

Applying Lean Methodologies in Knowledge Creation: A Case in the Energy Sector

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Abstract: This study aims to explore the value of using lean methodologies (LM) on knowledge creation (KC) and consequently business processes. The need for a proper, efficient, and effective mechanism to create knowledge is crucial for organizations' continuous improvement; this triggers stakeholder to utilize new technological solutions, like LM to boost knowledge creation and consequently sustain a continuous improvement in business processes. This study utilized semi-structured interview method with several open-ended and close-ended questions to get in-depth understanding of this study objective. Five participants (lean and knowledge workers) of a leading organization in the energy sector were interviewed. Collected data analysed using thematic analysis. Results indicated that several LM add value to knowledge creation in the energy organization; Value Stream Mapping (VSM), Six Sigma and the A3 are the most frequently used as well as the most added value. The findings also indicated that the application of LM in KC, enhances business processes' efficiency and effectiveness, but limited on innovation. This study provides insights for researchers and practitioners to applying the Lean Methodologies in KM to enhance the effectiveness, efficiency, and innovation of the business processes.

1 INTRODUCTION

Due to the crucial role of knowledge for business operations and competitiveness, several researchers want to focus on the Knowledge Management (KM) and how its practices can be enhanced, utilized, and sustained (Ode & Ayavoo, 2020). A full KM process consists of three main stages, Knowledge Creation, Knowledge Integration and Knowledge Utilization (Saini & Bhargava, 2020; Martins et al., 2019). "The knowledge creation process as "a continuous process in which the knowledge created by individuals becomes available and amplified within the organization's knowledge system" (Majid et al., 2013, P. 106).

The energy organizations operations are very customized and relatively expensive (Rachman & Ratnayake, 2016), and organizations in this sector are looking toward strategic approaches to maximize the benefits and minimize the resources like time, manpower or raw materials (Amann et al., 2021). In practice, Lean Management has become one of the most popular philosophies for the organizations where processes' activities can be managed and operated quite differently (Gong & Blijleven, 2017).

Lean Methodologies are defined as the approaches or the tools that institutions should use to shorten timelines, reduce the effort and the workloads, fix the work processes, and produce efficient and effective working environment (Rafi et al., 2020). Despite the increased interest in lean management and KM, limited studies have provided practical evidence which links the lean management to the KM umbrella (Vlachos et al., 2020; Asif, 2019; Zhang & Chen, 2016; Kropsu-Vehkaperä & Isoherranen, 2018). The objective of this study is to explore the value of using lean methodologies (LM) on knowledge creation (KC) and consequently business processes. The below section provides literature review, followed by methodology, findings and then conclusion.

2 LITERATURE REVIEW

2.1 Lean Management in Knowledge Management

There is a strong positive relationship between the KM and Lean Management. There are two types of knowledge associated from this relationship, lean

knowledge (Varl & Duhovnik, 2020), and business processes' knowledge (Wakode et al., (2015)). In the changing and dynamic business environments, where organizations focus on implementing new strategies like lean, a knowledge is considered to be the most essential resource of the organizations to stay competitive and ensure business's efficiency and effectiveness (Saini & Bhargava, 2020). Also, it is the main engine for establishing and ensuring the lean approach within the organizations. KM plays a vital role in applying Lean Management to the businesses (Zhang et al., 2020) and in improving the lean sustainability which focuses on sharing and transferring the lean knowledge into the organization (Martins et al., 2019; Wakode et al., 2015). Lean Management has changed significantly over the time and organization need to explore the lean knowledge to learn and get familiarized (Zhang et al., 2020).

An efficient KC process through lean methodologies' support assist in enhancing the business innovations to explore an effective way to eliminate wastes and stay competitive. It provides the organization with the future high-level knowledge as well, which can support the decision-making process, reducing cost, time and getting better quality (Zhang & Chen, 2016; Canonico et al., 2020). Lean implementation highly depends on the steer of the lean knowledge, where the output is in the format of explicit knowledge like forms, reports, tables, graphics, cost estimation tables and many others, or in the form of Tacit Knowledge, which is impeded within the individual's actions, behaviours, and performance (Zhang et al., 2020). Most of the Lean researchers emphasize on eight common LM which are: Six sigma, Value steam mapping, 5 whys, 5S, Just in Time (JIT), Kaizen, Poka-yoke, Kanban (Varl & Duhovnik, 2020; Asif, 2019; Kropsu-Vehkaperä & Isoherranen, 2018; Zahari et al., 2019; Tyagi et al., 2015; Wang et al., 2020). The focus of these methodologies is to eliminate the waste for the purpose of enhancing the business quality and securing the business by sustaining the competitiveness (Zahari et al., 2019; Wang et al., 2020).

2.2 LM and KM Impacts on Business Processes

Based on the prior studies, most of the researchers collectively agreed on the positive correlation of the Lean methods like VSM (Zhang & Chen, 2016; Zhang et al., 2020), Kanban (Oliva & Kotabe, 2019; Zahari et al., 2019; Zhang & Chen, 2016), Kaizen (Zahari et al., 2019; Galeazzo & Furlan, 2019; Gong & Blijleven 2017; Zhao et al., 2016), LSS (Baysan et

al., 2019; Asif, 2019), Poke-Yoke (Zahari et al., 2019; Zhao et al., 2016) and the 5 Whys sessions (Oliva & Kotabe, 2019; Tyagi et al., 2015) on the KC Process. Applying these methodologies on the KC Process would assist the institutions in triggering new business related knowledge which could be utilized to improve the daily routine jobs (Zhang et al., 2020), institution's strategic plans (Baysan et al., 2019; Asif, 2019), quality of the products (Galeazzo & Furlan, 2019; Zahari et al., 2019; Zhang et al., 2020) or the staff daily activities (Oliva & Kotabe, 2019; Baysan et al., 2019) and, most importantly, the decision-making processes (Zhang & Chen, 2016; Zahari et al., 2019). Consequently, these will assist institutions in eliminating wastes or process's defects and proactively act in any business-related decisions (Gong & Blijleven 2017; Zahari et al., 2019). Their results are adopted from various context, especially in the manufacturing sector. Most of these studies are wither literature reviews or case studies. Table 1 illustrates prior studies in this area.

Table 1: Prior Studies about applying LM in KC.

LM	Significance	Source
Value Stream Mapping	Production cost reduction, improved process sustainability and production quality	(Zhang et al., 2020)
	Waste elimination and value and innovation maximization, and enhanced decision-making process, cost, and quality.	(Zhang & Chen, 2016)
	Waste elimination	(Zhao et al., 2016)
Kaizen	Enhanced business process, relationships, cost reduction and waste elimination	(Vlachos et al., 2020)
	Enhanced productivity, innovation, production quality, decision-making process and communication process.	(Zahari et al., 2019)
	Enhanced organization's learning and problem-solving	(Galeazzo & Furlan, 2019).
	Enhanced business processes efficiency and effectiveness.	(Gong & Blijleven 2017)
	Reduced errors and defects and processes' delays.	(Zhao et al., 2016)
Kanban	Enhanced knowledge creation and practice	(Oliva & Kotabe, 2019)
	Enhanced productivity, innovation, production quality, decision-making process and communication process.	(Zahari et al., 2019)
	Waste elimination and value and Innovation maximization; enhanced decision-making process, cost, and quality.	(Zhang & Chen, 2016)

Table 1: Prior Studies about applying LM in KC (cont.).

LM	Significance	Source
Six Sigma	Reducing the resources consumption and cost of energy.	(Baysan et al., 2019)
	Waste reduction, business processes improvement and sustaining low-cost strategies.	(Asif, 2019)
	Enhanced products' quality and continuous learning.	(Dominic & Godwin, 2018)
	Enhanced productivity, innovation, production quality, decision-making process and communication process.	(Zahari et al., 2019)
	Eliminating waste by minimizing the processes' delays and incorrect inventory.	(Zhao et al., 2016)
Poka-Yoke	Enhanced productivity, innovation, production quality, decision-making process and communication process.	(Zahari et al., 2019)
	Eliminating the waste by minimizing the processes' delays and incorrect inventory.	(Zhao et al., 2016)
5 whys	Enhanced business process, relationships, cost reduction and waste elimination	(Vlachos et al., 2020)
	Ensuring best practice for the daily activities.	(Oliva & Kotabe, 2019)
	Improving the production performance	(Tyagi et al., 2015)

3 METHODOLOGY

3.1 Research Design

The main objective of this study is to understand how the LM foster the KC, and consequently, the business processes,

For this, the study is followed by the qualitative approach, in order to gather data and, an analysis to get an in-depth understanding and answers for the above-mentioned research objectives.

A great attention is paid to the qualitative approach as "The qualitative research interviews aim to elicit the participants' views about their lives, as portrayed in their stories, and so to gain access to their experiences, feelings and social worlds" (Vlachos et al., 2020, p. 17). Zhang et al, (2020) supported the qualitative approach to be followed while studying the Lean methods and KM, due to the wealth data,

that those domains could produce for its study, and, as a reference for the future studies in the same area.

Semi-structured interview, which consists of several pre-defined questions to explore the main research areas, with flexibility for the interviewer and the interviewees in order to ask or respond in more details. Open and closed ended questions were included. Many researchers recommend building the interview questions based on the existing related literature to increase the question's effectiveness (Ravitch & Carl 2019). Validating the interview question is an essential step to facilitate the data collection process (Ravitch & Carl 2019; Kumar, 2018). This validity could be done by conducting a face validity and pilot-test (Kumar, 2018). This study presents part of these questions due to size limit.

This research followed the Snowball sampling approach where the institutions or individuals are deliberately selected to provide information of KM and lean management in energy sector that others cannot provide. Those people are then directed to another group of people who might provide an additional and useful set of information related to the topic. The study follows the thematic analysis approach's phases developed by Braun & Clarke in 2006. Steps followed, getting familiarized with the collected data, forming appropriate codes and themes and then producing the right report based on those themes.

3.2 Organization and Participants Profile

The organization is one of the leading companies in the energy sector in Oman. LM have been introduced in one part of the institution, since 2017. Now the leadership team has decided to apply the LM and principles across the entire institution's units. A successful pilot has been done in around six projects which were applied in the big business' processes. These projects proved to the management that LM can improve the business processes with lesser investments in resources.

This on hand study, followed a qualitative approach where a total of five in-depth semi-structured interviews have been conducted with this institution to explore the impact of LM in KC and consequently, the business processes. These interviews have been conducted via online WebEx meeting according to interviewees' preferences due to current Covid-19 pandemic status. Many researchers recommend building the interview questions based on the existing related literature to increase the question's effectiveness (Ravitch & Carl

2019; Kumar, 2018; Gill et al., 2008). The research on hand, follows this strategy to maximize the questions’ effectiveness. For this study the research questions were adapted from Canonico et al. (2020) and Möldner et al. (2020). The demographic information about the interviewed participants from institution A. All of them are male and have over 14 years of experience, with Bachelor and master’s degrees. Most of them have over 10-years of experience in the Lean Management and are holding a Lean coach position. Additionally, two leaders from the lean side and from the engineering and operation side respectively, have also been interviewed to give their views about the Lean Impact and KM.

Table 2: Interviewees codes.

Position	Overall Years of Experience	Years of experience in lean
Lean Coach (LC1)	24 years	14 years
Lean Coach (LC2)	20 years	20 years
Lean Coach (LC3)	17 years	14 years
Department lead (DL1)	38 years	4 years
Department Lead (DL2)	30 years	15 years

4 FINDINGS AND DISCUSSION

4.1 Lean Methodologies

Figure 1 illustrates that most of the participants agreed that most of the LM were used for KC. Specifically, all the five interviewees agreed that VSM, 5 Whys, and Six Sigma assisted the organization in creating new knowledge. DL1 said, “The 5 Whys method is mainly a KC methodology, as it keeps repeating the why question 5 times, in order to get knowledge of people on that matter”. The Figure also shows that four out of five participants agreed on the functionality of A3, Kanban and 5S.

Another open-ended question, within this question that was asked to all the participants was to identify any other methodologies which were in use and not mentioned in the question. The main methodologies as indicated by the participants are, Fishbone which was mentioned by three participants. Furthermore, the other methodology was Leader Standard Work (LSW) and Gemba-Walk which was identified by three participants, being in their use to support KC. Leader Standard Work is a structured approach which enables the leaders to manage the specific area with a structure and consistency in that

management area. The structure includes a list of activities and responsibilities which need to be achieved by the manager within a specific timeframe (Biskupska & Ratnayake, (2019). Moreover, Gemba’ is a Japanese term which means ‘the place where work takes place’. Other questions on the most frequently used methodology indicated A3(average=3.8), VSM(2.8),5 Whys (2.8), Kaizen(1.4) and Kanban (0.8); whereas the most added value methodologies are in order: A3(average=4.6), VSM(4.2), 5 Whys(2.2), Kaizen(1.6), and 5S(0.8).

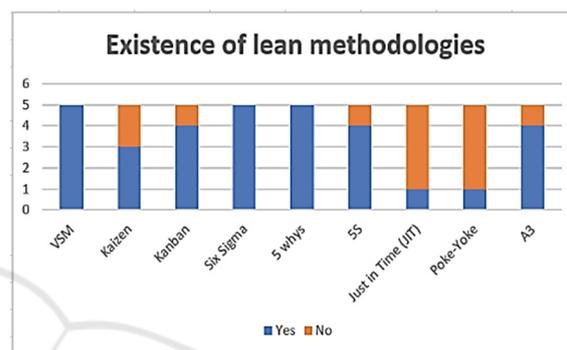


Figure 1: Existence of Lean Methodologies.

4.2 Lean Methodology on Knowledge Creation Impact

Close-ended question was included to measure the impact of the LM in KC consequently on predefined business processes’ impact by using the three-point Likert Scale of high, medium, and low. These predefined business processes’ impacts were developed based on prior studies presented in table 1. Table 3 shows that at the bottom of the list is staff’s moral development; hence it was not much improved via the knowledge created through the LM. On the other hand, the top of the impact list are related to efficiency and effectiveness indicators; it include the quality improvement, time reduction, enhancing the decision-making process, enhancing the communication process, waste elimination, and better coordination with the stakeholders, the management, and leadership, scored the highest among the other listed factors of 2.2. It was all followed by the cost reduction and optimization, process defect elimination; promote better and practical problem-solving behaviour which scored 2. The remaining listed factors are almost scored the same. Innovation indicators, such as process innovation (1.2), are scored low, which indicated that the application of LM on KC has very limited impact on the business process innovation.

Table 3: Impact of Applying LM in KC on Business Process.

Impact	AVG	Impact	AVG
Quality Improvement	2.2	Promote process sustainability	1.8
Time Reduction	2.2	Productivity maximization	1.8
Enhance decision-making process	2.2	Value and Gains maximization	1.8
Enhance communication process	2.2	Skills development	1.8
Waste Elimination	2.2	Process Innovation	1.2
Better Coordination with the stakeholders	2.2	Organizational learning' maximization	1.2
Management and Leadership	2.2	Good, safe, and suitable working environment	1.2
Cost reduction and Optimization	2	Enable Continuous learning culture within the institution	1.2
Promote better and practical problem-solving behaviour	2	Staff's Moral development	1
Process defect elimination	2		
Average is based on scale points: Low=1; medium 2, high =3			

Open ended question was included explore the impact of the LM in the KC and consequently the business processes in term of efficiency, effectiveness, and innovation. Three participants provided the same example to illustrate the effectiveness impacts of the LM in the KC. "Gate to gate" project was aimed to improve the process of delivering fuel from the refinery to the domestics. The lean team with business process' owners and the key workers were able to draw the full end to end process using the VSM, 5 Whys and the Visual Management. This visualization and the root cause analysis using the 5 Whys, helped them in improving and streamlining the process by eliminating the wastes and standardizing the process. According to Bait et al., (2020); Lindlöf et al., (2013), VSM helps in identifying the possible alerts in the business processes and hence assists in defining the wastes.

The main achievement in term of efficiency for the same project is, the ability to reduce the full cycle time to 50% with zero investment and hence achieve high customers' satisfaction. This is achieved due to the knowledge created from people's tacit knowledge or from the existing documents which explain the process inputs and outputs. LC2 also commented, "I can see where we are now with the efficiency, as we are able to complete any lean project with Lean Methodologies' assistance in a period of 90 days or even less". Moreover, the complaints' settlement issue takes more than 90 days. This process normally starts with the receiving of the complaint till the customers get compensated and, so, 90 days is considered as too much for the customers. With the LM's assistance like the 5Whys, VSM and A3, the lean team and business process' stakeholders managed to streamline the process and minimize the cycle time to 30 days only. Moreover, applying the Gemba-Walks and VSM in one of the main logistic activities, enables the lean team to create new knowledge by drawing the full process and see the wastes. Henceforth, the institution manages to eliminate the penalties that occur due to the ships' movement time and hence reduce the unnecessary costs. Additionally, in term of effectiveness, the daily production is also maximized due to these changes.

In terms of innovation, and performance, the management system was developed as a solution for the issue where people could show creativity by providing new suggestions or ideas about certain business activities, but nobody was able to manage the ideas or take any action, hence they visualized the full process using the VSM. The created knowledge aided them to build the new system to facilitate the responsible team in reducing the time for reviewing the actions or the ideas, and to attend to them whenever possible.

4.3 Linking Lean Methodologies to on Business Processes Impacts

Another question is intended to explore the LM which are used to achieve and improve the pre-defined impacts. Table 4 summarizes the participants' views regarding the listed impacts and how LM can help to achieve or improve the respected impacts.

Additionally, an open-ended question was asked all the participants to indicate if they knew about any other impacts, not mentioned in the table. Only DL1 mentioned that the performance management was an impact which could be achieved and improved via the 5S.

Table 4: Linking Lean Methodologies to Impacts.

Impact	The Lean Methodologies Used
Cost reduction and Optimization	VSM and 5 Whys (by 3 participants), and SOP (2 participants).
Promote process sustainability	Gemba-Walks and LSW (3 participants); VSM and the SOP (2 participants), all (one participant)
Quality Improvement	Poke-Yoke, Fishbone and the 5 Whys (two participants); VSM (one participant), Six Sigma (one participant).
Time Reduction	VSM to identify the waste and Kaizen to eliminate the waste and, hence reducing the unnecessary time. (All participants).
Productivity Maximization	All the 5 participants indicated about the VSM.
Process Innovation	Kanban (one participant)
Enhance the decision-making process	Practical problem solving (PPS) and Gemba-Walks (by 2 participants); VSM (by one); 5 Whys (by one participant).
Enhance communication process	VSM (by 2 participants); SOP (by one); A3 and LSW (by two participants).
Waste Elimination	VSM (All participants); Kaizen (by one); A3 and 5 whys (by one participant).
Value and Gains Maximization	VSM and the Kaizen (by 2 participants); Kaizen, Kanban and 5S (by one participant); A3 (by one participant).
Organizational learning Maximization	Gemba-Walks and the VSM (by 3 participants).
Promote better and practical problem-solving behaviours	Root cause analysis methodologies like 5 Whys (All participants); A3 (by 2) and PDCA (by one participant).
Process defect elimination	VSM (by 2 participants); 5 Whys and Poke-Yoke (by two participants); and Six Sigma (by one participant)
Good, safe, and suitable working environment	5S and the Gemba-Walks (3 participants).
Enable continuous learning culture within the institution	DL1 and LC3 (by two participants); VSM (by one); Kaizen (by one participant).
Staff's Moral Development	"All LM" (only one participant); and Coaching Kata (by one participant).
Management and Leadership	Coaching Kata and the leader Standard Work (by 3 participants); Gemba-Walks and Coaching Kata (by one); and VSM and Kaizen (one participant).
Skills Development	VSM, Kanban and 5S (only one participant); and most of the LM (by one participant)

5 CONCLUSIONS

5.1 Findings Summary

As the study aimed at identifying the main LM, which added value to an energy organization in Oman, and its impact on business processes. The main methodologies which are most frequently used and added value to the energy organization are, A3, VSM, 5 Whys, followed by Kaizen, Kanban, and 5S. These methodologies are implemented in the manufacturing domain and energy institutions are trying to imitate their implementation to achieve the intended results.

The major impact of using LM in Knowledge capture in business processes are mainly related to efficiency and effectiveness indicators but limited on innovation.

5.2 Implications

From theoretical perspective, this study contributes to the KM and Lean Management as a whole, as it provides a study that combines both areas. There are very limited studies in this area, specifically in energy sector, which nobody in Oman has touched yet.

From the practical perspective, this study concludes by providing several relevant implications for institutions applying the LM. The findings can be applicable to other countries' energy companies that share a basic profile with the study sample. Thus, this study provides valuable insights to establish a solid foundation of LM and principles especially for complex business' nature institutions. The managers and decision makers can utilize the study direction and the results as a guidance to enhance the current business processes and to facilitate the decision-making process.

5.3 Limitations & Future Direction

This study has some limitations and should be addressed by future research. The study is based only on one organization; hence more cases should be included; the study also explores the impact on KC, hence other KM processes should be investigated. Generalization of the qualitative study's results is a common issue. Hence, a future study may be needed to check the significance and the validity of the results by using quantitative approach. More studies may be needed to explore the enablers and the success factors of LM in KM.

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