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EXAMINING THE CRITICAL SUCCESS FACTORS IN THE ADOPTION OF VALUE STREAM MAPPING

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ABSTRACT

Value Stream Mapping (VSM) is a functional approach to reorganizing production system in line with lean vision. It has been applied in many sectors to improve performance. However, there are several factors that need to be considered while implementing VSM in practice. This paper presents a literature review of the Critical Success Factors (CSFs) in the implementation of VSM across five different sectors: manufacturing, healthcare, construction, product development, and service. The review covers the peer-reviewed journal articles on VSM in Scopus from 1999 to 2015. A four-stage search criteria is designed to refine the publications. 14 CSFs are identified through the deep analysis of the five sectors, and six of them are common success factors, namely, empowered inter-principle lean team, top management, organizational culture, theory refinement and integration, resource availability and communication. The differences of the factors in five sectors are also discussed in this paper. The main limitation of this study is related to the source of the selected papers because conference papers are excluded in this review. The findings of this study provide a good basis for industry practitioners to effectively implement VSM.

KEYWORDS

Value stream mapping, critical success factor, cross-sector review

INTRODUCTION

Value Stream Mapping (VSM) is a process improvement technique that aims to maximize final customer value by identifying and eliminating waste in entire value chain (Rother and Shook 1999). VSM has been proven to be able to provide significant

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improvements in efficiency, productivity and service quality, and to lead to a reduction in production lead time as well as production work process. Although a variety of successful VSM cases have been demonstrated in a number of empirical studies, the implementation of VSM has still encountered several considerable challenges. Therefore, there is a need to identify the Critical Success Factors (CSFs) in the implementation of VSM. Through a better understanding of the CSFs, project managers can conduct the corresponding solutions to facilitate the successful implementation of VSM in practice. Limited research work has been done to recognize and classify the CSFs in the adoption of VSM. Moreover, the different contexts of sectors are not seriously respected during CSF development. Therefore, this paper aims to (1) identify the CSFs through a comprehensive and systematic literature review, and (2) analyze and classify the identified CSFs across different sectors.

RESEARCH METHOD

A comprehensive search through the relevant literature was conducted for the years from 1999 to 2015. In this study, articles from journals were identified, analyzed, and classified. Since VSM has been implemented in a wide range of sectors, it is necessary to search through a wide range of studies. The scope of the search is not limited to specific journals. Consequently, Scopus was selected as a searching platform to provide a comprehensive bibliography of the literature on VSM. To acquire a more elaborated understanding of VSM related research, the search for article was further refined by four stages:

In stage 1, document search was conducted under "keywords/title/abstract". Keyword "lean" was searched with value stream mapping, value stream map, value stream, VSM, value process, value stream management, and value stream analysis. The search was further limited to article, article impress and review of the document type. The initial search yielded 280 articles.

In stage 2, a brief review of the abstracts and contents of these papers in stage one was conducted to filter out the highly-related articles. After the two-stage search, a total of 90 VSM-related articles distributed over 33 different referred journals were identified.

In stage 3, the manual search was served as a means to complement the possible omissions of VSM research articles archived by the search engine. After the three-stage research, a total 97 articles were identified and coded by analyzing applied sectors. VSM implementations were classified into five sectors, including (1) manufacturing (72 articles), (2) healthcare (11 articles), (3) construction (8 articles), (4) product development (4 articles), and (5) service (2 articles).

In stage 4, a qualitative content analysis was adopted. In this method, the emphasis is on lensing the articles which potentially suggested key factors for efficient VSM implementation in five sectors. Finally, 25 articles conducted in various sectors were identified. Each article was carefully reviewed, and the CSFs for VSM implementation were identified.

RESULTS

Based on the selection criteria, 25 articles were investigated in this study. Table 1 shows the distributions of the articles under the categories of implementation sectors and lists the 14 CSFs for VSM implementation. These factors were 'empowered inter-principle lean team (a)', 'top management support (b)', 'training and education (c)', 'theory refinement and integration (d)', 'organizational culture (e)', 'communication (f)', 'IT support (g)', 'resource availability (h)', 'stage control (i)', 'manageable size (j)', 'skill and abilities (k)', 'strategies alignment (m)', 'standardization (n)', and 'tools and techniques (o)'. Each of the CSFs is discussed in detail in the following section.

EMPOWERED INTER-PRINCIPLE LEAN TEAM

The effective implementation of VSM requires building an inter-principle lean team with roles in accordance with what the VSM technique advises. In addition, the decision makers in the project team should be empowered to make effective decision.

TOP MANAGEMENT SUPPORT

This factor an essential CSF for VSM implementations. Successful implementations require management involvement and top management support in decision making (Serrano Lasa et al. 2008). The roles of leadership in VSM implementation include developing a general understanding of the whole process, establishing a reasonable goal for work improvement, educating staff during handover meetings, explaining their work during the mapping exercise, and communicating strategy to all employees (Cookson et al. 2011). All of the studies in the five sectors showed a high degree of consensus on the critical role played by strong top management support.

TRAINING AND EDUCATION

Lean knowledge training is another important key factor for successful VSM implementation. Serrano Lasa et al. (2008) confirmed a positive correlation between the investment of training and the achievements of the future state map. Dal Forno et al. (2014) indicated that the cause of issues related to people in VSM implementation was training shortage**.**

THEORY REFINEMENT AND INTEGRATION

'Theory refinement and integration' is the most frequently cited CSF for VSM implementation. The existing VSM applications mentioned in many cases are not complete because of the gap between theory and practices (Serrano Lasa et al. 2008). In order to fully release the benefits of VSM, incompleteness of VSM theory itself has been addressed by refining VSM theory (Serrano Lasa et al. 2009; Yu et al. 2009) and integrating the related ideas , such as simulations and IT(McDonald et al. 2002).

ORGANIZATIONAL CULTURE

A supportive organizational culture defines the values that establish the focus and end goal of collective efforts. According to Mi Dahlgaard-Park et al. (2006), the definition of organizational culture comprises many facets. One cultural aspect is customer

satisfaction, which emphasizes on building a mutual understanding of the value from the viewpoint of customers. Collaboration is also another fundamental aspect of a shared value culture. This is because VSM implementation requires a collaborative culture to interact, exchange and share the values with everybody's participation (Saad et al. 2006).

Table 1: CSFs for VSM implementation in five sectors

		CSFs of VSM													
Sector	**Articles**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**m**	**n**	**o**
Manufacturing	(Abdulmalek and Rajgopal 2007)				*										
	(McDonald et al. 2002)				*										
	(Seth* and Gupta 2005)		*				*						*		
	(Serrano et al. 2008)	*	*	*	*			*		*	*	*			
	(Lian and Van Landeghem 2007)				*										
	(Chen et al. 2010)				*										
	(Serrano Lasa et al. 2008)				*			*							
	(Singh et al. 2011)	*		*	*										
	(Gurumurthy and Kodali 2011)				*										
	(Serrano Lasa et al. 2009)			*	*										
	(Lu et al. 2011)				*										
	(Bertolini et al. 2013)				*										
	(Saad et al. 2006)	*	*			*			*			*			
	(Dal Forno et al. 2014)	*	*	*		*	*			*	*	*	*		
	Subtotal	4	4	4	11	2	2	2	1	2	2	3	2	0	0
Healthcare	(Carter et al. 2012)		*				*				*				*
	(Michael et al. 2013)						*								
	(Cima et al. 2011)						*								
	Subtotal	0	1	0	0	0	3	0	0	0	1	0	0	0	1
Construction	(Yu et al. 2011)	*	*	*	*									*	
	(Nath et al. 2015)			*				*							
	(Arbulu et al. 2003)	*		*			*		*					*	
	(Yu et al. 2009)	*	*	*	*	*								*	
	Subtotal	3	2	4	2	1	1	1	1	0	0	0	0	3	0
Product development	(Ali et al. 2015)				*										
	(Tyagi et al. 2015)					*									*
	(Tuli and Shankar 2015)						*								
	Subtotal	0	0	0	1	1	1	0	0	0	0	0	0	0	1
Service	(Radnor et al. 2006)		*			*	*		*				*		
	Subtotal	0	1	0	0	1	1	0	1	0	0	0	1	0	0
	Total citations	7	8	8	14	5	8	3	3	2	3	3	3	3	2

COMMUNICATION

Clear and effective communication at all levels of an organization is necessary before and during VSM implementation (Dal Forno et al. 2014). Communication comprises two aspects: involvement of all employees and equal input from all the team members. The involvement of all employees is the foundation of mutual understanding and clear communication occurs within the entire organization (Radnor et al. 2006). Equal input from all the team members encourages group decision making rather than any exclusive dominant.

IT SUPPORT

IT support can be categorized into three levels. Level 1 is a group of software tools that solve the static issues of VSM, e-VSM and IGRAFX VSM and other Excel and Visio templates are used to help the users to draw the map and conduct basic calculations (Braglia et al. 2009). Level 2 is a connection with Enterprise Resource Plan (ERP) system for obtaining, comparing and processing data in terms of the production flow (Serrano Lasa et al. 2008). Level 3 is a Building Information Modelling (BIM) and Virtual Reality (VR) supported collaboration for the inspection, assessment, repair and 3D visualization of the work flow (Shou et al. 2015; Wang et al. 2015; Wang et al. 2016).

RESOURCE AVAILABILITY

Resource availability is a primary concern in VSM. Financial and human resource are the two resources usually mentioned aiding actual VSM implementation. This is because finance enables all useful provisions such as consultancy and training can be made (Saad et al. 2006). Human resource is a type of resource requiring a committed delivery team work on VSM implementation with a dedication of time (Radnor et al. 2006).

STAGE CONTROL

Effective control of the stages of VSM has been mentioned many times in manufacturing sector. According to Serrano Lasa et al. (2008), VSM implementation in each stage should be carefully measured and controlled for correct decision making.

MANAGEABLE SIZE

Selection of a manageable size project attracts much attention in manufacturing and healthcare sectors. The selected project should ideally reveal the key issues in process and must be aligned with the objectives of the organization (Dal Forno et al. 2014; Radnor et al. 2006).

SKILLS AND ABILITIES

The specialists' skills and abilities for conducting the VSM activities in process were mentioned in manufacturing. This is because some of the lean techniques applied for future state improvement have some requirements to employee skills and expertise, especially improvement link to information technology (Dal Forno et al. 2014).

STRATEGIES ALIGNMENT

In order to reach long-term success and improve performance, VSM implementation must be aligned with the company strategy. Understanding the strategic context of a VSM program is essential to maximize the value for process improvement (Dal Forno et al. 2014).

STANDARDIZATION

This factor was mentioned in the construction sector as building process was full of variety and uncertainty (Yu et al. 2009). Standardization is recommended to eliminate handover problem which caused by variations in construction processes.

TOOLS AND TECHNIQUES

Appropriate tools for data measurement are required for reducing the issue of low data accuracy. For example, Ali et al. (2015) utilized appropriate techniques to eliminate wastes in healthcare environment.

DISCUSSION

Understanding and identifying the CSFs are essential to increasing the chances of a successful implementation of VSM. This study indicates that the CSFs identified are generally relevant to the VSM implementation projects across sectors. However, it is also found that the projects engaged in VSM implementation in different sectors differed significantly in performance concerning some CSFs. These phenomena are discussed comparatively in the following subsections.

THE CSFS IN THE ADOPTION OF VSM

According to Table 1, two of the fourteen factors were mentioned in at least four sectors, namely ‘top management support’ and ‘communication support’. Factors of ‘empowered inter-principle lean team’, ‘theory refinement and integration’, ‘organizational culture’, and ‘resource availability’ are in the second tier. This result is nearly consistent with the work of Saad et al. (2006), who evaluated the four factors (‘leadership and management’, ‘financial capabilities’, ‘organizational culture’, and ‘skills and expertise’) and rated them as most critical to the success of lean implementation. However, factors such as ‘stage control’ and ‘standardization’ were only cited in one sector.

VSM TRENDS ACROSS SECTORS

It is not surprising that most of the research that was examined on the subject of CSFs for VSM implementation was conducted in manufacturing. This is because VSM is emerged from lean manufacturing theory and has been widely adopted according to the review results. Lean concept has become a buzzword in the healthcare sector in the last few years because of the concern to improve organization performance. There were three studies examining the CSFs for VSM implementation in the healthcare sector, while four studies in the construction sector. Interestingly, there has only been limited relevant CSFs research conducted on sectors of service and product development, although VSM has

started making inroads in both sectors. Future researchers can more focus on investigating the CSFs in sectors except manufacturing, especially service sector, to see whether there are any differences.

DIFFERENCES AMONG THE FIVE SECTORS

This study also shows several differences of CSFs for each individual sector. The factor 'theory refinement and integration' received the highest attentions in the manufacturing sector while less in the other four sectors. The underlying reasons can be twofold. Firstly, the incompleteness of VSM theory was recognized after many of the implementations were conducted in the manufacturing sector. For example, VSM is a static image of the value stream, and only the most obvious changes are suggested (Lian and Van Landeghem 2007). In addition, VSM fails to map value streams characterized by multiple flows merging together (Dal Forno et al. 2014). Trial and error method, which employed for continuous improvement to accomplish the desired level of future state, causes waste of resources (Tyagi and Vadrevu 2015). Therefore, in order to achieve the full functionality of VSM, the incompleteness must be overcome by refining VSM theory and integrating related ideas. Secondly, the VSM implementation in the other four sectors is still in the initial stage, and current research is mainly focusing on how to adapt the existing VSM theory to the corresponding domain context.

The CSFs in the construction sector have a lot of overlaps when comparing with the manufacturing sector. The construction sector has a significant development on project management theory since the concept of Transfer-Flow-Value (TFV) from lean theory was introduced (Koskela 1992). The construction sector has recognized the functionalities of VSM, and used it as an effective lean tool to improve process performance. It is acceptable to claim that VSM has a decent implementation in the construction sector. However, the full capability of VSM has been hindered by the negative effect of variations in construction projects. This is the reason why "standardization" was a critical technique and referred as a CSF for VSM implementation in the construction sector. Future VSM implementation should focus on the standardization aspect for construction projects.

There is no repetitions of the CSFs in product development sector as compared with other sectors. All the three articles were published in 2015. Although the samples identified for CSFs analysis are not enough, we can conclude that the discussion of the CSFs just starts in product development sector.

There is only one article was identified based on the selection criteria in the service sector, although a little more research can be found when we only consider the 'lean' keyword in stage 1 of research methodology. VSM application in this environment is still emergent, with a focus on a small volume of projects, and considering only one or two stages of the VSM implementation. There is a need for further examination of the explicit and directed application of the VSM to the pure service environment.

In this regards, it would be reasonable to conclude that VSM implementation in manufacturing sectors is several years advance than that other four sectors. VSM adoption case in other sectors could benefit from the widely used experience in manufacturing.

CONCLUSIONS

This paper presents the results of a study on CSFs for VSM implementation in five sectors. A total of 14 success factors were identified from the literature review. This comparative review of the literature has shed light on common CSFs for VSM implementation. It was concluded that there were six common success factors across the five sectors.

Although this paper cannot claim to be exhaustive, it does provide a comprehensive review of the CSFs for VSM implementation. The results presented in this paper have several important implications for VSM practitioners and researchers alike.

The limitations of this study are the fact that only journal articles were approached in this review. Conference proceedings are not considered which may offer a wider view on issues related to the impact of critical factors on VSM application. Moreover, relatively few articles could be found for most sectors, except for manufacturing. Readers should be cautious in interpreting the results of this study. Further research is needed to investigate the disparities and the reasons underlying for cases of different sectors.

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