A systematic literature review of lean manufacturing implementation in manufacturing-based sectors of the developing and developed countries

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Abstract

Purpose: This study aims to comparatively discuss the effect of lean manufacturing (LM) implementation in the manufacturing sectors of developing and developed countries.

Design/methodology/approach: An in-depth literature review focused on previous research published between 2015 and March 2020. The papers published by the databases such as Google Scholar, Scopus, ProQuest and Web of Science were used in the study. A total of 63 studies that focused on LM application in manufacturing industries in developing and developed countries were used in the research.

Findings: It was observed that LM improves operational performance for manufacturing organizations in developing and developed countries. Small and medium-sized enterprises in both developed and developing countries have difficulties transforming their organizations into lean organizations compared to large enterprises. Furthermore, the review also found that there seems to have been no paper had reported the negative impact of implementing LM in manufacturing industries in developing and developed countries from 2015 to March 2020.

Research limitations/implications: The study used research papers written between January 2015 and March 2020 and only considered manufacturing organizations from developed and developing nations.

Practical implications: The study provides more insight into LM implementation in developing and developed countries. It gives the LM practices and the implications of applying these practices in manufacturing organizations for developing and developed countries.

Originality/value: A preliminary review of papers indicated that this seems to be the first paper that comparatively studies how LM implementation has affected manufacturing organizations in developed and developing countries. The study also assessed the LM practices commonly used by the manufacturing industries in developing and developed countries.

Keywords: Lean manufacturing, Developing countries, Operational performance, Developed countries, Manufacturing organizations

1. Introduction

Manufacturing and service organizations in the developing world have not been left behind in the quest for implementing lean manufacturing (LM). This is because they face the need to enhance the three main dimensions of performance: economic, environmental and social, known as the triple bottom line (Henao *et al.*, 2019). Though much effort has been put into implementing LM, most LM implementations have not yielded the desired results in developing countries than developed countries (Marodin *et al.*, 2018). Most manufacturing organizations in the developing world use outdated manufacturing systems and machinery (Carvalho *et al.*, 2019; Goshime *et al.*, 2019; Gupta and Jain, 2013). They also lack skilled labour and have insufficient resources such as capital, raw material, water and electricity (Zahraee, 2016; Kinyondo *et al.*, 2014). Goshime *et al.* (2019) reported that most industries in the developing countries are still in an infant stage in adopting the LM philosophy, while Yadav *et al.* (2020b) asserted that many organizations have not yet adopted the LM philosophy in the developing world. The developing countries lack the expertise that helps in the implementation of LM (Hokoma *et al.*, 2010; Ghosh, 2013; Khusaini *et al.*, 2014), and there is also more knowledge of LM in the developed countries compared to the developing countries (Hokoma *et al.*, 2010; Panwar *et al.*, 2016). In addition to that, authors such as Khaba and Bhar (2018), Shamah (2013) and Wong and Wong (2011) averred that some employees fear losing their jobs due to retrenchment when non-value-added activities become visible. Organizations in developing countries also lack organizational and governmental support (Sangwan *et al.*, 2014; Shamah, 2013; Wong and Wong, 2011; Pearce *et al.*, 2018; Coetzee *et al.*, ; Thanki and Thakkar, 2018; Singh *et al.*, 2019); therefore, they consider the implementation of LM as expensive thus have not ventured to apply it.

Marodin *et al.* (2017) stated that LM studies in developing countries are still lower in quantity than in developed countries. A review of academic papers published for LM between 1991 and 2017 by Durakovic *et al.* (2018) showed that the USA contributed 34.1% of the publications, India had 10.9% and UK 6.8%. Yadav *et al.* (2020b) reported that 30% of the firms in the USA and 25% in the UK have been successful in implementing LM. There are indications that not only do organizations in developing countries have difficulties implementing LM but the developed world also faces similar challenges in implementing it. This is because the philosophy requires a gradual implementation of its principles as it may not be possible to implement them all at once. This paper will compare academic articles written on the impact of LM in manufacturing organizations for developing and developed countries.

Several reviews have examined the impact of LM in manufacturing industries. A study by Durakovic *et al.* (2018) presented a review of the industries that applied this philosophy, the advantages, opportunities and challenges faced in implementing LM. Negrão *et al.* (2016) assessed the degree of adoption of lean practices and their effect on operational or financial performance in manufacturing organizations in several countries around the world. Stone

(2012) identified the five phases of LM, such as the discovery phase, dissemination phase, implementation phase, enterprise phase and the performance phase. He highlighted the practices, theories and themes associated with LM for a period of 40 years.

This paper is different from other LM literature review studies published because it compares how LM has affected manufacturing organizations in developed and developing countries. Furthermore, the study assessed the LM practices commonly used by manufacturing organizations in developing and developed countries. In this review, the authors used the human development index (HDI) (Kinnunen *et al.*, 2019) and gross national income (GNI) (Nielsen, 2011) to classify countries as developing or developed country. The authors of this paper used the HDI with cut off points of 0.55, 0.7 and 0.8 to classify a country as a developed or developing country (Fantom and Serajuddin, 2016). A country with an HDI of less than 0.8 was classified as developing, while a country with an HDI of more than 0.8 was classified as developed (Churilova *et al.*, 2019). A country was classified as a developing country if the GNI was less than $12,375 and a developed country if the GNI was more than $12,375 (Loayza, 2020).

The study is organized as follows: Section 2 gives the methodology followed in conducting the study. Section 3 describes a review of the literature on the implementation of LM by countries. Section 4 presents the study results and Section 5 gives the discussion, conclusion and limitations of the study.

2. Methodology

The authors performed a systematic literature review (SLR) to aggregate the research findings from papers published on LM in developed and developing countries. This method allowed the authors to select, evaluate and interpret the existing literature on LM in different parts of the world. Furthermore, in this review, the researchers identified gaps between LM applications in developing and developed countries. The articles published for LM between 2015 and March 2020 were used in this study. A SLR conducted by Antony *et al.* (2020) found that about 72% of papers written in LM were done between 2016 and 2020. Thus, this paper's authors used studies written between 2015 and March 2020 as a meaningful comparison can be made because a vast number of publications can be investigated. Papers published before March 2020 were used because the lockdowns implemented by different countries could have affected results obtained from manufacturing industries due to the COVID 19 pandemic. The steps for conducting SLR given by Magnani *et al.* (2019) in Figure 1 were used in this research. The initial search for papers published by the databases such as Google Scholar, Scopus, ProQuest and Web of Science yielded 673 articles on LM in the manufacturing industries. In total, 273 papers were duplicated by the databases and were then removed from the list. The keywords used in the search were combined differently. In total, 122 academic papers were obtained by combining LM applications in manufacturing organizations and developed countries; 133 papers were obtained combining LM in manufacturing organizations and developing countries. In total, 68 academic articles were obtained using LM application, operational performance and developed countries and 77 research papers were obtained by combining LM application, operational performance and developing countries. In the first filter, 300 papers from the non-peer-reviewed journals, book chapters and reports were removed, leaving 100 academic papers. In the second filter, the

authors read the keywords and the abstracts and removed papers from the service industries and other papers that did not specify the type of industry, leaving 81 academic papers. Paper with terms such as health care and accounting were eliminated because the review was focusing on the manufacturing industries. In the third filter, 81 full papers were read and the exclusion and inclusion criteria used in the paper is shown in Table 1. In total, 18 papers were removed because they did not specify the country where the research was conducted. Finally, a total of 63 articles that focused on LM application in manufacturing industries in developing and developed countries were used in the research. These articles were then arranged according to the country of origin and were later classified according to the research type the paper falls under.

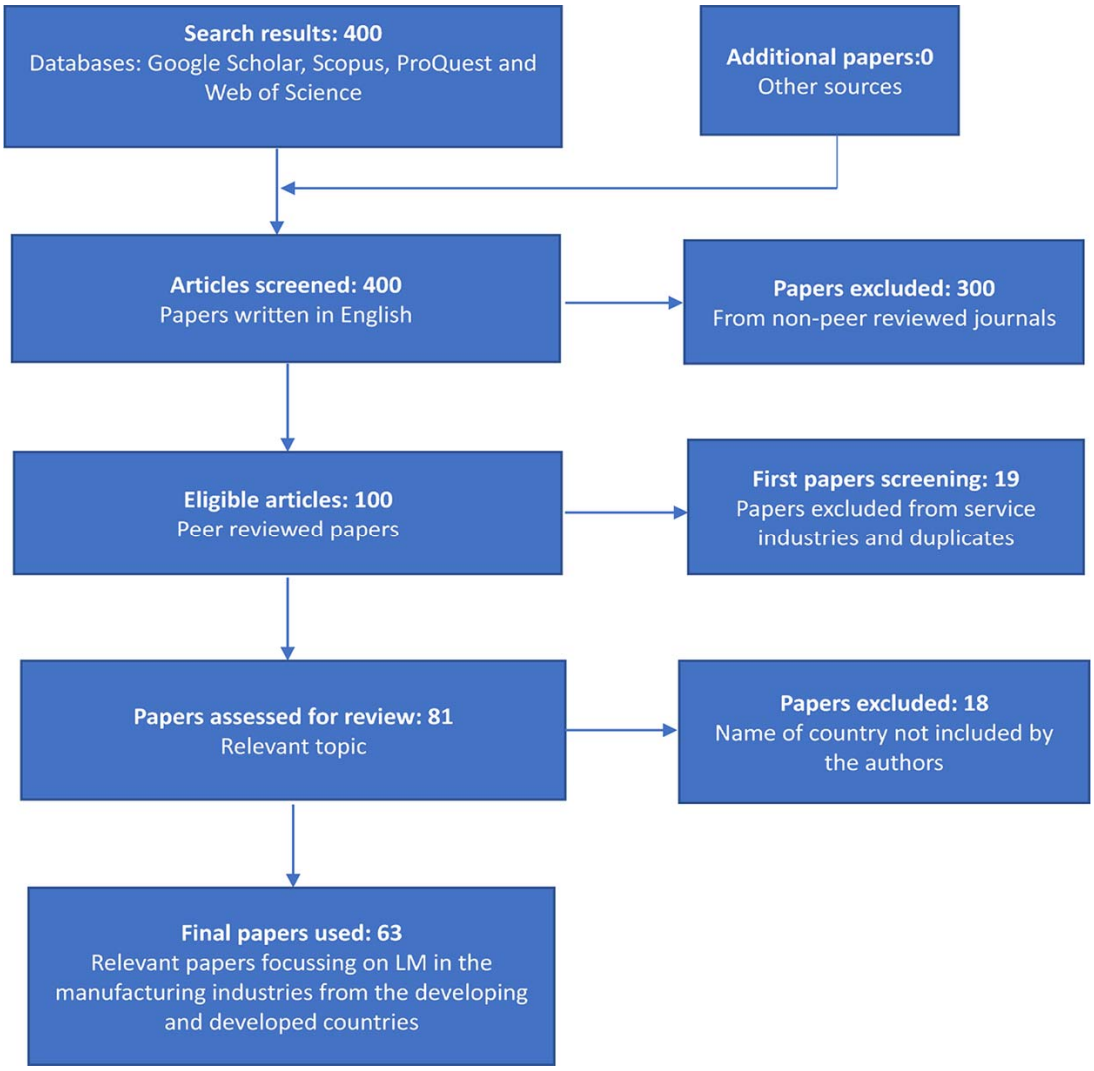

Figure 1. Article selection process

Table 1. Research papers selection process

Keywords	LM application, operational performance, developing countries and developed countries
Boolean operators	OR and AND
Databases	Google Scholar, Scopus, Proquest and Web of Knowledge
Inclusion criteria	• Case studies and surveys that analysed the impact of LM on operational performance in manufacturing industries in developing and developed countries • LM studies that described how LM practices or tools were adopted in manufacturing in developing and developed countries
Exclusion criteria	• LM studies from the service industry • LM studies that did not specify the industry type where the research was conducted • LM studies that did not state the country where the study was conducted
Language	English
Document type	Published scientific papers in academic journals
Years of publication	January 2015–March 2020

3. Review of literature conducted on lean manufacturing

It is important to note that several articles had reviewed the impact of LM in manufacturing organizations. A study conducted by Yadav *et al.* (2020b) established a framework for implementing LM in the manufacturing industries for developing countries. The study analysed the LM drivers for implementing LM for small and medium-sized enterprises (SMEs). The framework developed was evaluated using a case study. Psomas and Antony (2019) reviewed the research gaps found in the LM literature and classified them into themes. The study identified the pre-implementation phase themes, implementation phase themes and post-implementation phase themes. This study could not differentiate how LM has affected the manufacturing firms in developed and developing nations. The study mentioned that more research papers were found in the European and Asian continents.

Gupta and Jain (2013) reviewed academic articles written between 2000 and 2013 for LM philosophy, LM case studies and LM surveys. The study revealed that the LM techniques and tools adopted by manufacturing industries differ according to the type of waste the organizations experienced. Furthermore, the study also discussed the barriers and benefits realized by implementing LM. However, this research did not mention the industry type and country where the studies were conducted. Bhamu and Singh Sangwan (2014) listed the diverse definitions of LM found in the academic papers written between 1988 and 2012. They suggested that the lack of a standard way of implementing LM had caused practitioners to adopt different lean tools that suit the types of wastes they face. These authors then developed a lean implementation framework that practitioners can adopt. The study listed the industry type and the country where it was conducted; however, the study made no distinction between developing and developed countries. Samuel *et al.* (2015) noted that there was no standard definition of LM from an analysis of papers published between 1988 and 2013.

Jasti and Kodali (2014) highlighted an increase in the number of papers published on LM between 2000 and 2011 and a surge in published papers for the developed countries because

of the benefits realized in using this management philosophy. This study also revealed that the number of studies conducted in the developed countries for the period (1988–1999) and (2000–2011) for the developed countries were more than those done in the developing countries. Authors such as Psomas and Antony (2019), Hu *et al.* (2015) and Jasti and Kodali (2014) revealed that the UK and the USA were leading in LM implementation and had more research papers. The current study is unique because it analyses and compares the implementation of LM in developing and developed nations and considers the time after these reviews were done.

Negrão *et al.* (2016) assessed the research papers that evaluated how the manufacturing industries adopted LM and the impact of LM tools on organizational performance worldwide. The results revealed that LM tools were adopted haphazardly by manufacturing organizations. A positive association was found between LM tools and organizational performance. Cocca *et al.* (2018) discussed the advantages and disadvantages of 31 leanness measurements methods used by manufacturing organizations found in the literature. Hartini and Ciptomulyono (2015) found that LM and sustainable manufacturing positively affected three performance dimensions: economic, environmental and social. This study used papers from both developing and developed countries; however, no comparison was made between developing and developed countries.

Antony *et al.* (2020) investigated the internal practical implications themes, external practical implications themes and future research themes in LM for manufacturing organizations worldwide. Gülyaz *et al.* (2019) developed a customer value matrix tool that helps organizations deepen their understanding of customer value to design a product that meets customer needs. Goienetxea Uriarte *et al.* (2019) identified the literature trends for combining LM and simulation and suggested future research perspectives for these two areas. On the other hand, Rosin *et al.* (2019) investigated the Industry 4.0 tools that enhance the application of LM practices. The study revealed that LM practices such as Jidoka and just in time (JIT) were improved by Industry 4.0 while no improvement was found on lean tools such as teamwork and waste reduction.

3.1 Lean manufacturing in manufacturing organizations in developing countries

A summary of the papers written for LM in the developing countries is given in Table 2. The table gives the author names, country of study, description of the study, the manufacturing organization's classification, type of research article and the study results. The papers were arranged according to the research method used in the study.

3.2 Lean manufacturing on manufacturing firms in developed countries

A summary of the papers written for LM in the developed countries is given in Table 3. The table gives the author names, country of study, description of the study, the manufacturing organization's classification, type of research article and the study results. The papers were arranged according to the research method used in the study.

Table 2. LM studies in developing countries

Author	Country	Type of research paper	Study	LM practices and tools implemented	Classification of manufacturing organizations	Key findings
1 Mamat *et al.* (2015)	Malaysia	Literature review	The influence of soft lean strategies on the automotive SMEs in Malaysia	Reward system, training, communication, human resource management (HRM), continuous improvement, teamwork, supplier management, employee commitment, customer focus and employee involvement	SMEs	Soft LM practices are crucial for the execution of lean in Malaysian automotive organisations
2 Dondofema *et al.* (2017)	South Africa	Literature review	The degree of application and endorsement of LM in South African industries	Employee empowerment, waste elimination, continuous improvement and value stream mapping (VSM)	Undisclosed	The application of LM is still at an initial stage in South African industries
3 Shrimali and Soni (2017)	India	Literature review	The obstacles and the vital factors for applying LM in Indian SMEs	VSM, 5S, six sigma, Kaizen, visual management, JIT and Poka Yoke	SMEs	Factors that cause SMEs to implement LM are the urge to maximize profit, reduce cost and inventory and increase competitive advantage and plant utilization
4 Azadeh *et al.* (2015)	Iran	Case study	Analysis of leanness in the printing and packaging companies using a fuzzy cognitive map	JIT, vendor development, kaizen, lot reduction, quality control, kanban, waste elimination, quality function deployment (QFD), total quality management (TQM), total productive maintenance (TPM), poka-yoke, material resource planning, pull production, CM	SME	A leanness measure such as production procedure had the most influence on leanness strategy
5 Kim (2015)	Philippines	Case study	An analysis of how Toyota company help their suppliers to implement LM	Root cause analysis (RCA), fishbone diagram, kano model, process workflow, VSM, 5S, poka-yoke, heijunka, genchi genbutsu, single minute exchange of a die (SMED) and kanban	Large enterprise	Implementation of LM for the Toyota suppliers requires a small number of tools such as 5S, jidoka, standardized work and heijunka
6 Gupta and Jain (2015)	India	Case study	Application of the 5S technique in Indian small scale manufacturing company	5S, cause and effect and standardization	SME	There was a reduction of tool searching time and an increase in the Indian manufacturing company's audit score
7 Panwar *et al.* (2016)	India	Case study	An investigation of the factors that cause the Indian process industry not to adopt LM philosophy	TPM, 5S, preventive maintenance and visual control	Large enterprises	Lack of technical expertise, knowledge of LM, support from top management and coaching were significant hindrances to the adoption of this philosophy
8 Ali Naqvi *et al.* (2016)	Pakistan	Case study	Application of the systematic layout planning technique at a multinational company	Systematic layout planning	Medium-scale	Four possible layouts for the production departments were designed
9 Ali and Deif (2016)	Egypt	Case study	Measurement of the degree of leanness for a kitchen manufacturing company in Egypt	Work in progress reduction and overall equipment effectiveness (OEE)	Large enterprise	The model developed enabled demand rate to have the most significant effect on leanness score dynamics

10 Campos and Vazquez-Brust (2016)	Brazil	Case study	The symbiotic effect of LM and green practices	Supplier relationship, JIT, employee involvement, training, worker empowerment, kaizen, inventory reduction, 5S, TPM, TQM, kanban, lead time reduction and VSM	Large enterprise	Lean and green practices have a symbiotic effect on each other, especially when there is increased trust and shared risks
11 Li *et al.* (2016)	China	Case study	Analysing the factors that affect the implementation of LM in the Chinese construction industry	5S, TQM, last planner system (LPS), JIT, concurrent engineering and visual management	Large enterprise	The factors that influenced LM implementation were market orientation, the structure of the organization and its culture and knowledge of LM
12 Losonci *et al.* (2017)	Hungary	Case study	The effect of culture on the shop floor and subculture on LM tools	Kanban, statistical process control (SPC), 5S, RCA, CM, standardization and employee involvement	Large enterprise	There was a weaker relationship found between organizational culture and LM tools
13 Gupta *et al.* (2018)	India	Case study	Analysis of waste in the tyre manufacturing company in India	Inspection, preventive maintenance and set up reduction	Large enterprise	The application of LM led the rubber manufacturing organization to achieve a higher level of greenness
14 Maradzano *et al.* (2019)	South Africa	Case study	The development of a framework to implement LM in the South African construction industry	JIT, standardization, 5S, prefabrication, 5whys, VSM, LPS, TPM, pareto analysis, TQM, fishbone diagram, waste elimination, pull systems, daily huddle meetings, poka-yoke, target value design and failure mode effect control analysis	Large enterprise	The implementation of the LM framework yielded benefits to the construction industry
15 Tortorella *et al.* (2016b)	Brazil	Case study	The impact of leadership styles and contextual variables on LM implementation	Pull production, flexible workforce, continuous improvement, prioritization, problem-solving, flow, organizational design, cross-functional teams, zero defects, workplace organization, quality assurance, maintenance system, product/process quality planning, takt time, production levelling and standardized work	Large enterprise	Adoption of LM in a manufacturing setup depended upon the contextual leadership variables
16 Jasti and Kodali (2016)	India	Survey	The level of implementation of lean principles in the manufacturing sector of India	Concurrent engineering, cross-functional team working, process sharing, use of multiple small machines,	Large enterprise and SMEs	Most organizations in the Indian manufacturing sector were in their initial phases of implementing lean driven by the need to satisfy customers and improve their operations
17 Godinho Filho *et al.* (2016)	Brazil	Survey	Assessment of the degree of adoption of LM and its impact on Brazilian SMEs	SPC, customer involvement, TPM, supplier development, employee involvement, supplier JIT, supplier feedback, pull, continuous flow and setup reduction	Manufacturing SMEs	LM in Brazilian SMEs was not being implemented holistically. Three LM tools such as TPM, employee involvement and SPC were mainly used
18 Nawanir *et al.* (2016)	Indonesia	Survey	The effect of lean practices in the Indian manufacturing industries	Flexible resources, supplier networks, cellular layout, TPM, pull system, quality at the source, uniform production level and small production lot	Large enterprise	LM tools had a positive and direct relationship with business performance
19 Prasad *et al.* (2016)	India	Survey	Assessment of the application of green and LM tools in the Indian foundries	5S, VSM, CM, supply chain management, kaizen, SPC, JIT, RCA, TPM, autonomation, pull production and setup reduction	Undisclosed	The was a positive relationship between green and LM practices

20 Marodin *et al.* (2016)	Brazil	Survey	The impact of contingencies such as the company size, time that the firm has implemented LM and its position in the supply chain on LM implementation	Andon, Jidoka, multifunctional teams, TPM, setup reduction, one-piece flow, pull production, production levelling, visual management, standardized work and problem-solving	Large enterprises and SMEs	The benefits of implementing LM for higher lean adopters were a reduction of lead time, inventory and improvement of turnover. The results also showed that the first and second-tier firms were leaner than third-tier firmsl.
21 Marodin *et al.* (2017)	Brazil	Survey	The influence of LM on operational performance in the Brazilian automotive industry	Andon, one-piece flow, pull production, jidoka, multifunctional teams, TPM, setup reduction, production levelling, visual management, standardised work and problem-solving	Undisclosed	There was a reduction in inventory levels due to the implementation of LM practices such as TPM and JIT
22 Tortorella *et al.* (2017)	Brazil	Survey	Determination of the lean supply chain management bundles and their relationship with lean supply chain management performance	Pull system, functional packaging design, close relationship with the customer, consignment stock, heijunka, continuous replenishment, establishment of distribution centers, two-way feedback assessment, value chain management, hoshin kanri, standardized work, material handling system, kyoryokukai, keiretsu, VSM, problem-solving and value chain management	Large enterprises	Lean supply chain performance increased because of the execution of lean practices
23 Ansah and Sorooshian (2017)	Malaysia	Survey	Development of a framework used to prioritize LM tools for the construction industry	Fail-safe for quality, QFD, plan do check act (PDCA), RCA, daily hurdle meetings, construction process analysis, six sigma, poka-yoke, visual management, 5S, SPC, work structuring, work standardization, Kanban, Muda walk, 5whys, line balancing, suggestion schemes, checkpoints and control points, multi-process handling, team preparation, heijunka, failure mode effect analysis (FMEA), bottleneck analysis, set up reduction, first in first out (FIFO), kaizen, check sheet, smart goals, TPM, work and motion studies, LPS, continuous flow, pareto analysis, VSM, JIT and first-run studies	Undisclosed	The most commonly used tools for the construction industry were LPSs, daily hurdle meetings and concurrent engineering
24 Nimeh *et al.* (2018)	Jordan	Survey	The impact of lean supply chain management tools on market and supply chain performance	Waste reduction, JIT, customer relationship, supplier relationship and flow	Undisclosed	There was a positive relationship between lean supply chain management and market and supply chain performance
25 Pozo *et al.* (2018)	Brazil	Survey	An investigation of how performance goals prioritized by the Brazilian automotive manufacturing companies influence the LM pillars implemented	JIT, Jidoka, standardization, kaizen, 5S, heijunka and pull production	Undisclosed	The LM pillars adopted had an interlink with different companies' performance objectives
26 Soliman *et al.* (2018)	Brazil	Survey	The impact of LM on the complex socio-technical systems in Brazil	Flow, pull production, Andon, workload levelling, visual control systems, teamwork, genichi gembutsu and continuous improvement	Large enterprises and SMEs	The use of LM reduced the number of workers, improved employees' belief and behaviour, reduced disruptions in the operational systems and increased resilience and interactions among the major stakeholders

27 Shi *et al.* (2019)	China	Survey	The impact of LM on productivity changes and the moderating effect of research and development on this association in China	JIT, TQM, TPM and kanban	Undisclosed	LM had no positive relationship with productivity changes and research and development had a positive relationship with technological changes' efficiency
28 Saengchai and Jermsittiparsert (2019)	Indonesia	Survey	The effect of supplier network and flexible resources on the association between LM and organizational performance	VSM, waste elimination, takt time and JIT	Undisclosed	The supplier network tool acted as the mediating variable between the association of LM and organizational performance. While flexible resources acted as a moderating variable for this relationship
29 Panwar *et al.* (2017)	India	Survey and case study	The effect of LM tools in the Indian process industries	Production levelling, TPM, pull production, 5S, quick changeover techniques, quality management programme, JIT purchasing, work standardization, lot size reduction, SPC, new equipment and technology, supplier integration and partnership, continuous improvement programs, bottleneck/constraint removal, visual control, small number of supplier, long term relationship with suppliers and flexible and cross-functional teams	Large enterprises	The Indian process industries realized a reduction in inventory, cost and wastes and an increase in productivity and quality
30 Abu *et al.* (2019)	Malaysia	Survey	The effect of implanting LM in the Malaysian wood and furniture industry	5S, quality control, preventive maintenance, TPM, poka-yoke, Jidoka, takt time, training, zero defects, TQM, visual management and kanban	Undisclosed	Implementation of LM improves efficiency space utilization and organizational workplace. The major barriers for LM implementation are lack of knowledge, the resistance of employees to change, financial resources and training
31 Chauhan and Chauhan (2019)	India	Survey	Development of a framework for implementing LM	Automation, TQM, TPM, quality control, setup reduction, training, worker empowerment and setup reduction	Undisclosed	A framework that contains three phases was developed for implementing LM in Indian engineering firms was developed
32 Minh *et al.* (2019)	Malaysia	Survey	The effect of LM implementation on job satisfaction in Malaysian manufacturing organizations	Process and equipment practices, customer relationship, manufacturing planning and control, product design, supplier relationship and HRM	Large enterprises	LM practices such as HRM, product design and customer relationship had a positive relationship with job satisfaction, while practices such as process and equipment had a negative effect on job satisfaction
33 Soliman *et al.* (2018)	Brazil	Survey	The impact of LM on the complex socio-technical systems in Brazil	Flow, pull production, Andon, workload levelling, visual control systems, teamwork, genichi gembutsu and continuous improvement	Undisclosed	Use of LM to reduce the number of workers, improve employees' belief and behaviour, reduce disruptions in the operational systems and increase resilience and interactions among the major stakeholders

34 Jasti and Kodali (2019)	India	Survey	Evaluation of the suitability of LM framework in the manufacturing firms of India	Concurrent engineering, top management commitment, JIT, HRM, customer relationship management, elimination of waste, supply chain management (SCM), information technology system, TQM, standardization, continuous improvement and concurrent engineering	Large enterprises and SMEs	The LM framework proposed had high reliability, thus could be used to implement LM in Indian manufacturing firms
35 Maware and Adetunji (2019a)	Zimbabwe	Survey	The effect of adopting LM practices in the Zimbabwean manufacturing industries	JIT, Jidoka, stability and standardisation, HRM	Large enterprises and SMEs	Implementing LM tools increased operational performance in manufacturing industries
36 Maware and Adetunji (2019b)	Zimbabwe	Survey	The moderating impact of industry clock speed on the association between LM strategies and organisational performance	JIT, Jidoka, stability and standardisation, HRM	Large enterprises and SMEs	Industry clock speed moderated the relationship between LM strategies and organizational performance
37 Chisosa and Chipambwa (2018)	Zimbabwe	Survey	The impact of work-study practices in the fashion industry in Zimbabwe	Time study and motion study	Undisclosed	The clothing industry in Zimbabwe did not have adequate knowledge of the work-study practices and employees had negative perceptions about the practices
38 El-Khalil (2020)	The Middle East and Northern Africa (MENA) region	Survey	Assessment of the interactions and correlations of the LM practices and their relationship with organizational performance in developing countries in the MENA region	Standardization, workstation satisfaction, direct run loss, 5S, visual management, JIT, quick changeover, poka-yoke, PDCA, problem-solving, teamwork, TPM, training, VSM, production levelling and master planning	Large enterprises	Organizations in the MENA region had significantly implemented LM and the LM bundles had a direct relationship with organizational performance
39 Khaba and Bhar (2018)	India	Survey	The impact of LM practices used, enablers and barriers for LM in the Indian coal mining	Work standardization, CM, bottleneck analysis, VSM, visual management, jidoka, TQM, JIT, kaizen, TPM, Key performance indicators, SMED, OEE, RCA, PDCA and poka-yoke	Large enterprises	Coal mines in India that are ISO certified have a higher implementation rate of LM practices. The most common LM enabler was top management support
40 Sahoo and Yadav (2018)	India	Survey	The impact of LM tools and constructs on the Indian manufacturing industry	TQM and TPM	Medium and large enterprises	LM constructs have a more significant impact on operational performance compared to LM tools

Table 3. LM studies in the developed countries

Author	Country	Type of research papers	Study	LM practices and tools used	Classification of manufacturing organizations	Key findings
1 Bevilacqua *et al.* (2016)	Italy	Survey	Impact of LM practices on operational responsiveness in Italian companies	HRM, supplier management, JIT and TQM	Large enterprises and SMEs	There was a positive association between LM practices and operational performance variables such as time effectiveness, while these practices negatively influenced innovation and product mix
2 McLeod *et al.* (2016)	USA	Survey	Development of a framework to implement LM in SMEs in Indiana state in the USA	Supplier feedback, employee involvement, JIT, SPC, supplier development, TPM, customer involvement, set up time reduction, flow production and pull production	SMEs	A new framework was developed that identified new factors such as training, supplier/customer feedback and supply chain coordination
3 Marin-Garcia and Bonavia (2015)	Spain	Survey	The impact of employee involvement on LM and its relationship with productivity	Employee empowerment, remuneration, training and communication	Undisclosed	Employee involvement had a positive effect on LM, which, in turn, affect production outcomes
4 Chavez *et al.* (2015)	Ireland	Survey	The moderating effect of technological turbulence on the relationship between LM tools and organizational and operational performance	Supplier partnership and customer relationship	Large enterprises and SMEs	Supply chain relationships positively affect internal LM tools, which, in turn, affect operational performance and organizational performance
5 Garza-Reyes *et al.* (2015)	Turkey	Survey	Analysis of the level of readiness in the automotive industry in Turkey	HRM, customer relationship, process planning and control and top management support	Large enterprises and SMEs	There was a high level of readiness for the practices such as management support and customer relation, while a low level of readiness was seen for the supplier relations and process planning and control
6 Zhou (2016)	USA	Survey	Factors that affect the execution of LM in SMEs in the USA	5S, quality certifications, standardization, SMED, VSM, continuous improvement, process mapping, poka-yoke, cellular layout, energy management, pull system, PDCA, TPM, JIT, Six Sigma and environmental management	SMEs	The SMEs in the USA had more knowledge of LM, and the major drawbacks to its implementation were employee resistance to change and technical knowledge
7 Cadden *et al.* (2020)	UK	Survey	The effect of organizational culture on the relationship between LM and organisational performance	Layout of equipment, Kanban, batch size reduction and order release timeframe	Large enterprises and SMEs	The organizational culture practices such as employee orientation, open structures, market orientation and tight structures have a positive relationship with LM, while LM is negatively associated with organizational culture tools such as pragmatic cultures and results-oriented practices
8 Kroes *et al.* (2018)	USA	Survey	The impact of LM on capacity slack and inventory slack, which, in	Inventory reduction	SMEs	There was a linear relationship between firm performance and inventory slack

			turn, affect firm performance			
9 Inman and Green (2018)	USA	Survey	The impact of LM and green practices on operational and environmental performance	SPC, pull production, total productive maintenance, setup time reduction, continuous flow and employee involvement	Undisclosed	LM had a direct and positive relationship with green practices, environmental performance and operational performance. However, no relationship was found between green practices and operational performance, and the indirect relationship was found to be positive
10 Bevilacqua *et al.* (2017)	Italy	Survey	The effect of LM practices in high lean performers industry and low lean performers industries on operational performance	TPM, employee involvement, SMED, job rotation, standardized operating procedures, training, total quality control, supplier relationship, poka-yoke, pull production and heijunka	Large enterprises and SMEs	High lean performers had a higher turnover and more employees, while low lean performers had a high capability to customize production and alter their production schemes
11 Sartal *et al.* (2017)	The Netherlands, Croatia, France, Spain and Slovenia	Survey	The effect of LM on industrial performance with environmental technology and information technology acting as mediating variables	JIT, Jidoka and respect for people	SMEs	LM has a positive relationship with industrial performance via a mediating role of environmental technology and information technology
12 Salonitis and Tsinopoulos (2016)	Greece	Survey	An analysis of the impact of LM in manufacturing organizations in Greece	Customer involvement, SMED, supplier quality, 5S, lean supply chain, kaizen, JIT, waste reduction, worker commitment, TPM, employee involvement, VSM, quality circle, poka-yoke, heijunka, continuous flow, Andon, six sigma, pull production and CM	Large enterprises and SMEs	Implementation of LM assisted manufacturing firms in Greece to reduce waste and continuously improve their operations
13 Bortolotti *et al.* (2016)	Spain	Case study	The impact of supply chain characteristics on LM extension in the aerospace industry	VSM, new product development, pull and training	Large enterprises	There is an interaction between LM practices and supply network characteristics
14 Nguyen and Do (2016)	Germany	Case study	Transformation of a traditional production model in an electronic manufacturing firm to a lean production model	5S, continuous improvement, Kanban, VSM, spaghetti chart and brainstorming	Undisclosed	The lean production model's use resulted in a reduction in floor space usage, delivery time and the number of employees
15 Lacerda *et al.* (2016)	Portugal	Case study	Use of VSM to remove non-value added activities and waste in the automotive industry in Portugal	VSM and kaizen events	Large enterprise	The implementation of VSM led to a reduction in cycle time, number of workers, inventory and bottlenecks
16 Lindskog *et al.* (2016)	Sweden	Case study	The effect of visual management on the design process	VSM and look, ask, model, discuss act cycle	Large enterprise	Visual management had a positive impact on the design process

17 Papalexi *et al.* (2015)	Greece	Case study	Application of Kanban in the pharmaceutical supply chain in Greece	Kanban	Undisclosed	The Kanban system's adoption led to improved service quality and pharmaceutical products delivery
18 Birkie and Trucco (2016)	Italy		Analysis of the effect of dynamism and complexity on the relationship between LM and operational performance	TPM, TQM, visual management, HRM, supplier relationship and standardization	Large enterprises	Dynamism and complexity had a positive moderating role in the relationship between LM and operational performance
19 Belvedere *et al.* (2019)	Italy	Case study	Adoption of lean product development to improve efficiency and effectiveness in projects	FMEA	Large enterprises	The adoption of lean product development led to a reduction in waste and inefficiencies
20 Choudhary *et al.* (2019)	UK	Case study	Impact of green integrated VSM on SMEs in the UK	VSM and RCA	SME	Organisational and operational performance was improved through implementing green integrated value stream mapping
21 Sanders *et al.* (2016)	Germany	Case study	The application of industry 4.0 to overcome the barriers in applying LM in German manufacturing firms	Supplier feedback, JIT, supplier, development, customer involvement, pull production, continuous flow, setup reduction, TPM, SPC and employee involvement	SMEs	The factors that affect the implementation of LM, which are control and human, supplier, customers and processes, could be overcome by implementing industry 4.0
22 Rachman and Ratnayake (2019)	Norway	Literature review	The development of a framework for applying LM in the petroleum industry	Standardization, quality in a station, VSM, poka-yoke, six sigma, LPSs, kaizen, gain/pain share, cross-functional teams and contractors early involvement	Large enterprises	A framework was developed for the petroleum industry
23 Lööw (2019)	Sweden	Literature review	A review of the application of LM in the mining industry	Statistical quality control , VSM, TPM, preventive maintenance, defects control, 100% inspection, supply chain management, supplier involvement, autonomation, (jidoka), poka-yoke, andon, Visual control and management, Human relations management, cross-training, employee involvement, standardized work, team organization, continuous improvement (kaizen), improvement circles, housekeeping (5S), workforce reduction, RCA, JIT, production levelling (heijunka), time/work studies, pull system, takt time, inventory reduction, lead time reduction, policy deployment (hoshin kanri), setup time reduction, small-lot production, waste elimination, scientific management, CM, layout adjustments and multi manning	Undisclosed	The application of LM in the mining industry is still occurring in a fragmented way

4. Descriptive results

The concept of LM has been applied in different parts of the world. To check how LM has been applied globally in this study, the authors categorized the papers into developed and developing countries. A total of 63 academic papers were reviewed, 23 papers from the developed countries and 40 papers for the developing countries. In this study, the authors noted that many papers published for the developed countries were for the service sector. The reason was that developed countries had implemented LM in the manufacturing industry for a longer period than the developing countries. Thus, their focus is now on the service industry compared to the developing countries. This pattern agrees with the identifiable shift in the nature of industries based on the maturity of the economy and may also explain why there are more papers published in the area of manufacturing in developing countries compared to the developed countries.

Table 4 gives journals names and the distribution of articles they published for the developing countries. *International Journal of Lean Six Sigma*, followed by *International Journal of Production Economics*, were the leading journals that published 32.5% of the papers. Cogent Engineering, *Journal of Manufacturing Technology and Supply Chain Management*: An International Journal contributed 15% of the papers while Benchmarking: An International journal provided 7.5% of the articles.

Table 4. Journal names and percentage contribution of each journal for developing countries

Journal	**No. of papers**	**(%)**
International Journal of Lean Six Sigma	8	20
International Journal of Production Economics	5	12.5
Benchmarking: An International Journal	3	7.5
Cogent Engineering	2	5
Journal of Manufacturing Technology	2	5
Supply Chain Management: An International Journal	2	5
Journal of Teknologi	2	5
Expect Systems with Applications	2	5
International Journal of Production Research	2	5
Renewable and Sustainable Energy Reviews	1	2.5
Total Quality Management	1	2.5
International Journal of Mechanical and Production Engineering Research and Development	1	2.5
Sustainable Cities and Societies	1	2.5
International Journal of Operations and Production Management	1	2.5
International Journal of Quality and Reliability Management	1	2.5
Journal of Textiles and Apparel Technology and Management	1	2.5
Computers and Operations Research	1	2.5
International Journal of Lean Supply Chain Management *International Journal of Productivity and Performance Management*	1	2.5
Humanities and Social Sciences Review	1	2.5
Journal of Cleaner Production	1	2.5
South African Journal of Industrial Engineering	1	2.5

Table 5 lists journals names that published papers for developed countries. The *International Journal of Production Economics* contributed 22.7%, which was the highest, followed by the *International Journal of Production Research* that provided 18.2% of the papers. Procedia CIRP and *International Journal of Logistics Research* contributed 18.2% of the papers while the rest of the journals contributed each 4.1%.

Table 5. Journal names and percentage contribution of each journal for developed countries

Journal	No. of papers	(%)
International Journal of Production Economics	6	27.3
International Journal of Production Research	4	18.2
Procedia CIRP	2	9.1
International Journal of Logistics Research	2	9.1
International Journal Productivity and Performance Management	1	4.1
Annals of Operations Research	1	4.1
Journal of Advanced Management	1	4.1
Journal of Industrial Engineering Management	1	4.1
Journal of Manufacturing Systems	1	4.1
Journal of Manufacturing Technology Management	1	4.1
International Journal of Lean Six sigma	1	4.1
Production Planning and Control	1	4.1
International Journal of Production Management	1	4.1

In this study, the authors also determined the leading researchers who have worked in the LM domain for developing and developed countries. The contribution of each author was determined by calculating the sum of the occurrence of each author. In the case of a single author, a score of 1 was allocated and for m authors, a score of 1/m was given to the author (Inkpen and Beamish, 1994). Giuliano Almeida Marodin appeared in the first position for the developing countries, followed by Panwar, Avinash, Maurizio, Bevilacqua appeared in the first position for the developed countries, followed by Roberto Chavez.

Figure 2 shows that 62.5% of the research articles published in developing countries used the survey technique, while 30% of the papers used case studies. Literature review papers contributed 7.5% of the study. A greater percentage of the surveys (75.2%) in the sample papers used a research sample of less than 250 units and 25.8% of the studies used research samples greater than 250 units. Based on the research papers explaining case studies (12), 80% of the studies were based on less than four manufacturing companies, while 20% of the research papers used more than four companies.

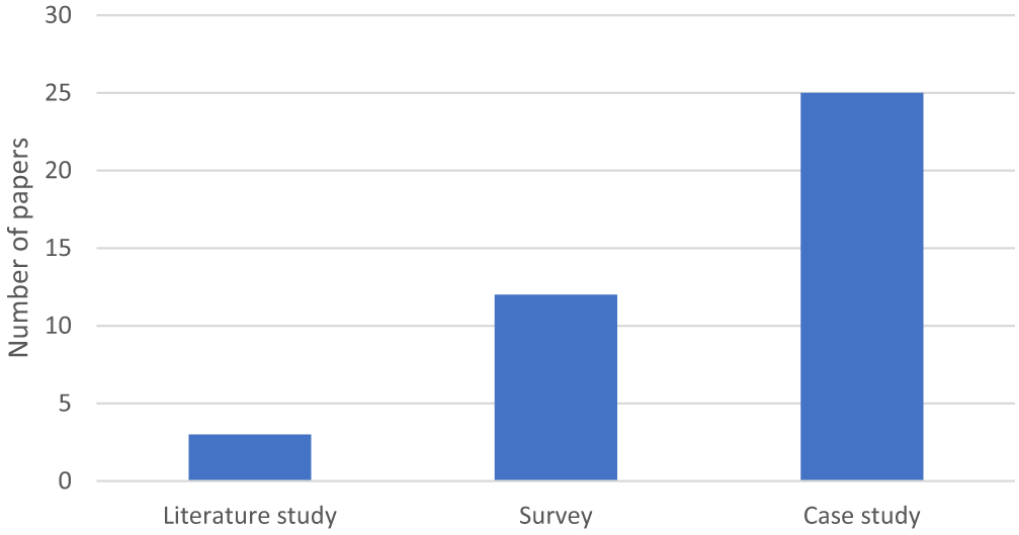

Figure 2. Type of research papers used in the developing world

Figure 3 shows the number of papers published for each developing country. This figure illustrated that 29% of the papers came from Brazil, India contributed 20%, Malaysia and Zimbabwe contributed 10% and 7%, respectively. Countries such as China, Indonesia and South Africa contributed 15% of the academic papers reviewed. Tunisia, Pakistan, Egypt, Iran, Hungary and Jordan contributed 1% of the papers individually.

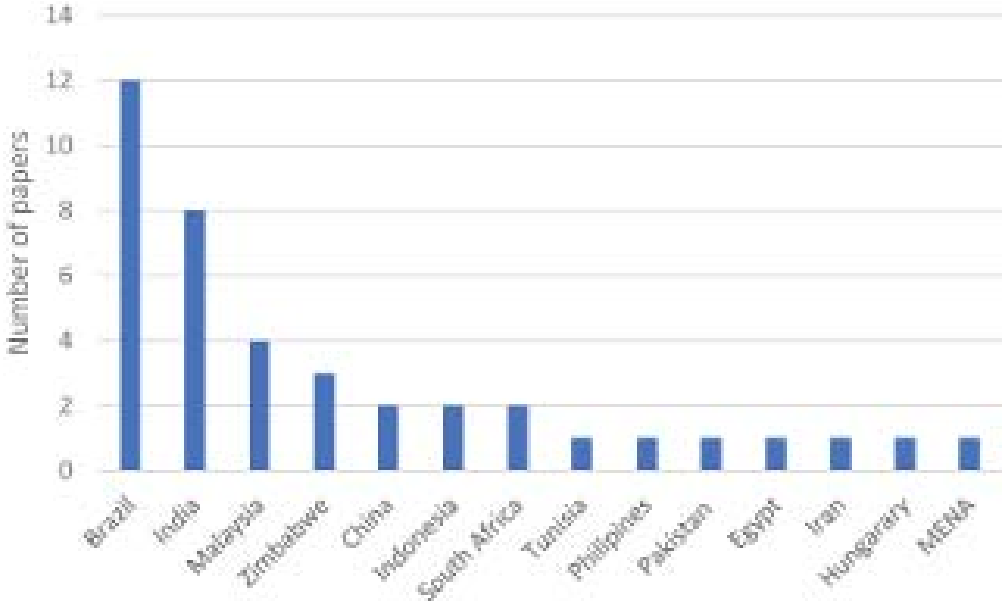

Figure 3. Number of academic papers in each developing country

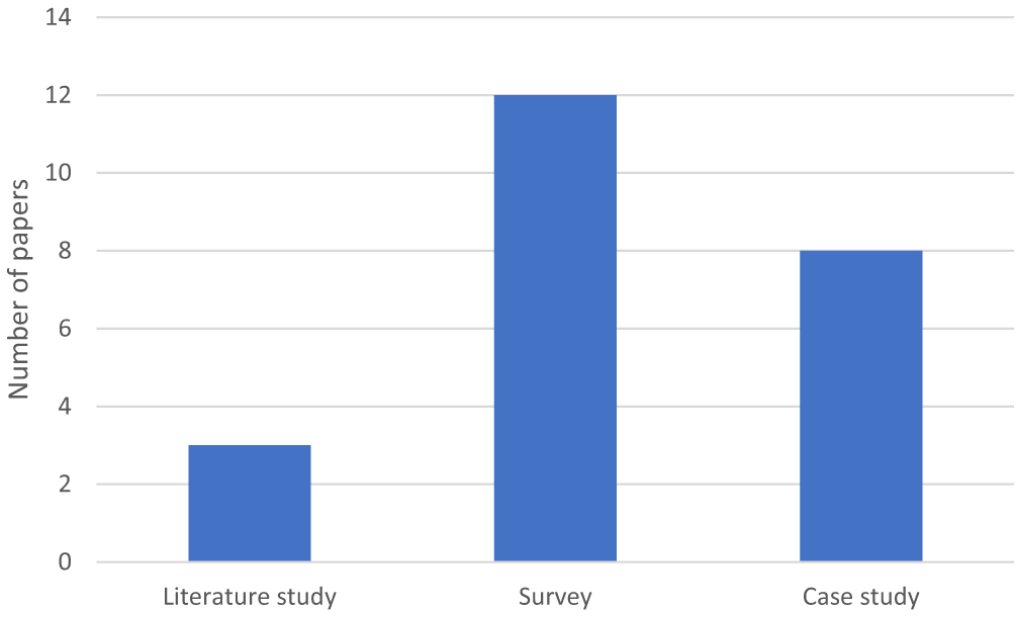

Figure 4. Type of research papers for developed

In this study, the authors also examined the types of researches conducted for developed countries. Figure 4 shows that 50% of the research articles published in the developed countries used the survey technique, while 36.4% of the papers described case studies. Literature review papers contributed 14.6% of the research papers. A greater percentage of surveys (80%) described in the sample papers used less than 100 research units and 20% of the studies used research samples greater than 100. More than 70% of the research papers describing case studies were based on three or fewer manufacturing companies and 30% of the case studies used more than three manufacturing companies.

Figure 5 illustrates the number of academic papers for the countries in the developed world. The figure shows that four papers came from Italy while the USA contributed three papers. Countries such as Germany, Greece, Sweden and the UK contributed 2 papers each. Finally, Spain, Norway, Turkey and Portugal contributed 1 paper each.

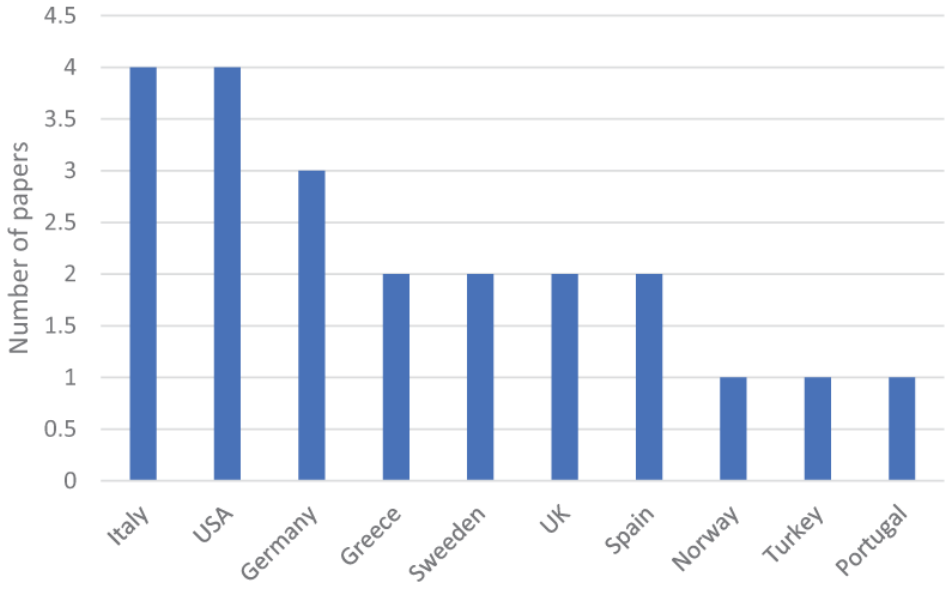

Figure 5. Number of academic papers in each developed country

The data collection methods used by the researchers are shown in Figure 6. The figure highlights that several researchers used questionnaires for data collection.

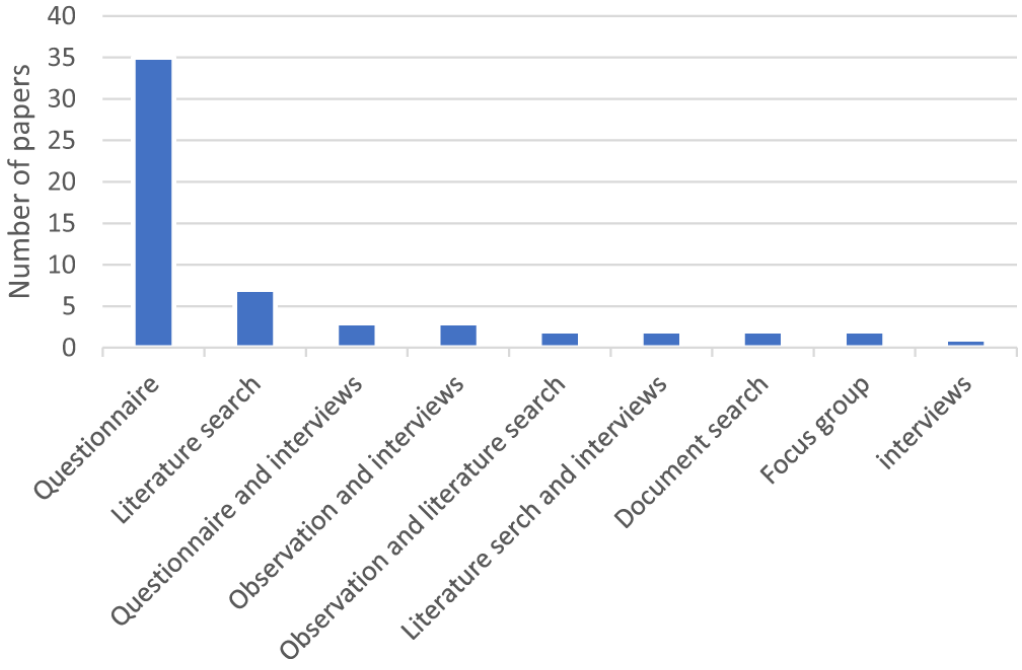

Figure 6. Data collection tools used

The authors of this study also examined the most commonly used LM tools in developed and developing countries. Figure 7 shows the distribution frequency of LM tools, as mentioned by articles in developing countries. Jasti and Kodali (2014) stated that the success of LM in organizations depends on the set of LM tools that these organizations use. Figure 7 shows

that 17 articles mentioned the use of JIT by manufacturing organizations, followed by 5S and heijunka that were mentioned by 16 and 15 articles, respectively. Other commonly used tools by manufacturing firms were pull, visual management, standardization, jidoka, setup reduction and on, total quality management (TQM), flow, teamwork, poka-yoke, kanban, employee involvement, cellular manufacturing (CM), waste reduction and customer involvement. Only five articles mentioned the use of statistical process control (SPC), root cause analysis (RCA), human resource management (HRM), training and quality assurance, while four articles mentioned supplier development, concurrent engineering, supplier networks, supply chain management (SCM) and preventive maintenance. Tools such as the kano model, single minute exchange of a die (SMED), quality function deployment (QFD), supplier JIT, systematic layout planning, lead time reduction, process sharing, quality at the source, policy deployment, maintenance system, consignment stock, continuous replenishment, the establishment of distribution centres, kyoryokukai, keiretsu, JIT purchasing, lot size reduction, failure for safe quality, muda walk, line balancing, first in first out (FIFO), check sheet, smart goals, first-run studies, SMED, overall equipment effectiveness (OEE), inspection, target value design, management commitment and IT were only mentioned by one article. This showed that organizations considered them as having the least importance.

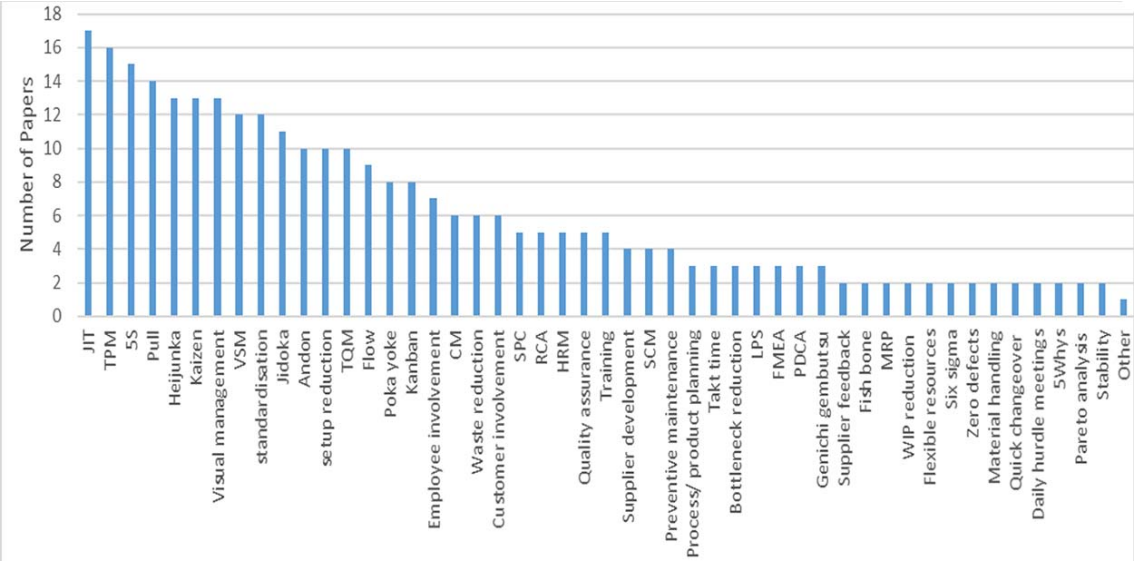

Figure 7. Number of articles that used specific LM tools in developing countries

The authors of this study investigated LM tools used by manufacturing organizations in developing countries. The LM tools were categorized according to the frequency of the papers that mentioned them, as shown in Figure 8. The figure suggests that JIT was the most commonly used tool, with 30% of the papers mentioning its use in manufacturing organizations. This was followed by poka-yoke and standardization mentioned by 25% of the authors. Tools such as set up reduction, 5S, SPC, HRM, supplier development, customer involvement and heijunka were referred to by 15% of the papers. The least used tools by the manufacturing organizations in developed countries were preventive maintenance, production planning, takt time, brainstorming, last planner system (LPS), failure mode effect analysis (FMEA), respect for people, scientific management and communication.

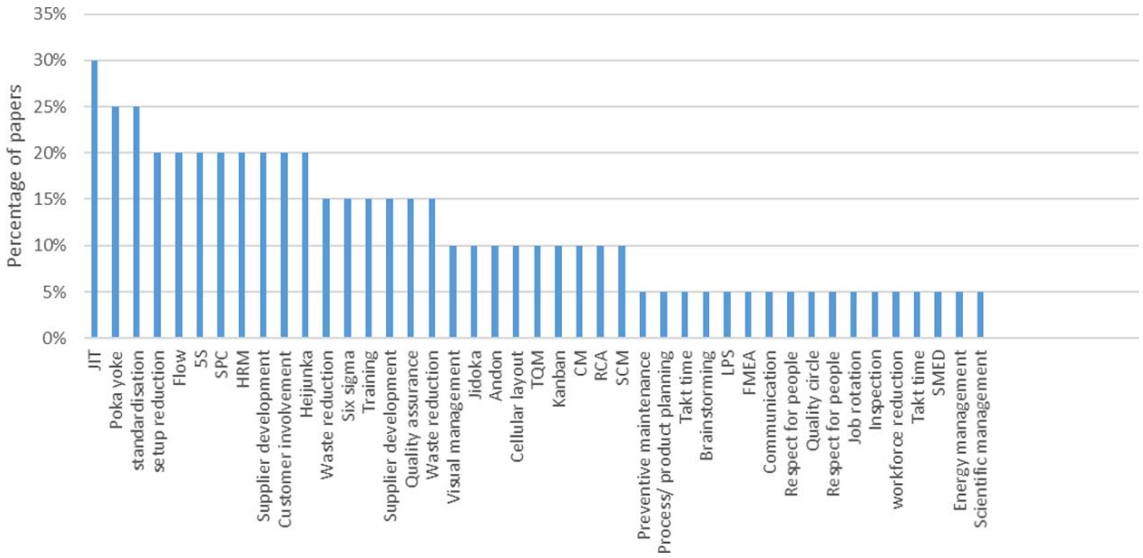

Figure 8. Percentage of papers that used specific LM tools in the developed countries

5. Discussions

To the best of the authors' knowledge, this is the first study that compares the effect of LM in the manufacturing industries in developing and developed countries. Several reviews have been done on LM, but none has given a juxtaposition of the effect of LM between the developing and developed countries. Thus, in this review, a collation of LM philosophy's effect in the manufacturing industry for the developing and developed countries is given. The next sections discuss the themes found in developing and developed countries and major findings for developing and developed countries.

5.1 Research themes in developing countries

The themes that emerged in developing countries are given in Table 6.

5.2 Research themes in developed countries

Table 7 gives the themes that emerged in developed countries.

Table 6. Developing countries research themes

Theme	Supporting research papers
Leanness measurement	Researchers assess the leanness level organizations using qualitative and quantitative tools. Leanness measurement checks how the lean system is performing. Qualitative tools such as data envelopment analysis (DEA), fuzzy DEA and decision-making trial and evaluation laboratory (Azadeh *et al.*, 2015) are used. System dynamics has also been used to measure the leanness of a system (Ali and Deif, 2016). Qualitative measurement methods involve using questionnaires to assess a system's leanness. Researchers advocate for the use of questionnaires because they are easy to administer and can assess the whole organization's leanness. Questionnaires were used by (Nawanir *et al.*, 2016; Maware and Adetunji, 2019a, 2019b; Marodin *et al.*, 2017; Pozo *et al.*, 2018; Prasad *et al.*, 2016; Godinho Filho *et al.*, 2016; Marodin *et al.*, 2016). Leanness measurement methods involved structural equation modelling (Maware and Adetunji, 2019a; Nawanir *et al.*, 2016; Pozo *et al.*, 2018; Godinho Filho *et al.*, 2016), regression models (Marodin *et al.*, 2018; El-Khalil, 2020), correlation analysis (Prasad *et al.*, 2016), propensity score matching (Shi *et al.*, 2019) and multivariate analysis of variance (Marodin *et al.*, 2016)
Effect of LM application	Researchers have investigated the interaction among LM bundles (Maware and Adetunji, 2019b, 2019a). LM tools have also been used to assist supplier development (Kim, 2015). Some studies examined the LM tools commonly used by manufacturing organizations to improve operational performance (Godinho Filho *et al.*, 2016). Other studies also investigated the synergistic results obtained by the interaction between LM and green practices (Campos and Vazquez-Brust, 2016; Prasad *et al.*, 2016). Researchers also determined the LM tools and their adoption level in manufacturing firms (Tortorella *et al.*, 2016a), while other researchers examined the effect of LM tools on economic, political, environmental, technological and legal factors (Ansah and Sorooshian, 2017). Marodin *et al.* (2018) analysed the impact of lean product development and LM tools on performance
Barriers and drivers for LM implementation	Panwar *et al.* (2016) examined the barriers to LM implementation in the process industry, such as lack of familiarity with the philosophy and lack of qualified personnel and management support. Abu *et al.* (2019) found that technical know-how and employees' resistance to change were also major barriers. Furthermore, Jasti and Kodali (2016) revealed that implementing a few LM tools, worker resistance to change and lack of financial resources impeded LM implementation. Shrimali and Soni (2017) cite demand volatility, lack of training and culture that support LM implementation and Khaba and Bhar (2018) state that fewer trainers and consultants for LM, lack of coordination between departments and going back to former ways of doing things were major barriers. The major drivers were identified as the need for an organization to continuously improve and satisfy customers (Jasti and Kodali, 2016). For SMEs, factors such as the urge to increase profit, reduce waste and inventory and enhance competitive position are major drivers (Shrimali and Soni, 2017). The need to empower workers and help from lean experts enhance LM implementation (Khaba and Bhar, 2018)

Table 7. Developed countries research themes

Theme	Supporting research papers
Impact of LM on operational performance	The adoption of the Kanban system led to the improvement in service quality and delivery of pharmaceutical products (Papalexi *et al.*, 2015); the implementation of VSM led to a reduction in cycle time, number of workers, inventory and bottlenecks (Lacerda *et al.*, 2016) and improvement in operational variables such as time effectiveness innovation and product mix (Bevilacqua *et al.*, 2016). In addition to that, LM caused a reduction in waste and continuous improvement in operations (Salonitis and Tsinopoulos, 2016); LM led to an improvement in capacity slack and inventory slack, which, in turn, affect firm performance (Cadden *et al.*, 2020)
The integration of LM with other management approaches	The implementation of Industry 4.0 overcomes the factors that affect the implementation of LM, which are control and human, supplier, customers and processes (Sanders *et al.*, 2016). The adoption of a green integrated value stream led to improved organisational and operational performance (Choudhary *et al.*, 2019); SCM has a positive effect on internal LM tools, which, in turn, affect operational performance and organizational performance (Chavez *et al.*, 2015) and lean and green manufacturing led to an improvement in operational performance (Inman and Green, 2018)
Drivers for LM implementation	Studying the factors that lead to LM implementation, such as the need to reduce cost, lead time, labour requirements and inventory and improve visibility, quality, profits and market share (Zhou, 2016); the need for improving floor space usage, delivery time and number of employees (Nguyen and Do, 2016); enhancing cycle time and reducing bottlenecks (Lacerda *et al.*, 2016); increasing the product design process (Lindskog *et al.*, 2016). The urge to improve customer and supplier processes (Sanders *et al.*, 2016) and reduction in waste and improvement in operations (Salonitis and Tsinopoulos, 2016)

5.3 Thematic summary of findings

Some thematic areas of findings were found that showed the impact of LM in manufacturing *organizations for developing and developed countries.*

5.3.1 Impact on operational performance.

The implementation of LM by manufacturing organizations in both developing and developed countries led to improved operational performance. Studies conducted by researchers in the developed countries showed an improvement in product quality and delivery time (Papalexi *et al.*, 2015; Nguyen and Do, 2016); productivity (Marin-Garcia and Bonavia, 2015); market share, sales, profit margins, cost, labour productivity and lead time (Chavez *et al.*, 2015); reduction of cycle time, inventory and bottlenecks (Lacerda *et al.*, 2016); product mix improvement (Bevilacqua *et al.*, 2016); turnover (Bevilacqua *et al.*, 2017) and reduction in waste and inefficiencies (Belvedere *et al.*, 2019). The studies conducted by the researchers in the developing world also showed an improvement in operational performance variables such as profitability, sales and customer satisfaction (Nawanir *et al.*, 2016); lead time and turnover improvement (Marodin *et al.*, 2016); inventory reduction (Marodin *et al.*, 2017; Panwar *et al.*, 2017; Marodin *et al.*, 2016); financial performance (Sahoo and Yadav, 2018); speed, flexibility and dependability (Maware and Adetunji, 2019a; Maware and Adetunji, 2019b); productivity and quality (Marodin *et al.*, 2018; Panwar *et al.*, 2017; El-Khalil, 2020).

5.3.2 Possibility of a negative impact.

This study noted that no paper had reported any negative impact of implementing LM in manufacturing organizations for developing and developed countries from 2015 to March 2020. The researchers in the developing and developed economies showed that LM practices positively enhances operational performance measures. Examples of such research studies in the developed countries are Papalexi *et al.* (2015), Nguyen and Do (2016), Marin-Garcia and Bonavia (2015), Bevilacqua *et al.* (2016), Chavez *et al.* (2015), Bevilacqua *et al.* (2017) and Belvedere *et al.* (2019). Researchers in developing countries such as Marodin *et al.* (2017), Maware and Adetunji (2019a), Marodin *et al.* (2018), Nawanir *et al.* (2016) and El-Khalil (2020) have also shown that LM improves operational performance. However, researchers such as Losonci *et al.* (2017), Yadav *et al.* (2020a), Negrão *et al.* (2016) and Bhasin and Burcher (2006) have reported that very few organizations have been successful in implementing LM. This causes many manufacturing firms in developing countries to be sceptical in adopting this philosophy because of this notion. A review by Negrão *et al.* (2016) revealed that LM tools had a negative effect on financial or operational performance only in five studies. Abolhassani *et al.* (2016) also reported that it is difficult for manufacturing organizations to continuously improve their manufacturing processes after implementing LM due to resources constraints.

5.3.3 Drivers of lean manufacturing.

The major drivers for organizations implementing LM in developing and developed countries are improving manufacturing operations and customer satisfaction (Jasti and Kodali, 2016; Sanders *et al.*, 2016; Salonitis and Tsinopoulos, 2016). The developing countries also cite other drivers, such as reducing waste and increasing profit (Shrimali and Soni, 2017) and worker

empowerment (Khaba and Bhar, 2018). While the developed countries cite drivers such as reduction in the number of employees and floor space utilization (Nguyen and Do, 2016); improving the product design process (Lindskog *et al.*, 2016); reduce cost and number of workers (Zhou, 2016) and reducing bottlenecks (Lacerda *et al.*, 2016).

5.3.4 Participation of small and medium-sized enterprises in lean manufacturing implementation.

SMEs in both the developed and developing countries have difficulties transforming their organizations to lean (Sanders *et al.*, 2016). The major drawbacks for SMEs in the developing world were lack of funding, technical know-how, tendency to go back to the old ways, employee resistance and management support (Zhou, 2016; Godinho Filho *et al.*, 2016). SMEs in the developed countries cited the implementation of fewer LM tools (Abolhassani *et al.*, 2016); a lack of resources (Sanders *et al.*, 2016). SMEs apply LM to become competitive and match their standards with large enterprises (LE) (Shrimali and Soni, 2017). Globally, most SMEs lack the resources needed for training employees and acquiring resources needed during the implementation of LM (Ulewicz and Kucęba, 2016; McLeod *et al.*, 2016). This finding is also supported by research published before 2015 (So and Sun, 2010; Doolen and Hacker, 2005). Large firms in developing countries are more likely to implement LM successfully than SMEs (Marodin *et al.*, 2016; Belhadi *et al.*, 2019). Yadav *et al.* (2020b) also corroborated a higher rate of adoption of LM in the developed world because of many large scale enterprises compared to the developing countries. Although most researchers cite that LE are more likely to implement LM than SMEs, Fullerton *et al.* (2014) stated that LEs also lacks finances to use during LM implementation.

5.3.5 Popular lean manufacturing tools and practices.

The commonly used practices in the developed countries are JIT, poka-yoke, standardization, setup reduction, 5S, SPC, HRM, supplier development, customer development and heijunka. While the commonly used practices in developing countries are JIT, total productive maintenance (TPM), 5S, pull, heijunka, kaizen, visual management, value stream mapping (VSM) and standardization. The use of practices such as supplier development and customer development shows that developed countries have implemented widely across the supply chain. It looks as if the developing countries are concerned with adopting internal lean practices and the adoption of LM has not yet extended to the various supply chain.

5.3.6 Implementation framework.

The adoption of LM tools in manufacturing firms for both the developed and developing countries occurs haphazardly. Different organizations adopt LM tools based on the condition and the organization's problems (Dombrowski *et al.*, 2016). Negrão *et al.* (2016) suggested that this haphazard adoption of LM tools can also contribute to LM philosophy's failure in many organizations. These authors corroborated the need for manufacturing organizations to redesign their processes, train and assign responsibilities to employees and agree on the LM tools to adopt before the LM implementation starts. Similarly, Secchi and Camuffo (2019) averred that the way the LM process is arranged and the order of implementation of tools could lead to the controversial results obtained during LM implementation. The initial

adoption of various LM tools has led to the development of different LM frameworks both in developed and developing countries. Very few manufacturing firms have adopted the Toyota house of Lean. This suggests that the implementation of LM for the developed and developing nations is not a one size fit all approach. Authors such as Jasti and Kodali (2019), Kehr and Proctor (2017), Kumar *et al.* (2015) and Pozo *et al.* (2018) used the Toyota Production System house; however, the tools used in building their Toyota Production System house structures are different.

5.3.7 Collaboration among authors.

The collaboration between authors in the developed and developing countries for LM is less compared to collaborations between researchers in the same country. Collaboration among scientists in developing and developed countries help their research results to gain credibility and visibility, improve the quality of research (Osareh, 2005), improved citations (Pohl, 2020), increase knowledge and technological transfer (Banal-Estañol *et al.*, 2015). Kato and Ando (2013) revealed that international collaboration among authors helps them to gain more scientific knowledge, technological innovation and access to expensive equipment. International research collaboration in LM can help create trust and commitment among academicians and industrialists in developed and developing countries. Kwiek (2020) stated that researchers in Europe value international research collaboration rather than national and institutional collaboration because it improves research credibility, enhances access to research funding and increases academic prestige. Similarly, Franceschet and Costantini (2010) state that research collaboration can help manage the accuracy, completeness, originality and significance of the results, thus enhancing the cross-fertilization of propositions. Jasti and Kodali (2014) also found little collaboration among LM researchers. Examples of collaborations seen between authors in the developed and developing countries include (Bortolotti *et al.*, 2015a).

5.3.8 Data sources.

Developed countries have databases containing manufacturing companies where information can be used for research purposes compared to developing countries. The availability of these databases helps researchers obtain data that can test hypotheses among different countries and draw conclusions. Sartal *et al.* (2017) used data from the European manufacturing survey to assess the impact of LM on industrial performance with environmental technology and information technology acting as mediating variables among five European countries. Similarly, Bortolotti *et al.* (2015a) studied the effect of soft LM tools and organizational culture in 10 developed countries. In that study, the authors used data were obtained from the high-performance manufacturing database. The study concluded that successful LM implementation is characterized by specific organizational culture and soft LM tools.

Few authors have used data from different countries worldwide in a single research. Fewer researchers used data from both the developing and developed nations. Examples of these research studies were conducted by (Bortolotti *et al.*, 2015b; Garza-Reyes *et al.*, 2018; Netland *et al.*, 2015). Garza-Reyes *et al.* (2018) studied the effect of LM tools on environmental performance. The study obtained responses from Asia, North America,

Europe, Australia and South America. The study revealed that LM tools such as VSM and autonomation had no impact on environmental performance, while JIT, kaizen and TPM positively impacted environmental performance. Bortolotti *et al.* (2015b) assessed the impact of LM practice bundles on the cumulative performance in 10 countries from the developed and developing nations. The study results revealed that JIT and TQM practice bundles directly affected quality which, in turn, affected delivery, flexibility and cost. Though these studies used data from the developing and developed nations, no comparisons were made to assess the LM philosophy's impact in the developing and developed countries.

6. Conclusions

Numerous research papers have been written on the application of LM in manufacturing industries both in the developing and developed world. This study filled a void in the literature by providing a comparative review of the effect of LM implementation in developing and developed countries. These findings are crucial for the manufacturing managers who have questions on the impact of this philosophy in developed and developing nations. This study can also help developing countries adopt this philosophy to enhance their operations. The study has shown that the adoption of LM can cause an organization to improve its operations both in developing and developed countries. The benefits that organizations in the developing world have realized include customers' satisfaction by providing high-quality products timeously. This research has also highlighted the main drivers and barriers faced by manufacturing organizations in implementing LM in developing and developed countries. This study also revealed that SMEs in developing and developed countries face difficulties when implementing LM, causing them to be hesitant to adopt this philosophy. The research showed that LM tools had been adapted haphazardly by manufacturing organizations in developing and developed countries depending on the type of waste.

6.1 Limitations of the study and research gaps

In this study, the authors highlighted several limitations that affected this study's scope and its results. The study used research papers written for manufacturing organizations from developed and developing nations. A further study comparing the service industries that have adopted LM in the developed and developing countries can be conducted. This will help to generalize the results of the impact of LM both in the developed and developing nations depending on the industry characteristics. Secondly, researchers in developing and developed countries should collaborate to improve the research findings for developing and developed countries. Thirdly, the study did not use textbooks and information from company websites. These sources could also provide valuable input on how different manufacturing organizations view the application and impact of LM.

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Further reading

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