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Value Stream Mapping Implementation in Healthcare a Literature Review

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Abstract: The implementation of Value Stream Mapping (VSM) in healthcare institutions has been in place since the 1990s, mainly for fulfilling the current needs for improved quality and efficiency in delivering services. VSM is one of the lean tools that can be used for process improvement in reducing both waste and lead time. This paper provides an overview of VSM by reviewing previous literature in VSM implementation in healthcare through the identification and eliminating of waste. In this study, the data were collected from previous research related to lean operation, VSM and healthcare from 2003-2015. From thousands of related journals/articles, 21 were selected based on the selection criteria for full article review. The analysis of this study focuses on the type of lean wastes that can be found in healthcare and also the implementation of VSM in healthcare. The reviewed literature based on VSM was discussed according to the type of waste stated in each of the studies. Overall, VSM contributes significantly in the development of healthcare around the world for a better healthcare performance. Despite its importance to the overall healthcare delivery system, there is a lack of studies related to VSM, particularly in the field of Malaysian healthcare. This study contributes to the existing body of knowledge by collecting significant information on VSM as well as on process improvement in the healthcare sector.

Key words: Healthcare, process improvement, value stream mapping, implementation, value stream mapping

INTRODUCTION

Healthcare industries are confronting an intriguing challenge due to the pressure on them to improve the quality of services and costs. The expectation for better services is growing in line with the increasing population numbers, particularly in the era of modern technology. Therefore rapid changes and growth of healthcare sectors can be seen since the early 1990s, up to the present time (Cheong *et al*., 2009). Healthcare providers across the world have been trying to improve the productivity level and quality of patient care. Nevertheless, rising demand and long waiting time have turned into typical issues that need to be specifically confronted by the public healthcare. These issues could be overcome by adopting a systematic process improvement method. In Malaysia, the government has shown their commitment to and responsibilities for healthcare industrie's development by taking actions in reducing the gaps in the healthcare sector in today's competitive environment. According to the 10th Malaysia Plan, healthcare providers in Malaysia need to restructure and transform themselves in order to meet the Millennium development goals by using process improvement method (MOH, 2010). The process improvement method which started some decades ago has managed to reduce errors, costs and cycle time which has consequently increased the efficiency and quality of a patient's care (Koelling *et al*., 2005; Lighter, 2011; Gowen *et al*., 2012). Process improvement can be improved in many ways such as by changing the layout using Promodel (Ramlan *et al*., 2010), redesigning the flow (Kamma, 2010; Matthews, 2013), modifying the system using VSM (Koelling *et al*., 2005; Lummus *et al*., 2006; Lowe, 2013) and improving process delay (Jenkins, 2006).

The process of removing waste and reducing lead time in an operation or production is called Value Stream Mapping (VSM). VSM is one of the process improvement techniques and preferred tool to be utilised in the service industries. Through VSM, the most critical wastes that occur in healthcare could subsequently be determined (Matthews, 2013). Waste can be described as anything that does not add value or a non-value-added activity (Melton, 2005). Given the significance advantage of VSM in the healthcare industry, this study presents an overview of VSM and VSM implementation in healthcare to eliminate waste based on previous studies in this area.

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MATERIALS AND METHODS

A literature search related to Lean Healthcare for the years 2003-2015 was conducted. The limited search terms included English language, value stream mapping, elimination of waste using several bibliographic databases (Ebscohost, Emerald, IEEE, Science Direct, Scopus, SAGE, etc.) and internet searches. Titles and abstracts were reviewed searching for techniques used in the studies and based on the selection criteria. The 21 journals/articles involving value stream mapping implementation in healthcare were selected for full article review.

A review of value stream mapping

Value stream mapping: VSM is a tool that significantly assists the implementation of successful Lean (Teichgrber and Bucourt, 2010). Rother and Shook (2003) stated that VSM is a lean technique that can be described as visual and that encompasses the entire set of processes through a simple but coherent and capable representation of the procedure which includes both the current state (reality) and the future state (goal) (Nash and Poling, 2011). Generally, VSM allows the identification of a process step that does not add value to the customers. By drawing the process flow methodically, the issues, struggles and opportunities that exist during the current state could be more easily identified by the employees for later analysis for solutions, eliminations of waste and improvement of the process in general (Nash and Poling, 2011). This is consistent with Mazzocato *et al*. (2010) who argued that through VSM, the organisation is able to understand the processes involved in a much clearer way in order to identify and analyse issues of concern. The efficiency and effectiveness of the processes could also be increased and organised through VSM. Besides, this approach has also been proven as a method to improve error, quality and productivity by emphasising the importance of each of the processes. VSM has also been used as a method to manage changes and solve problems through the scientific method (Mazzocato *et al*., 2010).

Basically, VSM consists of two parts (or maps) which are the current state (reality) and the future state (goal). The current state map is a flowchart that shows a picture of the process as it currently operates while the future state map is a flowchart that shows a picture of the process drawn representing the desired process flow. The identification of value-added processes and wastes is crucial before the process of eliminating wastes take place. In lean, there are eight types of waste these are defect/error, overproduction, waiting, travel/transportation, inventory (excess), underutilised people, motion (excess) and also excess processing. Defect/error is a type of waste that involves any type of undesired result or mistake-proofing processes (Lowe, 2013). In the context of healthcare, defect/error is a failure to meet one of the acceptance criteria of the customers/patients. Meanwhile overproduction is a type of waste when making or producing more or sooner than needed by the next step or process (Rother and Shook, 2003). Next, waiting is a waste that is any amount of time spent waiting for anything that prevents the process from flowing. (Nash and Poling, 2011).

According to Nash and Poling (2011), travel or transportation waste occur when unnecessary or excess travel of people or product take place around the facility or organisation. Meanwhile, inventory (excess) is a type of waste when any product supplies are in excess of the absolute minimum requirement to meet customer demand. Underutilised people is a type of waste when the employers or organisation are not using employee's mental, creative and physical abilities or doing so in a way that is less than optimal. The seventh waste is excess motion; this is when any movement of product or machine or employee movement, does not add value to the product or service. The last is excess processing. Excess processing is any effort that adds no value to the product or service from the customer's point of view (Nash and Poling, 2011).

Implementation of VSM: From the wide range of studies done, the implementation of VSM can be found in a variety of sectors such as manufacturing, service, food, infrastructure, financial, healthcare and others (Melton, 2005; Abdulmalek and Rajgopal, 2007; Ari, 2010; Mathey, 2012; Cadro, 2013). This indicates that the implementation of VSM in the organisation has been proven to be beneficial. VSM implementation facilitates communication among people in the organisation to manage process issues efficiently (Mathey, 2012; Tyagi *et al*., 2015). Besides, VSM is also able to reduce the costs, reduce the amount of waiting time, increase the efficiency of the process, reduce errors and reduce the number of overproduction and inventories (Shahrbabaki and Jackson, 2011; Mathey, 2012; Rahani and Ashraf, 2012). In certain areas, VSM is able to increase process speed, resulting in the volume of production (Abdulmalek and Rajgopal, 2007; Rohana *et al*., 2013).

VSM in healthcare: The implementation of VSM in healthcare can be traced back decades. However, the application of VSM in Malaysia's healthcare system is still in the early stages (Haron and Ramlan, 2015). From

Table 1: Implementation of VSM in healthcare

Authors	Process	Type of waste							
		Error/defect	Overproduction	Waiting	Transport/ travel	Inventories	Underutilised people	Motion	Process (excess)
Sobek and Jimmerson (2003)	Work process	X	-	-	X	-	-	X	X
		-	-	-	-	-	-	-	-
Koelling *et al.* (2005)	Patient process flow	-	-	X	-	-	-	-	-
Jimmerson *et al.* (2005)	Work process	X	-	X	-	-	X	-	X
Bahensky *et al.* (2005)	Work process and	X	-	X	X	-	-	-	X
	Patient process flow	-	-	-	-	-	-	-	-
Lummus *et al.* (2006)	Patient process flow	-	-	X	-	-	-	-	X
Persoon *et al.*(2006)	Work process	X	-	X	-	-	-	X	X
Jenkins (2006)	Work process and	X	-	X	X	-	-	X	X
	Patient process flow	X	-	-	-	-	-	-	-
Ben *et al.* (2007)	Work process	-	-	X	-	-	-	X	X
Peterson and Leppa (2007)	Work process	X	-	X	X	X	-	X	X
Coons (2009)	Work process	-	-	X	X	-	X	X	X
Joosten *et al.* (2009)	Patient process	-	-	X	-	X	-	-	X
	flow and work process	-	-	-	-	-	-	-	-
Castle and Harvey (2009)	Work process	X	-	X	X	-	-	X	X
Kamma (2010)	Patient process flow	-	-	X	-	-	-	-	-
Teichgrber and Bucourt (2010)	Work process	-	-	-	X	-	-	X	X
		-	-	-	-	-	-	-	-
Erfan (2010)	Patient process flow	-	-	X	-	-	X	X	X
Holden (2011)	Work process	X	-	X	X	-	X	X	X
Cookson *et al.* (2011)	Work process	X	X	X	X	X	X	X	X
Singh (2012)	Work process	X	-	X	-	X	X	X	X
Puterman *et al.* (2012)	Patient process flow	-	-	-	-	-	-	-	X
Lowe (2013)	Work process	X	X	X	X	X	X	X	X
Haron and Ramlan (2015)	Patient process flow	-	-	X	-	-	X	-	X

the literature review, only one study was found that explored the VSM implementation in Malaysia's healthcare environment; the study aimed to reduce the lead time and waste in the process flow of patients in a clinic (Haron and Ramlan, 2015). According to Lowe (2013), there are seven types of flow in healthcare namely; flow of patients, flow of clinicians, flow of medications, flow of supplies, flow of information, flow of equipment and flow of process engineering that could be implemented in VSM. Table 1 lists the previous studies that discuss the implementation of VSM in healthcare since 2003 until early 2015.

From the literature on VSM that has been collected, the studies were divided into two strands-work process flow and patient process flow. Reaserch process has been described as a work standard on how a job/process should be done (Jimmerson *et al*., 2005; Persoon *et al*., 2006; Ben *et al*., 2007; Peterson and Leppa, 2007). The reserach process flow covers the processes involved in healthcare such as standard procedure for documentation, procedure for handling items/machines and others. Besides the work process, VSM had also been applied in the patient process flow. The patient process flow was described by Koelling *et al.* (2005), Lummus *et al.* (2006), Erfan (2010) and Kamma (2010) as process flow for the patient in healthcare, starting from the patient's arrival right through to discharge. The table records the type of waste identified in each of the study referred to and recorded in this study.

RESULTS AND DISCUSSION

In the healthcare context, examples of defects include medication error, error in medication delivery, system failures, errors in labelling specimen and also misplacement of specimen (Jimmerson *et al*., 2005; Persoon *et al*., 2006; Lowe, 2013). Jenkins (2006) argued that error during the process of documentation as well as disorganised and inefficient record keeping can also be considered as defects in healthcare. Castle and Harvey (2009) and Puterman *et al.* (2012) added that defects could occur in healthcare due to errors related to equipment such as when the clinicians were unable to track diagnostic images from the server and also when the CT machines were blocked. When a high number of patients are leaving healthcare without being seen/attended to by the staff, this is also recognised as a defect in healthcare (Holden, 2011). Besides that, defects occur in healthcare when the staff are ordering unnecessary investigations (Cookson *et al*., 2011) and even when the staff misuse, overuse or underuse services and equipment (Singh, 2012).

Next, overproduction is a type of waste caused by excess of what is really needed. According to Cookson *et al.* (2011), recording the same information multiple times is categorised as a waste of overproduction. In addition, processing documents that stay in a queue, providing copies that were not requested, forwarding email unnecessarily causing the recipient to

waste time and producing forms that rarely used are also a type of overproduction which constitutes waste in healthcare.

Meanwhile, waiting is a type of waste that is typical among patients and staff and results in delay. Waiting could affect the healthcare performance and customer satisfaction. Based on past studies, waiting in healthcare is due to many factors. As mentioned by Koelling *et al.* (2005), Jenkins (2006), Lummus *et al.* (2006) and Kamma (2010) waste exists when patients have to wait to be attended by the staff usually during the in-between process. Besides the patient, the healthcare staff normally have to wait because they are sharing certain equipment and this will in turn cause a delay in the delivery processes. Moreover, bottlenecks in the process/system also affect the flow of the patient where the patient has to wait before being attended to (Jenkins, 2006; Lummus *et al.*, 2006; Persoon *et al.*, 2006). Persoon *et al.* (2006) stated that errors in information caused delays to the flow of processes. Queuing for using the elevator is also a waste since staff or patients have to wait and therefore it is categorised as a non-value-added activity (Jenkins, 2006). Jenkins (2006) further argued that waiting occurs because the nurses have to wait for the doctor to return calls to attend the patient. Apart from that, congestion in the emergency department due to the difficulties in getting appointments also results in delay (Ben *et al.*, 2007). Next, Coons (2009) claimed that when certain procedures are not done in a correct way, this led to the need for rework which in turn later effects the total waiting time. In a study by Castle and Harvey (2009), error in accuracy of length-of-stay data for the patient also could be a reason for waiting which is considered as waste. They also added that when the staff are waiting for test results in circumstances where they do not know where the sample is situated or when the results may become available such situations will cause delays in a process flow. Kamma (2010) mentioned that the issue of waiting starts when the nurses have to do multiple tasks. As a matter of fact waiting is also due to a shortage of staff such as doctors or physicians as well as a shortage of facilities such as beds, medical equipment, space and others (Erfan, 2010). This is also affected by the escalating number of patients and the increase in length of stay for patients (Erfan, 2010; Holden, 2011). Therefore, there are many contributing factors to waiting waste in the healthcare system.

Next, transport/travel in healthcare has been identified as a type of waste. Sobek and Jimmerson stated that it was a waste when there were obstacles along the pathways or the pathways are too complex when delivering medicine and other products. Bahensky *et al.* (2005) added that a waste of transport/travel occurs when the staff member has to go back and forth to handle documents. This is supported by the study done by Jenkins (2006) who also mentioned that it is a waste when each process requires the staff to pass through complex pathways to complete it. Besides, Jenkins (2006) also added that if a discharged patient did not leave according to schedule, a waste of transport/travel will occur. Furthermore, the waste of transport/travel occurs when the travel distance for staff and patients are high and excessive (Peterson and Leppa, 2007; Castle and Harvey, 2009; Cookson *et al.*, 2011). Similarly, Lowe (2013) emphasises the waste of time incurred when a physician or staff member looking for supplies as well as when clinicians have to walk to use a computer during a patient examination because all these activities do not add value to the process flow.

In healthcare, people/patients are equivalent to inventories when it comes to process flow of patient (Lummus *et al.*, 2006). Waste of inventories occurs in healthcare when factors that increase the cost or total lost are involved. For example when the process or activity consumes a lot of time because it involves waste of specimen/supplies the patient is expected to have no change after the diagnostic process the patient deteriorates after diagnosis stocks are unavailable when needed or out of usable date keeping stockpiles of medication but not using them by expiration dates (Jimmerson *et al.*, 2005; Joosten *et al.*, 2009; Cookson *et al.*, 2011; Lowe, 2013).

In healthcare waste of underutilised manpower occurs when the staff are being utilised in a less than optimal fashion. As mentioned in previous studies, this type of waste takes place in healthcare when the staff in charge of certain processes are too many or there is overcrowding of staff which leads to higher idle time. On the other hand, other processes are a shortage of staff resulting in a bottleneck in a process flow (Erfan, 2010; Haron and Ramlan; 2015).

Motion has a big impact on staff performance. A waste of motion affects the performance of the staff in healthcare. Sobek and Jimmerson claimed that waste of motion occurs due to, for example, interruption by telephone calls while working, poorly designed connections and also interruptions when using equipment which leads to delay. Waste of motion appears in healthcare because of the process of sorting specimens where it should be arranged accordingly in the first place and also when the specimen is placed on the shelf/rack before being processed (Persoon *et al.*, 2006). These types of motions are considered as waste because these motions do not add value in a process flow. Besides,

waste of motion even occurs when the staff did not use the system to place the patient; instead they use phone calls and also when the nurses have to undertake management tasks (Jenkins, 2006). Peterson and Leppa (2007) reported in their study that it was a waste of motion when the staff have to administer indirect care to the patient; for example when essential care supplies are not place near to the patient or when the nurses have to walk for a certain distance. This is supported by Coons who stated that disorganised drawers and workstations affect the procedures and the performance of the staff and this matter was regarded as a waste of motion. In addition, excess movement of staff, staff walking back and forth to use equipment, rework and adding labels for the coding process are categorised as a waste of motion related to ergonomics (Castle and Harvey, 2009; Teichgrber and Bucourt, 2010; Cookson *et al*., 2011; Singh, 2012).

For healthcare, excess of process is one of the wastes that have to be curbed continuously to ensure that the service performance of a healthcare is effective. The existence of waste processing has been acknowledged by scholars in previous studies. Sobek and Jimmerson argued that waste of processing occurs when there was interruption in the pharmacy unit from other departments which led to unnecessary delays in the pharmacy process. Unclear and unaligned processes related to a specimen results in an incomplete task which will directly affect the process flow (Jimmerson *et al*., 2005). Such a situation also occurs when there is unspecified activity in handling equipment, medicine and information, among other factors, since it will result in inconsistent work processes (Jimmerson *et al*., 2005; Peterson and Leppa, 2007).

Additionally, Teichgrber and Bucourt (2010) claimed that the process of ordering, delivering or implementing inaccurate procedures relating to equipment as well as the acquisition of excess equipment is considered waste. Moreover, a process or an activity that was carried out manually instead of using the relevant system is also a type of wasted process because it might be duplicative (Jimmerson *et al*., 2005; Jenkins, 2006; Ben *et al*., 2007). It is a type of waste where the staff have to go back and forth in order to use equipment such as when the staff have to do the documentation process for patients in different locations (Bahensky *et al*., 2005; Peterson and Leppa, 2007; Castle and Harvey, 2009). Lummus *et al*. (2006) and Jenkins (2006) identified waste of process in their study when each process consumed too much time for instance the process of transferring the patient. This was due to the PUSH system used by the healthcare system which caused a bottleneck in the middle of the process flow.

Furthermore, waste of process also takes place in healthcare when there is insufficient equipment because this will inevitably lead to delays (Castle and Harvey, 2009). Study by Erfan (2010) and Haron and Ramlan (2015) indicated that when certain processes consume a longer cycle time but other processes consume a shorter cycle time, this may also cause bottlenecks and result in idle time, resulting in waste. On the other hand, lack of communication and coordination as well as low machine utilisation have also been categorised as wasted process (Puterman *et al*. 2012; Singh, 2012) (Fig. 1).

Figure 1 presents the graph for the volume of waste in lean healthcare discovered from studies undertaken from 2003 until early 2015. The figure shows the waste of processing as the most referred to by studies, accounting for 19 of the 21 journal articles reviewed. On the other hand, overproduction was the least referred-to type of waste mentioned in only two out of 21 articles reviewed. Waiting ranked second highest after excess of process, mentioned in 18 articles. The ranking of waste recorded in the reviewed healthcare journals from the most to the least are as follows:

- Process (excess)-19
- Waiting-18
- Motion-13
- Error/defect-11
- Transport/travel-10
- Underutilised people-8
- Inventories-5
- Overproduction-2

Figure 1 indicates that wastes in term of process and waiting have been typical issues that need to be addressed by the healthcare institutions around the world. This is due to the nature of the healthcare industries that normally involve a large number of patients

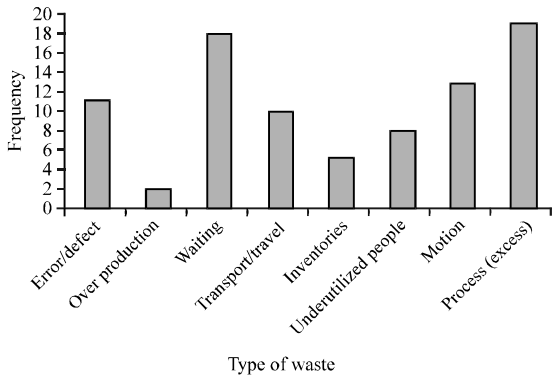

Fig. 1: Waste of lean in healthcare

and staff as well as medical and administration processes. The implementation of VSM in healthcare has managed to reduce the total lead time in the process flow of the patient and even eliminate the waste that occurs while delivering services to the patient (Kamma, 2010; Puterman *et al*., 2012; Haron and Ramlan, 2015). Moreover, VSM is proven as a tool that manages to reduce the operational costs of healthcare (Shazali *et al*., 2013).

CONCLUSION

Value stream mapping has become one of the important methods that can be used to enhance healthcare performance and eliminate waste. VSM has had resulted in better healthcare performance which includes patient satisfaction, employee performance and also financial performance. The implementation of VSM has contributed greatly to the development of healthcare around the world and its impact can be seen in the growth of healthcare. Since, there is a lack of evidence of VSM implementation in the Malaysian healthcare context, this study contributes new support and knowledge related to the VSM practices, particularly in Malaysian healthcare.

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