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LEAN PHILOSOPHY: THE LEAN TOOLS ENHANCEMENT IN HIGHER EDUCATION

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ABSTRACT

Lean philosophy and methodology is accomplished in the organisation process improvement by using lean tools . The research is focusing in several systematic reviews carried out on lean tools and the impacts of the lean tools benefits in the Higher Education Sector around the world. The present study sets out to analyse the existing literature on lean tools' adaptation practices towards the impacts of lean management in higher education. The benefit of this paper is that it condenses previous research in identifying the research gap. Guided by the PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses) review method, a systematic review of the Scopus and Web of Science databases identified 23 related studies. Further review of these articles resulted in 24 main themes – 5S, Kaizen, Value Stream mapping, Gemba Walk, Root cause analysis, pull system, Kanban, A3, Standardization, Hoshin Kanri policy, OEE, SMED, Bottle Neck, and others. These 24 themes further produced a total of 15 sub-themes of lean benefits. Several recommendations are highlighted for the purpose of conducting more quantitative studies, to propose a specific and a standard systematic review method for guiding research synthesis in the context of lean

tools' usage benefits, and to practice complimentary searching techniques such as citation tracking, reference searching, snowballing, and contacting experts.

INTRODUCTION

Lean is exclusively described as a set of waste elimination of non value added process in the organization. Lean philosophy is divided into continuous improvement and respect for people. Lean thinking is sustain by using lean tools identification procedures involving explicit knowledge sharing that is easily codified. Lean tools (also known as lean toolbox) are acknowledged as medium used by the institution process reduction, amendment and demonstrate change (Mrugalska & Wyrwicka, 2017; Pakdil, Toktaş, & Leonard, 2018; Shradha Gupta Monica Sharma Vijaya Sunder M, 2016) embedded in an entire organisation (Sfakianaki & Kakouris, 2019). Lean encompasses a set of five principles introduced by James P. Womack in 1990 (Awni et al., 2017). Businesses have seen performance improvements through lean management (Evangelia Siachou, 2016), which has been widely applied in the service sector with its own beneficiary(Shradha Gupta Monica Sharma Vijaya Sunder M, 2016).

Lean is a methodology and a set of nearly 24 tools that are intended to remove non value-added matters or waste from a system or task in educational activities of universities(Chistnikova, 2019). Lean is divided into value added type 1 and type 2 is non value added:

i. The first is value-added matters which consist of products and/or services that the customer is willing to pay for, after receiving sufficient information on them.
ii. The second is non value-added matters which consist of products and/or services that the customer is unwilling to pay, but needs to acquire due to necessity, documentation, and operational processes.
iii. The third is non value-added matters which consist of products and/or services that the customer is unwilling to pay, as they do not affect customer experience(Yorkstone, 2019).

The current scenario has seen very little research and evidence on the usage of lean tools and their benefits to the education sector, especially in the teaching and learning process (Andrew J. Thomas Jiju Antony Mark Francis Ron Fisher, 2015; Sremcev, Lazarevic, Krainovic, Mandic, & Medojevic, 2018; Tılfarlıoğlu & Anwer, 2017), as well as in administration (Magalhães, Alves, Costa, & Rodrigues, 2019)

Research gap in the existing study on lean tools

Lean tools involve methods used in implementing lean in the manufacturing sector, and have been adapted in the service sector recently. There are twenty four types of lean tools (Chistnikova, 2019) that can be adapted in the education sector to eliminate waste and to minimise non value-added work flow processes where the lean philosophy embeds continuous improvement and respect toward others(Womack, 2003). Many studies have focused on lean tools, which have been implemented sufficiently, starting in the manufacturing industry, before being adopted into the health industry, the public sector, and other industries. Anyhow, the usage of lean

tools is still new to the higher education sector and there is still an insufficient number of scholars who have conducted systematic studies.

A systematic literature review is suggested to develop the body of knowledge on the previous studies in the topic of interest. SLR describes the process to identify, classify, select, and review previous studies to answer any formulated research question critically (Okoli, 2015). The search effort should be based from several databases to elucidate the research process so that a similar process can be replicated and reproduced by other researchers (Xiao & Watson, 2019). An SLR information table must be developed for the purposes of constructing the research objectives and in sustaining the findings. Researchers should search rigorously for the strategy to answer the research questions, to enhance quality in future research. For the present study, a performance review process using keywords in article selection was conducted to confirm the study's analysis and generalisability.

The review was guided by a central research question – What are the lean tools practices in the education sector which have been adapted from the manufacturing sector; and how will they benefit the education sector? This study aimed to systematically fill the gap left from the review of previous related studies, to gather more information and gain understanding by recognising the appropriate tools that have been adapted. The selection of the previous studies was taken from all over the world to find the usage pattern of lean tools.

The present study offered several contributions with regard to practical applications and to the body of knowledge. By referring to this study, interested parties like policy makers in departments, lean management departments, the public, other researchers, and academic institutions may use suitable lean tools to integrate knowledge, strategies, and adaptation to their respective organisation. This can narrow the gap in the already available information on conventional working styles, may change outlooks on management, and may encourage policy makers to eliminate waste and reduce non value-added workloads. The authors of this study specifically assisted in the search for knowledge, information on specific areas, and content that should be focused by the higher education sector.

Literature Review

The Review Protocol

The present study was guided by the PRISMA review protocol (PRISMA) or Preferred Reporting Items for Systematic Reviews and Meta-Analyses, which is a published standard to conduct a systematic literature review. Generally, publication standards are required to guide authors with the related and necessary information that will enable them to evaluate and examine the quality and rigour of a review. In addition, PRISMA emphasises on reviews that evaluated randomised trials, which can also be utilised as the foundation in reporting systematic reviews for other types of research (Moher et al., 2009). Normally, PRISMA is often utilised within medical studies, and at the same time, is able to identify the inclusion and exclusion criteria for a particular study. Moreover, PRISMA examines the

extensive database of scientific literature at a defined time, which allows for an accurate search of terms to be conducted with regard to lean tools implementation in higher education. Other than that, the use of PRISMA enables implicit information which concerns future lean tools implementation reviews (Mohamed Shaffril, Samah, Samsuddin, & Ali, 2019).

Based on the review protocol, SLR would be formulated accordingly to the research question for the review. This study will explain the systematic search strategy, followed by the three main sub-processes of identification, screening (inclusion and exclusion criteria), and eligibility. The appraisal of the quality will be revealed to ascertain the quality of the articles to be reviewed. Lastly, the abstraction of data, and how they were analysed and validated will also be explicated.

Formulation of the research question

The formulation of the research question was based on PICo. PICo is based on three main concepts, namely the population/problem, interest, and context. The PICo for the present research are the higher education sector (population: polytechnic and community college), lean tools adaptation (interest), and worldwide setting (context), which guided the authors of the present study to formulate the research question: What are the lean tools practices in the education sector which have been adapted from the manufacturing sector; and how will they benefit the education sector?

Systematic searching strategies

The systematic search process involved identification, screening, and eligibility. (Refer to Figure 1).

Identification

Identification is the process of searching any synonym, related terms, and variations for the main keywords of a particular study; specifically, lean tools adaptation in higher education. It aims to provide more options for the selected database to search for more related articles for review. The keywords are developed based on the research question, as suggested by (Okoli, 2015), and the identification process relied on online thesaurus, keywords suggested from previous research and experts, keywords suggested by Scopus and Emerald/Web of Science (WoS). The authors managed to enrich the existing keywords, and developed a full search string (based on Boolean operator, phrase searching, truncation, wildcard, and field code function) on the three main databases namely Scopus, Emerald, and Web of Science (Table 1). The three main databases helped the authors of the present study to perform the systematic literature review because of the advantages they possess, such as advanced search functions, comprehensive indices (indexing more than 5000 publishers), article quality, and multidiscipline focus, including the keywords on lean implementation and lean tools in related studies. Other databases, namely ProQuest, Science Direct, and EBSCOhost, were utilised as supplementary sources for searching keywords, (e.g. lean tools, lean method, education, higher education, etc.) longer phrases, and Boolean operators (e.g. OR, AND). ProQuest was selected as an additional database in line with supporting the findings of this systematic review process. This process

yielded a result of 386 documents from Scopus, 512 documents from Web of Science (WOS), 455 documents from Emerald, 12 documents from EBSCOhost, and 296 documents from ProQuest.

Table 1: Keywords and Search Strings

Databased	Keywords used
SCOPUS	TITLE-ABS-KEY ("lean tools" OR "lean methodology") AND DOCTYPE (ar) AND PUBYEAR > 2014 386
Web of Science (WoS)	("tools" OR "lean tools" OR "lean methodology" 512
Science Direct	("lean tools" OR "lean methodology")
Emerald	(Lean AND tools) OR (Kaizen) OR (poke yoke) OR (5S) OR (*Gemba* walk) OR (Kanban) OR (Value Stream Mapping) OR (5Why) OR (hoshin kanri) OR (standardization) OR (PDCA) OR (visual management) AND (higher education) AND (education sector) AND limited to (Social Science) (Publish 2020-2015) ("lean tools" or "lean methodology") 455
EBSCOhost	("lean" OR "tools" OR "lean tools" OR "lean methodology" OR "education") Or Lean tools 12
ProQuest	("lean tools" OR "lean methodology") 296 Duplication 15

Screening

Screening is the process of identifying, including, or excluding data according to the criteria determined by the authors with the assistance of selected databases. The suitable articles would be selected from the systematic review process based on screening, eligibility, inclusion, and exclusion criteria. First, with regard to timeline, this study would only review the related publications retrieved based on the selected time range: from May 2015 to June 2020. Second, with regard to document types, only journal articles with empirical data were selected, whereas others, such as article reviews, books, chapters in books, and conference proceedings, were excluded because they were not considered a primary source. Third, in terms of language, only journal articles written in the English language were chosen for the systematic literature review (see Table 2). This was to avoid unnecessary translation and linguistic confusion. After the identification process, out of the 149 documents that were screened, 126 articles were subsequently removed (see Fig. 1).

Table 2: The Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Timeline	2015-2020	<2015

Document Type	Journal (Research Articles)	Journal article review, proceeding, book, book chapter;
Language	English	Non-English

Eligibility

Eligibility is the process that includes or excludes articles manually, according to the 'specified criteria' set by the present study's authors. The articles retrieved were thoroughly reviewed in the process, excluding any article that did not meet the criteria. Before the eligibility process was carried out, duplicate documents were first removed. Out of the 149 articles from the identification process, 126 similar articles were excluded from both databases for the next phase; 23 documents were left for the eligibility process and were screened manually for literature, focusing on lean tools or methods and criteria from the earlier screening processes (inclusion and exclusion criteria).

Data abstraction and analysis

The study relied on integrative review. This technique would allow diverse research designs (SLR, qualitative, quantitative, mixed-method) to be included in the review. The present study's authors read the 23 articles, particularly in the sections of abstract, results, and discussions. Data abstraction was conducted based on the articles' research questions; this process denotes that information or data that may have answered a paper's research questions are abstracted and placed in a table. This study selected the qualitative technique.

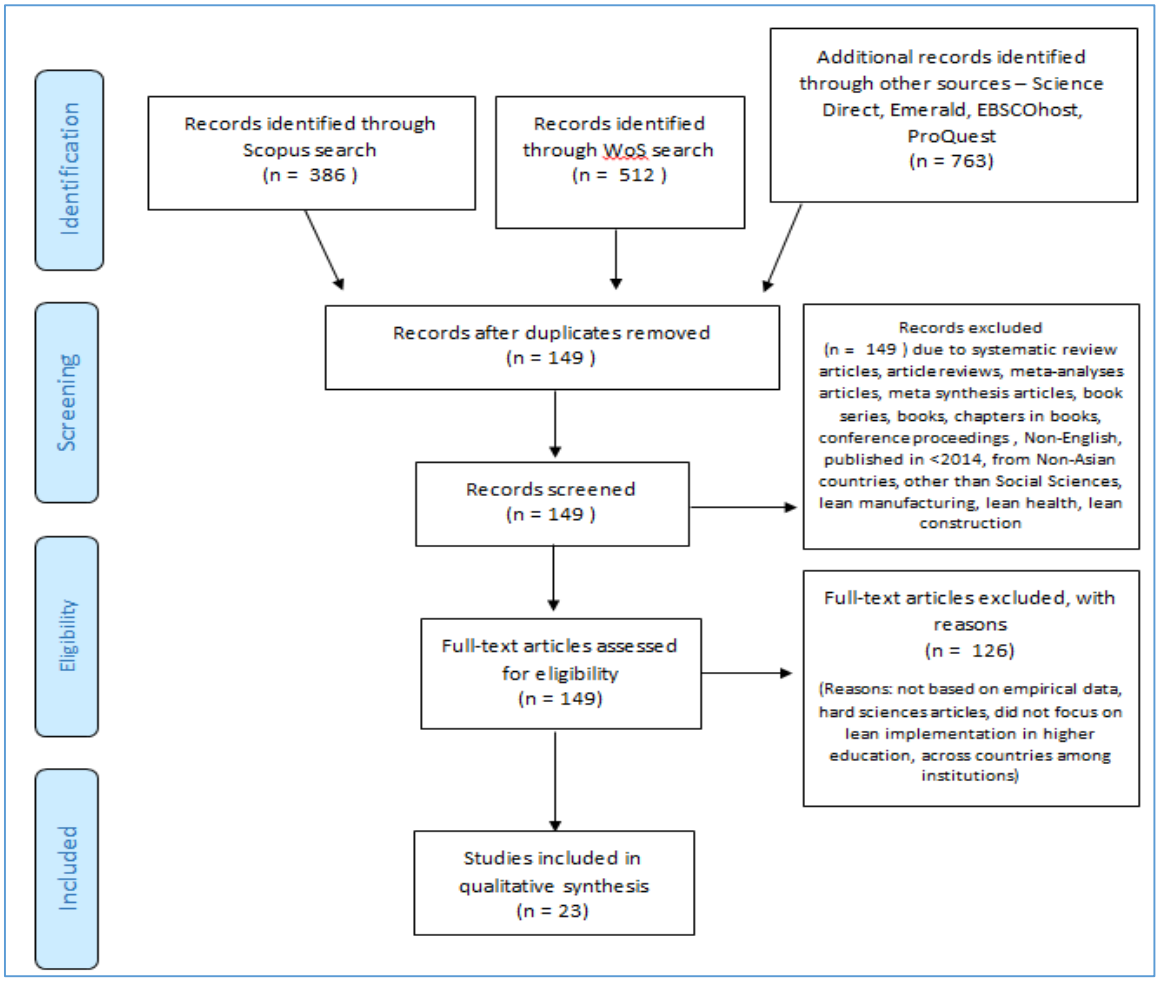

Figure 1: The Flow Diagram of the study

Result And Findings

Background of selected articles

The review managed to obtain 23 selected articles. Based on the thematic analysis, the themes were divided into 24 lean tools, highlighted to be used in the education sector. Each lean tool has its own function and role in its usage benefit. The lean tools that have been highlighted in the study are: 5S, *Kanban*, Value Stream Mapping (VSM), *Kaizen*, A3 problem solving, Pareto Chart, Pull System, cause and effect diagram, standardized work, visual management, *Gemba* walk, Hoshin Kanri Policy, Key performance index, eliminating waste, PDCA, *Poka Yoke*, Analysis Problem Root Cause, Smart, *Andon*, *Heijunka*, Just-in-time, SMED, *Jidoko*, and OEE. All these tools have been used worldwide, which started in the manufacturing sector before being adapted in the health sector, and followed by the recent adaptation in the education sector. The lean tools have been implemented in South Africa, USA, Malaysia, United Kingdom, Mexico, India, Serbia, and Turkey. The selected papers to be reviewed were published any time from 2015 to 2020, with USA and United Kingdom having the highest usage of lean.

Table 3: The findings

Author(s)	Country	Study Design
(Ruben, 2015)	India	SLR
(Thomas, Antony, Francis, & Fisher, 2015)	UK	Interview Qualitative
(Jacqueline Ann Douglas Jiju Antony Alex Douglas, 2015)	UK	Case Study Qualitative
(Theresa Waterbury, 2015)	USA	Semi structured interview Qualitative
(Kizhakethalackal, 2015)	USA	SLR
(Balzer, Francis, Krehbiel, & Shea, 2016)	USA	SLR
(Shradha Gupta, Monica Sharma, & Vijaya Sunder M., 2016)	India	SLR
(Suhaimi, Alias, Siew-Eng, Jasman, & Othman, 2017)	Malaysia	Qualitative – Open ended question
(Kruger, 2017)	South Africa	SLR
(van der Merwe, 2017)	South Africa	Longitudinal study Qualitative
(LeMahieu, Nordstrum, & Greco, 2017)	USA	Case study Qualitative
(Tılfarlıoğlu & Anwer, 2017)	Turkey	Quantitative
(Vukadinovic, Djapan, & Macuzic, 2017)	Serbia	SLR
(Sremcev et al., 2018)	Serbia	Case Study Qualitative
(Koromyslova, Steinlicht, Hall, Yordanova, & Garry, 2018)	South Dakota	Case study Qualitative
(Anete Petrusch & Guilherme Luís Roehe Vaccaro, 2018)	USA and UK	Quantitative Survey Research
(Magalhães et al., 2019)	Portugal	SLR
(Bârsan & Codrea, 2019)	Romania	Case study Qualitative
(Chistnikova, 2019)	Brazil	Comparative study
(Wiid, 2019)	New Zealand	
(Kazancoglu & Ozkan-Ozen, 2019)	Turkey	Research quantitative
(Kregel, 2019)	Germany	Action research Case Study Qualitative
(Nawanir, Binalialhajj, & Lim,	Malaysia	Cross sectional

2019)		study Quantitative
(Garay-Rondero, Rodríguez Calvo, & Salinas-Navarro, 2019)	Mexico	Case Study Qualitative
(Adam, Hofbauer, & Stehling, 2020)	Austria	Case study Qualitative

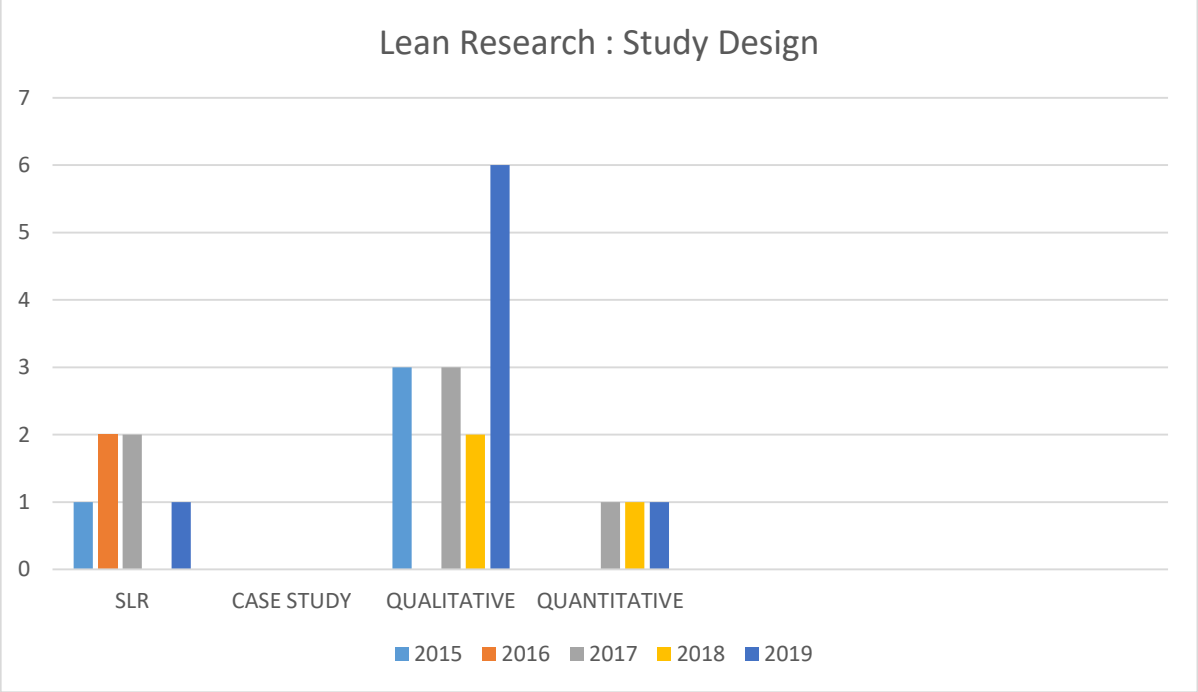

Figure 2 : the Study Design

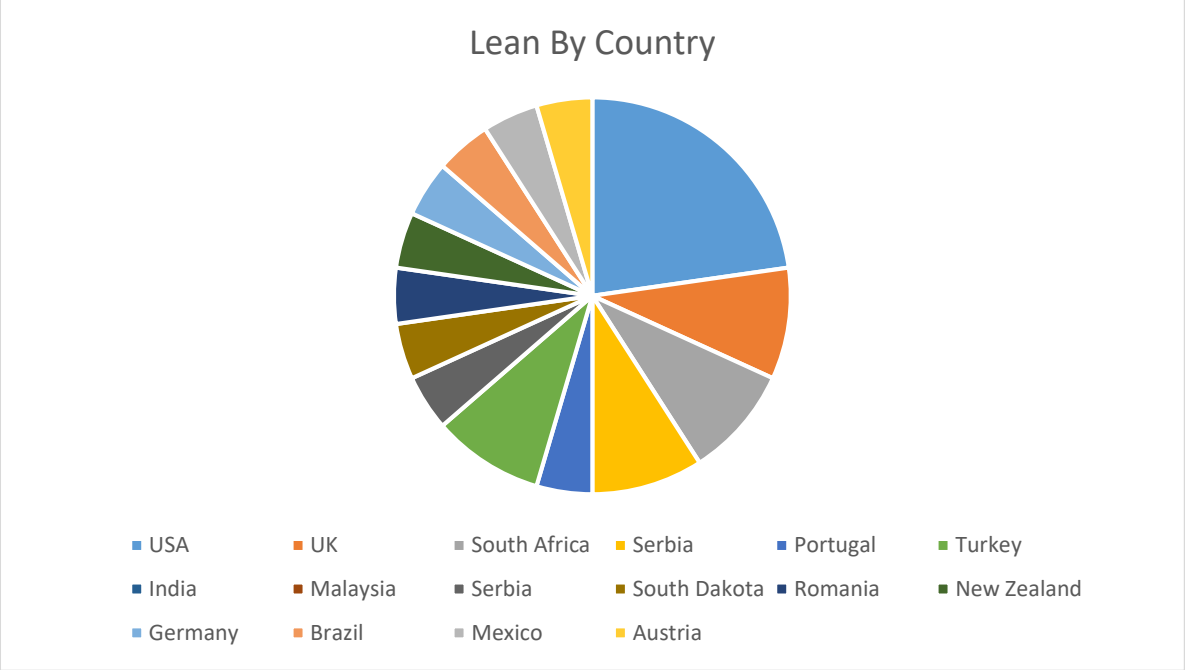

Figure 3 : Lean by Country

DISCUSSION

1.Lean tools utilisation in higher education.

The present study has discussed 24 lean tools to determine their best in higher education. Lean tools may help to reduce workloads, repair work processes, shorten timelines, sustain cost management, and produce a conducive working environment based on effectiveness and efficiency that fulfil customers' need.

The 5S technique (i.e. sort, set in order, shine, standardize, and systematise), which is one of the methods of determining an organisation's approach to its business (Ruben, 2015), has been mentioned a lot in literature. 5S is a technique used to maintain quality of the working environment and can be very useful in the education sector. 5S creates a working environment where equipment and materials are placed in such a way that no time is wasted, which provides a value-added process (van der Merwe, 2017). 5S is a way of ensuring orderliness to be embedded in the day-to-day routine of accomplishing tasks; it prepares the ground for instilling what needs to be a daily discipline (Shradha Gupta Monica Sharma Vijaya Sunder M, 2016). 5S projects the implementation of processing and storing students' information, which will result in reduced waiting time and better quality of services for students (Anete Petrusch, Guilherme Luís Roehe Vaccaro, 2018; Garay-Rondero et al., 2019; Jacqueline Ann Douglas Jiju Antony Alex Douglas, 2015; Koromyslova et al., 2018; Sremcev et al., 2018; Tılfarlıoğlu & Anwer, 2017). Recently, 5S electronic standardization has been conducted using IT facility to visualise the outcomes of eliminating waste in a university's administration department (Magalhães et al., 2019). In Malaysia, the public sector conducive ecosystem (EKSA) is an adaption and rebranding of 5S tools, which provides the same methods to enhance the corporate image of institutions (Unit Pemodenan Tadbiran dan Perancangan Pengurusan Malaysia, 2015).

The term *Kanban* literally means 'signboard' in Japanese, and has shown less usage in the education field. It is a systematic method of regulating the flow of goods, both within the factory and with outside suppliers and customers. It is based on the principle of automatic replenishment through signal cards that indicate when more goods are needed. *Kanban* maintains inventory levels by generating a signal to produce and deliver new shipment as material is consumed. These signals are tracked by the replenishment cycle and bring visibility to suppliers and buyers. It is a useful tool which helps in achieving JIT, by reducing inventory levels (Chistnikova, 2019; Ruben, 2015; van der Merwe, 2017). The tools matter more than the production flow and factory. However, the suggested tools can be adopted in the classroom learning process by stimulating teaching and learning through experiential learning or lean factory simulation classrooms to train and familiarise students with real working environments.

Value Stream Mapping (VSM) is an effective tool most suitable to identify the non-value-added activities associated with the manufacturing process, and has been adapted in many universities (Kazancoglu & Ozkan-Ozen, 2019). It helps to analyse the current state and to design the future state for a series of activities that are involved in the manufacturing of a product, often acknowledged as "seeing the system" (LeMahieu et al., 2017). It uses a standard set of symbols to depict and improve the flow of information and inventory. It visually maps the flow of the production process and also highlights improvement opportunities. Wastes are identified in the current processes and a road map for improvement through the future state is provided. This tool can be applied in all types of organisations, including process and service industries (Ruben, 2015). However, VSM can also be used to solicit the views of key stakeholders, such as students, teachers, parents, policy makers, administrators, and boards of executives, with regard to value, curriculum preparation, assessment list, administration, department-student support process, maintenance operation, virtual library, physical department, and the development of teaching instructions or delivery process in a university (Balzer et al., 2016). Value Stream Mapping (VSM), standardization, and visual management can identify and eliminate the root cause of wastage, leading to a more improved service quality and customer experience, in a rapid manner (Adam et al., 2020; Cañizares et al., 2015; Chistnikova, 2019; Fisher, 2015; Jacqueline Ann Douglas Jiju Antony Alex Douglas, 2015; Kazancoglu & Ozkan-Ozen, 2019; LeMahieu et al., 2017; Magalhães et al., 2019; Narayanamurthy, Gurumurthy, & Chockalingam, 2017; Nawanir et al., 2019; Shradha Gupta Monica Sharma Vijaya Sunder M, 2016; Theresa Waterbury, 2015; Tılfarlıoğlu & Anwer, 2017).

Kaizen is defined in Japanese as 'change for better,' which delivers small improvements, standardization, and results in terms of the overall productivity (Ruben, 2015); Miller, Wroblewski & Villafuerte, 2014). The term 'continuous improvement' is another way to understand *Kaizen*, based on its literal morphemes of *kai*—continuous, and *zen*—improvement (Coetzee, van Dyk, & van der Merwe, 2019; Wiid, 2019). *Kaizen* has been adapted by Toyota Production System (TPS) based on a techno-social system. This cornerstone concept needs to be clearly stated and aligned with the strategic direction of the specific educational institution (Maseleno et al., 2019). Strategy must be a reflection of 'customer value' as monitored through simplicity, quality, speed, cost, motivation, and growth measurements. *Kaizen* can be utilised to involve staff members in brainstorming ideas to identify and eliminate waste (Wiid, 2019). A successful *Kaizen* is characterized as a small change in the process (Kruger, 2017). *Kaizen* is a holistic approach to make everything and everyone better, e.g. the workplace, processes, policies, people, the environment, the economy, and humanity. It is a techno-social system where processes and people are purposefully and continually improving through scientific problem solving that enables the creation of value for the end customer and all other stakeholders (Wiid, 2019). The idealistic notion is that everything and everyone must benefit from improvements; *Kaizen* does not cause harm (Emiliani, 2015)

The sustainability of *Kaizen* events will be according to process improvement procedures, which enhance the similar and systematic coordination of information in each different department (Koromyslova et al., 2018). *Kaizen* includes maintaining a balanced financial performance, achieving planned growth, improving research performance, promoting a shared sense of purpose, improving teaching/learning performance (Koromyslova et al., 2018; Kregel, 2019; Tılfarlıoğlu & Anwer, 2017; Vukadinovic et al., 2017), recruiting/retaining outstanding staff, and maximising benefits from information technology infrastructure (Balzer et al., 2016). A study revealed that the implementation of *Kaizen* does not show the prosperity of continuous improvements for long term purposes. However, with a *Kaizen* approach, this can be turned around as proven in many sectors. It will require knowledge, skill, experimenting, and learning, inspired by committed *Kaizen* leadership. *Kaizen* needs to be combined with the *Gemba* walk, visual management, *Kaizen* leadership, and performance to generate effective outcomes (Wiid, 2019).

The Ishikawa and fish bone diagram utilise the 4M (machine, method, men, and material) in the problem process brainstorming when there is a rejection. Thus, the 5Why root cause analysis technique should be used to find the solution and eliminate the causes of problems (Chistnikova, 2019). The cause and effect diagram has shown an improvement in teaching materials (Balzer et al., 2016; Kazancoglu & Ozkan-Ozen, 2019; Kruger, 2017)

Visual management is an effective tool to highlight the status of work in progress, solve problems of process invisibility, and help in streamlining communication. Thus, it may lead to better problem solving, specifying outcomes by measuring and monitoring the impact on the processes. Their combined improvements should be standardized, by preparing simple checklists written down in detail (Anete Petrusch, Guilherme Luís Roehe Vaccaro, 2018; Garay-Rondero et al., 2019; Magalhães et al., 2019; Shradha Gupta Monica Sharma Vijaya Sunder M, 2016)

Gemba or *Gemba* walk is the action of visiting physical locations by the manager, or director, or senior leaders (Kizhakethalackal, 2015) to see the process created in enhancing the customer value. *Gemba* visit must base on four concrete cornerstones. The first is by visiting the real work on a daily basis. The second is by examining the explicit process in action. The third is by scrutinising the process or any arising problem, and lastly is by gathering genuine facts of the process. *Gemba* is a technique of gaining knowledge through observation, for example, scheduled visits to the classroom, not to micro-manage people but to support people to reach the strategic objectives of the team (Wiid, 2019).

Poka Yoke refers to mistake-proofing, or error-proofing, or fool-proofing (Chistnikova, 2019)(Magalhães et al., 2019)(LeMahieu et al., 2017). These are creative devices that make it nearly impossible for an operator to make errors (Tılfarlıoğlu & Anwer, 2017). The procedure is basically implemented in the manufacturing sector, and it is one of the most powerful lean tools that creates a new standard for manufacturing, forming

a baseline for future improvements (Ruben, 2015). This has been adopted in experiential learning in the teaching and learning process (Garay-Rondero et al., 2019).

Some tools are really new to the education system, having less utilisation. For example, the A3 problem solving normally captures the facts surrounding issues faced by the organisation. A3 is used in structuring problem-solving processes to align with the Hoshin Kanri (strategic management), a scientific method that forces individuals to observe reality, present data, propose a working countermeasure design to achieve the stated goal, and follow up with a process of checking and adjusting for actual results (Garay-Rondero et al., 2019; Kazancoglu & Ozkan-Ozen, 2019; LeMahieu et al., 2017). The Pareto Chart contains a bar chart and a line graph where individual values are represented in a descending order by bar, while the cumulative total is represented by the line. This chart has been used in Lean Six Sigma Analysis in higher education (Cañizares et al., 2015). Elimination of *muda* is the identification of areas that cause losses in the field of education; thus, their competent and timely elimination will contribute to the improvement of education quality at a university (Chistnikova, 2019).

Overall Equipment Effectiveness (OEE) is a framework for measuring productivity loss for a manufacturing process. It provides measures to track the progress of eliminating waste from manufacturing processes. OEE splits the performance of a manufacturing unit into three measurable components, namely Availability, Performance, and Quality (Chistnikova, 2019). The possibilities of using the component indicates an aspect of the process that can be aimed at improving losses and equipment efficiency in higher education.

Mathematically, OEE is calculated as the product of availability, performance, and quality. OEE measurement is also commonly used as a Key Performance Indicator (KPI) in conjunction with lean manufacturing efforts to provide an indicator of success. These KPIs can be a great help to influence major decisions from the high level direction and will be visually displayed on a dashboard for monitoring (Magalhães et al., 2019).

SMED is a setup time reduction technique, where the setup/changeover is made in less than 10 minutes. It is one of the key lean techniques to reduce waste in the manufacturing process (Ruben, 2015). *Jidoko* is a technique to partially automate the manufacturing process and to automatically stop when defects are detected (Ruben, 2015).

Just-in-time (JIT) is a production strategy where parts are pulled through production based on customers' demand, instead of pushing parts through production based on projected demand (Chistnikova, 2019). Just-in-time is a type of operations management approach, which originated in Japan in the early 1950s. It was adopted by Toyota and other Japanese manufacturing firms. It is highly effective in reducing inventory levels and improving cash flow. The main focus of the JIT technique is having "the right material, at the right time, at the right place, and in the exact quantity" (Ruben, 2015). PDCA is interpreted as Plan (create a detailed plan), Do (plan

implementation), Check (achievement control), Act (review of actions taken in terms of effectiveness, the development of more productive actions if necessary). PDCA allows a systematic approach to problems and can be applied in any field of activity, including higher education (Chistnikova, 2019; LeMahieu et al., 2017), and can compensate any unsolved problem in Just-in-time (JIT).

Systematic Literature Review (SLR) in lean tools has shown results that 5S, *Kaizen* improvements, Ishikawa fish bone and root cause analysis, visual management, *Poka Yoke*, *Gemba* walk, and Value Stream Mapping, have all been adapted in the education sector among the other tools discussed in this paper, demonstrating that their implementation provides efficiency and effectiveness in the teaching and learning process. However, there is a gap that indicates these lean tools are still underutilised. There is still less evidence based on the tool implementation that needs to be studied in the future. Most of the reviews have focused on case study methods, interviews, quantitative research, and SLR, so this area of study needs to be empirically tested.

2.Benefits of lean tools usage

Lean tools adaptation has provided some benefits in higher education to sustain efficiency in the process improvement. Lean tools usage has been tested experientially in small processes and projects in higher education. The selection of the lean tools is basically from the teams who have engaged in the implementation of the process. The usage of lean tools is still new in higher education, but has been used in USA and UK, and is gradually spreading to Asian countries.

From the Systematic Literature Review findings, the usage of lean tools has been tremendously applied to generate efficiency in quality management systems, as well as teaching and learning activities (Balzer et al., 2016; Chistnikova, 2019; Kadarova & Demecko, 2016; Kazancoglu & Ozkan-Ozen, 2019; Koromyslova et al., 2018; Kregel, 2019; LeMahieu et al., 2017; Magalhães et al., 2019; Ruben, 2015; Sfakianaki & Kakouris, 2019; Sremcev et al., 2018; Sunder M, 2016; Thomas et al., 2015; Tılfarlıoğlu & Anwer, 2017; Wiid, 2019). Lean tools have been used in designing, scheduling, and delivering courses and curricula, planning academic programmes, improving grading systems, and upgrading assessment practices in the education sector. The classroom presentation culture should utilise visual sheets, standardization in syllabus, and scheduled materials (Tılfarlıoğlu & Anwer, 2017).

Lean tools have been used actively for teaching in simulated classrooms and for course learning in industrial engineering; lean lab factory-style concept classrooms have helped academics to minimise their workloads and focus more in saving students' learning time through hands-on practice (Adam et al., 2020; Garay-Rondero et al., 2019; Marsono & Sadeghifam, 2017; Tılfarlıoğlu & Anwer, 2017; van der Merwe, 2017). The notion of learning has been presented in the context of real-world experiences to develop relevant competencies in real business settings for manufacturing and service industries. Thus, students would be prepared with genuine knowledge, skills, and transferable experience.

In the context of lean usage in administration, the coverage has included financial departments, student administration processes, and facilities management (Andrei Neagu et. al, 2018; Andrew J. Thomas Jiju Antony Mark Francis Ron Fisher, 2015; Anete Petrusch, Guilherme Luís Roehe Vaccaro, 2018; Balzer et al., 2016; Bârsan & Codrea, 2019; Chistnikova, 2019; Jacqueline Ann Douglas Jiju Antony Alex Douglas, 2015; Kadarova & Demecko, 2016; Kazancoglu & Ozkan-Ozen, 2019; Kizhakethalackal, 2015; Koromyslova et al., 2018; Magalhães et al., 2019; Petrusch & Vaccaro, 2019; Sfakianaki & Kakouris, 2019; Theresa Waterbury, 2015). Lean office has introduced an integration of lean electronic standardization with the absence of key performance indicators (KPIs), which has impacted file searching time, information and data storage, information handling, and input time reduction (Magalhães et al., 2019)(Balzer et al., 2016)(Sunder M, 2016)(Suhaimi et al., 2017).

E-Library in the inventory management process is one of the lean higher education tools which has a potential of reducing book storage and providing easier access to databases. It has led to the reduction of waiting time, minimised storage places, and easier access (Balzer et al., 2016; Choo Han Yau, Lee En Shin, Lok Yee Peng, Ng Shi Hui, 2013; Kizhakethalackal, 2015) . In the context of entrepreneurship, lean has been acknowledged in tech start-ups or service businesses, which have always been a hit-or-miss proposition. Respecting the well-known, old formula: writing a business plan and developing a business closer to the potential customer, will focus on "validation" and less on "intuition" (Andrei Neagu et. al, 2018) to sustain technology in business.

Lean implementation will generate an outcome that may reduce all types of wastage in higher education which affect an organisation, such as overproduction, over processing, inventory restocking, elimination of waste, and the reduction of motions, errors, and transportation (Suhaimi et al., 2017). However, the primary objective of lean is to sustain cost efficiency in performing high profit margins by utilising fund saving and cost budgeting. An organisation's funding will be distributed to other value-added activities and investment project profiles (Anete Petrusch, Guilherme Luís Roehe Vaccaro, 2018; Balzer et al., 2016; Kadarova & Demecko, 2016; Nawanir et al., 2019; Ruben, 2015; Sunder M, 2016; Wiid, 2019).

In conclusion, lean implementation has generate and produced a lot of outcomes in reducing all types of wastage, such as overproduction, over processing, inventory restocking, elimination of waste, and the reduction of motions, errors, and transportation (Balzer et al., 2016; Kizhakethalackal, 2015; Suhaimi et al., 2017) to enhance efficiency and effectiveness in an organisation's management process.

Recommendation

The findings and systematic review process of the present study reviewed the lean implementation in higher education. The result showed that lean tools are still new in the education system, and the systematic review process revealed that future studies should be conducted more on lean tools utilisation and its impact within Malaysian institutions. Available prevailing

studies are unable to offer a clear explanation on how the adaptation of lean tools usage can benefit the higher education sector. Such studies are important due to the lean philosophy of sustaining continuous improvement and respecting others. Future studies need to scrutinise on the enhancement of human factors, the cultures of organisations, and the use of lean tools, to produce an accurate finding of lean implementation in higher education. The lack of previous research, which were based on interviews, case studies, and Systematic Literature Review (SLR) processes, shows that there is a lack of quantitative research. This situation has been contributing to the gap in research. Thus, the combination of mixed method research is suggested to develop a deeper understanding of lean implementation, to measure quantitatively all the lean tools utilisation, and to recognise which tools can really help to reduce waste and sustain cost efficiency.

Conclusion

The main purpose of this study was to systematically review the adaptation of lean tools in higher education to sustain the lean philospohy. The study offered several significant contributions for practical purposes and the body of knowledge. Interested parties, especially policy makers, the public, researchers, and organisations can generate short- and long-term adaptation of lean tools in higher education. The result will offer a localised knowledge with scientific findings for future studies and can provide some ideas on the usage of each and every tool. Furthermore, the result will inform future researchers on the specific areas and content of studies related to the implementation of lean tools and their benefits to organisations; this should be the focus of their studies. Moreover, the cooperation between leaders and employees needs to be reviewed prior to executing lean tools, so that the philosophy of "doing more with less" can be implemented and the eight wastes in higher education can be reduced on a continuous basis for improvements in the long run.

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The authors of this research declare that they have no known conflicting financial interest, or personal relationship that could appear to influence the work reported in this study.

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