to recognizing a need for a change to organizational routines. When a need for change has been recognized, new options are typically pursued to design out defects via updates to a HAs Employer's Requirements. Proposed solutions are selected by a review board and committed to organizational routine. After implementing a change, both structured and unstructured feedback is sought to establish the change's success. The findings from the HA discussion demonstrates that OL can achieve defect reduction within the house building sector in the UK. The paper concludes by outlining a potential 'learning from defects model' for the housebuilding industry as well as describing future work.

***Keywords*—**Defects, new homes, housing associations, organizational learning.

I. Introduction

IN the United Kingdom (UK) there is a substantial shortfall in the number of dwellings available [1]. The housebuilding sector is under pressure to deliver upwards of 200,000 homes per year to meet demand [2]. Whilst responding to the pressure to increase supply, the sector is reporting materials, skills and workforce shortages following the 2008 economic downturn. The reported shortages are causing concerns within the industry over housing quality [3], [4]. Current data, for example the national customer satisfaction surveys, show that 93% of new homes contain at least one defect requiring a post-completion repair [5]. Housing associations (HAs) are responsible for the production of approximately 20% of the UK's new homes each year [6]. In recent years HAs have been under pressure due to the declining investment in affordable housing [7]. Affordable housing is defined as "social rented, affordable rented and intermediate housing, provided to specified eligible households whose needs are not met by the market" [8]. To further exacerbate the declining investment in affordable housing, HAs' have been required by the UK Government to reduce social housing rents by 1 per cent each year for the next four years (commencing April 2016) [9]. It is anticipated that these reductions will constrain the HAs' ability to meet the shared ambition of themselves and government to drive housing growth [10]. In response, many HAs have had to review their processes to prepare to build with limited or no grant [11]. As the quality of new homes is slipping and the number of defects increasing, and the typical average cost of each post-completion repair being circa £100 [12], learning from and reducing defects is a process currently under review in many HAs. Learning from defects experience is a useful approach for reducing defects in new homes, however, remains under-researched [13]. This paper presents the findings from the initial round table discussion with key HA stakeholders in an 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 and HAs learn from defects.

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II. 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, in Spain, for example, it is argued that if house builders analyse their defect performance they can gain an understanding of the nature of the defects occurring and develop strategies to reduce them [14]. In the UK context, it has been stated that the UK housebuilding industry should implement a feedback system to enable the builders to assess their current systems and their outputs [15]. Further emphasis has been placed on re-examining and modifying working practices to reduce quality failures [16]. The above ideas have been concluded by arguing continuous review, research and feedback as a means of reducing housing defects in the UK [17]. In addition to continuous review, research and feedback, an approach of sharing of good practice and the developments of others has the potential to improve processes to aid defect reduction [18].

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 [19] 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 home building report further recommends 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 [20], advocates an approach of: recording and analysing defect data, feeding the outcomes of the analysis into 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 organizational learning 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 [21].

III. Organizational Learning

Organizational learning (OL) has been recognized as a source of company competitive advantage and is a term frequently utilized within the general management literature. OL is defined as "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" [22].

It is argued that OL is ineffective in construction because there are a lack of structures, incentives and opportunities for project members to communicate and share knowledge and experience [23]-[25]. Furthermore, there is an inability for construction firms to store and access organizational memory [26].

It is argued that a cycle modelled from four main constructs can achieve successful OL in a construction setting [27]: (see Fig. 1).

First, 'signal recognition and interpretation' is where an occurrence is recognized as a novel situation which indicates that existing organizational routines are inappropriate or ineffective. It is argued that organizations are more likely to recognize a signal as a need for change the more frequent, clear and relevant it is to the organization.

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 adaption 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, and targets, etc. in order to transmit the new routine throughout the organization.

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.

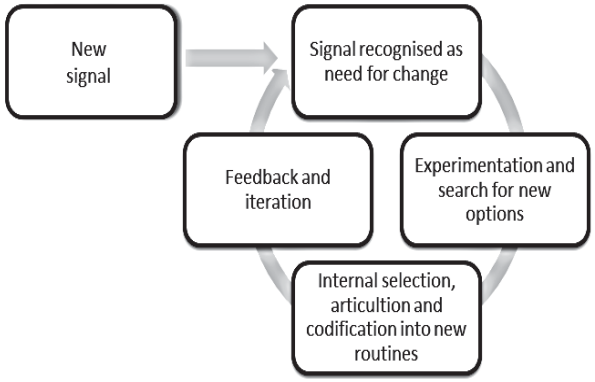

Fig. 1 Organizational learning [27]

The model has been shown to be successful in determining how the housing industry responds to climate change impacts that are recognized as significant, for example to analyze a house builder's technical innovation in response to persistent problems. Therefore, this model will be used to guide the initial discussion.

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 [28] and reducing errors in aircraft maintenance in the aviation industry [29].

IV. 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 contributes to objective one. Section V presents the research methodology used to address the research aim/objectives.

V. Methodology

An action research (AR) approach is considered appropriate for this research, as it aims to empirically investigate how house builders learn from defects experience in general; and, more specifically, 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" [30].

A cyclical process view of AR is resonated in the general literature [31] and in the construction literature [32] which further differentiates 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 organizational 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.

This research project is currently in the diagnosis phase of the AR cycle. This paper reports the early findings from the first task, which is to 'understand house builders' localized defects analysis procedures, and their current knowledge feedback loops to inform future practice' (objective 1). Data collection for task one involved semi-structured interviews with senior management and teams responsible for managing the defects process of five volume house builders and eleven HAs, in order to understand their current processes and therefore identify the problem/improvement opportunity. The house builders and HAs were targeted on an output basis (volume of properties built) and geographical coverage. The teams responsible for managing the defects process 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 organization.

The findings presented in Section VI are from an early round table discussion with key HA stakeholders. The discussion was arranged via an email which set out the premise of the discussion along with the ethical safeguards. The discussion took place in June 2015 with two Clerks of Works (who manage the defects process), an Asset Manager (who manages the build stock once completed), and a Quality Manager (who can make changes to the development process). The discussion lasted around one hour and the four participants were treated as one set of data, as each had expertise in different areas of the organizational processes.

The interview started with the participants presenting an overview of their defects management and learning processes, which then lead on to a detailed discussion about these processes as guided by the OL model presented in Fig. 1. Table I outlines the OL constructs and the questions asked to gain insight into how these constructs are achieved by a HA.

TABLE I
Interview Questions and OL Constructs

OL Constructs	Interview Questions
New signal	Can you provide me with an overview of your defects management process?
Signal recognized as need for change	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, why are those categories chosen?
	Do you analyze defect data?
	If so, what do you analyze?
	How frequently is the analysis undertaken?
	Why do you analyze defect data?
	How do you decide that the findings present a need for a change?
Experimentation and search for new options	If a change is needed, how do you identify adaptation options?
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 organization?
Feedback and iteration	When implemented, how do you monitor the new processes to make sure they are viable and remain viable?

During the discussion field notes were taken, as audio recording was not possible. Upon completion of the discussion the field notes were typed up and sent back to the participants for them to verify and update as necessary. In addition to verifying the meeting notes through the participants, some company documentation (defects management procedures) and defect records were obtained to triangulate the data. The discussion data was analyzed using thematic analysis. The findings are presented in Section VI.

VI. Findings

Fig. 2 presents the defect information flow within a HA based upon the overview of the HAs defects management processes provided during the discussions; and process documentation.

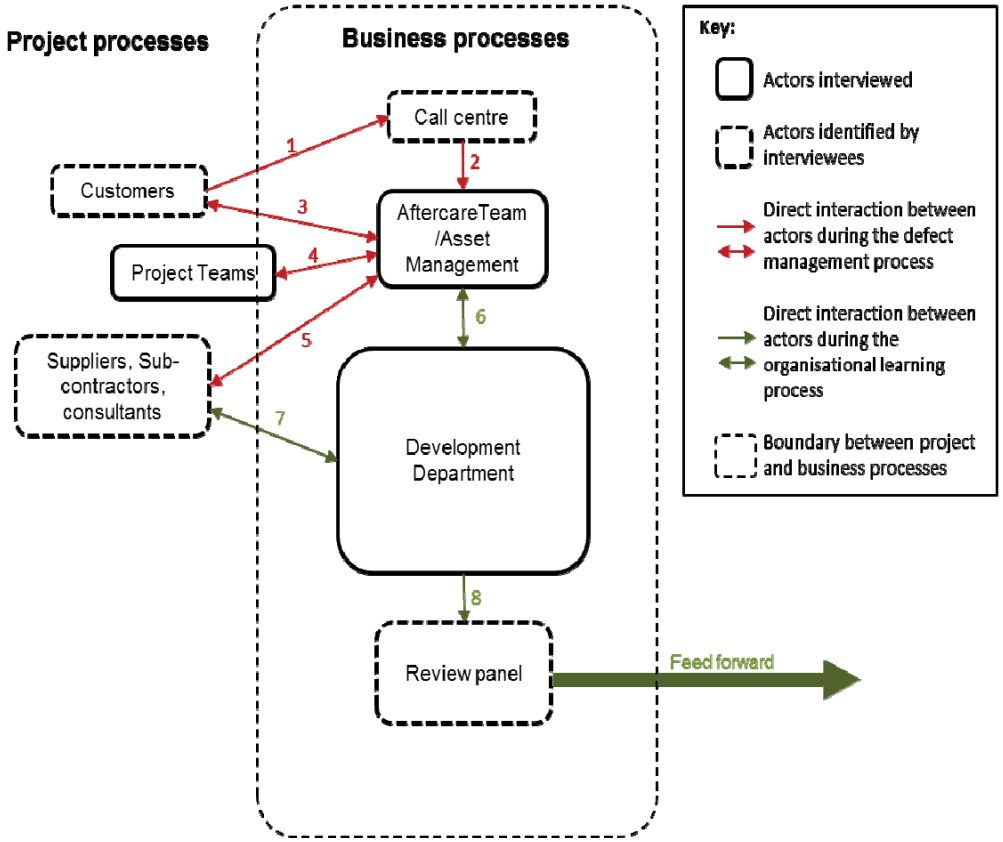

Fig. 2 Mapping of defect information flow within a HA

1. The customer contacts the HA's call center to report a defect within their home.
2. The call center then refers a request to the Aftercare team via an email to the Administrator.
3. The Administrator contacts the customer to discuss the defect further to gain additional information and arrange an investigation by a Clerk of Works.
4. A Clerk of Works (who, in addition to being part of the Aftercare team also forms part of the project team) will then investigate the defect and report back to the Administrator. When the investigation findings are reported back, the Administrator will log the details of the defect on the Defect Log (an excel spreadsheet).
5. The Aftercare Team (either the Head Clerk of Works or Administrator) will then arrange for remediation of the defect, based upon the investigation findings and recommendations, and monitor until completion.
6. On a weekly basis a performance review is undertaken by way of the Asset Manager, Head Clerk of Works and Administrator reviewing the Defects Log together to identify problem areas and areas of strength. First, the problem areas identified are fed back to site teams (typically the Clerk of Works) as 'areas to watch' on current and future developments. Then these areas are discussed between the Asset Management team and the Development department through bimonthly meetings between the Asset Manager and Quality Manager. In cases where the problem areas discussed during the interdepartmental meetings are deemed significant enough (feeling of high volume and high impact) to warrant a change to organizational routine, the HA's Quality Manager will tend to seek solutions – through both internal and external discussions.
7. In cases where the problem areas involve suppliers, sub-contractors, or consultants, the Quality Manager will discuss the problem areas with these actors to identify potential solutions, or raise awareness of areas to watch.
8. When a change to organizational routine is deemed necessary, and a viable solution has been identified (through stages 6 and/or 7), the proposal is put forward to a review panel consisting of a leadership group. The leadership group will then review the proposal. If the proposal is deemed suitable for the organization, the review panel will then commit these to company processes and feed them forward for subsequent projects.

Table II presents the questions asked and the themed responses provided by the discussion participants (note: question one has been removed as this is covered in detail in Fig. 2).

TABLE II
ROUND TABLE DISCUSSION QUESTIONS AND RESPONSES

Questions	Responses
New signal	
Do you record post-completion defect data?	Yes
At what level of detail is the data captured?	Unique reference number, date logged, defect description, property details, contractor, warranty policy number, claim against warranty, repair cost, estimated savings, status of work
Do you use any categories to classify defects?	No
Signal recognized as need for change	
Do you analyze defect data?	Yes
If so, what do you analyze?	Overall frequency, overall cost incurred, frequency by type, frequency by contractor
How frequently is the analysis undertaken?	Weekly
Why do you analyze defect data?	Monitor contractor performance, monitor product performance, monitor system performance, identify improvement opportunities, reduce defects
How do you decide that the findings present a need for a change?	High number of specific defects
Experimentation and search for new options	
If a change is needed, how do you identify adaptation options?	Internal staff, positive performance data, lessons learnt log, manufacturers
Internal selection, articulation and codification into new routines	
How are adaptation options decided and selected, and by who?	Review panel
Once selected, how are the new processes communicated around the organization?	Employers requirements, lessons log, internal meetings, internal training groups, manufacturer feedback
Feedback and iteration	
When implemented, how do you monitor the new processes to make sure they are viable and remain viable?	Anecdotal feedback, scheme review panel, continuous performance monitoring

First – signals coming into the organization: A HA records post-completion defect data in an excel spreadsheet. Individual defects are recorded against a unique reference number, the date the defect was logged, and a brief free text description of the defect's characteristics. The records contain a vast amount of property details (for properties experiencing defects), such as: the property type, address details, the construction type, and the completion date. The details of the contractor responsible for the build were noted, along with the details of any warranty policies on the plot. The records contain confirmation of whether any claims have been made against the warranty provider's policy, any repair costs incurred, any estimated cost savings; and, finally the status of the work was recorded (i.e. complete, ongoing). The key HA stakeholders confirmed that they do not attempt to classify defects and rely on a free text description for manual review analysis purposes.

Second – signal recognized as need for a change: A HA analyzes their defect log by looking at overall numbers and costs of defects. More detailed analysis is undertaken through a manual review of the defect descriptions in an attempt to pick out any trends within the log. The key HA stakeholders explained that these trends enable them to monitor both contractor performance, and product and system performance in order to identify any potential areas where improvement could be made to ultimately reduce defects. The analysis is undertaken on a weekly basis, and the need for change is typically identified when there is a comparatively high volume of specific defects relating to one of the products, systems or contractors (see Fig. 3).

Third – experimentation and search for new options: When an alternative solution is deemed necessary to the organization, a HA initially has both inter and intra departmental discussions to see if co-workers have prior experience or knowledge of the given situation and could offer recommendations to solve the problem. In addition to the discussions a HA will also review better performing projects to identify if any aspect of these could resolve the given situation and be applied to all future builds. If the above two approached are believed to be incapable of resolving the given problem, a HA will refer to their lessons learnt log (a log of previous occasions where beneficial lessons had been recorded) to identify whether there are any lessons from previous projects that can inspire a solution. If the defect(s) relate to particular products or systems, then a HA will have discussions with various manufacturers. These discussions are to identify potential products or systems that could act as a solution.

Fourth - Internal selection, articulation and codification into new routines: A HA typically looks to adapt their Employers Requirements (specification documents) (ERs), for this reason when a potentially viable adaptation option has been identified, in order for it to be selected and accepted within the HA, the option is required to go through a review panel. The review panel will review the HAs' ERs every two years along with any proposed adaptation options, and will come to a conclusion of whether to include the proposed change in the updated document. When an alternative solution has been accepted it is typically codified into a HA's processes through updates to the ERs. The change is then articulated around the organization by way of internal meetings with key stakeholders, and also training groups for site teams. Externally, meetings with manufacturers are advocated as a means of providing feedback over products and systems, and outline any changes the HA has made due to product or system failures. Finally, where other lessons are identified in

projects, but are not suitable for an ER update, these will be recorded in a HA's lessons learnt log, for example a list of problem areas to watch on new builds.

Finally – feedback and iteration: Initially, after implementing a change a HA will seek early anecdotal feedback to gauge the feeling around the change and its suitability and success. Following this early feedback, a HA tends to employ a more structured approach through a continuous review of performance comparing the volume and type of defects both pre and post implementation of the alternative option. In addition to the continuous review, a HA also has a panel that meets at the completion of each scheme to review the general performance of the build, problems identified, and positive aspects identified to generally record these in a HA's lessons learnt log.

Fig. 3 shows an example of how OL has assisted one HA in reducing cracking in timber frame properties over 3 storeys high.

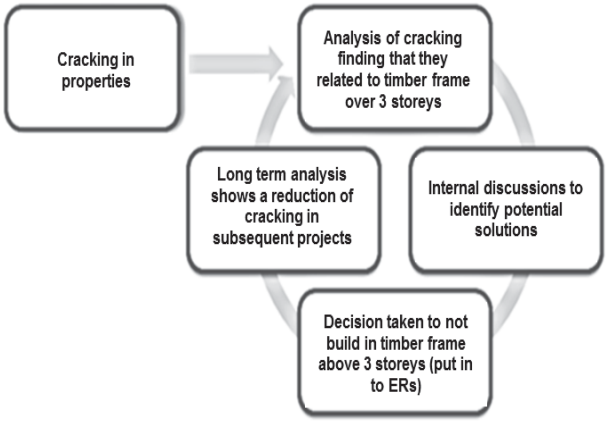

Fig. 3 OL to reduce cracking in timber frame properties over 3 storeys high in one HA

First new signals were entering the organization through the HA's call center via reports of cracking to properties.

Second, the Aftercare team and Asset Management team analyzed data for trends and found a comparatively large number of cracking reports. Further, more detailed analysis showed that the cracking typically related to properties above three storeys high of timber frame construction.

Third, the Asset Manager sat down to discuss the problem with the Quality Manager, and through the discussions they came to the simple solution of not building in timber frame above three storeys.

Fourth, the Quality Manager put the proposal forward to a formal review panel that approved the proposal, and had the change codified into an organizational routine through updates to the HA's Employers Requirements document (specification).

Finally, after building with the new requirements for some time, long term analysis and continuous performance review identified that the alternative method of constructing properties above three storeys in height had reduced the number of reports of cracking (comparatively) since its introduction.

VII. Discussion

Learning from defects is a frequent recommendation to reduce defects within the literature. There is however, very little knowledge of how HAs and house builders actually learn from defects. This study contributes to our understanding of this question by investigating how HAs collect and learn from defects through undertaking an early round table discussion with key HA stakeholders. OL was deployed as the theoretical lens to understand HAs' localized defects analysis procedures, and their current knowledge feedback loops to inform future practice.

The findings provide seven distinct empirical contributions. First, a HA records significant volumes of defect related data through a combination of actors: their call centers, Administrators, and the Clerk of Works. This data recording documents an integral part of the defects OL method as it forms the platform for the subsequent stages of the learning process.

Second, a HA actively seeks to identify problem situations that signify a need for a change through periodic analysis of their defect data. Without this analysis a HA would not be able to recognize signals that identified a need for a change to organizational routines. However, it should be noted that the way in which signals were identified within HAs was laborious and potentially inaccurate due to it being a manual process which involved looking into a large number of free text descriptions to pick out trends.

Third, searching for new adaptation options was achieved through internal searching for knowledge between co-workers, as well as external searching via manufacturers. The external searching was identified as the most frequent form of identifying new options as the main focus of a HA appeared to be to design out defects by way of updates to their ERs. This designing out defects logic placed large emphasis on product and system performance, and broad changes throughout the organization (i.e. updates to ERs). There was very little experimentation of changes on a small scale.

Fourth, the internal selection process tended to be undertaken by an impartial central review panel (leadership group) to review proposed changes in line with organizational objectives and strategies.

Fifth, two consistent methods of codifying changes into new organizational routines were identified: updates to a HA's ERs, and the completion of a Lessons Learnt log.

Sixth, after a change had been implemented there was a two stage feedback process: first, initial unstructured feedback was received through anecdotal channels; and, second, a structured continuous review of data. The continuous review of data was undertaken concurrently with the process of identifying new signals.

Finally, and most importantly, through the example provided (Fig. 3) one HA has shown that OL can achieve defect reduction within the housebuilding sector, and should be an ongoing priority for the UK housebuilding industry.

The empirical contributions that a HA captures and records significant volumes of defect related data, frequently analyzes that data with a view to identifying improvement opportunities; and, look to make broad changes throughout the organization with limited small scale experimentation provides associated theoretical contributions.

Whilst the OL model adopted assisted in identifying 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 findings formed the capability to adapt the existing model with a view to developing a specific learning from a defects model.

Fig. 4 represents the adapted learning from defects model.

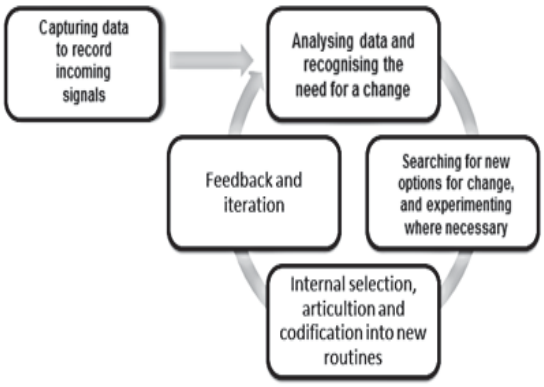

Fig. 4 Potential learning from defects model

First, because defect data recording forms the platform for the learning process, the incoming signals concept within the existing model has been adapted. The adaptation now explicitly outlines the need to capture and record defect data, thus recording all new signals (defects) entering the organization.

Second, as defect data analysis is a key enabler to recognizing a need for a change to organizational routines, the signal recognized as need for a change construct within the model has been modified. This modification is to ensure the direct link between structured periodic analysis and the capability that generates to identify key signals as a need for change.

Finally, since broad changes throughout the organization (e.g. updates to ERs) appear to be the advocated approach to OL within the HA environment, and as there was very little evidence of experimentation of changes on a small scale; the model has been updated to acknowledge this.

VIII. Limitations and Future Work

The contributions of this study are subject to certain limitations that will be researched in future work.

First, this paper reports the findings from the initial HA round table discussions, therefore the picture generated from the findings is likely to be incomplete. There is thus a further need to undertake additional interviews with HAs until saturation occurs to gain a more 'complete' picture of industry practice.

Second, as HAs contribute circa 20% of the UK's housing output (by volume); speculative house builders (HBs) form a significant part of the housebuilding industry. HBs may have different approaches to HAs; there is consequently a need to undertake interviews with HBs to understand their learning process.

Finally, this paper has proposed an outline for a potential learning from defects model based upon the initial discussion. Developing a 'learning from defects model' based upon one round table discussion suggests that the model will be limited. Due to the limited nature of the model development, the model will be further tested and adapted (as necessary) in subsequent HA interviews. Furthermore, the model may be different for HAs and HBs, an area to be further investigated by the action research approach.

IX. Conclusion

This paper set out to contribute to our understanding of how HAs learn from defects by undertaking the initial HA round table discussion of an ongoing collaborative research project with the NHBC to better understand how HBs and HAs learn from defects to reduce their prevalence. The discussion found that defect information runs through a number of groups, both internal and external of the HA during both the defects management process and OL process. Furthermore, the discussion identified that HAs' are reliant on capturing and recording defect data as the basis of the OL process. During the OL process defect data analysis plays a key role in recognizing specific defects as novel situations requiring change to organizational routines. When a novel situation has been recognized new options are typically pursued to design out defects via updates to a HA's ERs. Proposed solutions are selected by a review panel and committed to organizational routine. After a change has been implemented unstructured feedback is initially sought to gauge the general feeling towards the suitability of the change, followed by structured feedback to establish the change's long-term success. The findings from the initial HA round table discussion have shown that OL has the potential to address the persistent defect problem within the housebuilding sector in the UK. The findings also suggest the potential to develop a 'learning from defects model' for the housebuilding industry.

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