Implementation of Lean for Small and Medium-Sized Construction Organisational Improvement

Abstract:

Purpose: Small and medium-sized enterprises (SMEs) within the construction sector are highly vulnerable to disruptions caused by political and economic decisions or even pandemics. This study evaluated the current operations of selected SMEs providing engineering design and consultancy services against Toyota Production System (TPS) lean tool. The purpose is to juxtapose SME operations and processes with TPS to ascertain the level of their operations conformity to the established TPS lean thinking tool.

Design/methodology/approach: This study used a qualitative data collection and analysis approach to evaluate the current processes of participating SMEs against Liker's 14 management principles of Toyota Production System (TPS). The data collected were analysed using thematic analysis to identify patterns and themes that emerged from the qualitative data.

Findings: The analysis revealed that focus on short-term goals, immediate profit and duplication of effort resulting from insufficient collaboration is currently creating waste in participating SMEs' operations. Hence, the implementation of TPS was recommended as a lean tool and a framework based on TPS lean tool was developed for improving the operations of SMEs.

Originality: The study advances contemporary issues in promoting lean implementation in construction sector and developed an improved framework based on the TPS to enhance the performance of SME construction businesses.

Research limitations: The study is limited to SMEs operating only as consultants providing project planning design within the construction industry. Data collection is limited to qualitative even though observations would improve the outcome of the study.

Keywords: Lean Principles, Operation; Small and Medium-Sized Enterprise, Toyota Production System (TPS); Improved TPS Framework

1.0 Introduction

The construction sector is highly volatile, making the construction output response to fluctuations and disruption more significant. This has been recently evident in the construction sector's performance during the recent coronavirus (COVID-19) pandemic with the sector being one of the most hard-hit sectors in terms of output as reported by the Office for National Statistics (ONS, 2021). Evidence suggests that the construction sector has historically struggled to bounce back after major political and economic shocks (Egan, 1998). For instance, before the global financial crisis in 2008, the construction sector accounted for 8.9% of the UK's Gross Domestic Product (GDP). This contribution to GDP decreased to 6.4% by 2014 with the construction sector entering recession three times in five years between 2008 – 2013 (Department for Business, Innovation and Skills (DBIS), 2013).

After the recent disruption caused by the pandemic, many of the affected businesses are likely to catch up and return quickly. However, the deficit of the construction sector will have a lasting impact on construction output, GDP contribution, housing supply, construction supply chain, liquidated damages, and other contractual provisions. The disruption caused by the pandemic currently threatens the total collapse of many small or medium-sized enterprises (SMEs) within the construction sector. Most SMEs, therefore, respond to this threat through rightsizing exercises i.e., directly reducing their staff to increase profit margins. Although staff reduction has helped reduce the operating cost, the workload has also increased significantly, which is currently affecting the statutory project delivery (Blackburn, 2020). This indicates that a movement for innovation in the operations of many of these SMEs in the construction sector is important and valuable to improve productivity. Years ago, a healthy economy sheltered most of these SMEs and created an enabling environment for prosperity without necessarily striving for innovation. However, the recent disruption which has impacted the productivity of SMEs in the construction sector is a seamless opportunity for SMEs to explore how established lean tools can be used to improve their operations to enhance productivity after disruptions.

This study, therefore, investigates the operations of selected SMEs providing multi-disciplinary engineering design and consultancy services to clients in the UK's construction sector. The aim of the study is to critically appraise the current operations of the selected case study SMEs against Toyota Production System (TPS) lean tool. The objectives are (i) to understand their current operations including their relationships with employees, clients and the supply chain, (ii) to establish the degree of conformity and discrepancies in their operations to the principles in the TPS lean tool, and (iii) to develop an improved framework based on the TPS lean tool that will improve the operation

and performance of SME construction businesses. This study is limited to SMEs within the UK construction industry operating only as consultants providing planning regulations and project design but does not account for any responses from SMEs working as contractors.

The paper is articulated into six sections with an introduction in section 1 and a critical review of lean thinking in section 2. Section 3 comprises the methodology involving the data collection and analysis, while sections 4 and 5 present the analysis of the results and the implication of the findings of the study respectively. Finally, section 6 contains conclusions and recommendations for improving the operations of the case study SMEs to provide solutions to the problems identified in the survey.

2.0 Literature Review

According to Clark (2022), the construction sector in the UK has around 914,000 businesses with 99.97% of those being SMEs. This represents the highest number of SMEs in any sector of the UK economy as of 2022. This means that the drivers for growth and improved productivity within the UK construction sector are SMEs. The UK Department for International Trade (DIT, 2021) defines SME as any business whose employee and annual turnover are less than 250 personnel and €50 million respectively. SMEs are involved in the core operations within the UK construction sector such as civil/structural engineering, building construction, repairs, maintenance and even supply of materials. They are also specialised in various phases of built environment development such as project management, construction, planning and design, which is the area of service of the SMEs targeted in this study.

van Hoinaru and Stănilă (2019) highlighted that SME businesses are very flexible and often have flattened organisational structures which enable a direct line of communication between employer/manager and the employees/workers. This often leads to quick and timely intervention or implementation of new approaches for better project delivery or productivity. However, the main challenge of SMEs is the limitation of their resources which often makes it difficult for them to compete with large firms for contracts or even for recruiting and retaining skilled staff. These often affect their productivity and eventually their margins (Krndzija and Pilav-Velic, 2022). The recent crisis worsens the situation with SMEs with many of them having to think about reducing their staff to increase profit margins. Therefore, the Enterprise Research Centre (ERC, 2022) suggested that innovation is critical to the future growth and productivity of SMEs. As such SMEs should consider improving their operation through the application of innovative ideas such as implementing lean tools. Therefore, this study measured the companies' current performance against the notorious lean tool, Toyota Production System (TPS). As such, an abridged review of the TPS lean tool in the

context of end-to-end design and project planning process, which are the typical roles of consulting SMEs within the construction sector is presented subsequently.

The Toyota Production System (TPS) is Toyota's unique approach based on principles of just-in-time waste recognition and elimination principles (Chiarini et. al, 2018) that led to cost minimisation and productivity maximisation in the automotive manufacturing process. The TPS is the basis for much of the lean production movement that has dominated the manufacturing industry and has permeated other industry sectors, including construction for two decades of the 20th century (Mali and Kanade, 2020). Previously, the work of Liker in 2004 which has now been recently updated in 2020 has extensively explained the constitution of the TPS way using fourteen (14) key principles. These principles are the foundation of the TPS practised at Toyota manufacturing plants around the world. Liker (2020) divided the principles into four categories (i.e., Philosophy, Process, People/Partners, and Problem-Solving). This is often called the "4 P" model of Toyota way, as shown in Figure 1. A critical analysis of the 4P model demonstrates how the concepts of TPS can be extended beyond automotive production to any other sector of the economy such as construction.

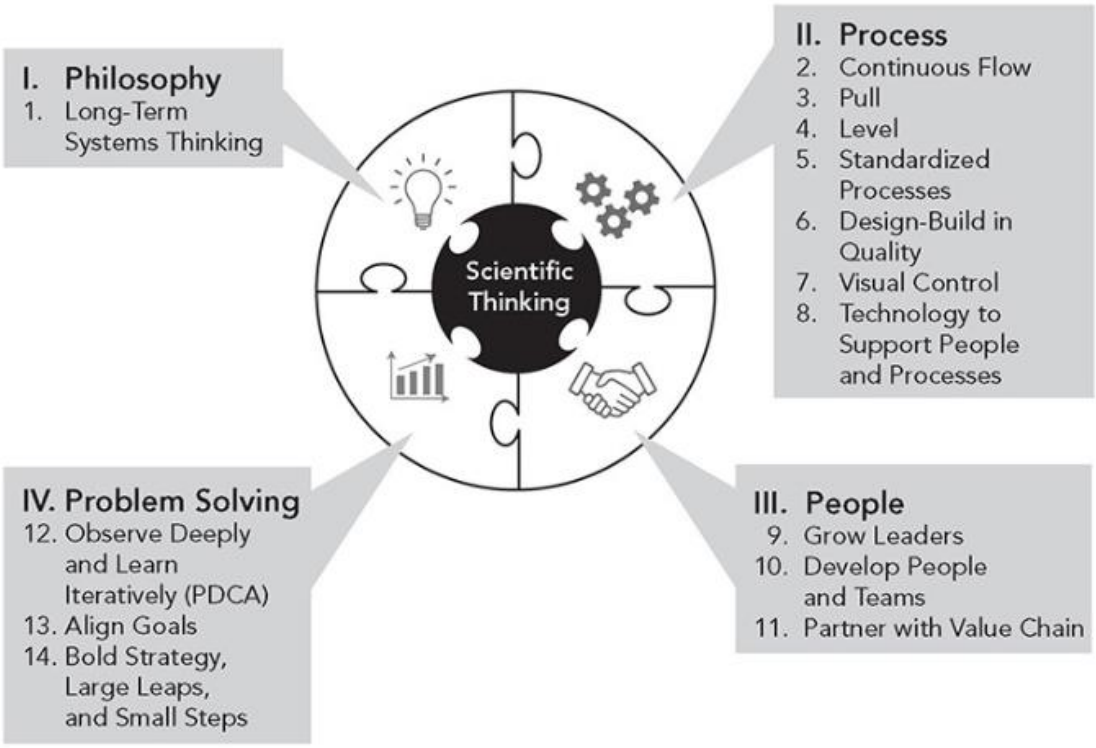

Figure 1. The ‘‘4 P’’ model and 14 principles of the Toyota way (Liker, 2020).

As shown in the 4P model in Figure 1, the starting point of the lean journey is Philosophy, described as the long-term systems thinking through which the most basic beliefs, concepts, and attitudes of an organisation are based. Joullié (2014) asserted that an effective corporate philosophy

helps a company develop a certain corporate culture and ethical practices that strengthen the relationship between employers and employees. It also positions the company's values in the minds of others within and outside the organisation. Its adoption in the construction sector will mean embedding the company's values in the minds of the employee and the clients, which then promotes timely and cost-effective construction project delivery.

A non-profit organisation, Lean Construction Institute (LCI) was created in 1997 to apply lean principles such as TPS pioneered in manufacturing to construction. The LCI postulated that lean thinking in construction recognises the importance of philosophy in the company's overall performance. Liker (2020) reaffirmed the earlier position stated in the first edition in 2004 that the most efficient philosophy is one that is based on long-term thinking. This set the stage for the scene that the individual within the company pursues. According to Liker's 14 principles, companies' philosophy should essentially be based on a long-term philosophy, even at the expense of short-term goals to accommodate lean principles. Alexander et. al (2019) further simplified this by asserting that focusing on longer strategic goals of improving the business. should be greater than earning a short-term paycheck. There should be a strong sense of mission and commitment to clients, employees, suppliers, contractors, and society. Also, companies' philosophy should prioritise customer satisfaction, and business decisions should have trust and mutual respect for associates in addition to economic productivity (Rasmy et al., 2022). Lastly, the companies' performance should be self-reliant rather than relying on outside business partners to thrive in a situation which is not normally applicable to the construction sector because of its interdisciplinary features requiring the input of several professionals (Babalola et. al, 2019).

Meanwhile, the key element that defines the functionality of an organisation is the process which is the second category of the 4P model. The process directly influences the output and is a group of related tasks instigated to achieve specific results to meet client requirements related to the construction environment (Locatelli et al., 2013). In the Toyota 4P model, seven (7) out of the fourteen (14) Toyota way principles are part of the process. Within these principles are most of the TPS tools for improving company processes which are key to achieving the best quality at the lowest cost with high safety and morale (Liker, 2020). The starting point of any lean expedition in construction is to ensure that a continuous flow or process is created (Locatelli et al., 2013). In construction, the target is to create a process flow that eliminates waste while adding values, revealing problems, and resolving them to deliver quicker, cheaper, and better construction projects. So, this will improve the productivity and sustainability records of the construction industry towards achieving sustainable built environment (Babalola et. al, 2019). The adaptation of the TPS to the

activities of SMEs within the construction sector involved the use of pull systems to avoid overproduction. Liker (2020) describes the pull system as organised to replenish customer pull. By this, only what the client wants will be produced at a specific time. Alexander et. al (2019) agreed that using pull system will deliver more value creation. However, this is difficult to implement in consulting firms because sometimes, the consultants work ahead of clients to create alternatives for most construction projects.

The other recommendations of the TPS, which the construction sector needs to evaluate critically, including levelling out the workload, creating a culture of stopping to fix problems at the early stage to get quality right the first time, standardising tasks, and processes for continuous improvement. The use of visual control and the adoption of reliable, thoroughly tested technology that correctly serves people and processes also need to be weighed when proposing lean implementation. In addition, Wagner et al. (2014) vividly affirmed that implementing the latest and advanced technology has a crucial role in fulfilling the promise of sustainable development, whether as technological change or as a choice set at a given point in time.

Regarding the 4P model in Figure 1, Toyota believes that continuous improvement, commitment to creating value and respect for people are the most important assets in any organisation (Liker, 2020). Locatelli et .al (2013) explain this as the ability of a company to grow leaders rather than purchase them and apply the first lesson of lean leadership by putting customers first. These are three (3) out of the fourteen (14) core principles of the TPS in the third step of the Pyramid. The final stage in the TPS is the problem-solving stage, where problems and waste in the process are eliminated. Adopting lean techniques in construction is essential because it is all about eliminating waste in processes (Ong and Sui Pheng, 2021).

Meanwhile, stable work processes are the foundation for continuous improvement and waste elimination, but this is not always possible in construction. Ballard (2011) reported that the concept called Last Planner System (LPS), a short-term project planning system first used in engineering construction 20 years ago helps to improve the predictability and reliability of construction production. LPS is a system where work is planned at the final stage by the last planner, the person doing the work (Bellard, 2011). Dallasega et. al (2018) highlighted that good real-time planning based on the LPS principle and effective measuring of the construction progress are, notoriously, the preconditions to productivity. Therefore, planning the job at the last stage is very important for efficient and timely project delivery (Bhatt et al., 2021).

LPS reliability depends on learning from the feedback by providing remedies to the issues affecting the percentage promise complete (PPC). Active collaboration between all parties involved must be implemented to achieve this. This is termed Collaborative Plan (CP) and it is vital to TPS, LPS and other lean tools without which lean thinking practice is unrealistic (Alexander et. al, 2019). Collaboration is very important because it creates an efficient flow that leads to efficient construction project delivery. This is a concept that aims to enhance supply chain integration by supporting and assisting joint practices. Similarly, Flankegård et al. (2021) argued that an established and functional external collaboration plays an increasingly important role in product development, usually in the form of project delivery to construction businesses.

Aslam et al. (2021) submitted that the concept of a lean project delivery system (often referred to as LPDS) has shown to be an efficient productivity improvement technique for construction businesses. However, despite the immense benefits of the LPDS, the construction industry is struggling with the effective implementation of the lean delivery system, especially in achieving Lean Construction (LC) principles like improving and maintaining an effective flow of the process (Sarhan and Fox, 2013; Aslam et al., 2021). The main reason for the struggle in its adoption in the construction sector is mainly down to the drawback of the TPS, LPS and other lean tools which is their relatively low ability to absorb disruptions to process. The TPS and others work effectively in a production environment where it's repetitive and predictable but their application to the construction sector is not straightforward. Therefore, this study evaluates how TPS lean principles could be adapted to the operations of SMEs carrying out design and consultancy services in the construction sector to improve their performances.

This investigation is based on a comparative study of the operation of selected SMEs against the TPS system to assess their present operating condition and performance. The purpose is to develop an improved framework based on the TPS lean tool that will improve the operation and performance of SME construction businesses.

3.0 Methodology

This study adopted a qualitative method of data collection and analysis to evaluate the current operations and processes of selected SMEs in the UK construction sector. The analysis juxtaposed SME operations and processes with established lean thinking techniques to ascertain the present level of their operations. The study started with an initial qualitative data collection carried out by administering semi-structured interviews to representatives from six SMEs selected based on their

willingness to participate (convenient sampling). The interview was considered suitable in this instance, as it facilitates in-depth exploration of the concept under investigation based on the experience of the research participants. The key criteria imposed in the selection is that the participating SMEs were based on their experience and professional capacities as consultants providing planning regulations and project design but not working as contractors. The data collected from the interviews were analysed using thematic analysis- a flexible approach that allows the data collected from the interviews to be summarised into key features that emerged from the large dataset (Clark and Braun, 2017).

3.1 Qualitative Data Collection

This study focused on comparing the operations of the participating SMEs to the TPS lean principle. The initial qualitative data were collected by conducting 20 - 30 minutes of interviews with six (6) representatives of participating SMEs. Hence, the interview process was semi-structured covering issues around the interviewees' organisational philosophy (e.g discussing the criteria for making decisions), process (e.g highlighting issues around their project execution plan, methods, response to demand and plan for process improvement), problem-solving (e.g, explaining their attitude to problems and complaints from clients) and people and partners (e.g teamwork, opportunities for progression within the company and keeping client base). These semi-structured interviews allowed the respondents to provide answers in their own words, thereby providing the basis for the selection of thematic analysis to gain deeper insight into their observations/responses. In order to ensure that primary data were collected, all respondents are decision-makers for SMEs with fewer than 50 employees, (i.e businesses classified as small scale according to the UK Department of International Trade (DIT, 2021)). Due to the constraints that decision-makers are specifically targeted in this study, there is a limitation on the number of interviews conducted. As such, the study relies on the concept of "saturation," which is the point at which no new information or themes are observed in the data (Saunders et al., 2018). After six (6) interviews were conducted, the data showed similar patterns in the interviewees' responses; this was then taken as the point of saturation, and the six interviews were sufficient to form the study. In addition, the six interviews are considered adequate as Creswell (2014) suggests a number between five and 25 respondents in qualitative research of this nature. Table 1 shows the demographic distribution of the six interviewees.

<Insert Table 1. Demographic Distribution of Interviewees>

3.2 Qualitative Data Analysis – Thematic Analysis

The thematic analysis was conducted in five different steps (See Figure 2) as derived from the study of Braun and Clarke (2006). In step I, the entire transcripts of the six interviews were studied to provide a general overview of the data orientation and also provide the foundation for the subsequent steps. Thereafter, inferences, data trends, discrepancies and commonalities between data were noticed and the initial coding was generated to represent these in step II. In step III, the generated codes were further examined for classification into different patterns of similar interest and collated as potential themes. The preidentified potential themes were then subjected to critical evaluation in step IV to first establish if they properly fit within the group. In the same step IV (i.e., themes reviewing step), data were re-sorted, themes were combined, and additional themes were created. Finally, having completed all the previous four steps, which is an indication of a refined thematic analysis, step V involved naming and giving a concise description of each already identified theme.

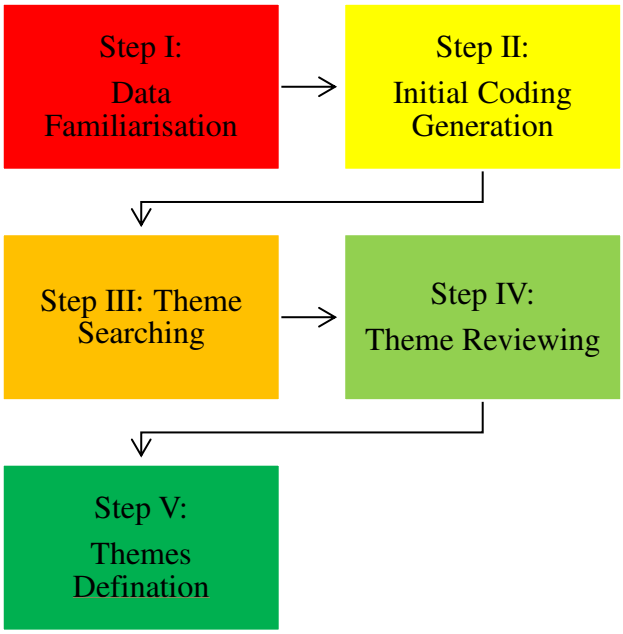

Figure 2. Overview of the steps involved in the Thematic Analysis

4.0 Results

Seventeen (17) factors in total emerged under four (4) main themes (see Table 2) as shown in the developed framework for SME construction business improvement using lean (Figure 3). The themes established from this analysis were named using the insight from the Toyota Production System (TPS) 4P models. The themes are tenets of trust and decision-making; continuous process improvement; teamwork and stakeholder engagement; and problem-solving through consensus. Each of these is discussed in detail in subsequent sections.

<Insert Table 2. Emerged themes from the interviews>

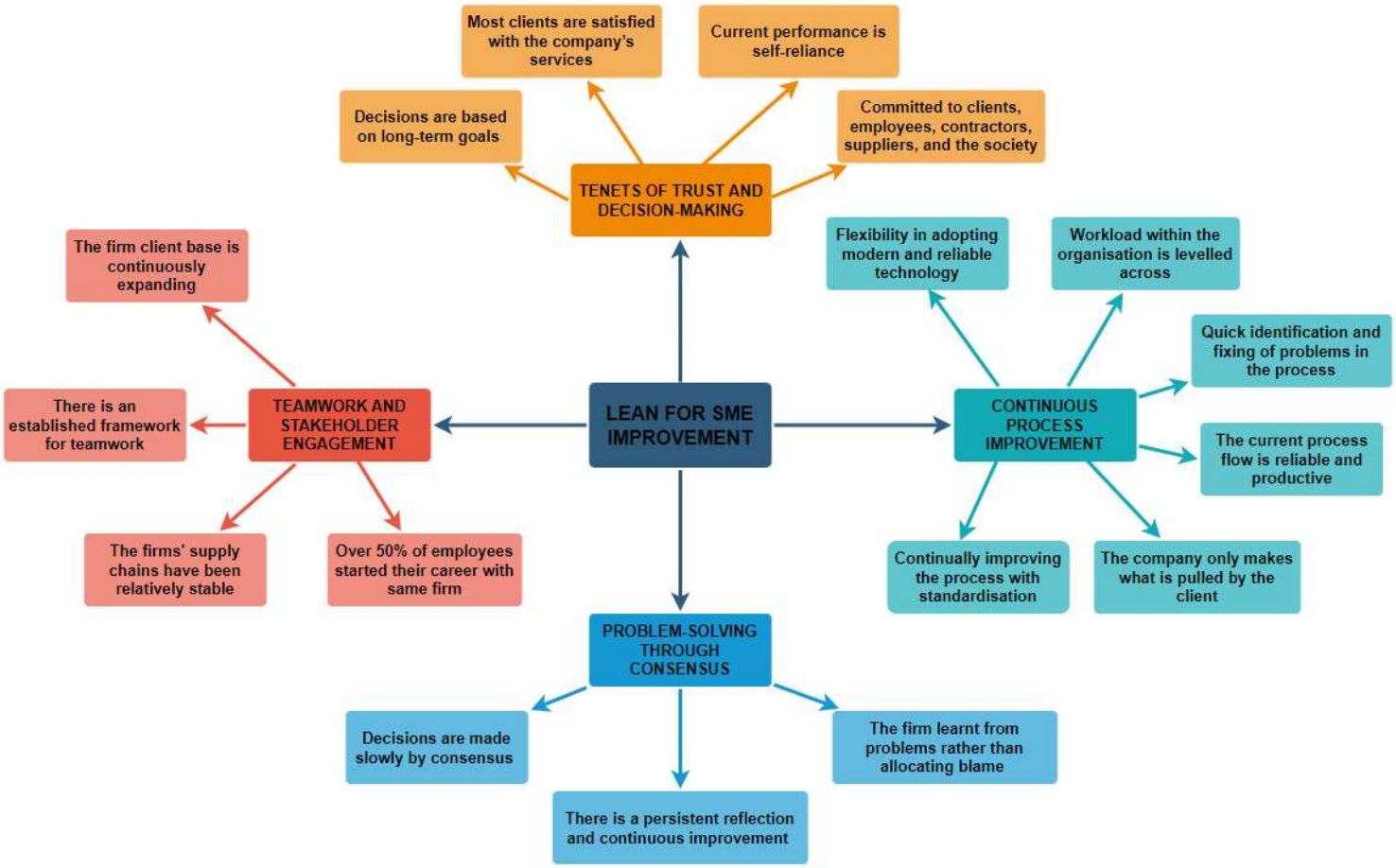

Figure 3. Adapted TPS Framework for SME Construction Business Improvement

4.1 Theme 1: Tenets of trust and decision making

Four (4) factors emerged under tenets of trust and decision-making theme from the thematic analysis of interview data. These factors were coded and derived their notations from the characterises of the participating SME's philosophy as extracted from the interviewees' responses. These factors are decision rationale, client satisfaction, company commitment, and performance reliance.

Sukarno et al. (2021) highlighted that one of the challenges of making new decisions such as adopting technological innovations or new operational procedures in start-up SMEs is focusing on initial profit. This is in agreement with the earlier study of Bajracharya et al. (2021) which argued that policies and practices that emphasise short-term goals and immediate profit are one of the key reasons for customer dissatisfaction and the higher failure rates of SME construction business. This implies that having a philosophy or making decisions that focus on long-term rather than short-term goals will be key for any desired operational improvement and flexibility of SMEs operations. This

was echoed in the interviewees' responses as all six respondents purported that their company make decisions based on long-term goals even at the expense of short-term goals. '*'Our company is very keen on creating a legacy by providing quality services to our clients. We believe in continual patronage rather than making one-off profit''* [IT-6]. This is a direct quote from IT-6 which supported the inference from the analysis.

Othman (2015) highlighted that long-term targets that aim at achieving a high level of customer satisfaction have been one of the key performance indicators of construction businesses. This is because the construction sector is a highly competitive business environment that requires each participant to sustain their competitive advantages. This resonated in the responses of the interviewees with a direct quote from interview 4 stating that ''*there is value in good customer feedback because these earn us many recommendations for the future job''* [IT-4]. In general, the participating SMEs recognise the importance of good client/customer satisfaction and claim to have already established their mark in the construction industry because of their commitment to long-term goals such as excellence, reliability, and integrity that offer them good customer recommendation, which is reflected in the quality of the projects they have executed to date. The key deduction from the interview analysis is that the participating SMEs already have a platform for lean implementation in their operations which is a policy that focuses on long-term goals and customer satisfaction.

A poor understanding of customer/partner expectations is a key barrier to successful quality improvement (Gremyr et al., 2022). One of the findings from this study is that most of the interviewees focussed more on customers/clients but pay little attention to the partners such as suppliers and contractors. This makes their operation less resistant to outside disruption. Therefore, alongside the emphasis on achieving good customer feedback, a modern lean approach via increased commitments to outside partners' success will help develop a truly customer-oriented culture and business. Aslam et al. (2021) suggested that the implementation of TPS and other lean tools will improve SMEs' commitment to clients, employees, contractors and suppliers and will inevitably influence the companies' self-reliance.

Although respondents in this study agreed that most of their customers' feedback shows that they are satisfied with their service, the survey also revealed that the company operations had encountered challenges due to the failure of their business partner, with interviewees 1, 3, 5 and 6 purported that their current performance is not self-reliant. *''It is very difficult not to be affected if one of the partners did not deliver within the agreed schedule''* [IT-1]. This means the success of many SMEs within the construction sector still depends on outside performance. Hence, this calls for urgent attention to improve their operations to make the company's performance less responsive to outside disruption.

This is very difficult to achieve in an ever-changing construction business environment (Schleifer and Asmar, 2021) but the implementation of lean tools such as TPS with a focus on commitment to clients, employees, contractors, and suppliers will inevitably influence the company's self-reliance (Ong and Pheng, 2021).

4.2 Theme 2: Continuous process improvement

The second theme that emanated from this study has six factors as listed in table 1. These factors are related to the operations and service delivery of the participating SMEs. An observation from the interview analysis is that the current operations/processes of the participating SMEs compared very well with the core principles of the TPS lean techniques discussed earlier in section 2.0. However, this does not mean that the participating SMEs are already lean accomplished as there is nothing like that. Conformity therefore only allows for seamless implementation of the whole principle in their operation to improve performance.

''We are very open to trying new technology to improve the quality of service we give to our clients" (IT-6); "we have invested in new design software applications for effective operations" (IT-3). These are sample quotes directly from the interviews that demonstrate that participating SMEs' current processes incorporate adopting the relevant modern and reliable technologies. This helps their organisation to optimise their performances and productivity by ensuring a continuous process flow that promptly identifies problems and fixes them instantly within the process (Mali and Kande, 2020). The lean process should be simple and easy such that problems are easily identified for quick fixing to promote workload levelling within the organisation (Jekiel, 2020). ‘*'We have always tried to look for the root cause of any delay or problem in our operations'' [IT-5]*. This is also evident in the responses of other interviewees as the finding of this study revealed that the ease of problem fixing and continuous improvement are aided by the levelled workload within the organisation.

Meanwhile, all interviewees except IT-2 did not recognise the use of pull systems in their existing processes, they are mostly operating on a push based on projections or past projects. One of the respondents elaborates on this by giving an instance where technicians carried out detailing of the structural members without the design output ready from the engineer hoping that he will modify it to suit when the information comes. Sometimes, the engineer comes out with typical detailing members that reduce the number of drawings that need to be produced; this leads to overproduction in the technician's work. Again, this is a waste of time and materials, causing unnecessary overburden on the technician. Therefore, the implementation of lean thinking will minimise waste in the process and improve performance (Ong and Pheng, 2021).

4.2 Theme 3: Teamwork and stakeholder engagement

In terms of teamwork and stakeholder engagement, the analysis revealed that all the respondents have established frameworks for teamwork and that their client base is expanding due to prioritising their customers' satisfaction. This is in agreement with the first lesson of lean leadership, which is putting customers first (i.e customer focus is paramount to lean implementation (Gao et al., 2020; Hines, 2012). Meanwhile, all interviewees' responses to the study imply that less than 50% of their employees started with them and grew through rank. Interviewee 2 specifically pointed out that, ''*We believe in developing people and allowing them to grow with our culture, but it is very difficult in the construction business where many employees tend to seek new challenges regularly*'' [IT-2]. This indicates that the respondents' current practices' success is based on a short-term fix by continuously recruiting people who can do specific tasks at a certain time. As such, the implementation of lean in their operations will improve their employee retention as strongly affirmed by the Lean Construction Institutes (LCI) that lean implementation will impact the company's ability to attract and retain the people they need.

In addition, the representative from the participating SMEs denied having a stable supply chain. Supply chain (SC) disruption, whether demand-sided or supply-sided, is conversely perceived to affect the organisational performance of construction firms (Kissi et al., 2021). This is an area where SMEs can improve to enable seamless adoption of the lean principle. The clear indication from the analysis revealed that most SMEs should initiate an effort to establish a workforce and supply chain that understands and value the company philosophy and prioritise that to attain effective project delivery. These findings support the claim of Jekiel (2020) that SMEs should invest tremendously in people to ensure success in the implementation of any lean culture.

4.3 Theme 4: Problem-solving through consensus

The fourth theme identified in this study, problem-solving through consensus derived its name from understanding how SMEs deal with issues/problems that arose in their operations. The commonality from all responses is that the participating SMEs engage in constant reflection and continuous improvement of their problem-solving approaches. *'The cost implication of any delay or mistake always motivates us to learn from past mistakes''* [IT-1]; *''We engage in a review of past projects to learn from the problems to improve our process to avoid unnecessary mistakes''* [IT-3]. In this study, the respondents generally insinuated that they have always taken advantage of a problem or error for learning rather than allocating blame. This is evident in the respondents' higher rate of customer satisfaction. It is therefore important that firms learn from the processes that are not

working and then develop strategies that can make them work (Liker, 2004). By doing so, an organisation will continually improve.

Generally, the participating firms' problem-solving attitude is encouraging with a good culture of lean where all is about everyone striving for improvement and not about risk/blame-shifting. However, lean thinking is a culture where everyone is striving to improve continuously and continuous improvement will definitely create more profit and value for the company and project (Omotayo et al., 2020).

5.0 Discussion of findings and implication for SME construction businesses improvement

Although crises are not necessary to turn a company around, they may prompt a lean movement to improve company operations. Meanwhile, Gao et al. (2020) submitted that despite the immense potential of lean thinking to increase construction process efficiencies, it has still not been embraced by most of the construction industry. However, the recent economic difficulty resulting from the disruption to construction activities has called for a reduction in operating costs while increasing profit margins. The first point of action of many of the SMEs operating within the construction sector is downsizing exercises to increase profit margins through staff reduction. The staff reduction has helped to reduce the operating cost, but the workload has also increased significantly, which is currently affecting the statutory project delivery. Thus, the crisis has challenged most of the SME's board of directors to be interested in lean thinking to eliminate the waste in the company operations and improve their performances. Therefore, this study has presented an evaluation of the current process of six randomly selected similar SMEs against the four (4) P models of Toyota Production System (TPS) lean techniques. The TPS applies cost minimisation and productivity maximisation approaches used in the automotive manufacturing process to the construction sectors.

The data collected with a semi-structured interview were analysed using thematic analysis. The analysis revealed four themes which are: (i) Tenets of trust and decision-making; (ii) Continuous process improvement; (iii) Teamwork and stakeholder engagement; and (iv) Problem-solving through consensus. The components of teamwork and stakeholder engagement theme are related to that of tenets of trust and decision-making which means stakeholders (people) and decision-making (philosophy) are central to the adoption of lean thinking. Also, process improvement and problem-solving approaches are equally related which indicates that the ease of problem-solving depends on the simplicity and accuracy of the process. With lean being a path of progress built on continual improvements, the analysis revealed that the current practices of the participating SMEs can be

improved through the adoption of lean thinking. Most of the participating SMEs revealed that their current performance is not self-reliant, it depends largely on other business partners' performances. This is a big issue that lean thinking will improve if adopted in the company policy and operations, as supported by the earlier findings of Bhatt et al., (2021).

Adopting lean principles that will make significant operations of the firm self-sustaining will mean that companies can save costs in terms of project time and cost overrun (Ong and Pheng, 2021). The findings of this study also imply that managers should remove duplication of effort resulting from a lack of proper coordination and collaboration within the organisation. This lack of integration makes different people in the firm do what is convenient for them even if there is no pull for it. Hence, there is a non-standardisation of processes and overproduction in many SMEs. An instant from the response revealed that the engineer's office and technician are not close, and this can affect collaboration and productivity. As such, one way of improving collaboration within the organisation is having an office setting that aids the flow of the process.

Further analysis of the responses shows that some participating respondents agreed that there is still a low level of adoption of reliable modern design methods to serve clients better due to design bias toward the traditional method and lack of understanding. This is very inefficient, with many case studies showing that the implementation of the latest and advanced technology has a crucial role in fulfilling the promise of sustainable development in construction (Mali and Kanade 2020; Aslam et al., 2021; Dauda and Ajayi, 2022). This is in line with the conclusion from the study by Wagner et al. (2014), where technological advancement and management were identified as key tools for sustainable business development. Therefore, this study implies that SMEs should be willing to train their employees to acquire the necessary skills needed to use these modern tools and technology. In addition, the evidence from the study also shows that suppliers' and contractors' improvements have not been taken as firms' concerns. Many of the firm design processes have not been accommodating potential contractor input (no collaboration), thereby causing a delay in design implementation on site.

Having established the level of conformity of the participated SMEs operations to the principle of TPS, it is clear that there is need for improvement, this study thus recommends that firms should immediately fully embrace lean tools like the adaption of the Toyota Production System to construction and design activities. Each firm should appoint or internally source a lean expert who will lead the implementation program. In order to succeed in implementing lean tools, there is a need for experienced people to lead the implementation. So, the firm should appoint people who understand lean philosophy's power, they will naturally look at the enormous waste in the process

and provide solutions to remove it. These people should be motivated to apply their knowledge of lean. The implementation success rate depends on the response of the decision-makers (Sicotte and Delerue, 2021).

Meanwhile, a deep understanding of TPS or other lean tools is not required from these decision-makers, but they will need to appreciate the power of the process and be passionate about the transformation. This means a member of the executive board will be delegated to monitor the implementation plan. In particular, SMEs are required to develop themselves by showing effective and dedicated leadership and management commitment. They should also focus on enhancing their staff's skills and exhibiting a conducive organisational culture to guarantee the successful implementation of lean philosophy in their organisations.

Also, the staff and business partners should be properly educated about lean and should be motivated to welcome it in their respective operations. Regular workshop training should be provided as this is highly essential to help people in the organisation improve their understanding of lean principles. Liker (2020) describes this as a continuous improvement workshop. A remarkable social invention frees up a cross-functional team to make changes in a week that otherwise can drag on for months. Selecting the right people for the team, setting aside time for those individuals, and providing management support are also essential. Using a talented and experienced facilitator who has a deep understanding of lean tools and philosophy will aid in what can be accomplished. A department similar to quality control should be established to monitor the implementation plan. This department should consist of at least a member of the director and a lean zealot. The study finally recommends that customers' feedback should be compulsory on all the company projects to track the progress and continuous evaluation should be carried out regularly to monitor the implementation progress. The main implication of this study is that the application of findings from the study can improve the operations of SME businesses in construction.

6. Conclusions and limitations of the study

This study evaluates how TPS lean principles could be adapted to improve the operations and performances of SMEs carrying out design and consultancy services in the construction sector. However, it is important to point out that the main limitation of this study is the relatively small sample size, the use of qualitative data collection only instead of the observation method or both. These can affect the results and the interpretation deduced from the study results.

Albeit this limitation, the study concluded that focus on short-term goals and immediate profit, duplication of effort resulting from a lack of proper coordination and collaboration are currently creating waste in SMEs operations. This study thus developed an improved framework adapted to TPS lean principles that SMEs can be used to ensure that their company philosophy, people, processes and problem-solving attitude align with core principles of TPS. This will improve the operations and productivity of the SMEs if implemented appropriately. Lean bundles including TPS can reduce operating costs and subsequently develop the quality and improvement of project delivery at its best price without time overrun.

The study recommends further studies where a broader range of data from diverse construction companies can be collected using observation method. Likewise, TPS dynamics may be studied from a simulated perspective to gain further insights into the current trends and challenges facing the construction sector. In addition, further investigations on the adaptation of a variety of other lean tools, which could develop the paradigm or solve problems to mitigate the impact of disruption caused by pandemics, and economic and political decisions on SMEs operating within the construction sector are recommended.

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