Organisational Learning in SMEs:
A Process Improvement Perspective

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Abstract

We investigate how Organisational Learning (OL) can occur through Process Improvement (PI) activities, leading to sustained improvements over time in the context of small and medium-sized enterprises (SMEs). We study PI practices in six engineering-oriented SMEs via interview-based case studies. We draw from a range of literature and use an OL conceptual framework, informed by Crossan et al.'s (1999) 4I framework, as an analytical lens. The OL perspective provides new insights to conceptualize the nature of PI as a multi-level practice in SMEs. Effective PI practices within SMEs are shown to be consistent with OL concepts, enabling firms to translate individually identified improvement opportunities into organisational-level changes that result in sustained benefits. A new conceptual model is presented that explains how SMEs can learn through improvement activities. The key role of management support, both operational and strategic, is highlighted. It is necessary for management to provide sufficient PI opportunities to enable and sustain beneficial learning. Management can provide additional learning opportunities by introducing new business that requires exploratory learning. Without such support, the reduction in improvement opportunities reduces the benefits that can be realised from PI. The findings provide a theoretically underpinned framework to achieve OL in engineering-oriented SMEs deriving from PI activities, highlighting the key mechanisms that enable learning from improvement activities. Further case-based, longitudinal, and survey-based research studies with firms of different types will enhance the generalisability of the findings, allowing the confirmation and extension of the new conceptual model. OL provides a multi-level perspective to understand both how smaller firms are able to undergo systematic improvements and the support required to continually improve.

1. Introduction

Small and Medium-sized Enterprises (SMEs) are crucial in delivering sustainable growth in most economies (OECD 2014). Not only do SMEs represent the vast majority of firms (95%) and employ the majority of the workforce (60-70%) (OECD 2014), they are also an essential part of the supply chains of many larger firms (Söderberg and Bengtsson 2010). The ability of smaller firms to improve is therefore crucial – for their own survival, for the effective operation of many supply chains, and for the competitiveness of many economies (Chaston et al. 2001, Söderberg and Bengtsson 2010). However, SMEs face significant barriers when seeking to improve and develop. They are often hampered by limited access to necessary skills and resources, managerial competences and finance (OECD 2014).

Over the last three decades, there has been considerable interest in the concept of Organisational Learning (OL) to understand and explain how firms can change and create a competitive advantage over time (Fiol and Lyles 1985, Levitt and March 1988, Jones et al. 2010, Crossan et al. 2011). To improve competitiveness, attention is needed not only on individual level learning but also on how organisations can harness individual learning for organisational gain (Chaston et al. 2001). It is argued that organisations, particularly small ones, need to orient learning behaviours around specific organisational practices if they are to realize benefits from OL (Chaston et al. 2001, Altinay et al. 2015). However, while OL has been identified as an appropriate theory for use within operations management (Amundson 1998), it has been largely overlooked in contributing to theory development in the discipline (Boer et al. 2015, Walker et al. 2015).

Process Improvement (PI) and Continuous Improvement (CI) have been enduring themes across research and practice in operations management. PI and CI encompass a spectrum of activities, methods and approaches that seek to improve the effectiveness and efficiency of business processes over time and ensure the alignment of business processes with the competitive environment. PI and CI are fundamental in many formal organisational development and accreditation processes (Benner and Veloso 2008, Anand et al. 2009). They are of immediate and direct relevance to SMEs (Wolff and Pett 2006, Tidd and Bessant 2013). PI and CI may assist smaller firms in overcoming some of the limiting aspects associated with firm size (Wolff and Pett 2006). They have been identified as key mechanisms for improving SME productivity (Terziovski 2010). However, only a limited amount of research has been conducted on the detailed nature of improvement practices in smaller firms (Tidd and Bessant 2013). Research has discussed the relevance of established and influential improvement frameworks such as Six Sigma in the SME context (Antony et al. 2005, Kumar et al. 2006) but has not investigated the nature of improvement activities in such environments in detail. Research is needed to examine improvement practices in SMEs and how such practices relate to organisational level change (Chaston et al. 2001), in particular to understand how SMEs can learn through PI (Amundson 1998).

In this study we examine the role of PI and CI activities in providing a route to achieving beneficial learning at an organisational level in SMEs. We address two key issues – how OL occurs through PI/CI practices in SMEs and what OL factors ensure sustained benefits are realised from PI/CI in SMEs. The study is conducted with a sample of engineering-oriented SMEs, environments where improvement activities would be expected. For comparability, the companies studied all have ISO quality accreditations, a standard which emphasises the role of improvement activities (Benner and Veloso 2008). The study draws from the PI, CI and OL literatures to provide theoretical underpinning for the research and to provide a research framework to conduct the study. The research framework draws on the influential 4I OL framework (Crossan et al. 1999, Crossan et al. 2011) to analyse learning from PI/CI activities in the sample of SMEs.

The findings are presented in the form of a new conceptual model of learning through PI. Rather than the mere existence of particular practices mandated by established improvement frameworks, the study provides new insights to re-conceptualize the nature of improvement activities in SMEs as a multi-level combination of practices, behaviours and perceptions that can enable effective learning. The study highlights the key role of management in providing support and resources for PI activities and in generating new business that provides continuing opportunities for improvement initiatives. The analysis identified a group of companies able to achieve sustained benefits from improvement activities and a group of companies that were less effective at realising sustained benefits. In considering the findings, we argue that OL provides an appropriate and valuable perspective to understand and explain how SMEs can use PI to develop and meet the needs of their operating environment. The new conceptual model lays the ground for further empirical research to enhance understanding of how SMEs can use and support PI activities as a means to achieve OL.

The paper has seven subsequent sections. The next section discusses relevant literature and justifies OL as an appropriate theory to use to study PI in SMEs, leading to the formulation of the research questions. The qualitative research approach adopted is then discussed, including the selection of case companies and the methods used for data collection and analysis. The succeeding sections provide brief 'within case' and 'cross case' analyses. The findings are discussed in section 6 and a new conceptual model for organisational learning through process improvement in SMEs is presented in section 7. The paper concludes by discussing the relevance of the study to practice, contributions to theory, limitations and avenues for further research.

2. Theory and Research Framework
We consider the state of knowledge and understanding of Process Improvement (PI) and Continuous Improvement (CI), with particular attention given to the context of SMEs. We discuss limitations of previous research, arguing why OL provides a valuable lens from which to consider PI and CI. The provenance and use of specific OL frameworks is then discussed, providing a conceptual framework that connects OL with PI and CI. The research questions addressed in the study are then presented.

2.1 PI and CI in SMEs
PI has been highlighted as being central to operations management (Anand et al. 2010). CI is distinguished from PI in the literature by its emphasis on moving from isolated improvement activities to organisationally-driven approaches that encourage, support, and exploit such activities for improved performance over time (Bessant et al. 2001, Jørgensen et al. 2003, Anand et al. 2009). CI is viewed as an essential practice for firms to remain competitive in a dynamic business environment (Anand et al. 2009). Here we use the term PI/CI to reflect the spectrum of activities that occur in practice and the non-specificity of some of the research literature on process improvement.

Research on PI/CI in SMEs has focused principally on the refinement of existing processes to improve what is currently done (Wolff and Pett 2006, Terziovski 2010) through the application of previously developed tools and techniques, presenting the benefits firms are able to realize from them (Antony et al. 2005, Lo and Chang 2007). Antony (2001) and Kumar et al. (2006) illustrated how PI methods could be used to dramatically improve process performance using objective process data, but gave limited attention to the sustainability of improvements over time. The sustainability of PI efforts was taken as a focus of the work by Bateman (2005) who identified key inhibitors and enablers in realising benefits from PI activities and sustaining improvement activities over time.

The rigour and resources required by formal improvement approaches, such as Six Sigma, may not be wholly relevant for SMEs, who tend to favour less resource intensive approaches (Antony et al. 2005, Lo and Chang 2007). Benner and Veloso (2008) discussed how the implementation of ISO 9000 processes could support and enable deliberate changes of operational processes, arguing that the repeated use of formalised procedures supports the gradual improvement of performance through repetition. For CI, it is not only necessary to sustain improvements once they are made, but also to initiate follow-up PI activities (Bessant et al. 1994). Jørgensen et al. (2003) focused on CI and gave particular attention to the role of process review, which provides initiating points to identify and pursue operational PI. To explore how improvement activities can be sustained and become embedded in organisations, Jørgensen et al. (2008) examined the role of human resource practices to promote the engagement of operational staff and achieve CI. They illustrated how human resource infrastructure could formalise improvement practitioner roles, helping to embed improvement behaviours at an organisational level. Barton and Deldridge (2004) discussed how human resource practices could promote development at an individual level, that in time could create a competitive advantage. They also highlighted how individuals needed support in order for them to contribute to CI behaviours, due to discretionary effort acting as a potential inhibitor of CI efforts. Lam et al. (2015) explored this issue still further, highlighting the critical role managers play by providing behavioural support for promoting employee commitment within CI initiatives. This is consistent with the findings of Bateman (2005) who noted that personnel dedicated to PI activities promoted the sustainability of PI. Anand et al. (2009) discussed the role of formal infrastructure for achieving CI, not only for improving existing processes, but also for revising improvement systems to ensure they remain aligned with the external environment. Notwithstanding the need to embed improvement practices in order to achieve CI, Zangwill and Kantor (1998) noted how benefits from improvement activities could reduce over time as inefficiencies were removed from processes.

Lee et al. (2000), Jørgensen et al. (2003) and Bateman (2005) identified the support and involvement of management, improvement goals, measures, and being provided with sufficient resources, as key enablers to sustain PI and achieve CI. Bessant and colleagues (Bessant et al. 1994, Bessant and Francis 1999, Bessant et al. 2001) identified similar topics of strategic leadership, tools and techniques, in addition to rewards and recognition. In particular, this stream of work suggested that firms could progress through five levels of CI maturity, each of which allowed greater benefits to be realised. The levels begin with random problem solving (level 0), through strategically aligned CI (level 3), to ultimately becoming a learning organisation (level 5). The model places attention on the development of CI infrastructure rather than focusing on operational activities, which may lessen its relevance to resource constrained SMEs. The empirical evidence gathered was primarily consistent with firms progressing to the strategic CI level (Bessant and Francis 1999), rather than achieving the hypothesised ideal of a learning organisation.

The literature distinguishes between the learning organisation and organisational learning (OL) – the former being much criticised (Tsang 1997, West and Burnes 2000). Garvin (1993) identified a selection of key practices necessary to build a learning organisation, which had parallels to enablers identified within the PI/CI literature (Bessant et al. 2001, Bateman 2005). He noted that "*continuous improvement requires a commitment to learning*" (Garvin 1993, p.78). Practices included management support, measurement, problem solving, working across organisational boundaries and incentives. However, while providing a framework to illustrate how improvement activities might be sustained, the learning organisation focuses on prescription, suggesting how an organisation *should* learn (Tsang 1997). Consequently, the concept of the learning organization provides insufficient insights to explain how organisations *can and do* actually learn.

There are gaps in the PI/CI literature on how improvement activities are carried out, specifically within small firms. Smaller firms tend to have a much greater focus on revenue generation (Terziovski 2010), with processes characterised by their informality (Marlow et al. 2010). Although representing a proportion of the firms involved in some previous studies on PI/CI (Bessant et al. 2001, Bateman and Rich 2003), attention was not given specifically to the requirements of SMEs. Even within work focused on improvement activities within smaller firms (Lee et al. 2000, Wolff and Pett 2006), attention has not been given to how frameworks or practices need to be adapted to account for a resource constrained context. Without such attention, suggestions related to formal, resource-based strategies, human resource policies (Bessant et al. 2001, Barton and Delbridge 2004) or improvement infrastructure (Jørgensen et al. 2003) may lessen their relevance for smaller firms.

Although previous research identifies a selection of practices to both sustain PI and enable the achievement of CI, the findings do not extend from the initial identification and testing of concepts to the building of relationships and theoretical frameworks for PI/CI or OL (Handfield and Melnyk 1998, Bryman 2012). Additionally, previous research has tended to give less emphasis to the details of operational PI, defining CI as "*sustained incremental innovation*" (Bessant and Francis 1999, p. 1107) without discussing what is being improved or how it results in sustained learning. Notwithstanding, PI has been identified as a primary source of innovation in small and medium-sized manufacturing firms (Terziovski 2010, Tidd and Bessant 2013) and therefore continues to have strong relevance for SMEs seeking to develop.

2.2 Achieving OL through PI/CI
In contrast to the 'learning organisation', organisational learning research seeks to understand the mechanisms that enable organisations to learn, change and adapt to account for the acquisition of new knowledge (Huber 1991). Building on previous reviews, Huber (1991) identified numerous perspectives on OL, from experiential learning related to practice, to vicarious learning from other individuals or organisations. Argyris and Schön (1992) explored issues at an individual and organisational level where gradual learning against established criteria could result in improvements in performance over time (defined as single loop learning). Within the CI literature, Zangwill and Kantor (1998) suggested that such forms of learning resulted in diminishing returns as system inefficiencies were removed. However, if a problem is more complex or different to existing frames of reference, individuals or organisations may be unable to resolve it. In such circumstances, Argyris and Schön (1992) argued that it was not only necessary for individuals or organisations to be able to solve problems based on existing criteria, but it was also necessary to engage in inquiry and to critically review existing mental frameworks (engage in double loop learning). This process not only allows organisations to improve activities they engage in, but also to exploit new opportunities and develop new processes and systems, similar to aspects of PI/CI (Jørgensen et al. 2003, Anand et al. 2009). Without engaging in such learning processes, organisations may, over time, become "*brittle and unchangeable*" (Argyris 1977, p.122). Levinthal and March (1993) provided considerable insights on issues associated with these two, potentially conflicting, forms of learning. While there may be a tendency to continually exploit existing mental frameworks to refine existing processes, they argued that the inefficiencies associated with exploration were less detrimental to long-term organisational health than over-exploitation.

In addition to understanding individual learning processes (Argyris and Schön 1992), attention also needs to be given to how these processes relate to the organisation as a whole. Fiol and Lyles (1985, p.804) stated that "*organizational learning is not simply the sum of each member's learning*". Following the acceptance of new information, insight is developed that may result in improvements,

which could be captured in organisational processes, systems, structures, and cultures, and affect subsequent behaviour. However, Fiol and Lyles (1985) also noted that an organisational crisis may be necessary to lead to the acceptance that established organisational processes and structures need to change. Nonaka and Takeuchi (1995) gave greater focus than previous research to the creation of knowledge from group activities, which link individuals with organisational level outcomes, to explain how learning could contribute to firm performance. They suggested that knowledge was created through conversion from a tacit state when held by individuals to an explicit state when codified. Engaging in these processes provided firms with key advantages by creating new knowledge and developing innovative solutions related to existing problems. In comparison to the other learning frameworks, Nonaka and Takeuchi (1995) gave attention to the forms of knowledge that may be difficult to codify (tacit knowledge). Although highly influential, and contributing to some CI thinking (Jørgensen et al. 2003), and to operations management more generally (Anand et al. 2010), the knowledge creation perspective overlooks how knowledge is exploited at an organisational level (c.f. Fiol and Lyles 1985). Notwithstanding these limitations, the work provides a valuable contribution to the improvement literature by linking group activities with organisational benefits.

There is a dearth of research specifically exploring OL within SMEs. Lee et al. (2000) noted that the vast majority of works on OL had been conducted within large organisations and thus were limited on the practical aspects of OL that could be implemented in SMEs. Chaston et al.'s (2001) work focused primarily on applying previously developed OL frameworks in the context of SMEs, and sought to illustrate how a range of OL practices might relate to improved SME performance. They found that it was only once organisational competences had been developed from learning activities that performance improved in SMEs. They recommended that more qualitative studies were needed to investigate how SMEs engaged in OL. Jones et al. (2010) examined learning in owner-managed small firms, focusing on the external connections possessed by the owner/manager and highlighting the role they play in institutionalising externally acquired knowledge. The work illustrates key gaps in the OL literature on SMEs and highlights the need to explore the mechanisms that relate operational practices (PI) to organisational benefits.

Huber's (1991) work provided valuable insights on the processes of OL. The process is initiated by knowledge acquisition, which needs to be converted to information and distributed through the organisation before being interpreted by those receiving the information and stored in organisational memory to be applied in the future. This enables OL to support long-term firm survival through alignment with a firm's environment, the "*ultimate criterion of organizational performance*" (Fiol and Lyle 1985, p.308). Based on a synthesis and analysis of previous work, Crossan et al. (1999) conceptualised OL as a process that acquires and intuits knowledge at an individual level, creates further knowledge at a group level through interpretation, and captures it at an organisational level. This process was encapsulated in their 4I framework illustrated in Figure 1. It shows the relationships between different learning practices, with lower levels feeding ideas to be discussed and developed within group activities, to allow the development of existing systems. It also shows how organisational level resources, such as policies, procedures and culture, feedback to direct lower levels of learning to inform behaviours, showing similarities with and an explanation of the exploitation of existing processes and mental models explored by Argyris and Schön (1992).

Crossan et al. (1999) argued that through this process, organisations could achieve strategic renewal, ensuring continued alignment with a dynamic operating environment. While highly influential within management research generally (Crossan et al. 2011), the 4I framework has received only limited attention within operations management and has not been investigated in a PI/CI context. Bontis et al.

(2002) tested the framework empirically, finding that the learning flows (feedback and feed forward) were as strongly related to performance, if not more so, than previously accumulated resources. A particularly relevant example was Jones and Macpherson (2006) who extended the framework to illustrate how external support from customers, suppliers or consultancies could facilitate strategic renewal in SMEs. However, their work did not explore how involvement impacted internal practices or the role of internal learning and improvement activities on organisational level outcomes.
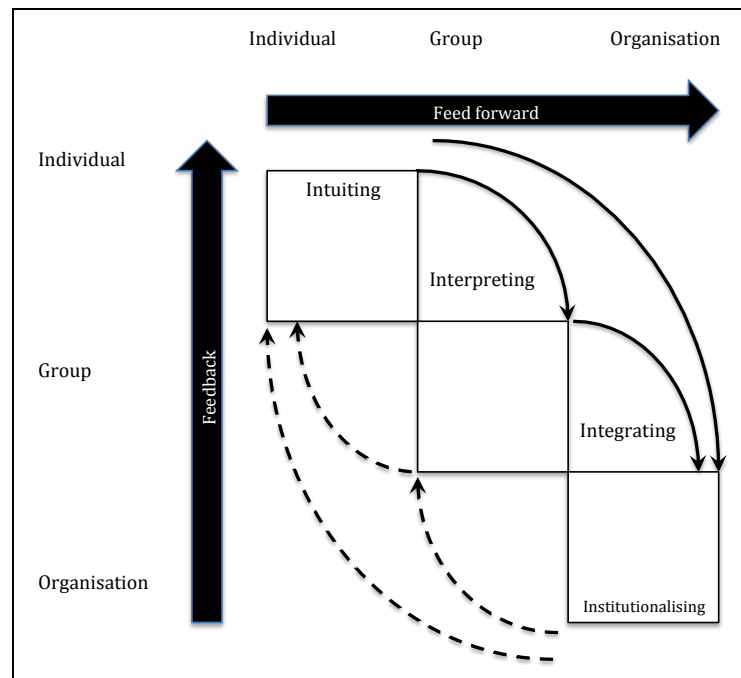

Figure 1: The 4I Framework (source: Crossan et al. 1999, p.532)

Amundson (1998, p.351) advocated for research that explored "*how OL occurs through process improvement*". Table 1 identifies the main practices of OL identified from the literature and relates them to the literature on PI/CI. Given the similarities and complementary nature of the concepts, studying PI/CI from an OL perspective is valid contextually (Boer et al. 2015). The concepts in Table 1 provide the basis for a research framework to study PI from an OL perspective. Furthermore, reflecting on the practices and behaviours identified within the literatures on both PI/CI and OL, Crossan et al.'s (1999) 4I framework provides an analytical lens to examine the mechanisms by which PI/CI practices in organisations may relate to one another to achieve learning. In this study, we use these concepts and the 4I framework to examine how SMEs engage in PI/CI and how OL can be achieved through PI/CI activities. In contrast to the maturity model (Bessant et al. 2001) that attempts to identify firms with idealised processes, the analysis framework seeks to examine how SMEs can acquire knowledge and assimilate and utilise learning through PI.

Drawing from the previously presented literature and the need for further research into OL in SMEs, we pose the following two research questions:

RQ1: How does OL occur through PI/CI practices in SMEs?
RQ2: What are the key OL factors that ensure sustained benefits are realized from PI/CI within SMEs?

Table 1: OL Conceptual framework for PI/CI

Concept	Contributing Literature
Individual behavior: Individuals identifying new ways of solving organizational issues (generating ideas)	March (1991), Argyris and Schon (1992), Crossan et al. (1999), Jorgensen et al. (2003)
Group discussions: Group activities focused upon identifying and questioning individually held assumptions (creating knowledge)	Nonaka and Takeuchi (1995),Crossan et al. (1999), Lee et al. (2000), Jorgensen et al. (2003)
Organizational processes: Organizational policies, culture and strategies that focus upon long-term development (learning resources)	Fiol and Lyles (1985), Levitt and March (1988), Bessant and Francis (1999), Crossan et al. (1999)
Policy development: Feed forward ideas from individual and group activities into organization-level processes (capturing insight)	Fiol and Lyles (1985), Francis and Bessant (1999), Crossan et al. (1999)
Policy use: Feedback organizational resources, strategies and procedures to inform individual and group-level behavior (translating insight into action)	Fiol and Lyles (1985), Crossan et al. (1999), Jorgensen et al. (2008)

Reflecting recent literature in the field of OL (Ingvaldsen 2015), the first research question highlights a necessary practical context in which to conduct research on OL. The second research question extends the first by examining the mechanisms that support learning processes to ensure the continued realisation of benefits from improvement activities in SMEs. The following section presents the research methodology employed in the study and explains how the collected data were analysed to answer the research questions.

3. Research Approach

Previous research has employed a range of approaches to investigate PI and CI, drawing from both objective and more subjective data to explore the relevance of previously developed frameworks (for example Antony 2001, and Anand et al. 2009). Approaches taken by Lee et al. (2000), Bessant et al. (2001) and Jørgensen et al. (2003) included action research and self-assessment to investigate improvement activities. While self-assessment tools may provide quantitative measures to compare the capabilities of different firms, McCutcheon and Meredith (1993, p.244) warned that such measures may be "*cloaked in objectivity*" and needed to be considered carefully. Lasagni (2012, p.331) also noted issues arising from such forms of self-assessment in smaller firms, creating a "*bias toward self-confident SMEs*" over estimating their capabilities.

A qualitative research approach using case studies has been adopted for this study. MacCarthy et al. (2013, p.940) state that operations management "*needs more good qualitative work*" to explore the issues being experienced by practicing managers. In particular, an interpretive approach to case studies was adopted to examine the relationship between OL and PI/CI in SMEs. Interpretive case studies are appropriate when depth of understanding related to organisational practices is sought (McCutcheon and Meredith 1993, Meredith 1998). An interpretive perspective supports the discovery and description of organisational practices, without the need to impose a pre-conceived external perspective on interviewees (Noke and Hughes 2010). The research approach does not provide interviewees with concepts or assessment frameworks (external perspectives) for practitioners to consider (Noke and

Hughes 2010), such as Lee et al. (2000) and Jørgensen et al. (2003). Instead, it allows practitioners to discuss topics in their own terms, using their own concepts. Understanding and interpretation of these concepts is developed through processes of active discussions between the interviewee and interviewer (Radnor 2001). The interpretivist approach differs from a strictly positivist approach to case research (Radnor 2001), giving less emphasis to the use of objective measures whilst placing greater emphasis on the meaning inherent in the information conveyed and its implications. It allows valuable follow up discussions, teasing out issues of relevance to the research study. An interpretivist approach does not preclude the use of other sources of information and data, and encourages the use of secondary data sources, product catalogues, web sites, brochures, and promotional materials. These were also used to support the analysis in this study.

3.1 Selection and overview of cases
Emphasis was placed on maximizing the diversity of firms involved in the study whilst maintaining a degree of comparability to ensure the robustness of insights developed and to strengthen external validity (Yin 2009). The selection criteria required that case study firms (i) had less than 250 employees, (ii) engaged in engineering related processes, and (iii) had an accredited ISO9000 quality management system (QMS). Given the selection criteria, firms were defined as 'engineering-oriented SMEs'. Formalized, externally-audited procedures have been identified as helping to facilitate PI by systematically changing procedures and ensuring improvements are cumulative (Benner and Veloso 2008). Formal operating procedures also represent organisational artefacts that provide evidence of capturing and deploying learning (Fiol and Lyles 1985, Jones et al. 2010). Requiring firms in the sample to have an accredited QMS reduced the variance between firms to some degree while ensuring firms had the necessary infrastructure to conduct process improvement (Lo and Chang 2007).

Firms were selected from an extensive practitioner-oriented company database designed to facilitate business-to-business interaction. Companies were contacted via post, email and telephone, in order to introduce the research and highlight the benefits of involvement – principally that feedback would be given on their PI practices in comparison to similar organisations. Six firms agreed to be involved in the study that were all located in the Midlands region of the UK. Selecting all of them helped maximize diversity and minimize case selection bias whilst ensuring the feasibility of the study due to the volume of interview transcripts and number of companies (Eisenhardt 1989). Reasons given by firms that chose not to be involved in the research related to the challenges being experienced in the period the research was conducted, which was in the aftermath of the global financial crisis. Case details are summarized in Table 2.

Table 2: Case Firms Summary

Company Name	Employees	Industry	Market	No. of Interviews	Position Held	Total time	Additional Data Sources
Engineering Manufacturer 1 (ENG1)	23	Sheet Metal	Various	4	Managing Director (MD, General Manager (GM), Project Engineer (PE)	5h	Website, site tour, follow up interview, company presentations
Engineering Manufacturer 2 (ENG2)	10	Compression Plastics	Oil/ Gas/ Various	2	Managing Director (MD)	3h	Website, initial meeting, site tour, informal follow up meeting

Injection Moulding 1 (INJECT1)	73	Injection Moulding	Automotive/ Various	4	Production manager (PDM), Project Manager (PM), Assistant Operations Manager (AOM)	5h30m	Website, site tour, follow up meeting, customer meetings
Injection Moulding 2 (INJECT2)	35	Injection Moulding	Double glazing/ Various	3	Managing Director (MD), Project Manager (PM) and Production Manager(PRM)	6h	Website, follow up interview, social media updates
Systems Integrator (SYSINT)	25	Advanced Manufacturing Equipment	Manufacturing Companies	3	Engineering Directors (ED), Operations Director (OD) and Project Engineer (PE)	7h40m	Website, site tour, partner websites
Building Contractor (BUILD)	49	Construction	Residential/ Care homes/ Industrial/ Various	4	Managing Director (MD), Quality Consultant (QC), Operations manager (OM), 2 x Project Managers (PM)	9h	Website, interviews with customer and supplier, site visits, site meetings, follow up meetings
Total				20		36h10m	

3.2 Interview approach

To answer the research questions, it was necessary to discuss in detail the nature of PI practices as perceived by practitioners in the context of their operating and market environment. In contrast to direct questions used in previous OL research such as "*do you believe that an employee's ability to learn is the key to improvement?*" (Yeung et al. 2007) or "*What mechanisms supported OL?*" (Zhang et al. 2006), questions in this study were oriented around eliciting operational stories (Radnor 2001) about and in relation to PI/CI and OL. The interpretive approach avoids the researcher using particular terms with which a practitioner may be unfamiliar. Instead it allows interviewees to reflect on their experience and describe them in terms with which they are familiar. However, it should be noted that each of these questions led to follow up discussions on topics of direct relevance to PI/CI in these organisations. The theoretical lens of OL was used in the analysis to interpret organisational practices rather than to direct data collection, so reducing bias. The approach is consistent with approaches adopted to explore OL in the context of specific organisational practices, such as customer feedback (Caemmerer and Wilson 2010), inter-organisational relationships (Jia and Lamming 2013).

The firm was taken as the unit of analysis, with multiple respondents enabling an embedded, multiple case design (Yin 2009). Interviews were targeted at those in upper management. The majority of interviews were conducted with Managing Directors (see Table 2). Bessant et al. (2001, p.74) noted that a major advantage of conducting research with smaller firms was that Directors were "*aware of what is going on…[and are] involved in allocating resources*", enabling such respondents to report effectively on company-wide practices. Where possible, interviews were conducted with operational level staff directly involved in PI activities to provide alternative perspectives, particularly within the larger SMEs in the study. Additional sources of data other than interviews were used, such as websites that included project case studies, machine lists, and details of products and services provided, with additional observational data gathered from site tours. While the research primarily drew from interview

data, other sources of information, particularly observations, are important for validating interpretivist research, providing "*interpretive renderings of sounder quality*" (Radnor 2001, p.51) and helping to triangulate interview data. The overall approach adopted helped to reduce some of the subjectivity and bias associated with case study research (Voss et al. 2002). In total 20 interviews were conducted, each lasting between 1.5 and 3 hours. All interviews were recorded with the agreement of participants and all were transcribed verbatim.

Following the introduction of the topics being researched when making initial contact with each firm, the interviewees (particularly those individuals not initially contacted) were briefed on the aims of the research and the topics that would be covered in the interview. In initial discussions with participants, examples of PI activities, such as operator initiated ideas, responses to returns from customers and activities to allow the introduction of new work were identified as possible areas where PI was likely to occur, providing a foundation for discussions on the topics. This enabled subsequent discussions to explore how operational improvement activities related to organisational outcomes within discussions on particular examples of PI. With each firm possessing an accredited QMS, how PI related to formalised systems focused discussions on topics interviewees were familiar with. Drawing from literature on PI and CI, discussions were elicited by asking questions related to the resolution of operational issues (e.g. internal non-conformance or returns from customers), the introduction of new machinery, the introduction of new business and the role of the QMS in the company (see Appendix 1).

Being deliberately broad, these topics provided opportunities for interviewees to cover aspects of the research framework, such as group work, formal procedures, management support, training and responsibilities given to individual staff. Without being explicitly directed, it was possible for interviewees to emphasise topics they considered important, with follow-up questions from the interviewer assessing whether topics included in the framework but not covered were relevant to the experiences of the interviewees. Questions led to discussion on topics of direct relevance to PI/CI processes in these organisations. For instance a question on handling a return from a customer led to follow up discussions on involving operational staff in the problem resolution process, with further questioning related to third parties that may become involved in solving more complex problems. An advantage of the interpretivist approach is that it reduces bias that may emanate from asking leading questions (Kvale and Brinkman 2009, p.301). By allowing interviewees to reflect on previously conducted improvement activities, it was possible to understand what initiated follow-up improvement activities. Evidence was also collected in each of the cases related to organisational level changes that had taken place over a prolonged period of time.

3.3 Data analysis
Before the analysis of the data, the interview recordings were repeatedly listened to and compared with notes taken within the interviews to assist with the appropriate interpretation of interviewee responses before the coding process took place (Radnor 2001). Data was analysed using the qualitative analysis software NVivo9. This helped to categorize and order the case database that consisted of over 36 hours of recordings and over 800 pages of transcriptions, documents and notes. The transcriptions were initially coded in relation to PI practices, providing examples of PI activities within each firm. The OL conceptual framework (Table 1) was then used to direct and focus the analysis of the examples of PI, categorising them as taking place at different organisational levels, how the levels related to one another, and how these related to PI outcomes. While employing a defined coding approach to structure the analysis, the process remained open to allow the identification of emergent themes not included in the initial coding (Radnor 2001, Noke and Hughes 2010). As a result, the research was deductive in assessing whether PI practices and the achievement of CI could be better understood through the lens

of OL. The research was also inductive in terms of discovering key factors affecting the ability to benefit from and sustain process improvement activities within an SME context. External validity was provided by the OL theoretical underpinning (Barratt et al. 2011, Boer et al. 2015), allowing the development of a context-specific conceptual model of OL and PI/CI in SMEs.

Company specific case reports discussing process improvement were returned to each company for validation, helping ensure internal validity (Yin 2009, Noke and Hughes 2010). The validation of within case analysis was further augmented through follow-up interviews. The 4 case companies able to provide further meetings (ENG1, INJECT1, INJECT2 and BUILD) allowed the findings to be discussed in a holistic manner and validate whether the findings were representative of practices carried out within their firms. Case specific results were analysed in terms of how practices discussed with each firm related to the research framework, thus linking process improvement and organisational learning.

Each individual case report was independently reviewed in depth by the research team for corroboration. Similarities and differences in practices in the case companies were identified. Explicit methods were used (see section 5 below and Appendix 2a and 2b) to appraise the case companies and place into two groups – those that had strong PI/CI processes that enabled sustained benefits and those that had more limited processes in place and were less effective at engaging in, and sustaining benefits from PI. From analysis of interviews on improvement activities carried out over a number of years, it was possible to appreciate if and how improvement activities were made over time and their effects on the firm. From analysis of completed and on-going PI it was possible to elicit the extent that each firm was able to achieve and sustain benefits.

The cases were further reviewed and analysed to identify additional emergent, aggregate themes related to PI/CI and OL in SMEs. These were discussed within the research team and compared and contrasted between the more and less effective improvers. Emergent themes were also reviewed in the context of the existing literature (Eisenhardt 1989). This process supported a balance between the inductive identification of new themes and ensuring the external validity of findings by relating themes to established theoretical concepts (Barratt et al. 2011). Table 3 summarises the chain of evidence between PI/CI related discussion topics, the deductive, theoretically underpinned OL coding framework (Table 1), and emergent aggregate themes (Yin 2009). Following the in depth analysis and comparison between the two identified groups, a new conceptual model was developed grounded in the empirical evidence provided by the cases and informed by organisational learning theory. The new model is proposed to explain how organisational learning can be achieved effectively through PI/CI activities.

Table 3: Chain of Evidence

PI/CI Practice	Organizational Learning	Emergent Themes
Operator Responsibilities	Individual Behaviors	Management support of individuals
Group work	Group Discussions	Management providing resources for PI
Formal Procedures	Organizational Processes	Management providing opportunities for PI
Management Support	Policy/Procedure Development	Individual perceptions of PI
Training	Policy/Procedure Use	Benefits realized from PI

The following section provides brief summaries of the case companies in order to outline the context of the research. Example excerpts of the individual case data are presented, with interpretations of the data and their relationships to the coding framework.

4. Case Background and Within Case Analysis

4.1 Engineering Manufacturer 1 (ENG1)

ENG1 works in sheet metal fabrication, operating as a job shop that produces customer-defined parts for a range of industries including automotive, rail and heating. Formed in the 1960s, ENG1 had undergone a management buyout in the late 1990s, following which, attention had been given to updating machinery, developing human resource practices and implementing and developing procedures in the form of an accredited QMS. Table 4 provides indicative example quotes related to PI activities in ENG1, the purpose and role of such activities, and the organisational level at which they occurred. As with Tables 5 to 9 in this section, the table does not represent the totality of evidence on PI/CI and OL in this organisation. More detailed evidence is provided in the Tables 10, Appendix 2a, 2b and Appendix 3. In addition to involving staff in product and process development activities, attention was specifically given by management in ENG1 to introducing new business and new machinery.

Table 4: ENG1 Case Analysis

Illustrative evidence	Interpretation	OL dimensions
"*If it takes a group of you to get together before we found out we've got a problem, I'm sure the group will get together and work it out, and we'll find a solution*" (PE, ENG1)	Sharing knowledge and solving problems through group discussions	<u>Individual</u> behaviour, <u>group</u> discussions, policy development
"*while that first order was going through [PE] was redesigning the unit into component pieces... 'we've got it to you as quickly as we can'... 'for any new ones, we're offering this now'... we make samples and prototypes, [the customer] takes it away, builds it and says 'great, off you go'... we've had 3 orders off the back of that with the new design*" (MD, ENG1)	Proactively improving products to win repeat and new business	<u>Individual</u> behaviour, policy development, <u>organisational</u> process, policy deployment
"*We will get a new drawing, an issue will change, [production control will] change the [route] card and pass through to programming whatever necessary changes they need to make and the card's updated for next time*" (GM, ENG1)	Deliberately changing product designs and organisational processes	<u>Individual</u> behaviour, <u>group</u> discussions, policy development, <u>organisational</u> processes, policy deployment
"*steel was going up and we were frightened to go back to the customers ... 'we'll have to put our prices up', we made a policy that every time a job came through, we were going to re-evaluate it, and look at the products [to see what saving could be made], and I tell you what, that made a big difference*" (MD, ENG1)	Raw material costs initiating formalisation of individual developed PI activities	<u>Individual</u> behaviour, policy development, <u>organisational</u> processes
"*these guys have been at loggerheads, it's like they all wanted to prove to me, I kept saying that's not what I'm after, I know whose good at what, I want you to work as a team to produce the product*" (MD, ENG1)	Pursuit of individual goals affecting group behaviours	<u>Individual</u> behaviours, <u>group</u> discussions, policy deployment
"*If we can keep learning about their product, and making it better, and [the customer will] modify [their designs] slightly, they'll learn about us as well, and at the moment, they're working with us to improve [their product], which I wouldn't say it's guaranteeing the business, but it's going a long way to making sure we get it, and we can keep performing and showing them savings*" (GM, ENG1)	Working with customers to realise benefits and helping to win new business	<u>Group</u> discussions (inter-organisational), policy development, <u>organisational</u> processes
"*what we introduced a number of years ago is a bonus that pays if the business does well it pays a portion to everybody, so that tends to bring people together a little bit, so they know that if the company does well, they win... one got 15 thousand [pounds] and bought a BMW*" (MD, ENG1)	Organisational policies to motivate individual behaviours that promote working together	<u>Organisational</u> processes, <u>group</u> discussions, <u>individual</u> behaviour, policy deployment

"we've got quite a good level machinery… they're fairly new, fairly up to date, but also we're using some of the good old ideas...the idea is get a lot of good lads and pay them quite well… but we're bring them on [through training] at the same time" (GM, ENG1)	Management investing in equipment and staff to support individuals to make improvements	<u>Organisational</u> processes, Policy deployment, <u>individual</u> behaviour
"I've been involved with BSI for quite a while now, over these past two or three years they've come into the real world... it's that you're doing your management meeting minutes, or an informal discussion and it's actually more in line with being integral to your business rather than a bolt on... promoting CI" (GM, ENG1)	Operating systems both being viewed by auditors and managers as part of how the business operate.	<u>Organisational</u> processes, <u>individual</u> behaviours, policy deployment

4.2 Engineering Manufacturer 2 (ENG2)

ENG2 is a job shop manufacturer that has produced compressed plastic parts primarily for the oil and gas industry for over 30 years. Due to the growth of domestic oil extraction, ENG2 enjoyed consistent orders for profitable work. Individual operators produce products on specific machines, allowing processes to be adapted and refined by operators without updating procedures. Table 5 provides indicative example quotes related to the PI activities carried out within ENG2, the purpose and role of such activities, and the organisational level at which they occurred. Management in ENG2 were involved in the updating of formal procedures following customer feedback, but did not take an active role in supporting improvement activities that involved operational staff. While individual operators took some responsibility for improvements, they did not always follow procedures and tended to resist manager initiated changes to their practice.

Table 5: ENG2 Case Analysis

Illustrative evidence	Interpretation	OL dimensions
"the lads on the shop floor tend to [make improvements] as well… sometimes they don't even tell me, they just start doing it… it is very difficult getting people to interact" (MD, ENG2)	PI being made by individuals in isolation and not integrated into procedures	<u>Individual</u> behaviour
"you can spend weeks and weeks showing someone on the shop floor how to [use a new piece of equipment], and they get up and leave [the company], because you've given them an extra qualification, and they can now go and get a better job" (MD, ENG2)	Individual training not linked to in company development or internal improvement activities	<u>Individual</u> behaviour
"the bigger companies… have a [non-compliance report] certification, which usually has a part you have to fill in and send back, with reasons why/how this [problem] arose, what you're doing about it, what are you doing to stop it happening again, so it's corrective and preventative action… I like to see [the product]… see if there is any sort of link, any road you can go down, that tells you why it has happened" (MD, ENG2)	Formal problem solving processes to demonstrate to customers changes have been made	<u>Individual</u> behaviours, policy development, <u>organisational</u> processes
"at the moment, I don't go out and look for the new business because it comes to us in the way of an enquiry, or somebody rings up and says do you supply?" (MD, ENG2)	Management not directing the type of business being acquired	<u>Individual</u> behaviour
"I mean it's such a small [portion of non-conforming parts], at one time the ISO people used to insist we did a statistical graph and it was like a line running along on the bottom and it would be something like 0.08% rejects... miniscule sort of percentage, so it's … not even viable to record in any statistical way" (MD, ENG2)	Operations systems effective at preventing returns from customers but fewer opportunities for improvement	<u>Individual</u> behaviour, <u>organisational</u> processes
"Why don't you just have it as a straight edge?... it would be a lot cheaper for you, it would be a lot easier for us to make, we'd be able to do it a lot quicker for you', things like that, for ease of manufacture point of view, occasionally their draftsmen, the people who do these drawings have not got much knowledge of production" (MD, ENG2)	Involvement with customers helping identify improvement opportunities	<u>Individual</u> behaviour, policy development, <u>group</u> discussions (inter-organisational)

"*you get a bit too busy, people tend to skip things*" (MD, ENG2)	Procedures not always been followed by operators	<u>Individual</u> behaviour, <u>organisational</u> processes
"*you tend to, it sometimes takes me to not pick the best person for the job for the training, because you know he'll accept it better or he'll fit in better doing it, because he's got the dominance to do it and brush off any sarcasm or criticism*" (MD, ENG2)	Individual and group behaviours affecting the support management provide	Policy deployment, <u>group</u> discussions, <u>individual</u> behaviour
"*it's not telling them how to do the job, they already know how to do the job, it's telling them how to do the job and make sure they've checked everything they're doing*" (MD, ENG2)	Management instructing operators to follow inspection procedures	<u>Organisational</u> processes, policy deployment, <u>individual</u> behaviour

4.3 Injection Moulding 1 (INJECT1)

INJECT1 is an independent UK-based subsidiary of a global corporation. It had originally focused on injection moulded audio and video products for the consumer market. The subsidiary was founded in the early 1980s and grew rapidly to meet large demand for their products. Following contraction of existing markets, INJECT1 moved into the automotive sector in 2000. Table 6 provides indicative example quotes related to the PI activities carried out within INJECT1, the purpose and role of such activities, and the organisational level at which they occurred. Although a QMS was in place, due to resource limitations and resistance of operational staff to adhere to procedures, it had not been maintained or developed. In combination with the impact of the global financial crisis on the car industry, INJECT1 experienced problems to the point where an external party, employed by a major customer, provided support in making improvements. From the evidence, it was evident that INJECT1 experienced persistent problems and had limited upfront involvement with clients, tending to acquire similar repeat business or previously developed work won from competitors.

Table 6: INJECT1 Case Analysis

Illustrative evidence	Interpretation	OL dimensions
"*there is nothing down there in the first place, nothing to tell you where to find that information [can be found], place, there are no procedures… if you hit on a problem, you experience it, you obviously write it down for the next time*" (PM, INJECT1)	Individuals capturing their own learning rather than procedures	<u>Individual</u> behaviour
"*[individuals not accepting the need to change] is exactly what's happening in this business, and it's took years really, and even now, it's a total resistance to change, I mean we're forcing through the change, but even so, it's more difficult because they're resisting it*" (AOM, INJECT1).	Production resisting changes suggesting internally and by consultants	<u>Individual</u> behaviour
"*when you were sort of drafted into the moulding side, and they're not keen or friendly regarding the tools and things there, you realise very quickly that they haven't got it... it's like going back 20 years*" (PM, INJECT1)	Production staff actively resisting external support for improvement	<u>Individual</u> behaviour
"*[A tier one automotive supplier] chose 5 of their suppliers… we are one of the 5 suppliers, because [they] probably choose bad suppliers, we need to improve quite a lot, [the consultants] came along to us and then we work on improvement activities*" (PDM, INJECT1)	Working with consultants to improve operational performance for a customer	<u>Group</u> discussions (inter-organisational)
"*If we wanted to go on say two visits to China, just to prove the tool, it would be so costly, you might as well have had the tool made in England*" (PM, INJECT1)	Management attention on short term, lower cost options	<u>Organisational</u> procedures
"*The business required ISO; the only thing was it's not really kept pace with the business… so you are reviewing it in times of desperation*" (PM, INJECT1)	Operational procedures not used to direct normal practice.	<u>Organisational</u> processes, policy deployment, <u>Individual</u> behaviours,
"*we've got our own [improvement initiative], that's key to the business… it's all about lean manufacturing basically… [production are] not even at that stage yet… they keep slipping back*" (AOM, INJECT1)	Internal improvement initiative not supported by production	<u>Organisational</u> procedures, policy deployment, <u>individual</u> behaviour

"We're definitely overworked, that's a fact… we're asked to do unrealistic amounts of work, projects we have to get involved in, I mean [the quality manager] is off at the moment, we end up taking the slack" (AOM, INJECT1)	Insufficient resources for improvement practitioners to implement and maintain changes to practice	<u>Organisational</u> processes, policy deployment, <u>individual</u> behaviours
"We're looking for any business, [but] there is a fine line ... you can win business you can sometimes not really desire, but it's revenue… If you've been given a tool transfer, you've got age, quality issues, problems inherent in the tool design, because you don't know why it's actually been moved, it could be cost, it could be quality, could be other things, the customer is not really going to tell you" (PM, INJECT1)	Business strategy focusing on increasing business introducing problems but not PI opportunities	<u>Organisational</u> procedures

4.4 Injection Moulding 2 (INJECT2)

INJECT2 was formed in 1989 and developed from producing components for the double-glazing industry to supplying complex injection moulded components and assemblies to a range of industries. Exploiting the relatively high margin products of the double-glazing industry, INJECT2 accumulated the necessary equipment and developed complementary capabilities to maintain, design and manufacture their own tooling. Table 7 provides indicative example quotes related to the PI activities carried out within INJECT2, the purpose and role of such activities, and the organisational level at which they occurred. Within these processes, management provided resources for engagement in group activities, and supported individuals in taking responsibility for the improvements they made, which were subsequently integrated through management support into formal procedures. The continued introduction of new work offered additional opportunities to engage in beneficial improvement activities.

Table 7: INJECT2 Case Analysis

Illustrative evidence	Interpretation	OL dimensions
"it's okay for us to put plastic in a machine and squirt it and fill a mould tool but we've got to absolutely ensure that that is absolutely bang on the nail. And all the staff have to be responsible for that, and not able to just walk past and take no notice" (MD, INJECT2)	Consistent use of procedures with operators focused on identifying any deviation	<u>Individual</u> behaviour, policy deployment, <u>organisational</u> processes
"it was very satisfying for us but also for [the customer], it resolved a massive problem that he came to a small company, we were that full package, we could look at the design of the mould tool… raw materials… And that produced a first-class product" (MD, INJECT2)	Multiples skills and capabilities to solve complex customer problems	<u>Individual</u> behaviour, <u>group</u> discussions, <u>organisational</u> behaviour
"The best solution I find to resolving production problems is to involve everybody. And I said it recently to our stores department, 'I am not going to dictate to you how you should run the stores department.' I'll put some corn down for you and you pick up and run with it… And the beauty of that is then of course if you have that discussion, everybody's bought into it. You're not dictating to somebody because you know, we all made the decision collectively. I think generally… well it's not perfect, of course it's not, generally it works" (MD, INJECT2)	Management supporting operators in solving their own operational issues, drawing from individual knowledge developed through group discussions to promote acceptance of new approaches to working	<u>Individual</u> behaviour, <u>group</u> discussions, policy development, <u>organisational</u> processes, policy deployment
"when somebody comes back to you with a mould and says 'Look what's happened', it jumps out at you what's happened." (MD, INJECT2)	Individual knowledge to identify improvement opportunities and solutions	<u>Individual</u> behaviour
"The trick with [moulding engineers] is not to try and deskill them, it's to make them understand yes, your skill is, you set that on day one, you set the standard, you told us that that's the best and it's written down now" (MD, INJECT2)	Management justifying to operators how their knowledge contributes to procedures and how use of procedures uses their knowledge to ensure consistency	<u>Organisational</u> processes, policy development, policy deployment, <u>individual</u> behaviours, policy development

"*Because ultimately, we all want a wage increase it's as simple as that. And the only way we get that is by making more profit and the only way there's going to be more profit is to be more efficient.*" (MD, INJECT2)	Management justifying the need for PI in terms of increasing wages	<u>Organisational</u> processes, policy deployment, <u>individual</u> behaviour
"*No matter how innocent you think that request [to change tooling] is, that has to go through the procedure*" (MD, INJECT2)	Consistent use of, and change to, procedures to ensure appropriate outcomes of process changes	<u>Organisational</u> processes, policy deployment, <u>individual</u> behaviour

4.5 Systems Integrator (SYSINT)

Two engineers who had previously worked within a large control systems equipment manufacturer formed SYSINT in 2002. They had identified an opportunity to provide a better service in designing and delivering advanced manufacturing technologies (combinations of control and production equipment) to a range of '*blue chip*' clients. A major element of each of their projects was the provision of bespoke software that integrated separately manufactured, modular production and automation equipment. Table 8 provides indicative example quotes related to the PI activities carried out within SYSINT, the purpose and role of such activities, and the organisational level at which they occurred. Continuing problems experienced in SYSINT related to the software-writing element of the work. A range of issues resulted in a lack of responsibility being taken by individual engineers in adhering to procedures and management not formally implementing software writing procedures. Even though resources were directed to PI, it was apparent that the organisation had failed to make deliberate changes to address issues to exploit improvement opportunities.

Table 8: SYSINT Case Analysis

Illustrative evidence	Interpretation	OL dimensions
"*that's probably where we're a little bit weak because we've relied on experience and quality of individuals rather than processes*" (OD, SYSINT)	Procedures not relied upon to direct individual behaviour	<u>Individual</u> behaviour
"*It's very rare that [the Directors] make [significant errors and]… have to do significant rework, but we don't get the same out of our employees… And to me it's an attitude issue rather than a clear training issue*" (ED, SYSINT)	Individual experience and approaches determining the standard of work produced	<u>Individual</u> behaviour
"*So at the moment we're just trying to get… a group together and work out how we can review our software design process. It's one of those things that over the past 10/20 years has always been done in the same way*" (OD, SYSINT)	Trying to change long embedded individual behaviour through group activities	<u>Individual</u> behaviour, <u>group</u> discussions
"*So [operator's attitude] creates an atmosphere in an office that prevents people sharing. Me telling you a story, [then someone] will butt in and so suddenly [the engineers'] office can be very quiet and yet [the Directors'] office can be full of banter and laughter… it can be affected by just whether or not one person's in the office*" (PE, SYSINT)	Individual attitudes affecting the willingness to engage in open discussions.	<u>Individual</u> behaviour, <u>group</u> discussions
"*as soon as the housing market crashed and nobody was building houses, the aggregate business has plummeted… bars of chocolate has gone through the roof, can't do enough. People eat… in depression they eat chocolate and smoke cigarettes and guess who our two biggest customers are?*" (PE, SYSINT)	Business growth determined by sector growth, reducing the motivation for PI	<u>Individual</u> behaviours, <u>Organisational</u> processes
"*I suppose one of the challenges that we have is we do tend to find that projects are already identified, budgets are already planned and then we're bidding on the basis of cost*" (ED, SYSINT)	Limited opportunities to develop acquired work	<u>Individual</u> behaviour
"*they're actively pairing people up in projects to try and start making this merge happen but there's definitely a two culture existence*" (PE, SYSINT)	Managers taking steps to change how individuals approach their work	<u>Group</u> discussions, policy deployment, <u>individual</u> behaviour

"You kind of recognise the value of having a good quality management system behind you to back up whatever stories you want to tell [the client]" (PE, SYSINT)	Operational procedures supporting interactions with customers	<u>Organisational</u> processes, policy deployment, <u>group</u> discussions (inter-organisational)
"[management are] realizing that they must make the new people work to procedures for them to have a successful business… I think they've gone through a real pain barrier of wanting freedom and at the same time recognising that they've got to have structure" (PE, SYSINT)	Managers changing their view of the role of procedures	<u>Organisational</u> processes, policy deployment, <u>individual</u> behaviour
"we are ISO9000 registered for panel building; we're not registered for software, we're not registered for systems and solutions." (ED, SYSINT)	Quality management systems not integrated to the processes that cause the most issues	<u>Organisational</u> processes

4.6 The Building Contractor (BUILD)

BUILD was set up in 2001 to design, engineer and manage construction projects in the commercial sector, including warehouses and distribution centres for national supermarkets. A diversification strategy was pursued in 2008 to reduce the risk of operating within a sector where projects were at times pursued speculatively with bank funding. The diversification strategy included moving into the public sector, which was identified as an area of growth (at the time), which required the implementation of an accredited QMS. Table 9 provides indicative example quotes related to the PI activities carried out within BUILD, the purpose and role of such activities, and the organisational level at which they occurred. PI/CI was a part of BUILD's strategy to develop formal operational processes that supported improved consistency. Through management support to adhere to and update operational procedures, combined with working closely with customers, suppliers, and open group-based problem solving activities, BUILD were able to develop new solutions and deliver them consistently.

Table 9: BUILD Case Analysis

Illustrative evidence	Interpretation	OL dimensions
"all staff know each other, we talk, so if somebody comes up with an innovative idea, you know, 'well he did this', 'but he did that', 'oh that's right', well we have project manager forums a couple of times a year where we all sit around the table together and discuss processes, better ways of doing things... We are all for change, about questioning tradition, think outside the box, why are you doing this, well we've always done it like that, well why?" (PM2, BUILD)	Individuals willing to question existing perceptions on problems through discussions with other organisational members	<u>Individual</u> behaviour, <u>group</u> discussions, policy development, <u>organisational</u> processes
"If you can keep so called firefighting down to an absolute minimum, then the more that you forward plan, the less fires you have to put out in the future... keeping the existing customers satisfied, so that you can hopefully get the next job with that customer" (MD, BUILD)	Procedures to minimize predictable errors without being the focus of managers, allowing managers to focus attention on less predictable issues	<u>Individual</u> behaviour, policy deployment, <u>organisational</u> processes, policy development
"We're looking to be more effective on site by controlling [systems], it's a balancing act, keep the paper work down to spend more time on site" (PM1, BUILD)		
"all the staff that worked on those jobs have [gone] off around the industry somewhere else, possibly, invariably that's what does happen so all of the knowledge and skill of those jobs had gone" (MD, BUILD)	Procedures as a means of capturing learning from individual projects to be applied on future projects	<u>Individual</u> behaviour, policy development, <u>organisational</u> processes, policy deployment
"when we took the mechanical and electrical [subcontractors] up to their plant, [the] manufacturer was there, well they decided amongst themselves... talked about and drew up [their solution] on the drawing and that would have massively improved the time to connect the units on site" (MD, BUILD)	Group discussion resulting in updated procedures and the reduction of errors on site	<u>Group</u> discussions, policy development, <u>organisational</u> processes, policy deployment, <u>individual</u> behaviour

"this guy at [one location] was very, very helpful, and talked us through all the processes, 'this can shift if you do this', and he helped you to value-engineer the job… and because of that we're using him on several jobs now" (PM2, BUILD)	Suppliers providing knowledge on what they provide that support the adaptation of internal processes	<u>Group</u> discussions (inter-organisational), policy development, <u>organisational</u> processes
"when we're handing buildings over, there are generally less issues than there were 12 to 18 months ago… we go and talk to the client after the job has finished and gain their thoughts on the job, that is part of the ISO and the way that we've written up the system" (MD, BUILD)	Systems to direct interactions with customers to enable further improvement and prevent problems recurring	<u>Group</u> discussions (inter-organisational), policy development, <u>organisational</u> processes, policy deployment
"we're pushing hard [in one sector], they're active at the moment with this [economic] climate, hotels are still active, we're pushing in that [direction], we've got two tenders in at the moment and we're looking at who is actually spending money" (MD, BUILD)	Management actively pursuing a range of business opportunities that introduce opportunities for PI	<u>Organisational</u> processes

5. Cross Case Analysis

The six case companies provide a spectrum of engineering-oriented SMEs, ranging from INJECT1 and ENG2 that focused primarily on manufacturing to SYSINT and BUILD that emphasised the delivery of engineering services. BUILD and SYSINT engaged in only limited manufacturing processes compared to INJECT1 and INJECT2, each of which had clearly defined manufacturing processes using specialized tooling. Between these extremes were ENG1 and ENG2 with a balance of tangible production equipment and intangible knowledge and operator skills to provide physical products, as well as advice and services in the redesign of existing products. This range of firms has provided the foundation for the development of robust insights relevant to other engineering-oriented SMEs.

Consistent with the literature on PI, CI and OL, there were some broad similarities across the sample in some aspects of how firms engaged in improvement activities, from initial problem identification to adaptation of formal procedures, consistent with their quality system accreditation. Table 10 shows evidence of similarities across the firms on processes for managing problems reported by customers, which reflects the QMS in place and the requirements placed on them by demanding customers. Notwithstanding these similarities, the effectiveness of PI varied across the sample.

Table 10 Similar PI activities across the sample of companies

Acknowledging customer complaints
• Eng 1 - Formal internal procedures for receiving customer feedback
• Eng 2 - Internal and customer procedures for receiving and recording issues
• Inject 1 - Customers and internal procedures for receiving customer complaints
• Inject 2 - Formal internal procedures for receiving customer complaints
• Sysint - Problems are identified and noted during implementation in customer's facility
• Build - Customer meetings to discuss issues during and after projects
• **Informing personnel and operators involved in the process**
• Eng 1 - Shares customer issues with operators
• Eng 2 - Notifies operators responsible for non-conforming parts returned from customers
• Inject 1 - Shares revised inspection procedures with relevant operators
• Inject 2 - Shares issues raised by customers with supervisors and operators
• Sysint - Engineers are required to rework non-conforming software

• Build - Non-conformance issues are shared across projects and with relevant operators
Audit processes to ensure adherence
• Eng 1 - Audited control of route cards to ensure use of correct versions
• Eng 2 - QMS systems audited and direct observations made of operator practice
• Inject 1 - Inspection of operator practice by improvement staff and customers
• Inject 2 - Formal auditing of QMS combined with auditing of operator practice
• Sysint - Panel building procedures audited as part of QMS, software writing outside QMS
• Build - Formal auditing conducted of procedure use and on-site practices
Sharing solutions with customers
• Eng 1 - Return of corrective actions to customers
• Eng 2 - Completion of customer correction and preventative actions documents
• Inject 1 - Return of customer specified corrective action documents
• Inject 2- Sharing of internal corrective actions with customer
• Sysint - Operation of projects verified with customers before sign-off
• Build - Formal meetings with customers to share issues and solutions on completion of projects

The effectiveness of process improvement in each of these organisations was assessed using the totality of evidence gained from the study. Effective improvers were identified as those that were not only deliberate and proactive in their engagement in improvement activities, but where the empirical evidence indicated that they also derived sustained benefits from improvement activities. Less effective improvers were identified as those that engaged only in ad hoc, reactive improvement activities and where the empirical evidence indicated that sustained benefits were not realised and/or where persistent problems remained. Following review of each of the cases, there was agreement across the research team on the partitioning of companies into two groups. The approach is consistent with the case study methods adopted by others, such as Lockett et al. (2014) in the context of sensemaking about organizational change in healthcare.

Three of the firms (ENG1, INJECT2 and BUILD) were classified as effective improvers that showed clear evidence of sustained benefits from improvement activities. Appendix 2a provides specific evidence on (i) how each of these firms engaged in improvement activities, (ii) the internal and external support and engagement that were evident in undertaking improvement activities, and (iii) the types of sustained benefits generated. In all three of the effective improver cases there was evidence of benefits generated from improvement activities resulting in better competitive positioning of these firms to meet the requirements of new forms of business.

Three of the firms (ENG2, INJECT1 and SYSINT) were classified as less effective improvers that showed only limited evidence of sustained benefits from improvement activities and that had clear recurring or persistent operational problems. Appendix 2b provides evidence on clear deficiencies in how these firms failed to engage effectively in improvement activities, including evidence in different cases on the lack of management support for improvement activities, the limited engagement of relevant personnel in development activities that could enable improvement activities, and the types of outcomes experienced. In all three of the less effective improver cases there was evidence of improvement activities not being effective at resolving problems and a limited ability to seize opportunities to improve.

In summary, PI provided a mechanism for some systematic improvement in all six case organisations, allowing firms to account for changes in their operating environment and identified opportunities. However, due to a range of factors, not all firms were able to realize sustained benefits from PI or continually improve.

6. Discussion

In this section we discuss the insights gained from the study on how OL can occur through PI/CI activities. This builds upon the evidence presented in Appendices 2a, 2b and 3 to explain how the more effective and the less effective improvers were able, or not, to realise   OL through PI activities. The empirical validation provides evidence with theoretical underpinning for specific organisational mechanisms that help to identify and explain how OL occurs through PI/CI practices in SMEs (Research Question 1) and the factors that ensure sustained benefits are realized from PI/CI (Research Question 2). Building on the analysis and discussion, we propose a conceptual model that explains the achievement of OL through PI/CI in SMEs in section 7.

The lack of formal, consistently used and accepted operational procedures within the less effective improvers resulted in individuals within these firms developing their own approaches to completing work. Whether setting up moulding machines (INJECT1), operating CNC (computer numerical control) lathes (ENG2) or writing software code (SYSINT), personal experience accumulated through trial and error was the primary driver of practice. While developing personal expertise is essential to carry out some complex tasks, it also meant that individuals tended to be less willing to deliberately change, learn new practices or follow procedures if they were different to their personal practice. Whether taking account of feedback from customers, responding to direction from management (ENG2), working with external sources (INJECT1), addressing recurrent issues (SYSINT) or exploiting insights from individual staff (ENG2), it was difficult for the less effective firms to make and sustain changes to practices. In contrast, individuals in ENG1, INJECT1 and BUILD accepted deliberate changes to practice resulting from feedback from management, customers or staff. This was helped by procedures being developed by individuals through group discussions, which allowed them to perceive procedure changes as resulting, in part, from their own learning and knowledge, and thus being more willing to accept them.

The way in which individuals perceived improvement activities, engaged in group discussions, and adhered to operational procedures, highlight further factors affecting the ability of firms to engage in and sustain PI. The positive effects of individual perceptions in the effective improvers and the negative effects of individual perceptions in the less effective improvers could be identified. Building on how personal experience had developed, INJECT1 and SYSINT both highlight how such individually established behaviours were difficult to change. In comparison, management within ENG1, INJECT2, and BUILD gave significant attention to justifying new approaches and encouraging individual staff to accept new practices. This supported individuals in 'unlearning' out-dated practices, changing their perceptions and accepting new modes of practice. This is consistent with the findings from the PI (Bateman and Rich 2003), CI (Jørgensen et al. 2003, Lam et al. 2015) and OL (Fiol and Lyles 1985) literatures that identified such factors as important barriers to learning and sustained improvement.

Management support played a key role in determining whether the use of procedures was supported and the time that was provided for improvement activities. ENG2, INJECT1 and SYSINT showed that without support in these areas, it was difficult to effectively engage in and sustain changes made from PI, resulting in these firms engaging in ad hoc forms of improvement. In comparison, ENG1, INJECT2

and BUILD carried out practices that were more strongly consistent with the conceptual framework. They were able to proactively and deliberately change in response to customer feedback, identified improvement opportunities, and in pursuing and developing new business. Drawing from OL theory, effective improvers developed understanding of problems and opportunities within group discussions (Nonaka and Takeuchi 1995), with insights then captured within organisational procedures to be deployed in the future (Fiol and Lyles 1985). Management support was necessary to ensure that once developed, individuals took responsibility for adhering to these procedures.

Consistent with the PI/CI literature, following the initial pursuit of improvement activities, there can be a diminishing return of benefits as inefficiencies are eliminated (Zangwill and Kantor 1998). Within the case studies, this occurred due to major problems being identified, resolved and not recurring, with subsequent issues being less severe, and hence providing fewer benefits when solved. This gives rise to a paradox: if operational problems are resolved effectively, there may be fewer opportunities to engage in PI. A key issue, therefore, is whether the quantity and scope of improvement opportunities reduce over time: e.g. whether following effective engagement in PI activities, "*there is nowhere to go*" (PE, ENG1). The use of improvement suggestion schemes has been proposed in the PI/CI literature to sustain improvement activities (Bessant and Francis 1999, Lee et al. 2000, Jørgensen et al. 2003), as well as the introduction of incentives (Jørgensen et al. 2003) and formal infrastructure (Jørgensen et al. 2008, Anand et al. 2009). Apart from a general profit-sharing policy in ENG1, neither formal suggestion schemes, nor improvement-based incentive schemes were used in the case companies. However, some of the firms were still able to continuously improve with beneficial effects on the organisation because of the way that PI was viewed and supported. ENG1, INJECT2 and BUILD pursued developments through training staff, introducing new business, new process technology and working with new suppliers, which had a considerable impact on the nature and outcomes of PI activities. These activities were justified not only in terms of direct business arguments (e.g. increasing turnover), but as necessities for developing organisational capabilities to reflect current and future market requirements.

By neither deliberately identifying new business opportunities nor introducing new types of work, ENG2, INJECT1 and SYSINT continued their established behaviours and practices. INJECT1 and SYSINT did not have sufficiently close involvement with clients to allow individual staff to apply their knowledge. This was highlighted by INJECT1 and SYSINT working with customer-developed tooling and customer-defined project specifications, respectively. In contrast, ENG1, INJECT2 and BUILD proactively made changes to customer-defined designs, drawing from employee understanding in addition to capabilities of their suppliers to augment internal resources. New types of work required these firms to adapt internal processes through PI activities, resulting in a requirement to generate new insights, which could then be captured in new organisational processes necessary for consistently delivering new business. In contrast, for ENG2 that did not systematically introduce new business, the over-refinement of operational processes led to individuals resisting change, creating problems when it was necessary to introduce new equipment. While there is a requirement to maintain existing business, ENG2, INJECT1 and SYSINT illustrate the risks associated with the over-exploitation of existing processes that limit strategic development, reflecting OL theory (Levinthal and March 1993).

The introduction of new business can thus be viewed as a form of strategic management support necessary to provide opportunities to continue to engage in and sustain benefits from PI. This has not attracted explicit attention within the PI/CI literature, which has viewed the development of new products and processes as taking place only at the highest levels of CI maturity (Bessant and Francis 1999). Underpinned by organisational learning theory (Crossan et al. 1999), the research provides fresh

insights for the role of the introduction of new business in achieving CI and ultimately OL. However, there is a need to balance exploratory (new business) and exploitative (existing business) forms of learning to both develop new capabilities while generating revenue from existing capabilities. New business can therefore be viewed as a source of opportunities that can initiate improvement activities in SMEs, similar to problem solving and waste reduction activities that have been the typical focus of PI/CI (Zangwill and Kantor 1998, Jørgensen et al. 2003, Bateman 2005).

7. Conceptual model of organizational learning through process improvement

We answer our two research questions through a conceptual model (see Figure 2), which was developed to show how OL can occur through PI in SMEs using the evidence gained from the analysis of the cases studied. In the context of engineering-oriented SMEs, the proposed model captures both the mechanisms by which learning occurs through PI/CI practices (Research Question 1) and the factors that influence the effectiveness of such learning in achieving and sustaining organisational benefits (Research Question 2).

The model presented in Figure 2 shows six main *effects*. The arrows show the direction of each effect as explained below. Appendix 3 provides specific evidence from each of the sustained improvers of the existence of each of the effects delineated in the model. Appendix 3 also highlights specific evidence of the behaviours present or not within the non-sustained improvers related to each of the effects.

1) Individual perceptions play a key role in determining individual PI behaviours, which themselves impact individual perceptions (Effects 1.1 and 1.2). Individuals in the more effective improvers were willing and able to reflect on their own practices, question established approaches and perceive new ways of working (*Effect 1.1*), and change behaviours (*Effect 1.2*) when necessary. Without an ability to perceive new ways of working, individuals within the less effective improvers tended to maintain their personal perceptions of how processes should work (*Effect 1.1*), resulting in an unwillingness or inability to engage in problem solving activities, reinforcing existing behaviours that emphasised trial and error (*Effect 1.2*).

2) Individuals are willing and able to contribute problem solving and process knowledge to groups, leading to the development of new procedures that are effective for the organisation (Effects 2.1 and 2.2). For SMEs to engage in relevant and effective PI, it is necessary for individuals to discuss their experience of operational issues in group settings. Individual perceptions and behaviours influence their willingness and ability to contribute to group level discussions and problem solving (*Effect 2.1*). Following the development of solutions within groups, solutions need to be captured in organisational processes (*Effect 2.2*). In the more effective improvers, individuals were willing and able to contribute personal knowledge to group problem solving in developing solutions and new processes. Individuals in the less effective improvers were less willing to share individually developed approaches to working (*Effect 2.1*) and the organisations tended not to have formal systems in place to capture solutions (*Effect 2.2*).
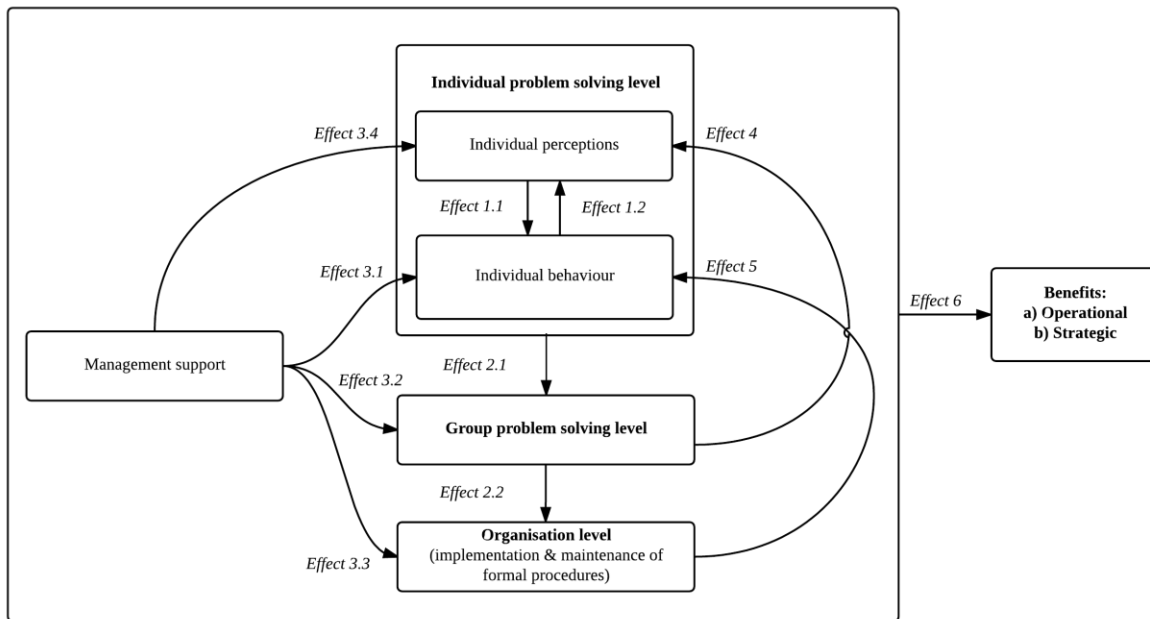
Figure 2: Conceptual model for OL through PI in SMEs

3) Management support is essential at all levels of process improvement and problem-solving (Effects 3.1 to 3.4). The requirement to engage in PI needs to be stipulated by management to become an established organisational behaviour and the resources necessary to enable PI need to be provided at all three levels – individual, group and organisation. These include supporting individuals (via training and time) to follow procedures (*Effect 3.1*), providing time and resources to develop solutions at the group level (*Effect 3.2*), and implementing, maintaining, and mandating the use of procedures at the organisational level (*Effect 3.3*). Individual perceptions of PI can also be influenced by direct management intervention to explain and justify changes or the need for changes and improvements (*Effect 3.4*). In the more effective improvers, management support was evident in all problem-solving activities, and included personal support to change individual perceptions of PI. In contrast, in the less effective improvers, management was not actively involved in engaging operational staff in the need to accept new procedures. Management in the more effective improvers also provided critical organisational level support (*Effect 3.3*) by introducing new types of business that provided additional opportunities to engage in group problem solving, that required the introduction and learning of new procedures and process techniques. Within the less effective improvers, this element of management support was largely missing.

4) Group problem solving affects perceptions of individuals (Effect 4). Involvement in group problem solving affects individual perceptions of solutions and PI activities, improving acceptance of solutions. When individuals are willing to engage and contribute to group activities, group interactions and discussions, they are able to develop new insights on improvement opportunities, building on the experience of others, which leads to changes in their perceptions. A lack of participation in, or acceptance of group activities results in individuals maintaining their existing perceptions. By engaging in group problem solving, individuals in the more effective improvers were able to develop their perceptions of solutions and PI activities by building on the experience of peers and managers, improving the likelihood of them accepting developed solutions. Within the less effective improvers, a lack of involvement and acceptance of group activities allowed the maintenance of existing individual perceptions.

5) Formal organisational procedures affect individual behaviour (Effect 5). Formal procedures, when adhered to, directly affect individual behaviour and become accepted behaviour determining how individuals engage in operational activities. Through the repeated use of procedures, codified knowledge becomes part of an individual's tacit knowledge, affecting their perceptions. In the more effective improvers, documented organisational procedures were integral to how individuals operated. The absence of formally supported organisational procedures in the less effective improvers resulted in individuals maintaining personal operational behaviours and approaches to PI.

6) OL through PI can result in both operational and strategic benefits (Effect 6). Operational benefits are expected from PI activities and these were evident across the case companies (Effect 6a). Strategic benefits support firms in securing repeat business, working with new customers and in changing internal processes to support on-going organisational change (Effect 6b). In the more effective improvers, deliberate changes to product designs and processes provided reductions in costs and lead times, leading to the introduction of additional development work with new and existing customers. The less effective improvers exhibited only limited *ad hoc* operational improvements and were unable to engage in long-term firm development through PI activities.

The proposed model provides new insights on how PI activities in SMEs take place and how they relate to organisational level outcomes. The model extends previous research on PI (Bateman 2005) and CI (Bessant et al. 2001, Jørgensen et al. 2003), by explaining the mechanisms through which PI practices, when supported, can result in beneficial organisational learning in SMEs. In particular, the findings and proposed model highlights the roles of individual perceptions, group activities, organisational procedures, and management support in facilitating effective process improvement. This new insight builds upon Barton and Deldridge's (2004) ideas of discretionary effort, with the need to support and justify to those involved in PI activities the importance of making an effort and engaging fully in such activities**.** The findings also build upon Lam et al. (2015) by illustrating of critical role of management in building employee commitment to improvement activities. By identifying a lack of opportunities and individual perceptions are barriers to OL in SMEs, the research is also able to make contributions to OL theory, in terms of how individual perceptions impact learning at different levels of the organisation (Crossan et al. 2011).

Our research provides evidence for the dynamic nature of learning through PI in the SME context across the three levels of OL identified by Crossan et al. (1999). From the identification or introduction of improvement opportunities at an individual level, through the achievement of shared understanding and the development of improved operational processes at both individual and group level, revised procedures can be implemented at an organisational level, which ultimately results in organisational benefits. This is consistent with the findings of Altinay et al. (2015), who found that OL enabled firm to be entrepreneurial by providing a process for translating opportunities to business level benefits. How the different levels relate to one another are consistent with the conceptual research framework and the feed-forward and feedback processes identified by Crossan et al. (1999). The nature of groups in SME learning processes often involves inter-organisational groups with customers and/or suppliers and is consistent with the findings of Jones and Macpherson (2006), reflecting the need for SMEs to extend their limited resources. Additionally, the critical role of management support is evident at all levels for effective organisational learning to occur.

Although management support for group activities is vital, there was little evidence of organisational procedures impacting directly on group level behaviours in our sample. The lack of such effects is consistent with what would be expected given the nature of SMEs that tend to focus their

formalised operational procedures on revenue generating processes (Terziovski 2010). Many of the group activities resulted from the introduction of new business, interaction with customers or suppliers and the identification of problems. Group behaviours were more informal (Marlow et al. 2010) and hence were not directed by operational procedures. However, for larger organisations, with more formal organisational structures, it is likely that the feedback loop from the organisation to the group level would be more clearly evident in stipulating group-related organisational procedures and policies.

8. Conclusions and Research Implications

The research has studied a spectrum of engineering-oriented SMEs, ranging from those focused primarily on manufacturing to those with a greater emphasis on providing engineering services. Applying an organisational learning lens across the six cases has helped to explain how effective and sustained process improvement with learning can occur in SMEs. The study makes contributions to theory and practice of PI/CI and OL in SME contexts.

The research has used an appropriate theory of OL to structure, analyse, and interpret observations of practice. A new conceptual model is presented that enhances our understanding of the relationships between PI/CI activities, OL, and the benefits that may be realised in SMEs. The conceptual model provides contributions to PI/CI and OL theory by explaining how different elements of PI, some identified in previous literature, relate to one another and to organisational outcomes. The research develops existing theories on PI/CI, emphasising the multi-level nature of effective process improvement that can generate learning of benefit to organisations. It provides insights on how problems are solved, how knowledge is created, captured and embedded into organisational systems, and later deployed over time. It also highlights factors that act as barriers to OL, in particular how individual perceptions can act to block these multi-level processes. The findings emphasise the critical role that management support plays at every level – individual, group and organisational levels. It also emphasises the strategic support that management can provide to maintain improvement opportunities by introducing new business into the organisation that requires continual process development and improvement.

The research has implications for SMEs and for policy makers in supporting and accelerating the development of OL in smaller firms through PI activities. Most directly for practice, it highlights the need for PI/CI activities to be viewed and supported at three levels – individual, group and organisation. Managers must understand their critical role in providing support at each level and in particular their role in influencing individual perceptions by emphasising the value that the organisation places on improvement, the need for individuals to engage positively in PI, and the need to follow procedures that have been formally established. The research also sends a message to managers that, notwithstanding the challenges of engaging in new forms of business, it can have a beneficial organisational effect in generating improvement opportunities for individuals and groups, resulting in beneficial organisational learning.

The study provides significant new empirical evidence to support the findings but, as with any study of this type, there are limitations. Building upon our findings, further research could be conducted to develop appropriate measurement constructs for the identified mechanisms and factors, relevant to the SME context, to form the basis for survey research. These could test specific relationships or the mechanisms and structure of the presented conceptual model across a larger number of firms. Such research could also assess more objective measures of process improvement and the benefits realised, for example, the number of changes to operational procedures, new product introductions, level of investment in new machinery or profitability of work. Additionally, longitudinal studies, although time

consuming and resource-intensive to conduct, can add rich insights to our current understanding, helping to further explore causal relationships and processes of organisational evolution that enhance learning. Such research may provide new insights into how individual perceptions of PI change over time, how individual insights are integrated in group discussions, and the processes of selecting which insights are captured in procedures. Notwithstanding these limitations, the findings presented in this research provide a foundation, structure, and motivation to conduct such studies, with the new conceptual model of OL providing a framework through which to interpret findings.

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Appendix 1: Interview Protocol
Demographic
- Could you describe the nature of your job, with details of the different activities it involves?

General
- What continuous improvements initiatives are you undertaking at the moment?

Training
- What training programmes do you have in place?

Process Improvement
- On receipt of a non-conforming, what activities take place to resolve them?
- Is there a structured approach to problem solving?
- Do you have time formally allocated to resolving issues and implementing identified improvement opportunities?
- Can you describe the quality control processes of some of the parts you produce?
- How is the performance of corrective actions measured?

New Product Development
- When introducing new business, what activities does this involve?
- To what extent are customers involved in this process?
- To what extent are suppliers involved in this process?

Process Review
- How are new product developments and process improvements documented?

General
- What other forms of process improvements take place (including changes to production machinery)?
- What is the general perception about the continuous improvement program among employees?
- In relation to return on investment, customer satisfaction, number of defective parts, waste and other measures of performance that are important to you, how does process improvement affect firm performance?

Appendix 2a:

	Appendix 2a
	Evidence from the more effective improvers
How	**Groups developing new procedures** • Eng 1 – specific evidence of the output of group discussions resulting in new procedures being developed • Inject 2 – specific evidence of solutions being developed and captured in new procedures • Build – specific evidence of project manager and supplier meetings resulting in developed and new procedures
	Dedicated improvement practitioners • Eng 1 – specific evidence of a project engineer responsible for coordinating improvements and developing new products • Inject 2 – specific evidence of a project manager responsible for introducing new business • Build – specific evidence of consultant employed to introduce new operational procedures
Support and Engagement	**Engage staff and operators to develop solutions** • Eng 1 – specific evidence of operators proposing changes to processes and procedures • Inject 2 – specific evidence of operational staff given responsibility to develop solutions to recurring operational problems • Build - specific evidence of working with different trades to develop new practices and inspection procedures
	Utilise groups to share process knowledge • Eng 1 - specific evidence of group discussions to utilise process knowledge of operational staff to develop solutions • Inject 2- specific evidence of supervisors and operational staff forming cross functional groups to discuss and develop solution • Build - specific evidence of project managers, customers and suppliers discussing problems in regular project meetings to develop solutions
	New business introduced that requires internal developments • Eng 1 – specific evidence of the requirement for new machinery and processes to manufacture new business • Inject 2 – specific evidence of actively introducing new processes to be able to satisfy additional customer requirements and win new business • Build – specific evidence of implementing a third party accredited QMS to meet requirements of public sector customers
	Involvement with customer supported product development • Eng 1 – specific evidence of working on the development of existing and new product designs with customers • Inject 2 – specific evidence of early stage product development work with customers to match product designs with process requirements

	• Build – specific evidence of redesigning customer solutions based on process knowledge and further developing designs with customers
	New equipment and suppliers proactively involved in product development • Eng 1 – specific evidence of working with equipment suppliers to learn process capabilities to apply to product development • Inject 2 – specific evidence of working with materials and equipment suppliers in order to apply learning to product development • Build – specific evidence of on-site involvement with suppliers leading to changes in product design
Benefits	**Benefits Realised from process improvement** • Eng 1 - specific evidence of operational cost reductions helping to address the problem of increased material costs and win back previously lost business. Development of product designs to account for process requirements supporting the reduction of cost and improvement of functionality while maintaining profitability of work, enabling further investment in staff and new machinery.
	• Inject 2 – specific evidence of improvements in operational capabilities supporting the consistent running of machines and processes to ensure consistency and reduce errors. Improvements in product and tooling design to support the introduction of new business by adapting product designs to improve manufacturability and reduce cost. Development of tooling designs and manufacturing capabilities to enable short-run, high value added manufacturing, leading to further introduction of new process equipment.
	• Build – specific evidence of on-site process improvements to solve problems that are now captured in formal systems and transferred across projects, helping to improve consistency in subsequent projects. The design team, with suppliers, introducing new building techniques to reduce costs, improve consistency and reduce build programme duration, aiding the winning of new business and supporting the implementation of innovation originating from suppliers.

Appendix 2b:

	Appendix 2b **Evidence from the less effective improvers**
	Developing solutions individually • Eng 2 – specific evidence of operators changing processes and not documenting changes • Inject 1 – some evidence of operators changing process settings resulting in changes to product characteristics and non-conformances • Sysint – consistent evidence of the project engineer developing software without support from management to develop formal procedures
How	**Largely individuals making changes to production and inspection procedures** • Eng 2 – consistent evidence of senior management developing and implementing formal procedural changes without engagement of operational staff • Inject 1 – some evidence of project and quality management staff developing procedures individually

Support and Engagement	• Sysint – specific evidence of the project engineer developing procedures without support from management to develop formal procedures
	Limited involvement by the firm in product development • Eng 2 – specific evidence of only ad hoc involvement in refining existing product designs • Inject 1 – specific evidence of the acquisition of work with pre-approved tooling, leaving limited opportunities for development • Sysint – specific evidence of only key personnel informally discussing product development opportunities with customers
	Limited involvement of personnel in any product development that takes place • Eng 2 – specific evidence of only the Managing Director being involved in product development • Inject 1 – limited evidence of direct involvement in the development of products, with only the project manager working with customers • Sysint – specific evidence of only key personnel informally discussing product development opportunities with customers
	Investment in product equipment to carry out current business • Eng 2 – some evidence of investment in new machinery to replace existing, outdated machinery • Inject 1 – limited evidence of investment in new machinery, primarily using existing, under-utilised machinery • Sysint – some evidence of engineers learning about new process technologies, but limited opportunities to apply learning, but management attention focused on refining personal approaches to writing software
Some benefits but persistent problems	**Effects of process improvement activities, and persistent and/or recurrent problems** • Eng 2 – some evidence of cost and cycle time savings through involvement with customers and transferring improvements across products during ad hoc new product introduction. Operators unwilling to engage in formal improvement practices, creating problems with following procedures leading to repeated errors from resistance to changed practices. Risks expressed of staff leaving the firm following training on new equipment. • Inject 1 - limited evidence of improvements occurring with operators focusing on refining previously approved procedures and resisting formal changes to practice. Some support from external parties and internal improvement activities promoting improvements, but operators not engaging with improvement activities nor adhering to new procedures, and reverting to previous practices over time leading to repeated errors. Lack of involvement in product development work meaning work primarily won on direct, price based competition. • Sysint – some evidence of improvements in project coordination resulting from the implementation of formal procedures but operational problems frequently recurring due to inconsistencies in individual engineers' practice. The need for changes in practice not demanded/mandated by management, enabling error creating practice to continue and not formally addressing issues of poor attitudes of engineers that prevent the sharing of ideas and insights. Lack of formal involvement in the development of projects with customers limiting opportunities to add value, with projects being won on cost.

Appendix 3:

	Appendix 3 Evidence of Effects	
	More effective improvers	**Less Effective improvers**

Effect 1	Individuals' willingness to reflect on own perceptions of practice and question established approaches to operating and change behaviours • Eng 1 – operators reflect on existing practices when informed of problems to consider new approaches (Effect 1.1) • Inject 2 – operators accept feedback and change practices to prevent reoccurrence (Effect 1.1, 1.2) • Build – project managers accept new ways of operating in an effort to improve project outputs (Effect 1.1, 1.2)	Individuals maintain personal perceptions of PI as an individual activity that results from trial and error • Eng 2 – incremental changes to practice to make operations easier or quicker (Effect 1.1, 1.2) • Inject 1 – established practices of refining machine settings to reduce cycle times (Effect 1.1, 1.2) • Sysint – individually developed expertise and refinement of practices as a result of experience (Effect 1.1, 1.2)
Effect 2	Individuals able to contribute personal knowledge to group problem solving and development of processes • Eng 1 – individuals proposing ideas in group discussions that are combined and refined to develop solutions (Effect 2.1, 2.2) • Inject 2 – contributing process understanding to group discussions (Effect 2.1) • Build – Individuals drawing from past project experience to develop solutions with other project managers (Effect 2.1)	Resistant to sharing individually developed approaches to working in groups and not capturing solutions • Eng 2 – operators unwilling to share individually developed approaches with colleagues or management (Effect 2.1) • Inject 1 – production personnel unwilling to be involved in improvement activities and limited procedures in place (Effect 2.1, 2.2) • Sysint – attitudes of individuals stopping the sharing of ideas in group settings and procedures not followed for particular activities(Effect 2.1, 2.2)
Effect 3	Management support given to all problem-solving activities at all levels, including personal support to change individual perception of PI • Eng 1 – QMS integral to operations with personnel and resources directed to PI (Effect 3.1, 3.2, 3.3, 3.4) • Inject 2 – QMS supported and individuals given time, resources and support by management to make improvements to change practices (Effect 3.1, 3.2, 3.3, 3.4) • Build – QMS implemented as company strategy, formal project manager meetings supported, and design teams to develop product designs (Effect 3.1, 3.2, 3.3, 3.4)	Management not actively involved in engaging or supporting operational staff in PI or in accepting procedures • Eng 2 – use of procedures supported by management but resources not given to involve operational staff (Effect 3.1) • Inject 1 – limited evidence of presence of operational procedures and production staff focused on delivery related issues (Effect 3.1, 3.3) • Sysint – resources provided to group discussions but the use of software writing procedures not actively supported (Effect 3.2, 3.3, 3.4)
Effect 4	Involvement in group problem solving affects individual perceptions of solutions and PI activities, improving acceptance of solutions • Eng 1 – group discussions build on operator understanding to develop solutions • Inject 2 – groups of operators given responsibility for proposing their own solutions	Lack of involvement and acceptance of group activities, maintaining existing perceptions • Eng 2 – procedures justified with the need to maintain accreditation with operators not involved in changes • Inject 1 – individual operator practice focused on individual expertise

	• Build – developing and justifying solutions based on the experience of peers	• Sysint – involvement in group discussion not linked to changes in practice
Effect 5	Organisational procedures become accepted behaviour for individuals • Eng 1 – procedures seen as integral to directing individuals behaviour • Inject 2 – procedures viewed as documented best practices to be adhered to • Build – procedures stipulated by management as necessary to key customers and improving consistency of projects	Individuals maintaining personal PI approaches and personal operational behaviours • Eng 2 – operators diverging from procedures when not directly observed • Inject 1 – lack of supported procedures affecting operator behaviour • Sysint – management accepting that individuals carry out work in different ways with different results
Effect 6	Deliberate changes to product designs and processes (OL) provide reductions in cost and lead time, leading to further introduction of additional development work with new and existing customers. • Eng 1 – reductions in product costs through redesign leading to repeat and increased volume of orders (Effect 6a, 6b) • Inject 2 – improved production consistency and the acquisition of design and development short run, high value-added production work (Effect 6a, 6b) • Build – significant reduction of lead-time leading to winning business and moving into other sectors (Effect 6a, 6b)	Limited ad hoc and gradual operational improvements but improvement efforts not contributing to long term firm development • Eng 2 – changing production methods to reduce cost and improve profitability (Effect 6a) • Inject 1- address short term customer quality concerns (Effect 6a) • Sysint – reduction in the number of errors in material ordering but limited evidence of improvement in software writing procedures over time (Effect 6a)