Lean Thinking and Organisational Learning: How Can They Facilitate Each Other?

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Abstract Academic study of both lean thinking and organisational learning has evolved and is now mature enough to warrant an in-depth review of the practices and issues of each approach. This study explores how lean thinking and organisational learning can facilitate each other's implementation and provides a conceptual model for future research and practice. The model shows the connections between organisational learning and lean thinking which is based on three propositions: (1) single-loop learning which focuses on error detection and correction in the current management system is closer to the tool-based lean approach while double-loop learning which emphasises changing the underlying governing values in the current system is closer to the sustainability-based lean approach; (2) both single-loop and double-loop learning can be operationalised and facilitated through employing a lean culture and a range of lean tools and (3) building organisational memory and institutionalising learning are the two solutions to enhance the sustainability of lean thinking.

Keywords Organisational learning · Lean thinking · Continuous improvement · Single-loop learning · Double-loop learning

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1 Introduction

As organisations increasingly have to compete against global competitors, researchers and practitioners have developed a number of management concepts and techniques. Amongst the most popular is the concept of lean production, or lean thinking (LT), based on the Toyota Production System (TPS) and popularised by the book entitled "*The machine that changed the world*" (Womack et al. 1990). Since the term "lean" entered the business management lexicon (Krafcik 1988) many organisations have applied, or attempted to apply, the principles of LT. Academic study of lean organisations, and research into lean, is now mature enough for reflection on this significant business improvement methodology.

Lean researchers (e.g. Bicheno and Holweg 2009; Hines et al. 2011) propose that developing the knowledge of workers by continual learning contributes to the fifth principle of lean, that of continuous improvement; this is confirmed by Wong et al. (2009) in the context of superior performance in project management and by Barton and Delbridge (2001) in a discussion on contemporary manufacturing in the context of a "learning factory". Although the importance of organisational learning (OL) has been widely discussed, West and Burnes (2000) point out that, given the complexity of business management, employing one management concept or method, such as OL, is insufficient for organisations to achieve success. It is argued that researchers and practitioners still tend to consider OL and lean as two distinct concepts due to the unclear understanding of the connection between these two concepts (Flinchbaugh 2008). Based on a synthesis of the literature this study provides a conceptual model to illustrate this connection. The overall aim of this study is to illustrate the ways these two concepts can facilitate each other's implementation.

The remainder of this chapter is organised as follows: first, the research method adopted in this study is presented. The literature related to LT, including the evolution of the definitions of lean and approaches to becoming lean is then examined. Third, the definitions, typologies and levels of OL is also reviewed. Fourth, the ways to operationalise OL through lean and to enhance continuous improvement through OL are then analysed. A conceptual model is proposed to explain the theoretical linkages between these two concepts. Finally, the implications of the study and the areas of further research are identified.

2 Research Method

A conventional and narrative literature review is conducted in this study. Compared to the systematic literature review which follows a step-by-step guideline (e.g. Tranfield et al. 2003) and usually generates quantitative results through meta-analysis and hypothesis-testing (e.g. Glass 1976; Rosenthal 1995), a narrative review enables researchers to link studies with different topics together and

provokes new thoughts or controversy (Baumeister and Leary 1997). In other words, the narrative review is considered as a valuable theory-building and hypothesis-generating technique (Baumeister and Leary 1997). To search and identify the relevant literature in this narrative review, Bates' (1989) "berrypicking" techniques are adopted. Bates (1989) argues that the classic information retrieval model views a literature search as a linear and fixed process. However, in practice, most information or literature searchers start with a broad topic or one reference and then move forward to other related materials (Bates 1989). During the literature search process, the researcher can identify useful information or references (Bates 1989). The initial query can be satisfied by a series of selections of references and bits of information based on the ever-modifying search (Bates 1989). This "a-bit-at-a-time" information retrieval is termed as "berrypicking" (Bates 1989). Bates (1989, 1990) offers a number of techniques to carry out "berrypicking". Two of them are commonly used in the social sciences and humanities, including footnote chasing (i.e. also known as "backward chaining", it focuses on following up the references or footnotes of literature that the researcher is interested in and moving backward to other related literature) and citation searching (i.e. it starts with a citation and then finds out what other literature has cited it) (Bates 1990). In this study, the two most frequent cited (i.e. the times cited are calculated by Web of Science database) papers of lean (i.e. Hines et al. 2004; Shah and Ward 2003) and OL (i.e. Levitt and March 1988; March 1991) are used as the starting point of literature search. Footnote chasing and citation searching techniques are employed to identify more related literature. The key articles and books reviewed in this study can be found in both the review and discussion sections.

As this study aims to explore how LT and OL can facilitate each other's implementation, the reviewed LT and OL literature needs to be synthesised. The qualitative meta-synthesis method is used in this study. Unlike the meta-analysis which attempts to increase the certainty in cause and effect relationships in a specific area, the qualitative meta-synthesis method is more hermeneutic and it can facilitate the researcher to understand and explain findings (particularly qualitative results) of different literature and develop more formalised knowledge for a certain discipline (Sandelowski et al. 1997; Walsh and Downe 2005). Zimmer (2006) agrees that the qualitative meta-synthesis can assist the researcher to develop the theoretical framework in a specific area. Walsh and Downe (2005) suggest three common analytic techniques to conduct the qualitative meta-synthesis. The first is determining how literature is related by a compare and contrast exercise. The second one is reciprocal translation which means translating one study's findings into another by using commonly applicable concepts (Walsh and Downe 2005). The third technique uses the synthesis of translation to develop more refined concepts and core themes (Walsh and Downe 2005). In this study, the commonalities and differences across different literature in LT and OL can be found in the review section and the discussion section shows how the different concepts discussed in LT and OL literature can be connected. Three propositions are developed in the discussion as a result of refining the LT and OL literature and a conceptual model is presented in the conclusion section to visualise these propositions.

3 Review of LT

3.1 Definitions of Lean

A review of the lean literature shows that, although it has been almost a quarter of a century since the term "Lean" was coined by Krafcik (1988) to describe the Japanese automobile production system, there is no standard definition of lean (Shah and Ward 2007). Some researchers posit a tool-based definition and thus, lean means the application of various lean tools or techniques including value stream mapping (VSM), 5S, visual management, for cost reduction (e.g. Achanga et al. 2006; Faisal et al. 2006).

Womack and Jones' (1996) established five lean principles, namely: specifying value (i.e. customer value); identifying the value stream, making product flow smoothly; building a pull system (i.e. information flows from ultimate customer to raw material providers) and perfection. They argue the key to lean is the change from a push to forecast, or stock, system towards a pull, or flow, to actual customer demand system (Chen et al. 2010). Hence, they propose a system-based definition (also see Cooper 1996; Hopp and Spearman 2004; Shah and Ward 2003), which implies that lean, is a demand-driven operating system. In addition to the tool-based, system-based definitions, some researchers demonstrate lean as a management philosophy, and a set of guiding principles, that leads organisations to add value (see Womack and Jones 2005) as well as banish waste (see Bicheno and Holweg 2009; Staats and Upton 2011; Ward 2007) through continuous improvement (e.g. Bhasin and Burcher 2006; Hines et al. 2011; Liker 1996; Shah and Ward 2007). Researchers including Bhamu and Sangwan (2014), Holweg (2007), Moyano-Fuentes and Sacristán-Díaz (2012) and Samuel (2012) argue that lean is polymorphic and evolving, thus forming a precise definition is difficult and would only be applicable to that moment in time before a new understanding emerged. Therefore, whilst a universally accepted single definition of lean is elusive, considering it as a philosophy, or a combination of other meanings, provides more opportunities for researchers to gain comprehensive understandings of the essence of lean.

3.2 Approaches to Implementing Lean

A shop floor based view of lean still emerges as a prominent way of implementation. As argued by Bhamu and Sangwan (2014), Moyano-Fuentes and Sacristán-Díaz (2012) and Shah and Ward (2003), many lean related studies just focus on applying a single or some lean practices to the shop floor. The essence of this shop-floor based view is smoothing and improving operational processes through the application of lean tools. For example, managers employ a variety of mapping tools to identify the value-added and non-value added activities of each process.

From this they can reduce the operating costs by eliminating non-value added activities and re-organising value-added activities. Examples such as the application of 6S, cellular manufacturing and Kanban can be found in the literature (e.g. Gupta et al. 1999; Kobayashi et al. 2008; Kotani 2007; Marria et al. 2012; Tardif and Maaseidvaag 2001; Witt 2006). However, many researchers criticise this perspective arguing that, although the organisation could benefit in the short-term from improved efficiencies by the application of lean tools, these will often disappear in the long term (Lucey 2009; Lucey et al. 2005; Jackson et al. 2008; Hines et al. 2011). Hence, it is usually necessary to consider lean from a holistic systems perspective and to extend the approach across the entire organisation at both strategic and operational levels (Bhasin 2012).

Hines et al. (2004) built a framework for lean which revealed that, at a strategic level LT should be guided by the five lean principles whilst at an operational level, a lean implementation is composed mainly of tool-based activities. This idea is later supported and developed by Rich et al.'s study (2006) where the foundation of the "house of lean" model consists of deploying easy-to-use lean tools such as 5S and visual management. To build the house, the walls should cover quality control, system maintenance and pull systems, which strongly support the organisation's daily operations. The authors point out that the roof should contain policy and key performance indicators (KPIs), which should reflect, and be in accordance with, lean principles (Rich et al. 2006). Although the model extends lean implementation from the shop-floor level to a strategic level, its focus is on improving the company's operations system.

To gain a more strategic and in-depth understanding of lean implementation, Found et al. (2007) provide a sustainability-based lean approach—"the sustainable lean iceberg model" (see Fig. 1). They divide the content of lean implementation into two groups: visible and invisible elements. For the visible elements, it mainly addresses lean tools, technologies and process improvement activities. Whereas the

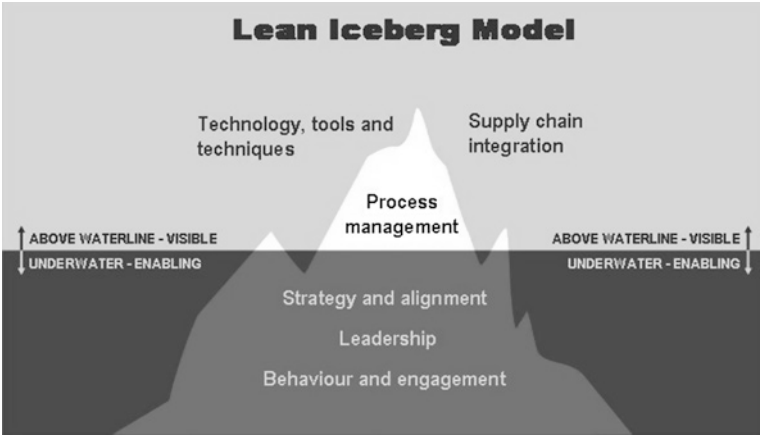

Fig. 1 The lean Iceberg model. *Source* Found et al. (2007)

invisible elements emphasise that lean should be integrated into the organisation's strategy, developing leadership capability, employee engagement and behavioural change (Found et al. 2007; Hines et al. 2011). One of the main contributions made by "the sustainable lean iceberg model" is that it extends lean implementation from efficient lean tools application to effective and sustainable lean based improvement.

3.3 Summary-Issues of Previous LT Literature

Various definitions of LT (i.e. tool-based, system-based and philosophy-based definitions) have been proposed by previous research. While most studies concentrate on how to use lean tools and improve operations efficiency on the shop floor, some researchers argue that lean implementation should be extended to the strategic level. This argument is later developed by some lean thinkers who point out that lean should focus on gaining long-term benefits, rather than only short-term benefits (Bhasin and Burcher 2006; Hines et al. 2011). In addition, lean, and other management concepts in the field of operations management, are criticised for lack of theory (Schmenner and Swink 1998). It may be argued that lean principles fundamentally support lean implementations; however, lean principles are closer to practical guidelines rather than a theory. To build up the foundation of lean, it is necessary to integrate lean with other organisation theories.

4 Review of OL

4.1 Definitions of OL

Researchers define OL from different perspectives; with some viewing OL as a technical process while others prefer to consider it as a social process (Easterby-Smith and Araujo 1999). Despite a variety of definitions (e.g. Argyris 1977; Fiol and Lyles 1985; Nevis et al. 1995; Klimecki and Lassleben 1998; Sadler-Smith et al. 2001; López et al. 2005), there appears to be a consensus that OL is a process of developing knowledge, or insight, by the firm (e.g. Argyris, 1977; Fiol and Lyles 1985; Levitt and March 1988; Nevis et al. 1995). Kolb (1984) helpfully makes the distinction between what people learn (know how) and how they understand and apply that learning (know-why), both relevant to an approach to improvement such as lean.

4.2 Typologies of OL

As there is no standard way to interpret OL, some researchers propose a more structured way to understand this concept. Fiss (2011) suggests typologies are

vital to investigate complex relationships and build organisation literature. In the case of OL, the typologies provide clear categories and dimensions, which enable researchers and practitioners to gain an in-depth understanding. They can also be viewed as evaluation dimensions to assess organisation learning maturity (e.g. McGill and Slocum 1993, knowing, understanding, thinking and learning organisation) and/or status (e.g. Argyris 1976, single- and double-loop learning) which contribute to the organisation's further development in terms of identifying the gaps between its current learning state and expected learning state. Argyris' single-loop and double-loop learning can be considered as the most widely accepted typology in the field of OL. Single-loop learning mainly concerns the error detection and correction (Argyris 1977). It aims at identifying and fixing the problems in the current operating system of the organisation. Double loop learning focuses on detecting the problems of underlying values and re-setting the routines, rules and policies in the organisation (Argyris 1977). The most important feature which differentiates single-loop learning from double-loop learning is the ultimate goal of learning. For single-loop learning, the ultimate goal is to ensure that the current system can be smoothly undertaken (Argyris 1999, 2003). Conversely, for double-loop learning, it aims to detect the issues to do with the underlying rules and policies and therefore, the current system can be re-set or at least improved (Argyris 1999, 2003). The idea of single- and double- loop learning is later developed by Fiol and Lyles (1985). They propose that single-loop learning is "lower level learning" which represents adjustments of part of the organization while double-loop learning is "higher level learning" which covers changes of rules, policies norms of the whole organization (Fiol and Lyles 1985). It seems that double-loop learning is more important than single-loop learning but it is worth noting that both of these two types are valuable to organisations and in most cases, double-loop learning is rare (Argyris 1977).

4.3 Levels of OL

OL is an organisational wide process with multiple levels. It is suggested that OL includes at least three levels, namely, individual level, group level and organisational level (Cangelosi and Dill 1965; Crossan et al. 1999). It is argued that individual learning may be the starting point (Kim 1993), but OL is more than a sum of individual learning, as this is limited to individual's preferences, interests and ability (Crossan et al. 1999; Shrivastava 1983; Wang and Ahmed 2003). Found and Kearney (2010) posit that investigating any issue from a single perspective is automatically incorrect as it is impossible for the individual to capture all of the complexities of the issue. Group learning, however, is not equal to OL either (one may argue that an organisation actually could be viewed as a large group). According to Wilson et al. (2007), group learning mainly focuses on the activities of information or knowledge sharing, storage and retrieval. Activities related to institutionalising (Crossan et al. 1999) and organisational memory building (Akgün et al.

2012; Huber 1991; Nevo and Wand 2005) which should occur at the organisational level including setting up organisational rules, routines and policies are not covered by group learning. March (1991) points out that members in the organisation can learn both from each other and from the organisational code.

4.4 Summary-Issues of Previous OL Literature

The review of OL literature shows that OL is not equal to the sum of individual learning. Learning at an organisational level means the learning results should be institutionalised and organisational memory should be built. Argyris (1977) suggests two types of OL, including single- and double-loop learning. While single-loop learning focuses on correcting errors in the organisation's current operations system, double-loop learning stresses the importance of changing the values and rules underpinning the current system. However, it is argued by Argyris (1991) that despite the success of introducing OL to the market place, many people including managers and employees do not know how to learn. Argyris' argument is later supported by Flinchbaugh (2008), who believes OL creates "thinkers" rather than "practitioners" as some managers who adhere to OL are more likely to simply propose new ideas in the name of OL thinkers. The possible result is that top managers may recognise the importance of enhancing learning, but they do not have a clear plan in terms of how to embed the idea of learning in their daily work. As the managers are not able to integrate OL with daily work, it could be more difficult for employees such as supervisors and operators to accept and understand the idea of OL. In addition, another issue of OL is how to ensure the effectiveness of learning. In other words, the issues of how to ensure managers or employees learn "the right thing". For an organisation, it may send and receive plenty of information every day and thereby, it is necessary to develop a guideline to sort out and filter information. Dodgson (1993) recommends that concentrating on customer based information may be a reasonable way to achieve effectiveness.

5 Discussion

5.1 Linking Approaches to Implementing LT with Types of OL

Single-loop learning as discussed previously focuses on error detection and correction in the current management system. This equates closely to the view of lean that suggests it stands for a tool-based approach to organisational improvement. This approach possesses several characteristics. First, it emphasises waste elimination rather than value creation, for example, most literature which addresses

lean tool application normally summarises its benefits as cost reduction including inventory reduction, lead time and cycle time reduction (e.g. Tardif and Maaseidvaag 2001; Kotani 2007). It implies that the main purpose of reducing cost through lean implementation is to ensure the organisation's current system could be operated smoothly without any interruption. Second, it frequently occurs at the operational level rather than the strategic level as most studies which relate to lean tool application discuss issues of the organisation's daily operations management rather than strategic management, for example, Hines' et al. (2004) "lean framework" shows that most lean tools belong to operational level improvement. Third, it is more likely to pursue short-term efficiency rather than long-term effectiveness, as the essence of many lean tools is to "do things right" rather than "do the right thing".

Double-loop learning, however, considers and evaluates the underlying rules, routines and policies and thereby, re-set these rules in a more appropriate way. In the case of lean, this idea refers to the sustainability-based lean approach. Compared to the tool-based approach, sustainability-based approach possesses the following characteristics. First, it highlights 'invisible' elements such as strategy, culture and employee engagement. Hines et al. (2011) use the term "enablers" to illustrate the importance of invisible elements of lean implementation and conclude these contribute to sustainable lean implementation in the long term. Lucey (2009), who investigates the relationship between employee engagement and sustainability of lean implementation supports this view and states that a lean implementation is more likely to be sustained when employee engagement is high (Lucey 2009). In addition, Bhasin (2012) demonstrates that there is a significant correlation between a systematic and controlled strategy and successful lean implementation. Second, it normally occurs at the strategic level, which implies it could lead to a strategic change. As a sustainability-based approach is expected to diffuse the idea of lean across the whole organisation including both strategic and operational levels, it provides more opportunities for managers to re-think whether or not the current strategy, policies and rules can satisfy the needs of lean operations. Third, it pursues long-term effectiveness. Unlike a tool-based approach, the sustainability-based approach views lean implementation as a never-ending journey with continuous improvement (Found et al. 2007; Hines et al. 2011).

- Proposition 1: tool-based lean approach is closer to single-loop learning while sustainability-based lean approach is closer to double-loop learning.

5.2 Operationalising OL Through LT

To facilitate OL an organisation should enable all the employees to gain access to information efficiently and effectively. In the case of double-loop learning, employees are encouraged to test out new ideas and the organisation guarantees to embrace both successful and unsuccessful results. However, it is difficult to apply these ideas to real practice. For example, as the organisation connects with

both internal and external resources, it could receive a vast amount of information every working day. Hence, to ensure employees obtain the information that they need can often be problematic. In other words, the organisation itself lacks a mechanism to sort out and filter information. In response many organisations have employed various information systems that can at least sort out and categorise information. It is worth noting that the information system itself will not provide the required information unless the organisation sets it up. In addition, the ability to ensure the efficiency and effectiveness of information transformation and communication between managers and employees, employees and customers could be another issue. From a lean perspective, establishing a lean culture could solve this practical issue. Although there is no standard definition for lean culture, the following characteristics can be summarised.

First, lean values customers above any other stakeholder. This means information related to customers such as customer orders, requirements and feedback should be selected as the "must-have" information for all the employees. Additionally, the organisation should build a team, which directly contacts customers and analyses or deciphers customer related information. In this case, it requires the organisation's current management system to be re-built or at least adjusted based on customer requirements (Teehan and Tucker 2014). Womack and Jones (2005) summarise some common principles from a customer's perspective: completely solving problems, solving problems as soon as possible, providing the right thing at the right time and place, and simplifying decision making processes. They suggest that every product or service provider should understand these principles, which implies that the new management system should also reflect these principles.

Second, a lean culture views any waste as the enemy and it encourages all employees to detect waste. To achieve high effectiveness of information transformation and communication, lean thinkers recommend the organisation to discover waste in the communication processes and knowledge work. Ward (2007) identifies three types of knowledge waste and proposes that, to cope with waste, the organisation should encourage employees to discover the root cause of the waste and learn its whole operational mechanism rather than piecemeal learning. Similarly, Staats and Upton (2011) demonstrate that the idea of lean is applicable to knowledge work improvement through finding out the root cause of waste. This implies that their ideas partly reflect Argyris' idea of double-loop learning as they guide the organisation to question or re-build the current rules, routines and policies.

The third characteristic of a lean culture is the emphasis on empowerment and coaching, where Toyota managers act as coaches who enable employees to experiment and learn from their ideas as frequently as possible (Spear 2004). Finally, a lean culture highlights continuous improvement. It means the organisation should, through PDCA (plan-do-check-action), be able to continually improve its current state (Gonzalez-Rivas and Larsson 2011).

In addition to a lean culture, many lean tools could facilitate the application of OL. Although it is discussed in the previous section that solely applying lean tools fails to gain long term benefits, it does not mean lean tools are useless. It is proved

by lean thinkers that lean tools contribute to streamlining and smoothing both physical and information flows (Bicheno and Holweg 2009). In the case of OL, single-loop learning follows the logic of detecting and fixing the problems in the current system whilst double-loop learning involves new ways of doing things. Researchers from an OL perspective do not provide a practical tool or mechanism to guide managers or employees to visualise or detect these problems. From a lean perspective, some fundamental lean tools such as visual management and 6S (Bicheno and Holweg 2009) could facilitate single-loop learning. The main advantage of these tools is they are easy-to-use and relatively low cost as the application of them does not necessarily require the organisation to be equipped with advanced machines or highly skilled employees.

For double-loop learning, the ultimate goal is to question and transform the underlying rules or policies of the organisation. However, it is commonly argued that double-loop learning is rarely achieved. From a lean perspective, other lean tools can be employed to support double-loop learning, for example, using the problem solving techniques, such as 5 Whys, to determine the root cause of a problem. VSM can also be considered as a useful enabler for double-loop learning. VSM enables the organisation to concentrate on the value added processes rather than waste (Rother and Shook 1999; Womack and Jones 2005). In addition, there are many higher-order lean tools, such as Quality Function Deployment (QFD), Design for Manufacture (DfM), concurrent engineering etc. (Hines et al. 2006; Bicheno and Holweg 2009) from the quality and new product development schools as well as processes such as Hoshin Kanri (Policy Deployment) and 'catchball' (Cowley and Domb 1997) that facilitate double-loop learning.

It is worth noting that many lean tools can be implemented in an integrative way to enhance both single- and double-loop learning. For example, VSM aligned with 5Whys and visual management. The organisation could identify the non-value adding activities through VSM of the current state, use problem solving techniques to detect the root cause of the problems and visual management to track progress towards the removal of the non-value adding activities and movement towards an improved future state. Furthermore, considering improvement tools within the context of learning could lead to the redesign of these activities.

- Proposition 2: the ideas of OL can be operationalised and facilitated through employing a lean culture and a range of lean tools.

5.3 Enhancing Continuous Improvement of Lean Through OL

Although lean has developed from shop-floor improvement to value system building, it is difficult for the organisation to achieve continuous improvement. It may be argued that some lean tools such as Kaizen could enable the organisation to set

up an efficient mechanism to support continuous improvement. However, Found and Kearney (2010) demonstrate that the nature of continuous improvement can be described as a "mess" (Ackoff 1974), which means issues related to continuous improvement are complicated and interdependent. In this case, it is insufficient to achieve continuous improvement by focusing on only one or two lean tools.

It is observed that external professionals and consultants assist many lean programs. The use of these external stakeholders raises an important issue: how can the organisation ensure that it can sustain the benefits from the program when the consultants or key members leave? From the OL perspective there are two solutions: organisational memory building and institutionalising.

It is argued that organisations own their memory, which comes from both internal and external resources (Huber 1991). Akgün et al. (2012) indicate that the components of organisational memory include declarative memory (e.g. facts, events), procedural memory (e.g. procedures, routines) and emotional memory (e.g. past emotional events). Huber (1991) suggests two computer-based approaches, an information system for storing "hard" data such as performance data and financial reports, with an expert system for storing professional skills and ideas (Huber 1991). Nevo and Wand (2005) confirms that information technology is central to organisational memory building.

Crossan et al. (1999) propose that institutionalising is also a powerful approach to retain the learned knowledge, which means the organisation should embed useful knowledge in its strategy, rules, routines and principles. As a result, even though consultants and key members leave the organisation, the established strategy and principles could guide its daily operations. For example, Tesco (the UK based global retailer) which has launched lean/continuous improvement program for more than 15 years, establishes its underpinning principles as better, simpler and cheaper and thereby, regardless of the changes within management teams, all the new ideas and initiatives proposed by managers and employees are assessed and selected based on these principles (Hu et al. 2012).

- Proposition 3: building organisational memory and institutionalising learning are the two solutions to enhance continuous improvement.

6 Conclusion

This study provides an in-depth view of the connections between OL and LT through integrating OL typologies, levels, lean definitions and lean approaches. It copes with the criticism of OL by using lean culture and lean tools to operationalise OL. It also copes with the criticism of lean production by employing the concept of OL to enhance its theoretical foundation. From a synthesis of the OL and LT literature we have analysed the definitions, typologies and approaches for both concepts and developed a model, "OL-LT model" which illustrates the connections between them (see Fig. 2).

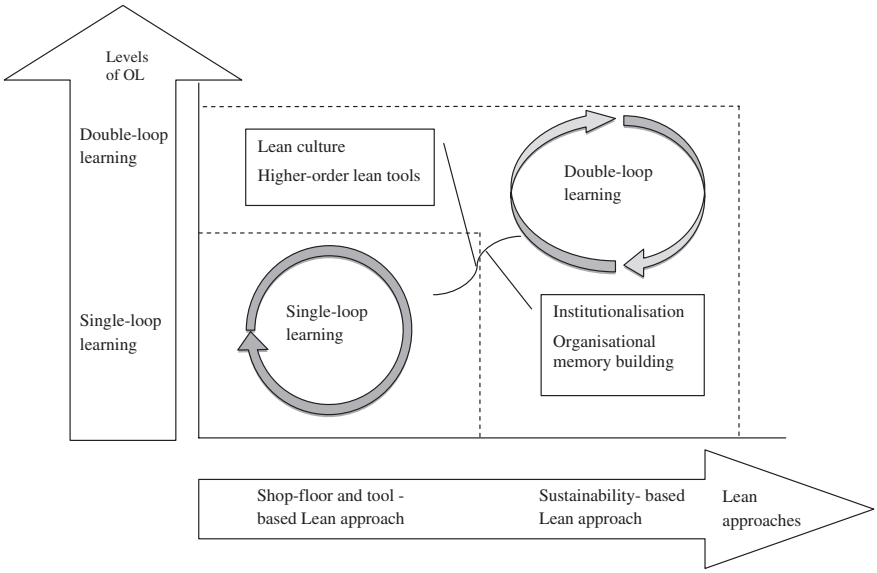

Fig. 2 The OL-LT model

There are several academic contributions of the "OL-LT model". First, it extends Hines et al.'s (2004, 2011) studies to a broader context through integrating OL typologies, learning levels, and lean approaches. Second, it contributes to the literature of these two concepts by clearly showing the theoretical links and interactions. It also operationalises the concept of OL by exploring the meaning of OL typologies and processes in the context of lean. Fourth, this study should also prompt a review of methods employed to assess how organisations learn to be lean or how lean can enhance learning.

This study has several managerial implications. First, this study proposes lean culture can have a positive impact on information transferring and filtering through highlighting customer based information, eliminating knowledge waste, emphasising empowerment and continuously improving the current status. Hence, managers who intend to apply both OL and lean production within their organisations are suggested to re-think and re-organise their current management system and information system based on the characteristics of lean culture.

Second, this study explores the way single- and double-loop learning can be achieved by applying lean tools. It indicates that some basic lean tools can facilitate single-loop learning whilst some higher-order lean tools can contribute to double-loop learning. The development of these two stages of learning is critical to the spread and sustainability of lean improvements. For managers who accept the ideas of OL, but do not have a practical plan of applying OL, lean tools can be considered as a start point and an easy-to-use method to operationalise the idea of OL.

Third, as lean implementation is often criticised for lack of sustainability, the last section addresses how the ideas from OL perspective, including building organisational memory and institutionalising, could enhance continuous improvement in a lean organisation. Managers are also advised to review and revise the organisational rules and policies to ensure that these rules and policies reflect the ideas of lean.

Finally, organisations need to ensure learning cycles are complete and if necessary remove any barriers to learning, such as constraints on job roles, ambiguity around learning, inability to codify learning for future use. In terms of improvement, the use of Plan-Do-Check-Action (PDCA) cycles may enhance the completion of learning and assist in codifying and embedding learning within the wider organisational actions or practice.

As a conceptual study, the proposed "OL-LT model" lacks empirical data to support it. The future research is encouraged to empirically test "the OL-LT model". In particular testing of the model across different industries would be useful. Those, such as the automotive sector, considered more sophisticated with implementing lean compared with those with less experience might provide some interesting insights to how learning is achieved. Similarly, geographic location and size of organisations may also provide some valuable insights into this area of research. There is also a need to observe how learning is captured, transferred and disseminated within the context of lean. For example, PDCA cycles may help to ensure learning cycles are completed and VSM may need to be modified so that knowledge flows are as prominent as material, information and financial flows.

We propose that building organisational memory and institutionalising the learning are essential to enhancing continuous improvement. For many organisations this will require managers to re-think the way they approach improvement and implement lean. Much more consideration should be given to management and information systems that can support and encourage learning. How and when lean tools and techniques are employed needs careful planning in order to foster a culture of learning and improvement.

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