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A REVIEW OF LEAN APPLICATION IN MANUFACTURING ENVIRONMENT: DEFINITIONS AND TERMINOLOGIES

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ABSTRACT

This article is a review of definitions and terminologies used in existing literatures related to application of Lean System in manufacturing environment. The article is made to provide clear insight and comparisons on various terms used in contemporary academic journals, books and published theses on the subject of Lean System. This review realizes that the term Lean Manufacturing was more popular among Malaysian and Asian countries, while Lean Production was mostly used by American scholars. From this review, readers also might learn that Lean System and Toyota Production System are not really the same system due to a missing principle. The present review is concluded with visual explanation regarding several major jargons in Lean System.

Keywords: *Lean manufacturing, toyota production system, just-in-time, lean definitions, malaysia*

INTRODUCTION

Lean is an operational improvement strategy inspired from Toyota Production System (TPS), founded by Taiichi Ohno. Ohno was an industrial engineer at Toyota Motor Manufacturing (TMM) had studied Ford Production System (FPS) to help TMM rebuild post World War II. TPS was developed with its core strategy to eliminate waste in every section and operation across the production timeline (Ohno, 1988). Waste in the context of TPS refers to non-value added activities in manufacturing operations that can be classified into eight types which include; i)

overproduction, ii) over processing, iii) defect, iv) excessive inventory, v) unnecessary motions, vi) unnecessary transportation, vii) waiting time and viii) underutilised labours (Kilpatrick, 2003; Ohno, 1988). Then, the term ‘lean’ was coined by John F. Krafcik to describe this waste-free production system and further popularised by Womack, Jones, and Roos (1990) through their book ‘Machine that Change the World’ (Bicheno & Holweg, 2009; Lean Enterprise Institute, 2014).

Krafcik was a manufacturing engineer at New United Motor Manufacturing Inc. (NUMMI) and also one of the member of International Motor Vehicle Program (IMVP) research team organised by Massachusetts Institute of Technology (MIT) (Krafcik, 1988). Lean System is also an analogy to Lean Body Mass (i.e. fat-free body mass) (Merriam-Webster's Dictionary, n.d.; Stone, 2012). The eight wastes defined by Ohno (1988) are regarded as the symbolic of “fat” in the organisational context (Stone, 2012). The word ‘lean’ that is originally applied to describe fat-free body mass was adapted in organisational context to describe waste-free manufacturing operation. Nevertheless, the application of lean in manufacturing operations had utilised several distinct terms to represent this strategy such as Lean Production (LP), Lean Manufacturing (LM), Lean Operations, Just-in-Time Production and Just-in-Time Manufacturing.

Apparently, various terms used to refer lean application in manufacturing environment in the literatures remained a problem for researchers and practitioners to properly understand lean and by extension to successfully implement it (Abdul Wahab, Mukhtar, & Sulaiman, 2017; Gurumurthy & Kodali, 2009; Islam, Sorooshian, Rahamaddulla, & Mustafa, 2018; Mirdad & Eseonu, 2015). In fact, many literatures simply used these terms (especially LP or LM) interchangeably without in-depth explanation on why these terms were regarded the same (Anvari, Ismail, & Hojjati, 2011; Bandehnezhad, Zailani, & Fernando, 2012; Che Mamat, Md Deros, Ab Rahman, Omar, & Abdullah, 2015; Muslimen, Mohd Yusof, & Zainal Abidin, 2011; Puvanasvaran et al., 2008; Shah & Ward, 2003). Therefore, this article aimed to make detailed comparisons between these terms in the hope of providing scholars and practitioners with clear insights regarding lean application in manufacturing environment.

LITERATURE REVIEW

Lean Production, Lean Manufacturing or Lean Operations?

Basically, ‘Lean Production (LP)’ system is regarded as the generic term for Toyota Production System (TPS) (Dennis, 2016; Emiliani, 2016; Jones, 2014; Mann, 2015). The term ‘lean’ was purposely used to differentiate the Americanized version of TPS from the original Japanese version (Bicheno & Holweg, 2009; Womack et al., 1990). Overall, this review has compiled ten different definitions of LP (see Table 1). Table 1 reveals that most authors included ‘waste elimination’ in their LP definitions, either directly (Abdul Wahab et al., 2017; Averill, 2011; Russell & Taylor III, 2016; Shah & Ward, 2007) or indirectly (Jacobs & Chase, 2018; Lean Enterprise Institute, 2014; Womack et al., 1990). The authors used expressions such as minimal inventory, fewer human effort, shorter time consumption and smaller production space, less capital, less material, and fewer defects to indirectly address waste elimination in their proposed definitions. These definitions therefore conclude that LP meanings are all primarily emphasized

on eliminating wastes. Moreover, out of ten definitions compilation, only one definition was proposed by local (Malaysian) authors (Abdul Wahab et al., 2017). Although, there were also other local authors had used the term ‘Lean Production’ in their study, they did not offer their own definition to operationalized this strategy (Anvari et al., 2011; Che Mamat et al., 2015; Iteng, Abdul Rahim, & Ahmad, 2017; Puvanasvaran et al., 2008). Therefore, this review supports Abdul Wahab et al. (2017) qualitative finding that claimed ‘Lean Production’ term was more popular among American scholars and practitioners. Unlike ‘Lean Production’ term which popular among American and westerner manufacturers, the term ‘Lean Manufacturing (LM)’ was more well-known to Malaysian (Abdul Wahab et al., 2017) and other Asian countries such as; Indonesia (Lukman & Salim, 2017; Nawanir, Lim, & Othman, 2013; Widiasih, Karningsih, & Ciptomulyono, 2015), Thailand (Kiatcharoenpol, Laosirihongthong, Chaiyawong, & Glinchaem, 2015; Sureerattanan, Napompech, & Panjakhajornsak, 2014), China (Bollbach, 2012; Taj, 2008) and India (Garza-Reyes, Parkar, Oraifige, Soriano-Meier, & Harmanto, 2012; Ghosh, 2012; Panizzolo, Garengo, Sharma, & Gore, 2012). Similarly, this review has compiled ten different definitions of LM (see Table 2).

Table 1.

Lean production definitions

No	Definitions	Authors
1	Producing more products with less resources (lower inventory, fewer manpower, shorter time consumption and smaller production space)	Womack et al. (1990)
2	A multi-dimensional approach that encompasses a wide variety of management practices, including just-in-time, quality systems, work teams, cellular manufacturing, supplier management, etc. in an integrated system.	Shah and Ward (2003)
3	An integrated socio-technical system with the main objective of eliminating waste by concurrently reducing or minimizing supplier, customer, and internal variability.	Shah and Ward (2007)
4	An improvement model and collection of tools that emphasizes the elimination of all types of waste (<i>muda</i>) and non-value added activities, and the delivery of high-quality products at the lowest possible cost	Averill (2011)
5	A business system for organizing and managing product development, operations, suppliers, and customer relations that requires less human effort, less space, less capital, less material, and less time to make products with fewer defects to precise customer desires, compared with the previous system of mass production	Lean Enterprise Institute (2014)
6	Lean Production or Lean System is the broad view of JIT; a philosophy that encompasses the	Reid and Sanders (2015)

	entire organization	
7	An integrated management system that emphasizes the elimination of waste and the continuous improvement of operations	Russell and Taylor III (2016)
8	A flexible and responsive production, which emphasizes on continuous improvement activities that focus on identifying, eliminating non-value added activities, by using the right tools and techniques and delivering at the right time and right quantity with optimum resources to achieve process stability and process design that are targeted towards zero waste, which adds value from both the customers' and suppliers' perspectives	Abdul Wahab et al. (2017)
9	Integrated activities designed to achieve high-volume, high quality production using minimal inventories of raw materials, work-in-process, and finished goods	Jacobs and Chase (2018)
10	Enterprise-specific methodical systems of rules for comprehensive and continuous designing of enterprise processes	Sieckmann, Ngoc, Helm, and Kohl (2018)

Consistent to Table 1, Table 2 also reveals most of the LM definitions contained the phrase 'waste elimination' to note its core strategy. In the same vein, both LP and LM definitions credited Toyota Production System (TPS) as its origin. Therefore, this review believes that previous studies used these two terms interchangeably because both LP and LM were originated from the same system and aiming for the same goal. In fact, some authors were very optimist to explicitly addressed both LP and LM in single definition.

For instance, according to American Society for Quality (ASQ) Lean Manufacturing/ Production is referring to:

An initiative focused on eliminating all waste in manufacturing processes. Principles of lean manufacturing include zero waiting time, zero inventory, scheduling (internal customer pull instead of push system), batch to flow (cut batch sizes), line balancing and cutting actual process times. The production systems are characterized by optimum automation, just-in-time supplier delivery disciplines, quick changeover times, high levels of quality and continuous improvement (American Society for Quality, 2018, p. Quality Glossary /L)

Another example, Anvari et al. (2011) defined that:

LM or LP which is often known simply as 'lean' is a production practice that considers the expenditure of resources for any goal other than the creation of value for the end

customer to be wasteful and thus a target for elimination; basically, more value with less work (Anvari et al., 2011, p. 1585).

Hence, it is common to perceive LP and LM as an identical system and interchangeably used both terms. However, Abdul Wahab et al. (2017) advocated that LP and LM could be distinguished in terms of its implementation coverage. Based on interview sessions with two Malaysian lean experts, Abdul Wahab et al. (2017) concluded that LM refers to lean transformation activities which occur at the manufacturing area within a production system. On the other hand, LP was described to cover a larger scope that may include supply chain operations. This finding was also in-line with the definitions of ‘production system’ and ‘manufacturing system’ postulated by Swamidass (2000) as follow:

A production system includes all aspects of business and commerce including manufacturing, sales, advertising, and distribution (Swamidass, 2000, p. 423).

A manufacturing system refers to a smaller part of the production systems; the collection of operations and processes used to produce a desired product(s) (Swamidass, 2000, p. 423).

Thus, this article agrees with Abdul Wahab et al. (2017) to consider LP and LM could be classified according to its implementation coverage.

Table 2.

Lean manufacturing definitions

No	Definitions	Authors
1	A design of a robust manufacturing operation that is responsive, flexible, predictable, and consistent that focus on continuous improvement through a self-directed work force and driven by output-based measures aligned with customer performance criteria	Feld (2000)
2	A philosophy of manufacturing that focuses on delivering the highest quality product on time and at the lowest cost	Liker and Wu (2000)
3	An approach that considers an operation system without waste which resulting in cost reduction and dramatic quality improvement.	Wan Mahmood and Muhamad (2008)
4	An approach to deliver the upmost value to the customer by eliminating waste through process and human design elements	Wong, Wong, and Ali (2009)
5	A comprehensive term referring to manufacturing methodologies based on maximizing value and minimizing waste in the manufacturing process	Abdul Rashid, Shaari, Mohamad Zakuan, and Hasan Basri (2010)
6	A manufacturing strategy that aimed to achieve smooth production flow by eliminating waste and	Nordin, Md Deros, and Abd Wahab

	increase the activities value	(2010)
7	A production system that focusing continuous flow within supply chain by eliminating all wastes and performing continuous improvement towards product perfection	Mohd Rose, Md Deros, Ab Rahman, and Nordin (2011)
8	The manufacturing system created from the Toyota Production System and empowering employees which continuously seeks to improve manufacturing output, improve production efficiency, reduce defects, and visually manage production systems	Scoggin (2017)
9	A systematic method used to eliminate waste while focusing on customer needs. It is the production system of the 21st century	Oon (2018)
10	A manufacturing system to reduce required time by eliminating waste	Islam, Sorooshian, and Mustafa (2018)

Moreover, another term often used by academic scholars to describe LP or LM is ‘Lean Operations’ (Cachon & Terwiesch, 2017; Harris, 2012; Heizer, Render, & Munson, 2017; Piercy & Rich, 2015; Slack, Brandon-Jones, & Johnston, 2016; Stevenson, 2018; Taj & Morosan, 2011). Again, this article presents several definitions of Lean Operations compiled from existing literatures to make detail comparison with LP and LM (see Table 3). Table 3 lists four distinct Lean Operations definitions from four different sources. Similar to LP and LM definitions, these definitions highlighted ‘waste elimination’ as Lean Operations core strategy and credited ‘TPS’ as its associated system. Hence, there was no doubt that the term Lean Operations is also appropriate to be interchangeably used for describing LP or LM. Therefore, from this paragraph and onwards, this article would use ‘Lean System’ as the generic term to represent LP, LM or Lean Operations. After all, regardless of the label put on “lean”, the crux of its definition still emphasised on waste elimination strategy which was founded by TPS.

However, some scholars simply considered JIT and TPS as the synonyms of Lean System (Kilpatrick, 2003; Muslimen et al., 2011; Slack et al., 2016; Stevenson, 2018). In contrast, Heizer et al. (2017) argued, there were little distinctions between these three strategies regarding their major focus. Heizer et al. (2017) claimed that Lean System emphasised on understanding the customer, JIT centred on forced problem solving, while TPS focused on continuous improvement, respect for people, and standard work practices. Yet, the authors agreed these three terms can be used interchangeably.

Meanwhile, Reid and Sanders (2015) viewed Lean System as a broader view of JIT. While JIT is simply defined as getting the right quantity of goods at the right place and at the right time, Lean System was perceived as JIT philosophy with a broader view that encompassed the entire organisation. This view was also in-line with numerous previous studies from abroad and local context such as Karlsson and Åhlström (1996), Soriano-Meier and Forrester (2002), Shah and Ward (2003), Puvanasvaran et al. (2008), Agus and Iteng (2013), and Che Mamat, Md Deros, Ab Rahman, and Ahmad Jami (2014). These studies had defined and analysed JIT as one of the

elements in Lean System. Therefore, this review article stands by Reid and Sanders (2015) view point to regard JIT as a sub-set of Lean System.

In the same light, constituent elements (i.e. tools, techniques, procedures and practices) under JIT, LP, LM, Lean Operations, and TPS are regarded the same and can be interchangeably applied for any of these improvement strategies. In addition, this review article doubts the notion that recognised Lean System as the equivalent system to TPS due to several arguments that are going to be discussed in the next section.

Table 3.

Lean operations definitions

No	Definitions	Authors
1	A concept that is almost synonymous with terms such as ‘just-in-time’ (JIT), the ‘Toyota Production System’ (TPS), and ‘stockless production’ that enables items flowing rapidly and smoothly through processes, operations and supply networks	Slack et al. (2016)
2	Reflects the operation’s goal to eliminate waste from the system, be it in the form of wasted flow time or wasted capacity	Cachon and Terwiesch (2017)
3	Operations that supply customers with exactly what they want, when the customer wants it without waste through continuous improvement.	Heizer et al. (2017)
4	A flexible system that uses minimal resources (i.e., activities, people, inventory, and floor space) and produces high quality goods or services. Sometimes, it is referred to as just-in-time (JIT) systems since many of the methods used in Toyota Production System (TPS) are now commonly used in lean operations	Stevenson (2018)

Do Lean System and TPS are Really the Same?

Although Lean System was originated from TPS, there was an argument on whether Lean System and TPS were really the same. MIT research team (Krafcik, 1988; Womack et al., 1990) coined and promoted the ‘lean’ term and interpreted it as a strategy similar to TPS. However, Emiliani (2016) argued that Lean System was a poor interpretation of TPS and have misled practitioners ever since. This wrong interpretation had prevented practitioners from enjoying greater achievement with Lean System. Apparently, there was a gap between Lean System and TPS in terms of its success level. TPS always capable to overcome infinite consecutive challenges to achieve greater success, while Lean System was usually ended up with failure or limited accomplishment (Emiliani, 2016; shmula.com, 2014). Emiliani (2016) claimed that Lean System neglected some critically important elements of TPS which related to the nexus between

human relations (social interaction) and continuous improvement. As the consequence, senior executives' eager quests for profit accrument using Lean System did many harms to their workers such as lack of trust between employee and management, job resignations, and limited benefits to the workers during the lean journey. These harms were the sources of workers, resistance towards Lean System implementation and its sustainable success (Hines, Found, Griffiths, & Harrison, 2008; Murti, 2009; Nordin & Md Deros, 2010).

In fact, Emiliani (2014) once recommended that Womack and Jones (1996) 'Five Lean Principles' (i.e. value, value stream, flow, pull, and perfection) must be ingrained with 'Respect for People' principle. The integration of Respect for People in Womack and Jones (1996) Lean Principles would make Lean System more effective and lead to much better outcomes to the workers and the organisation itself. This is what differentiate 'Real Lean' from 'Fake Lean'. Real Lean encompassed continuous improvement and respect for people while Fake Lean is where an organization concentrates only on the continuous improvement. In other words, Fake Lean environment blames workers for errors, oppressive (workers cannot speak truth to power), bureaucratic and frustrating to workers (Emiliani, 2007; shmula.com, 2014). In addition, Emiliani (2017) further visualized how Lean System had deviated farther away from the original TPS philosophy over years (see Table 4).

Table 4 exhibits comparisons between TPS and Lean System with regard to eight points; i) designer, ii) objectives, iii) principles, iv) ideal state, v) improvement focus, vi) major teaching approach, vii) object of interest, and viii) object of interest. Designers of TPS were referring to Taiichi Ohno, Shigeo Shingo and Yasuhiro Monden. They were all industrial engineers. Meanwhile, designer of 1988 version of Lean System was referring to John F. Krafcik, a manufacturing engineer. On the other hand, social scientists attributed as designers of 1996 version of Lean System were James P. Womack and Daniel T. Jones (Emiliani, 2017).

Along with this comparison table, Emiliani (2017) also highlighted some extra points to ponder including; i) How do the differences between TPS and Lean System affect the outcomes (business results)?, ii) What is the impact on business results and on employees? iii) What should be done if Lean efforts do not produce significant business results? iv) Does Lean System reflects actual business needs like TPS (customer satisfaction and business survival)? These extra points were queried to highlight that if Lean System had drifted away from the original TPS in any aspect since the beginning, hence it was impossible for Lean System to achieve the same business results as TPS. Based on these arguments, this review article views TPS as the original waste-free production/ manufacturing system, while Lean System is the flawed imitation of TPS.

Nevertheless, not everything that Lean System had deviated from TPS was making this strategy worse. For example, the objectives and aspiration of TPS were just focusing on cost reduction and productivity improvement to acquire customer satisfaction for the survival of the business. Instead, Lean System improvise the objectives to maximize customer value for achieving the perfection. Customer value, which describes anything that customers are willing to pay for, holds a more holistic meaning than customer satisfaction.

To elaborate, customer value means understanding what customers require and identifying every specific actions (process) required to produce what they are willing to pay (Balaguer, 2012;

Mirdad & Eseonu, 2015). In comparison, customer satisfaction simply means the result of delivering a product or service that meets customer requirements (American Society for Quality, 2018). It is also an indicator that determines how happy customers are with a company's products, services, and capabilities (American Society for Quality, n.d.; Bernazzani, 2019). Thus, this article conceives that what customers require (want) is not necessarily what customers value (willing to pay), because sometimes they want something that is not worth the price to pay. On the contrary, anything that customers value, is definitely what they are willing to pay because it is indeed worthy (valuable) to them.

Similarly, the aspiration of 'perfection' is deemed to encompass acquiring customer satisfaction for the survival of business. Perfection that describes zero waste existence and zero non-added value activities (Stone, 2010; Womack & Jones, 1996) may also resulting in business survival. Wastes such as defect and waiting time have major implication on customer satisfaction (due to low product quality and late delivery). Hence, when there is no waste exist in the process of product manufacturing, there will also no complaint on product quality and delivery time. Subsequently, customer satisfaction will be increased. Therefore, perfection is a better and improved aspiration than customer satisfaction and business survival.

Table 4.

TPS and lean system comparisons (Emiliani, 2017)

System	Toyota Production System	Lean System (1988 - 1995)	Lean System (1996 onwards)
Designer	<ul style="list-style-type: none"> Industrial engineers 	<ul style="list-style-type: none"> Manufacturing engineer 	<ul style="list-style-type: none"> Social scientists
Objectives	<ul style="list-style-type: none"> Cost reduction Productivity improvement 	<ul style="list-style-type: none"> Quality improvement Productivity improvement 	<ul style="list-style-type: none"> Customer value maximization
Principles	<ul style="list-style-type: none"> Continuous improvement Respect for people 	<ul style="list-style-type: none"> Continuous improvement 	<ul style="list-style-type: none"> Specify value Identify the value stream Flow Pull Perfection
Ideal State	<ul style="list-style-type: none"> Flow 	<ul style="list-style-type: none"> Flow 	<ul style="list-style-type: none"> No non-value added process
Improvement Focus	<ul style="list-style-type: none"> Human 	<ul style="list-style-type: none"> Technical 	<ul style="list-style-type: none"> Technical
Major Teaching Approach	<ul style="list-style-type: none"> Gemba kaizen 	<ul style="list-style-type: none"> Team leader 	<ul style="list-style-type: none"> Classroom

Object of Interest	<ul style="list-style-type: none"> • Muda (waste) • Muri (overburden) • Mura (unevenness) 	<ul style="list-style-type: none"> • Inventories 	<ul style="list-style-type: none"> • Creating value-added activities
Aspiration	<ul style="list-style-type: none"> • Business survival • Customer satisfaction 	<ul style="list-style-type: none"> • High plant performance 	<ul style="list-style-type: none"> • Perfection (zero waste)

Lean Jargons

Since Womack and Jones (1996) presented Lean System as a universal thinking that may span the entire company from production system to business strategy, it evolved and numerous jargons such as ‘Lean Philosophy’, ‘Lean Thinking’, ‘Lean Principles’, ‘Lean Process’, ‘Lean Practices’, ‘Lean Elements’ and ‘Lean Enterprise’ began to emerge. A recent review by Islam, Sorooshian, Rahamaddulla, et al. (2018) declared that Lean System might be perceived as a system, program, paradigm, model, tool, practice, thinking, way, means or approach by various authors, making its definitions were difficult to interpret. However, this article believes that, with proper grouping and classification of meanings, this difficulty can be overcome.

For instance, the word ‘approach’ can be considered as the synonym of ‘way’ ‘means’ or even ‘concept’ (Thesaurus.com, n.d.). Besides, these are simple vocabularies that usually do not contain any scholarly meaning or interpretation in business and management studies. Hence, further elaboration regarding these words is not necessary. Unlike ‘approach’ ‘way’, ‘means’ and ‘concept’, words such as ‘system’, ‘paradigm’, ‘program’ and ‘model’ may have specific interpretations unique to academic field. Business Dictionary, an online dictionary website hosted by Web Finance Incorporated (2019) defined these terms as follow:

Model: *Graphical, mathematical (symbolic), physical, or verbal representation or simplified version of a concept, phenomenon, relationship, structure, system, or an aspect of the real world.*
Retrieved from: <http://www.businessdictionary.com/definition/model.html>

System: *A set of detailed methods, procedures and routines created to carry out a specific activity, perform a duty, or solve a problem.*
Retrieved from: <http://www.businessdictionary.com/definition/system.html>

Program: *A plan of action aimed at accomplishing a clear business objective, with details on what work is to be done, by whom, when, and what means or resources will be used.*
Retrieved from: <http://www.businessdictionary.com/definition/program.html>

Paradigm: *Intellectual perception or view, accepted by an individual or a society as a clear example, model, or pattern of how things work in the world.*
Retrieved from: <http://www.businessdictionary.com/definition/paradigm.html>

Concluding these definitions, a ‘model’ can be in the form of a ‘system’. Besides, it may also represent a ‘paradigm’. Although, ‘program’ is not explicitly stated in model, system or paradigm definitions, its interpretation deem similar to a ‘system’. Hence, it is evident that distinct terms used to describe and interpret Lean System are just jargons or vocabularies to make academic writing looks versatile. In fact, plagiarism is a major concern among academic scholars. Most importantly, regardless of what nouns used to describe Lean System, the essence of its definition is about ‘waste elimination’ strategy that originated from Toyota Production System.

Nevertheless, this review would like to clarify several lean jargons that remained ambiguous in recent review article on the similar topic (Islam, Sorooshian, & Mustafa, 2018; Islam, Sorooshian, Rahamaddulla, et al., 2018). The jargons and its definitions are listed as follow:

- Lean Philosophy: The definition of lean, its principles and main concepts (Gupta & Jain, 2013).
- Lean Thinking: Recognizing Lean System as an operational philosophy that centres on reducing waste and adding value (Othman, 2016).
- Lean Principles: A set of beliefs based on Lean Thinking that guide operational strategy and decision (Nicholas, 2018). Five Lean Principles introduced by Womack and Jones (1996) are including; value, value stream, flow, pull, and perfection.
- Lean Practices: The tangible mechanisms used to operationalised and implement Lean Principles (Mirdad & Eseonu, 2015).
- Lean Building Blocks: Tools and techniques to introduce, sustain and improve Lean System (Alukal, 2006).
- Lean Process: An idea that expands beyond LM or LP which encompass all organisational functions (Pakdil, Leonard, & Bennett, 2015).
- Lean Enterprise: A ongoing agreement among all the organisations sharing the value stream for a product family to correctly specify value from the end customers’ perspectives, eliminate wasteful activities from the value stream, and make actions that actually create value occur in continuous flow as pulled by the customers (Lean Enterprise Institute, 2014).

Inspired by Saunders, Lewis, and Thornhill (2016) ‘Research Onion’ graphic, this review attempts to illustrate how majority of these jargons explain one another (see Figure 1).

Figure 1 displays the ‘Lean Onion’ which visualizes Lean System from the most general concept to the most specific component. The most general concept is illustrated as the most outer layer of the Lean Onion and vice versa. Lean Philosophy is regarded as a term to describe the utmost concept in Lean System since it is defined as the definition of lean, its principles and main concepts (Gupta & Jain, 2013). The second layer is the Lean Thinking which means accepting Lean System as an operational philosophy that focuses on reducing waste and adding value (Othman, 2016). Next layer, which is Lean Principles that represents a set of beliefs based on Lean Thinking that drive operational strategy and decision (Nicholas, 2018). In other words, Lean Principles also means adopting Lean Thinking as the operational strategy that emphasises on eliminating waste guided by five integrated principles namely; value, value stream, flow, pull, and perfection (Stone, 2010).

Deeper to the core of Lean Onion is Lean Practices which describe tangible mechanisms applied to operationalised and execute Lean Principles (Mirdad & Eseonu, 2015). For example, to operationalized the principle of Flow, Lean Practices such as quick setup, *heijunka* (work levelling) and streamlined layout are involved (Gurumurthy & Kodali, 2009). Similarly, JIT manufacturing and pull system are implemented to realize the Pull principle. Lastly, the most specific component of Lean System is Lean Building Blocks. Lean Building Blocks is a generic name of tools and techniques involve in Lean System implementation (Kilpatrick, 2003). In conjunction with Lean Practices, Lean Building Blocks (tools and techniques) such as Single-Minute Exchange of Die (SMED) are utilized to practice quick setup. In the same vein, *poka yoke* (error proofing tool), *jidoka* (stop production when error occurs) and *andon* (signal light) as the means of practicing Visual Management.

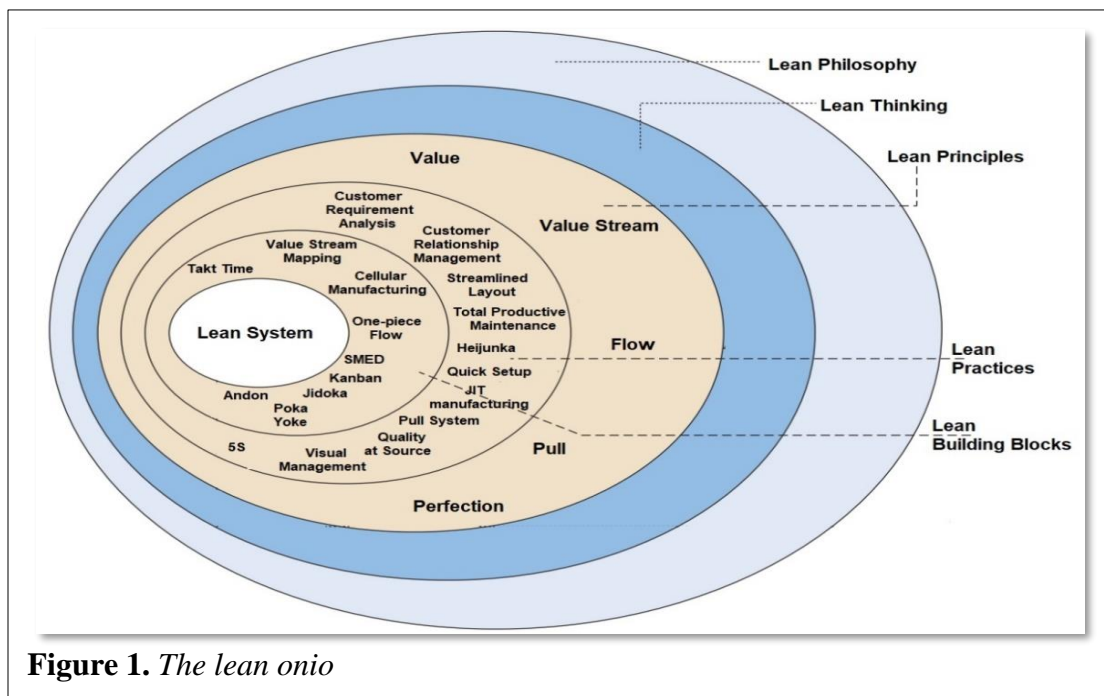


Figure 1. *The lean onion*

CONCLUSION

Lean System is a world class operational strategy that emphasized on waste elimination but often misunderstood due to diverse definitions and various terms used. Existing literatures had used terms Lean Manufacturing, Lean Production, Lean Operations and Just-In-Time (JIT) interchangeably. Apparently, the used of these terms interchangeably were appropriate since they were all acknowledging the same core strategy (i.e. waste elimination) and shared the same origin. In addition, critics on Lean System for drifting away from the original strategy (i.e. Toyota Production System - TPS) were also discussed. Lean System neglected the principle of Respect for People over years and had differences with TPS since the beginning. Finally, this article provides visual explanations called, the 'Lean Onion' to clarify major jargons that regularly appeared in Lean System literatures. The Lean Onion graphic demonstrates Lean Philosophy as the broadest concept to describe Lean System, while Lean Building Blocks as the

most specific component to apply Lean System in any environment (e.g. manufacturing, services, constructions, etc.).

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