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A Systematic Planning Scheme for Deployment of Technology Combined Lean Implementation Framework

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ABSTRACT

In this modern age, use of technology combined lean implementation framework seems beneficial which not only helps in lean implementation but also contributes to speed up the process with the availability of proper planning scheme. However, based on previous literature available, a gap has been observed regarding the availability of "Systematic Planning Scheme" which is essential for the deployment of technology combined lean implementation frameworks. Based on this, the aim of this study is to propose "Systematic Planning Scheme" for such frameworks and since, lean has its stakes in a wide range of sectors but carries the maximum stake in the automotive industry (based on literature review utilized) so it is feasible to develop planning scheme for automotive sectors. With the help of data collection methods that have been utilized were field observations, on-site plant visits, and organizational documents in case study, a Systematic Planning Scheme has been developed. The designed systematic planning scheme critically required three steps which were team selection, phase wise distributions of work, and access to lean tools for lean implementation (by the team to implement framework. The contribution and significance of this study is the provisions of new planning strategy which carried originality in its structure by following three goal steps and visions to implement modern frameworks in a systemized way.

Keywords: Planning scheme; lean manufacturing; planning implementation; Radio Frequency Identification (RFID)

INTRODUCTION

Optimization of resources for creating value to the customer, reduction in costs, inventory, and downtime and lead-time is the basis of lean manufacturing. In this regard, lean management helps companies to maximize their productivity and quality of products through continuous improvement. Lean is a continuous process which aims to reduce wastes and improve processes by minimizing queue lengths, lot sizes, and setup times (Chen et al. 2013; Narasimhan et al. 2006). These benefits of lean implementation have inspired different industries, such as machine tool, wood, ceramics, electronics, healthcare and in particular the automobile industry, to implement lean in their operations (Eswaramoorthi et al. 2011; Wahab et al. 2013). With the advancement of technologies in this modern age, it has been observed that latest technology like Radio Frequency Identification (RFID) has been utilized in a combination of lean and considered as a catalyst for lean implementation (Chen et al. 2013). Hence to deploy lean with new ideologies, many different lean implementation approaches have been considered in manufacturing division by previous researchers (Jasti et al. 2015; Mostafa et al. 2013). These implementation approaches include road maps, detailed planning, an assessment checklist, conceptual model, and implementation framework (Mostafa et al. 2013). However, the application of these approaches requires a proper systematic planning

that provides a device support to such lean implementation. Vinodh et al. (2011) have utilized lean "Planning Scheme" for lean six sigma conceptual model by applying the method of case study in a manufacturing company for lean implementation. "Planning Scheme" without providing any details of new technologies and lean team selection that is one of the fundamentals for project selection (since it is the responsibility of the lean team to implement project and framework). Undoubtedly, it has been observed there is a gap regarding the availability of certain "Planning Scheme" that can be helpful to deploy technology combined lean framework. In view of this, as systematic planning has not been deployed before so the research questions such as current state of planning scheme and formation of a new planning scheme will be addressed to attain required objective. Hence, to fill this gap, this research aims to design a "Planning Scheme" based on case study for the automotive sector since it carries maximum stakes among lean application sectors. Importance of technological management and adequate planning in achieving production optimization is of utmost importance (Zaheer,S. et al. 2020) and such "Planning Scheme" not only provides schematic agenda for planning a project but also helps in the deployment of lean implementation framework. Such structured tools for deployment of technology combined lean implementation framework along with associated technologies help manufacturers to identify suspected areas of improvement (Brintrup, A. et al. 2010).Such synergistic incorporation or pathways surely affirms high level production optimization and waste eliminations in a lean manufacturing setup (Amjad, S.A. et al. 2021) In achieving this objective of development and implementation of planning scheme, the remainder of this paper has been divided into four other sections. Section 2 provides detailed literature review regarding term lean and also provides confirmation of automotive sector as major lean implementation sector. Section 3 highlights the methodology and case study selection to design a systematic "Planning Scheme", Section 4 provides results and discussion while Section 5 concludes the paper.

LITERATURE REVIEW

Lean is one of the popular tools in manufacturing companies because of its abilities to minimize wastes and to struggle for continuous improvement (Moyano et al. 2012). The history of lean had started right after the World War II. At that time, the Japanese economy was in its worst period and seriously devastated in a business recession which had the bad effect on cars production and leading car manufacturers like Toyota (Moody 1997; Nicholas 1998). The financial crisis for Toyota was further enhanced when there were bulks of unsold cars in inventory and market got seriously infected with a lack of demand (Holweg 2007). These financial constraints were due to market behavior while the space constraints were due to large inventories further restrained the company to produce new varieties of cars and to buy new equipment equipped with modern technologies (Nicholas 1998; Womack & Jones 2010). Such scenario of Toyota had caused their production manager Taichii Ohno to develop a production system known as "Toyota Production System (TPS)" that focuses on essential and necessary systematic planned production rather than mass production and considered all the non-value added things as wastes (Forbes & Ahmed, 2010). Taichii Ohno has introduced the concept of seven wastes which were over production, over inventory, over transportation, over motion, over processing, over waiting, and defects in the production system and strictly worked to minimize these wastes (Bertelsen 2004; Fewings 2013).

Moreover, the concept of 'manufacturing without waste' is the pioneering slogan generated by lean processes (Taj, 2008). It is a continuous process which aims to eliminate wastes and improve processes by minimizing queue lengths, lot sizes, and setup times (Chen et al. 2013; Narasimhan et al. 2006).

In minimizing these waste, a different type of lean implementation tools have been introduced such as Value Stream Mapping (VSM), cellular manufacturing, line balancing, pull systems, Kanban, SMED, QCO, Poka Yoke, and 5S (Sundar et al. 2014). Among these tools, VSM is an excellent guide for implementing lean at dock-to-dock levels within manufacturing operations (Serrano Lasa, Castro, & Laburu 2009). The concept of TPS was very famous in the US manufacturing due to the publishing of a book by Womack and Jones (1990). Such concept "the machine that changed the world" with the name of "Lean Manufacturing" has helped the US manufacturing companies in their industries. Historically, Krafcik (1988), a leading researcher at MIT has introduced the term "lean" which means to lessen things rather than mass production while performing his research for International Motor Vehicle Program (IMVP). Even though there is no precise definition of lean (Bayou & De Korvin, 2008), the word lean is self-explanatory as explained earlier by Krafcik (1988). In the literature review, the first major concern was the introduction of term lean and selection of right implementation sector for the designing and implementation of Planning Scheme. In this regard, selection of papers has been done for the period of 1996 to 2020 based on the criteria of the implementation of lean in different sectors. The priority has been given to the most recent papers from year 2012 to 2020. Table 1, Figure 1, and Figure 2 clearly indicate that the major area of application is the automotive

sector as out of a total of 46 papers, 28 papers (61%) relate to lean manufacturing implemented in the said industry. The statistic seconds the previous statement of Sundar et al. (2014) as the researchers have also confirmed the inclination of the same trend in their literature review report. This study further illustrates that healthcare industry is the next prime mover in lean manufacturing after the automotive sector which is a vital sector and highly concerned with minimizing wastages.

Figure 2 further illustrates that the shares of the healthcare industry and the environmental sector in the literature survey are almost equal (Dickson et al. 2009; Hollyman et al. 2014; Stonier et al. 2009). Next are the bottling industry and the accounting sector with two papers (4%). While critically analyzing the literature, in Figure 1 and 2, the authors have also observed the utilization of lean in the accounting sector. The sector is a highly noticeable which does not relate to traditional manufacturing but its utilization of lean to minimize wastage (Bertolini & Romagnoli 2013; Fullerton et al. 2013; Jovanovic et al. 2014). Vinodh et al. (2011) have utilized "Project Charter" which is helpful for lean implementation. Furthermore, Karim and Arif-Uz-Zaman (2013) have explained about the selection of the lean team for lean implementation for a case study. Through this literature review, the authors have explored the observation of a gap regarding the availability of any "Planning Scheme" for deployment of Technology Combined Lean Implementation Framework. Using a systematic literature review, a comprehensive systematic planning scheme has been designed and implemented.

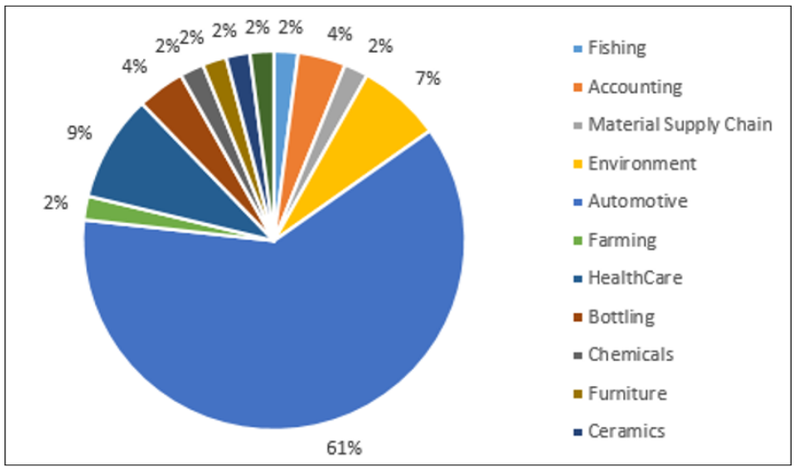

FIGURE 1. Lean application in Manufacturing Sector

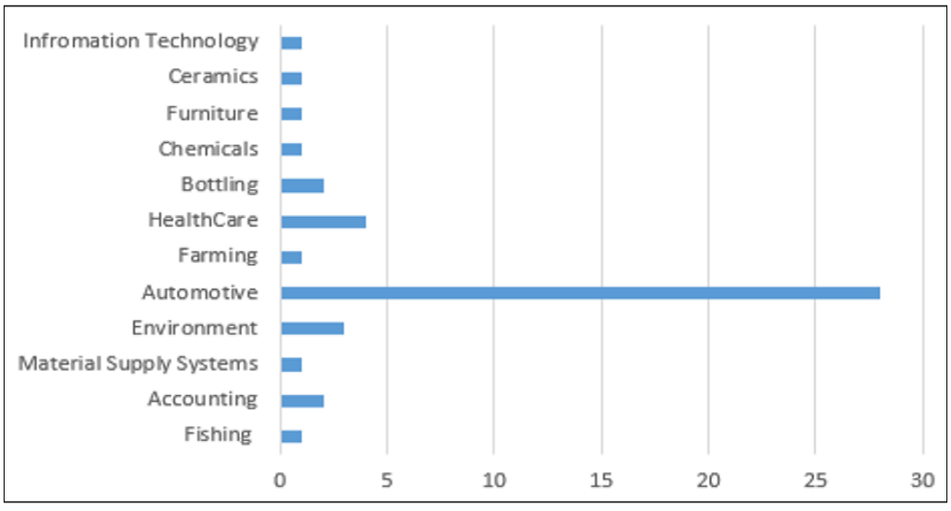

FIGURE 2. Number of publications for the lean application

METHODOLOGY

The authors had analysed the previous methodologies for the implementation of the framework (Karim and Arif-Uz-Zaman 2013; Vinodh et al. 2011). A "case study" based research method has been chosen for this study as focus is on contemporary phenomenon with in some real-life context (Robert K. Yin 2003).

Such method allows researchers and investigators to maintain the all-inclusive and significant features of real-life events. The method of case study carries two types, namely a longitudinal/single case study which involves the deep study of operations and a multiple case study which includes the study of different companies and their activities in general. The authors had planned to utilise the longitudinal case study type because of the requirement of an in-depth study of operations of a selected company named as "ABC automotive parts". The naming of the case study as "ABC automotive parts" was due to confidentiality issues of the original name and details. ABC automotive parts are a manufacturing company in Malaysia which produces automotive parts for leading automobile companies. The other leading reason for the selection of "ABC automotive parts" as a case study was due to the planning of the manufacturing industry to implement technology lean framework concept. The design of the planning is specifically for manufacturing companies that are in the planning phase to implement lean operations in their ongoing operations and also require enhancement in their technology levels.

Currently, the authors of this research work are attached to the deployment phase of planned framework. The authors had designed and implemented a "Planning Scheme" as per research methodology in Figure 3. It was a conceptual systematic planning scheme which has been first developed through actual implementation on case study, field observations, on-site plant visits, organizational documents and then validated through a cross case study based validation process on the another product of selected case study to confirm the validity of developed planning scheme. (Karim & Arif-Uz-Zaman 2013; Vinodh et al. 2011).

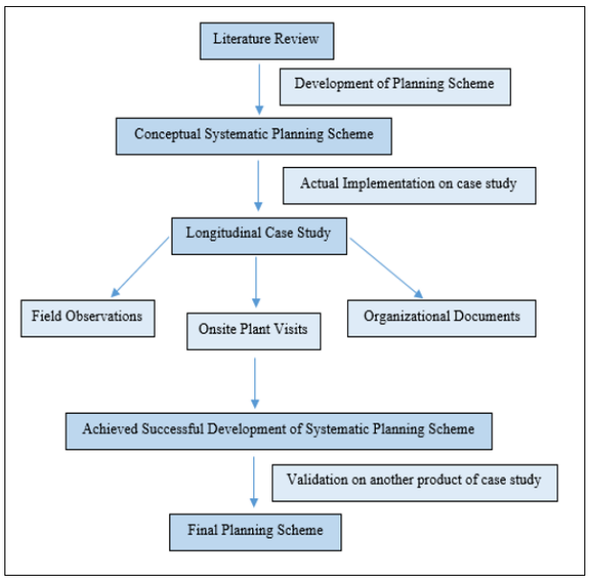

FIGURE 3. Research Methodology

RESULTS AND DISCUSSION

Vinodh et al. (2011) clearly mentioned that "Planning Scheme" is one of the leading requirements for any lean implementation framework deployment. Table 2 indicates the detailed "Planning Scheme" that has been designed and utilised for the selected case study based on their data collection, observations, and current credentials of implementation framework in fulfilling the requirement of the company. In this regard, Table 2 clearly presents the primary requirement required for deployment of any framework in manufacturing industries. In a broader picture. Phase wise details are appended below:

PHASE 1 – SELECTION OF LEAN TEAM

The selection of the lean team must be a joint venture between lean experts, lean researchers, and top management of selected company(Karim & Arif-Uz-Zaman, 2013). Overall, the designing of the lean team for this case study has four tiers, namely project expert, engineering members, ERP support for technology study, and HR Support.

The General Manager and a lean consultant were in a tier of project expert and managers of leading engineering departments like production, planning, TPM with the involvement of one student researcher in the lean field were considered in the engineering sector. In respect of the framework deployment, there was a requirement of one kaizen executive who works under TPM head. The kaizen executive has the responsibility in the execution of project insight of continuous improvement cycle for current and future aspects. After the selection members of the

engineering department, the other leading requirement of time was the involvement of team member from IT side that must be on a senior level like technology /ERP head or IT executive. As the modern world is running towards quick lean implementation process, which involves technologies, the planned lean implementation framework focused on the study of requirement and utilisation of first technology protocols like TOE framework. After designing of the lean team, the next leading task was the precise definition of the objective for the workability of the planned lean team. Since the aim of this lean team was to implement designed framework, there must be a clear definition of targets and details of benefits achievement in next phase, which acted as a pushing factor to keep the lean team on the right track. In achieving the realistic picture for "Planning Scheme," the aspects like assumptions, concerns, and constraints were among the major considerations. Elements such as the leading aspects of lean team's selection and study on the objectives and benefits of project needs to be well elaborated, because the details mentioned in this phase will be helpful to explore both pros and cons for the selected company.

PHASE 2 – PROPER SCHEDULING OF PHASE

The next step was the scheduling of whole project and distribution of time for the entire activity. Table 2 clearly provides the four phases of the implementation framework namely conceptual phase, preparation phase, implementation phase, and control phase. Therefore, a total of five months was allotted to achieve all these phases. Table 2 also presents that description of each and every phase should be required and mentioned in each and every phase.

After scheduling of project, the final principal task was the selection of lean tools for lean implementation in the case study.

PHASE 3 - PROPER ACCESSIBILITY OF TOOLS

In this regard, Value Stream Mapping (VSM) was the selected leading tool for lean implementation. In VSM, the decision regarding utilisation of supermarket or FIFO was also required by the lean team. Table 2 indicates on such scenario. After VSM, the another principal tool was the TOE framework which can be utilised to study current problems in ongoing technology systems and helped to answer the questions like what are initiatives required to plan and deploy new technology setups in the selected case study. Finally, the designed "Planning Scheme" had been thoroughly implemented in the selected case study and helped to achieve all the necessary core requirements and ideologies for the achievement of a successful implementation of Lean. The rigor of this research has been enhanced when the developed planning scheme has been thoroughly validated through a cross case study validation tool and implemented on another product of the selected case study. The results that has been generated are almost the same as that of during development as explained earlier that has confirmed its right development. Moreover, this comprehensive work also validates the concept of LARG manufacturing through case study approach and its implementation via systematic planning scheme (Amjad, S.M. et al. 2021).

CONCLUSIONS

Lean implementation is a philosophy which mostly requires frameworks for its implementation and this will be possible only if a proper project planning in the form of "Systemized Planning Scheme" exist and same has been developed in this research work. Undeniably, the development of a "Planning Scheme" through a case study (which has been thoroughly validated through cross-case study validation process) helped to achieve framework deployments by planning implementation in three stages. This study impacts as the first stage was the proper selection of "lean team" which should be capable enough to achieve objectives under the realistic picture of constraining, concerns, and assumptions involved. The second stage of this was to run framework deployments through "proper scheduling in phases" with a proper timeline. The third stage focused on the 'accessibility of lean tools" which were planned to be utilized. Finally, the research implications of "Planning Scheme" involves working of scheme as a key planner for project implementation which includes team selection, phase scheduling, and accessibility to lean tools details. Moreover, if the planning scheme will be further modified then it will provide the guideline and planning information about the efforts, resources, and financial performances indicators in its current state, thus expanding its research horizon. Moreover, in future, the utilization of some other aspects of simulation modelling and cost-benefits analysis can also be introduced for more optimized system.

TABLE 1. Lean Application Sectors

No	Reference	Fishing	Accounting	Material supply systems	Environment	Automotive	Farming	Healthcare	Bottling	Chemicals	Furniture	Ceramics	IT
1	Braiden and Morrison (1996)					x							
2	Mabry and Morrison (1996)					x							
3	Soriano-Meier and Forrester (2002)											x	
4	Ray et al. (2006)										x		
5	Fauske et al. (2008)					x							
6	Dickson et al. (2009)							x					
7	Mo (2009)												x
8	Stonier et al. (2009)							x					
9	Xiu-xu and Lin-yan (2009)					x							
10	Nordin et al. (2010)					x							
11	Huang et al. (2010)					x							
12	Nordin et al. (2011)					x							
13	Muslimen et al. (2011)					x							
14	Negrus et al. (2011)					x							
15	Azevedo et al. (2012)					x							
16	B. S. Kumar and Abuthakeer (2012)					x							
17	Sahwan et al. (2012)					x							
18	Huang et al. (2012)					x							
19	Qingyun et al. (2012)					x							
20	Salleh et al. (2012a)				x								
21	Salleh et al.(2012b)						x						
22	Bertolini and Romagnoli (2013)								x				
2 3	Diaz-Elsayed et al.(2013)				x								
24	Elmoselhy (2013)					x							
25	Fullerton et al. (2013)		x										
26	Jabbour et al. (2013)				x								
27	Qu et al. (2013)					x							

continue...

...continued

28	Rose et al. (2013)				x			
29	A. Rose et al. (2013)				x			
30	Aqlan and Ali (2014)							x
31	Chiarini (2014)				x			
32	Che Mamat et al. (2014)				x			
33	Fullerton et al. (2014)		x					
34	Van der Merwe et al. (2014)				x			
35	Hollyman et al. (2014)					x		
36	Jimenez-Garcia et al. (2014)			x				
37	Jovanovic et al. (2014)						x	
38	Khanchanapong et al. (2014)				x			
39	S. S. Kumar and Kumar (2014)				x			
40	Susilawati et al. (2015)				x			
41	Yang et al. (2015)	x						
42	Marodin et al. (2016)				x			
43	Nallusamy, Dr et al. (2017)				x			
44	Narayanamurthy et al. (2018)					x		
45	El Kihel, et al. (2019)				x			
46	Sahoo et al. (2020)				x			

TABLE 2. Planning Scheme for ABC Automotive

Organization	**ABC Automotive parts manufacturers**			
Project Title	To Improve Production Lead Time and Study on Current Technology Levels with Initial Protocols			
LEAN TEAM				
Experts				
MR A (General Manager)			MR B (Lean Expert & Consultant)	
Engineering Members				
Mr. C (TQM head)	*Mr. D (TQM Exec)*	*Mr. E (Plan Manager)*	*Mr. F (Quality Control Executive)*	*Mr. G (PhD Student currently working on lean)*
ERP support for technology study				
Mr H (ERP Head)			*Mr I (IT Executive)*	
Objectives				
• A set of performance for lean team which will focus on reducing lead time, space, efforts and defects • Deployment and validation of planned technology combined lean implementation framework designed for automotive parts manufacturing industry for process improvements and initial technology installation protocols study.				
Benefits				
• Study current manufacturing operations and current level of technology involvement in selected case study. • Assessment of participation of seven wastes and non-value added activates involved in current operations. • Study on current level of technologies involved and initials installations protocols required • To minimise non-value added activities to improve production lead time				
Assumptions, Concerns, Constraints				
Assumptions	Manufacturing plant has significant capability to run on better lead times and new technologies like RFID can be deployed in current operations			
Concerns	Manufacturing plant is quite old			
Expected Constraints	• Emergence of sudden emergency production schedules from top management can minimise lean team concentration toward implementation of framework • The employee's behavior and cooperation levels towards lean execution and modern technologies			
THE SCHEDULES IN STAGES- Total Project time: 06 months		**Descriptions**		
Phase	**Durations**			
Conceptual phase	1 month	Training on Lean basics. Revision on previous lean concepts		
Preparation phase	1 month	Study on current operations and selection of product family which has maximum production		
Lean Implementation phase	2.5 month	Utilisation of Lean tools and simulations		
Completion phase	1.5 month	Study on improvements and designing of improvement planning		
TOOL & TECHNIQUES				
VSM	Designing of current state and future state map			
Supermarkets/FIFO	Decision on installation of supermarket system or first in first out system			
TOE framework	Study on current levels of technology			
Kaizen	Development of improvement plan for kaizen			

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DECLARATION OF COMPETING INTEREST

None

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