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Lean Construction Implementation in Saudi Arabia's Housing Sector: Towards Saudi Vision 2030

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ABSTRACT

This study discusses the development of lean in the housing sector of the Kingdom of Saudi Arabia and how it could be beneficial towards achieving sustainability and a greener environment by utilising the concept's tools and techniques. The Kingdom of Saudi Arabia is determined to achieve sustainability in all its projects. This is why they set sustainable development goals to be achieved in the year 2030. This study discusses information about the utilization of lean in the construction industry, top management decisions and sustainability. It highlights the types of construction waste in the Kingdom, methods of construction as well as barriers facing lean implementation in the Kingdom's benefits and drawbacks. It also includes the plans set for the housing sector and the issues facing the housing sector, the waste management plans like the one set for the city of Riyadh and the housing program. In this study the results were collected using a mixed methodology, stating the recommendations that are required for further research in which semi-structured interviews were conducted with construction professionals in the KSA, as well as the questionnaires, were distributed online to acquire both qualitative and quantitative figures to help determine the findings and achieve the aims and objectives of this study. The key findings of this study summarized that the awareness of lean practice in the Kingdom is not low but not practical like other traditional methods are considered a huge obstacle to the openness of adapting lean and that the understanding of the utilization of lean tools and techniques in waste elimination could help achieve sustainability. Also aligning the implementation of the concept with consumers' needs. Civilians in Saudi are used to a certain traditional cultural but modern household. The barriers to implementing lean such as the influence of traditional management practice, unfavourable organizational culture, lack of technical understanding and other barriers discussed further in the study concluded to be overcome by defining client needs in lean and the suggestions needed to overcome the barriers of adapting the concept and that governmental support is the essential and lean implementation in the organization must be introduced in any organization or sector within a simple and precise guideline. Also, top management and frontline workers' performance are dependent on each other, and the organizational structure must be open to innovative ideas. The study concluded the benefits of lean in its implementation and how it could be beneficial to the housing sector and the community of Saudi Arabia and addressed the barriers to implementing the concept stating the frequency of occurrence of these barriers from previous research and providing a solution to overcome these barriers.

Keywords: Lean, Construction Industry, Housing sector, Professional, Saudi Arabia, Vision 2030,

1. Introduction

The kingdom of Saudi Arabia could use the help of innovative ideas since the King, the crown prince and the entire kingdom are after to find solutions towards achieving a sustainable, safe, vibrant, and stable society. The kingdom has already launched plans in motion toward achieving that. One of the issues that are facing the Kingdom in the housing sector of Saudi Arabia is the housing ownership percentage. Not just that but the amount of waste generated from construction in residential projects and other projects as well. The kingdom is seeking to find true solutions in achieving environmental sustainability and yet there are a lot of ideas that are present but yet not implemented. Lean practice is a concept that does not just ensure waste elimination but reduces energy, improving the quality of products and along with other benefits that include assuring the overall health and safety of employees and the project as a whole and minimizing its risks.

The Kingdom of Saudi Arabia is awaiting innovative ideas in every sector possible. This study focuses on the housing sector of Saudi Arabia and its issues, and how to overcome

them with previous research and recent feedback, lean could be the new key to open new doors to sustainability and productivity in the Kingdom. The Saudi vision 2030 is a plan set by the Kingdom of Saudi Arabia to diversify the Kingdom's economy. Among the many plans for the vision, the housing program is set to help in solving the query of the housing sector. This study demonstrates the usage of lean tools and techniques in the construction field and how that could be beneficial for the housing sector, achieving sustainability and waste elimination.

This study aims to define the benefits of lean and how it could be a true solution in the housing sector of Saudi Arabia and maintain a sustainable environment in the Kingdom. It also discusses how the Kingdom of Saudi Arabia has plans for the housing sector as a part of Saudi Vision 2030 (Rahman, R., & Qattan, A. (2021). The Kingdom of Saudi Arabia is determined in achieving a sustainable environment and a diversifiable income (Ouassaf S, 2020). This study states the usage of lean in construction and utilising its benefits for the sake of the Kingdom and how it could align with the sustainable goals Saudi Arabia has towards its society. This research explains lean tools and techniques in project management and construction, it describes how the usage of the concept if implemented aligns with the Saudi building code (SBC), which can be a solution to achieving sustainable successful projects even mega projects.

The concept of lean has been first used in the 15th century in Venice, but Henry Ford was the one to integrate lean in production to achieve standardisation of work (Hessing, 2018). The notion refers to "a collection of management practices such as quality systems, work teams, cellular manufacturing, supplier management" used to maximise quality and minimise errors in the production process (Shah and Ward: 2000). Drawing on Ford's flow of production concept, the Toyota Production System was implemented after World War II. Hessing (2018) mentions that the focus was shifted from the utilisation of individual machines to the workflow generated by the entire process, the aim being to meet the needs of a more dynamic customer by reducing production costs and increasing product quality and throughput times. For a better understanding of how the concept of lean construction fits into the Saudi Arabia Vision for 2030, first, it is essential to examine what it stands for. To maximise the strengths and capabilities of the country, Saudi Arabia has produced a detailed plan for the future that focuses on diversifying its sources of revenue which rely heavily on the oil industry at this moment (Vision 2030, 2020).

Building upon Islamic values such as excellence, discipline and hard work, that was crucial in the development of the country, they have come up with three pillars to guide them in achieving their future goals: a vibrant society, a thriving economy, and an ambitious nation. The potential of the country goes beyond oil extraction, its geographic position, investment capabilities and symbolic importance to the Muslim world are untapped sources of revenue that could take the economy of Saudi Arabia to a whole new level. Firstly, being a hub connecting Europe, Africa and Asia with access to bodies of water such as the Persian Gulf to the east and the Red Sea to the west unlocks more possibilities for trade (Salameh et al., 2021). Secondly, enlarging the Public Investment Fund and expanding the role of the oil-producing company Aramco into a global industrial conglomerate would position Saudi Arabia as a global investment powerhouse (Page 7- Vision2030, 2020). The housing sector in Saudi Arabia has been undergoing some challenges in terms of the percentage of citizens' ownerships, quality and needs clients sent. The concept of lean production featuring these challenges could be a key to achieving the aims of the vision. Saudi Arabia is currently applying innovative ideas in all sectors of the Kingdom, and the housing sector is benefiting from such enhancements. The introduction of lean construction in the Kingdom's housing sector will unfold various tools and techniques the Kingdom was lacking awareness, and the utilization of such techniques could maybe even accelerate the process of Saudi vision plans towards the housing sector and sustainability.

The purpose of conducting this research is aiming to investigate if lean construction implementation in Saudi Arabia's housing sector could be the true answer to achieving the Saudi vision 2030 with the following objectives:

- Explaining the Saudi vision 2030, outlining the housing industry's role in achieving the goal
- Exploring lean techniques, benefits, and challenges for the housing sector of Saudi Arabia.
- To highlight the type and amount of construction waste and its impact on the environment.
- To assess the level of impact of transforming from the traditional construction process to the lean method of construction in the Kingdom.
- To identify the barriers and challenges facing lean implementation.

2. Literature Review

2.1. Housing Sector in Saudi Arabia

The housing sector in Saudi Arabia is currently undergoing some challenges to help in balancing the drawback it faced during the past years, especially after the first three quarters of the year 2020 (GPG, 2020). The kingdom's real state index indicated an increase of 2.03% in 2020's third quarter year over year (y-o-y) after the increase in the first two quarters of the year by 1.84% in the first quarter and 0.79 % for the second according to the General Authority for statistics of the kingdom. (GAStat, 2020). Refer to appendix (A). Saudi Arabia's standards of living are different from other countries; therefore, the occupation of the houses and the distribution of a household could be different from other countries around the world. As a result of the growing lack of affordable housing, a worldwide housing crisis has developed. In comparison to the average income, housing prices rose at a far faster rate. This tendency is particularly noticeable in big cities, with recent research noting a 24 percent increase in real average home costs while real average income only increased by 8% in 32 major cities

throughout the world. A similar challenge was faced by Saudi Arabia which is why the Kingdom initiated a plan for the sector in increasing the homeownership percentage (MoH, 2020). A study by Al-Mutari et al., (2014) states the an average household in Saudi Arabia is between 5.5 to 8.4. On the contrary, a non-Saudi household average is between 2.6 to 4. In the year 2020, the average household in Saudi Arabia was recalculated to be 5.6 people per household (Arcgis, 2020) whilst in the UK it was calculated to be an average of 2.6 people per household (Statista, 2020). Refer to Appendix (B). Thus, the Saudi household size is greater than other households by 2 persons which is also triggered depending on the residential status. Also, the culture of the kingdom influences the number of people that can stay in a house and therefore the sizing varies.

Another study by Assaf et al. (2010) stated that after interviewing consultants, contractors and real state investors in Saudi Arabia, the responses indicated that the top ten factors affecting affordable house costs in Saudi Arabia were the following: inadequate availability of labour, materials standard, design change, quality of design, poor financial control on a site, contract period, lack of coordination, materials cost, site disputes, previous experience. The Saudi Government is investing in new development and trying to make a change to strengthen the volume of affordable housing available to help increase the ratio of homeownership among the citizens by 2030 as a part of the vision as well as the promising reforms the government is undertaking. Thus, it will help increase the percentage of homeownership from 47% to 70% towards the end of the plan (Oxford business group, 2020). In the year 2020, it was estimated that approximately 1.6 million Saudi citizens were waiting for the housing programmes launched by the government to be completed. With the current ratio of increase in population, the Ministry of Housing (MoH) announced that it would require an extra 3.3 million houses to be able to pace with the Kingdom's growing population. To help achieve that, the MoH, Public Investment Fund (PIF), foreign companies through the Public-Private Partnerships (PPPs) and the Sovereign wealth fund of Saudi Arabia of $230bn, are working together to enable the building of one million new houses by the year 2023 (Vision2030.gov, 2021).

2.2 Saudi Arabia 2030 Vision

The Saudi Vision 2030 is a vision developed by the Kingdom's Council of Economic and Development Affairs and chaired by HRH Prince Mohamed Bin Salman – Deputy Crown Prince. The vision is focused and built around three main pillars which are: a vibrant society, a thriving economy and an ambitious nation. To achieve each one, a series of commitments will take place. According to AlSaud (2020) – Crown Prince, the first pillar of the vision revolves around the Islamic vision of the Kingdom and utilising its resources to be more beneficial to achieve that, the Kingdom will increase the number of Umrah visitors from eight million annually up to 30 million as well as promote cultural and entertainment growth by doubling the number of sites of Saudi heritage and many other plans towards creating a vibrant society like the housing program and other plans towards the first pillar. The second pillar revolves around the determination of the Kingdom to become a global investment powerhouse through diversification of the economy and decreasing the dependency on oil and hydrocarbon income (SE,2020). It will contain a series of contributions, collaborations and commitments between various sectors including the private sector towards achieving the aims of the vision. The third pillar is about utilising the strategic location of the Kingdom by connecting three continents Africa, Asia and Europe and acquiring sustainable success (Vision2030gov, 2021). ARAMCO (Oil firm & Partner in the Saudi Vision) and SABIC the petrochemical firm are leading investments under a programme by the private sector of $1.3 trillion or 5 million Saudi Riyal by 2030 (Azhar, S & Ghantous, G, 2020).

2.1.1. Housing Program Saudi Vision 2030

According to the Saudi vision 2030 goals for the housing program, which was launched in 2018, the aim of it is to create a vibrant environment for the Kingdom's society and families as a whole. Since the initiation of the program, the focus was on enhancing the standards of living for the housing sector development to allow a variety of options for the citizens to obtain housing and therefore increasing the percentage of homeownership for the families and the society of the kingdom (Vision2030.gov, 2021). On the contrary, a study by Susilawati and Alsurf (2011), states how Saudi Arabia faces rapid growth challenges as a developing country with a high ratio of urbanisation and climate challenges suggesting that the kingdom's Government and responsible parties should interfere, placing laws and regulations that could lead to a solution to these challenges and achieve a sustainable environment. However, in the same study by Susilawati and Alsurf (2011), there were suggested several recommendations regarding achieving sustainability in Saudi Arabia, stating how sustainability could be achieved in the kingdom by a collaborative agreement between the government and the stakeholders. Examples of the recommendations suggested were creating an advisory stakeholder council government, increasing the awareness of sustainability among the politicians and officials, adopting proper guidelines and regulatory framework for sustainable construction, and providing funding for innovative technologies, emerging businesses, training and education. Al Fadl (2010) stated that Key Saudi developers are investing in the idea of sustainable construction whilst increasing political interest and that guidelines of having a green environment will be mandatory in a short time. According to (AlHogail, 2021) the Chairman – Member of the Council of Economic and Development Affairs, the housing program will continue its efforts to help increase the percentage of ownership to Saudi families and citizens by 70% by 2030. Due to the successful progress of increasing the ownership level from 47% in 2017 to 60 % in 2020. As well as boosting the sector's attractiveness to increase the chances of investment by the private sector to support the housing sector in terms of sustainability and stability.

2.2.2. Sustainable development goals (SDGs) & Waste management plan city of Riyadh

Since the initiation of the vision, the Government and responsible parties have been concentrating their efforts on achieving all its goals and the aims of it. Refer to appendix (C) A major part of the vision plan is achieving a sustainable

environment; thus the Government have set sustainable development goals as well as the waste management plan of the city of Riyadh. The vision endorses a series of programs and projects that are implemented to enhance the efforts in achieving sustainable development. Refer to appendix (D). In 2018, the kingdom gained approval from the King to demonstrate the efforts toward sustainable development in the United Nations High-Level Political Forum after the kingdom's desire to participate in 2017, all within the relevant dimensions in terms of social, environmental and economic (United Nations, 2018). Given the comprehensiveness of the sustainable development goals, several stakeholders are involved and responsible for the delivery of them, therefore it is vital that the responsible parties must focus on the outcome of the goals as a whole government affair rather than designated focal points.

Another part of the vision is the waste management plan for the capital city of Saudi Arabia -Riyadh. The waste management plan is focused on minimising the waste produced by the construction industry as well as municipal waste by improving the recycling process by 2035. The plan is to recycle 81% of municipal solid waste produced and 47% of construction waste produced annually (Globalrecycling,2020). The approximate amount of waste generated per year in the kingdom is about 8.4 million tons per year. The initiative took in July 2019, aiming to achieve environmental sustainability and protect the environment. It is also agreed by the organisations to remove and recycle 20 million tons of construction waste that was lying on different spots around the city of Riyadh (Steed, L, 2019). The agreement was signed by Abdulrahman Bin Abdulmohsen Al Fadely – the minister of environment, water and agriculture and chairman of the board of directors of the National Waste management centre, as well as Tariq Bin Abdulaziz AlFaris – Mayor of Riyadh region and Jeroen Vincent- CEO of Saudi investment Recycling company (SIRC). The first initiative of the agreement's framework will be focused on the waste resulting from demolition and construction and recycling into materials used for housing projects and road construction (GRI, 2019).

2.2.3. Methods of Construction in Saudi Arabia

The procurement arrangements in Saudi Arabia are mostly general arrangements where a designed plan is presented by the client in terms of; construction arrangements and engineering procurement (EPC agreements). Another method is build-only agreements which involve only one contractor (Husien, A, 2019). Generally, in the Kingdom, a procurement arrangement involves; A contractor and a client normally in the majority of cases will be a Saudi Arabian government entity. This applies when the parties involved in the arrangements are local. Examples of the contracting companies that engage in such arrangements are Saudi Bin Ladin Group, ElSeif, Saudi-Ogier and other large Saudi companies which are considered the Kingdom's preference in dealing with local projects as Saudi Arabia tends to deal with Saudi firms as much as possible.

The process is different when it involves international projects as approval for foreign investment is required to be obtained from the Saudi Arabian General Investment Authority (SAGIA). Once the license has been obtained, registration with the Ministry of Commerce must be arranged and established to enable foreign entities to practice. It was stated by Alsulaiman, A. (2019) that 82 % of construction projects experience delays due to material issues and the technical capabilities of the contractor. He also noted a study by Ali, A., (2013) after reviewing the responses of 209 employees who contributed to a survey for determining the causes of delays in Saudi Arabia. The results found that, stated that some of the causes are: lack of planning and clarity in the design and studies phase.

2.3. Lean practice in construction, project management and benefits of implementation

The concept of lean in construction has many benefits that help the industry. A study by Solomon et al. (2006), found that lean practice in construction projects could help lower costs significantly. Various other studies discussed the benefits of lean in construction projects, indicating that lean helps in increasing work productivity (Agbulos et al., 2006), achieving a higher level of job satisfaction (Khot et al., 2012), enhancing the overall quality of work (Leonard, 2006), improving working partners relationships (Turner Construction Company, 2012 & Salem et al., 2006), enhancing plans reliability (Ballard et al., 2011). Balfour Beatty (2011) undertook a football stadium project. Whilst undergoing the project, the Just In Time (JIT) delivery system was applied for the pipe reinforcement cages, which resulted in a 20% increase in the productivity rate (Sarhan et al., 2017). On the contrary, it is argued by (Gao, S & Low, S,2014) that the JIT philosophy in practice, requires the frontline workers to do continuous tasks that could lead to repetitive strain injuries, and that is what Toyota was accused of doing to their frontline workers (Crowther & Green, 2004). It was also suggested by Williams et al., (1992) that the practice of lean production is considered underhanded and dehumanising. However, various other studies indicated the benefits of lean. Salem et al., (2006), found that applying lean techniques in a car park project in Ohio, United States, resulted in an earlier finish to the project and a decreased overall cost. Moreover, a study by Telyas et al., (2011) discussed that after lean implementation in the US modular engineering building sector, the production rate increased up to 50%, the layoff costs decreased by 18 % and the efficiency of labour was enhanced with 10% only after 6 months of implementation.

This indicates the contribution of lean practice towards the construction sector and how it could be a solution towards sustainability, especially in the kingdom rather than other traditional methods in practice which could benefit the investors, mass developers investing in the Saudi vision and the private sectors. The Kingdom of Saudi Arabia has the resources and is open to executing and investing in innovative ideas, most importantly that can lead to achieving a sustainable vibrant environment for the citizens, which is a part of the Saudi vision, as well as lowering the budget and all the other benefits gained from the concept. According to Crown Prince Mohamed Bin Salman Al Saud (2020), he stated that to uphold and keep the environmental character of the region, laws and mechanisms regarding environmental sustainability will be developed and the natural resources will be utilised by the ethical approaches practised globally.

3. Research Methodology

3.1. Introduction

The approach in this investigation will be a mixed-method approach. A mixed method approach in a study is a combination of quantitative and qualitative approaches in terms of data collection and analysation. It helps explore perspectives that are diverse and uncover the detailed complex layers that relate to the findings (Myrick, R, 2021). Each qualitative and quantitative approach is implemented separately. Also, could achieve results in different research or investigations. But combining both methods could result in more in-depth and detailed findings, especially in this investigation. As lean practice implementation links to observed variables in subjective matters in terms of implementation, the risk in adapting the concept, enhancing sustainability, project management and front line workers' performance as well as quantitative figures relating lean practice performance in subjective matters, Considering these factors about the topic, the mixed method approach was selected to be the preferable approach to this study with which the open-ended questions constructed in the interview and the quantitative questions in the questionnaire, in addition, to help to broaden the concept's realization(Shibani et al., 2021; Araz et al., 2021; Shibani et al., 2022; Araz et al., 2022; Shibani et al., 2023; Shibani et al., 2024; Hassan et al., 2025; and Shibani et al., 2025). The benefit of using it may provide stronger evidence to the study and granular results. However, the method requires a vast amount of time in application and may require more expertise, time and resources which could be a disadvantage to this study. A series of questions in a survey will be distributed to construction professionals in Saudi Arabia, focus groups expressing their opinions and initially asked about their professional experience, years of experience, and their job title then asked the interview questions. The questionnaires were sent to most of the construction companies in Saudi responsible for public housing and residential building of whom 34 responded which is almost 57 percent of the expected response rate which is enough to build the investigation. These employees could be labours and lean production employees including professionals, frontline workers, project managers and coordinators. The interviews will be conducted with these participants to acquire the data required for utilizing the data to find a true solution of lean implementation and its benefits for the housing sector in the Kingdom of Saudi Arabia. This approach will be used to compare the results acquired after the surveys and the interviews to narrow down the barriers of implementation, define the client's needs and understand the ways of implementing the concept.

3.2. Questioner

The qualitative approach in this study is presented in a set of open-ended questions in an interview questionnaire plus a relevant case study relating to the concept of implementing lean in Saudi Arabia's construction industry presenting data collected from participants in that investigation in addition to the feedback from the participants contributed in the interview questionnaire constructed for this current research so as the quantitative. In other words, the combination of both methods will be able to compensate for each other in the finding whereas the quantitative statements will rely on the responses to the qualitative questions. The questions in the interview will also play a vital role in specifying the findings. The questionnaires were constructed via Bristol Online Survey (BoS) and hard copies were also made. The disadvantages of using such an approach are the time needed to collect the data, due to the staking nature of gathering and collecting information and field notes analysation. (Rahman,2016). The results of a study could be affected by the researcher's consciousness, in other terms, biased opinions among researchers could affect the conclusion of the study (the classroom,2021). Therefore, this study is assuring the elimination of any possibility of having a biased opinion, by depending on audience feedback, and case studies and then analysing the quantitative figures and merging them together to get more granular results. The questionnaires were distributed online, and hard copies were also kept in case of a possible hand-to-hand or face-to-face interview, depending on the implications of COVID. The questionnaire contains 12 questions that are designed to cover the objectives of the study by gathering the responses and analysing them as follows:

Q1: Are you aware of the Saudi vision 2030 plans (housing program) for the housing sector of the Kingdom of Saudi Arabia?
Q2: Lean practice in construction could be beneficial in achieving a greener future in Saudi Arabia
Q3: Lean practice is beneficial for the housing sector in Saudi to reduce energy consumption and construction waste.
Q4: Traditional methods of construction are time-consuming in the housing sector of Saudi Arabia Question (4), Question (4) and (11) are covering the 4th objective of this study which is the impact of shifting to a new idea like lean in practice in construction.
Q5: Lean implementation in Saudi Arabia will help maintain a sustainable and vibrant society in the Kingdom and therefore align with the pillars of the 2030 vision plans on sustainable development goals
Q6: The awareness of lean practice in Saudi Arabia is high
Q7: The housing industry needs skilful lean professionals to implement the technique which will require a vast amount of time and money to train individuals.
Q8: Implementing lean in the housing sector of Saudi Arabia will enhance the speed of delivery, the work environment and therefore the quality of work
Q9: Overcoming the barriers preventing the successful implementation of lean could in Saudi Arabia achieved through (Multiple options are applicable)
Q10: What tools and techniques of lean could be beneficial in use for the housing program or any plans for the housing sector (Multiple options are applicable)
Q11:How would you agree that Saudi Arabia may consider shifting to other innovative ideas like Lean construction if they have full knowledge of its benefits, especially since this is what the Kingdom is investing in and aiming for?
Q12: What do you think are the key benefits of lean practice? Please rate each of the following items on a scale of 1-10 where 1 is not important at all and 10 is very important: a) Improving managerial decisions; b) Waste reduction and elimination; c) Improving quality control and enhancing productivity; d) Enhancing waste

recycling; e) Improving delivery time of public housing projects; f) Reducing errors and minimizing risk in public housing projects.

3.3. Research Sample

The selection method of this study was not a random sample; it was a selection of people in the Saudi housing sector that have knowledge of residential projects. The construction companies SCC (Saudi Cyprian Construction LTD.), Alsaad general contracting, KAMCO, Tarouk and Saudi Co were contacted to acquire their expertise and gather information based on their residential projects experience. The participants include construction professionals from the Kingdom of Saudi Arabia in these companies, who are experienced in public housing projects or any residential project. Also, consultants, project managers, and skilled labours that have experience in the industry could provide answers regarding how the methods of construction in the industry are affecting it, how could the Kingdom benefit from sustainable construction and innovative ideas that ensure sustainability in their application. Global lean practitioners as well could help identify the benefits of using lean tools and techniques in other projects outside the Kingdom. Their professional opinion could be an eye opener to Saudi Arabia's conceptual thought of lean.

3.4. Interviews

The interviews that were conducted with the participants were semi-structured interviews allowing the interviewees to express their opinion with open-ended questions based on their professional experience to cover the knowledge areas needed for the research. The interviews were conducted to be able to acquire as much professional opinion as possible to help achieve the aims and objectives of this study. Six interviews were conducted with Saudi construction professionals and business owners. The Interview questions are as follows:

Q1: What do you think about Lean practice in the construction sector? And how do you think it will benefit the housing sector in Saudi Arabia?

Q2: Do you think Lean will have a true solution in contributing towards Saudi Vision 2030 goals?

Q3: Do you think it is beneficial for the housing sector in Saudi Arabia to implement Lean practice towards contributing to the Saudi Vision 2030 waste management plan and therefore a greener environment?

Q4: In your professional opinion, do you think numerous investors will contribute towards implementing Lean practice in Saudi and defining client needs?

Q5: Is it possible that lean practice will be a priority other than following traditional methods of construction in Saudi Arabia?

4. Results and Discussion

4.1. Questionnaire (Quantitative)

The purpose of Question (1) in the questionnaire was to acknowledge whether the respondent is up to date with the latest plans of Saudi Arabia for the country's development. Most respondents of this question were aware of the Saudi Vision 2030 plans for the housing sector, concluding their awareness of the government's efforts towards investing in new innovative sustainable ideas and setting programs like the housing program which is seen in Table 1.

Table 1 Awareness of Saudi Vision 2030

Responses	Yes	No
Number of Response	32	2

The purpose of Questions (2) and (3) is that they are targeting the second objective of this investigation by helping to identify and explore lean techniques benefits for the housing sector of Saudi Arabia in terms of sustainability and reducing construction waste.

Table 2 Benefits of Lean for a greener future in the Kingdom of Saudi Arabia

Agreement	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Responses	19	12	3	0	0
Responses (%)	56	35	9	0	0

The responses of the participants to this statement were agreeing with the fact of how lean practice could be beneficial to the Kingdom and help to achieve a greener future. Utilizing the waste elimination techniques of lean could be beneficial in the housing sector and the construction sector as a whole and therefore enhance waste management control in the Kingdom, especially a plan like the waste management plan of the city of Riyadh, the response of agreement shows in Table 2.

Table 3 Benefits of Lean for reducing energy consumption the Kingdom of Saudi Arabia

Agreement	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Responses	18	15	1	0	0
Responses (%)	53	44	3	0	0

Table 3 illustrated that almost all respondents to that statement were agreeing that with a concept like lean, the housing sector could gain benefits in terms of waste elimination and reducing energy from construction practices. Which assures the benefits that could come from implementing such a concept in organizations and the housing sector as shown in Table3.

Approximately 82% of the respondent to question (4) agreed that in the industry of the Kingdom, the routine methods of construction are time-consuming. Therefore, the methods of construction need enhancement. Adapting innovative ideas could be a solution to this query. The kingdom needs to utilize new methods of construction to also help with the housing sector's accumulated problems as shown in Table 4.

Table 4 Traditional methods of construction in the Kingdom in terms of time consumption

Agreement	Strongly agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Responses	13	12	3	3	0
Responses (%)	38	35	9	9	0

Questions (5), (8) and (12) were designed to assess the level of impact of implementing such a concept in the kingdom and the benefits that it could gain in terms of sustainability, waste reduction, delivery of speed and work environment which also evolves around the 2nd objective of the study. The answer to question 5 is illustrated in Fig. 5. Most respondents to this question agreed that implementing a concept like lean could benefit the housing program set for the vision of 2030 to increase the homeownership percentage and therefore fulfil the predetermined plans for the housing sector. About 88% of respondents agreed, while about 3% of respondents disagreed with that statement and 9 % came back with neutral responses.

Table 5 Lean implementation in the housing sector aligning with Saudi vision 2030

Agreement	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Responses	11	19	3	1	0
Responses (%)	32	56	9	3	0

Question 6 is presenting the awareness in the Kingdom to determine the level of knowledge of Saudi construction professionals in the Kingdom50% of the respondents agreed that the awareness of the concept is present and the other 50% is distributed between neutral responses and disagreeing with the presence of the concept in the kingdom in which 21% were neutral and 30% were disagreeing. These results indicate that the concept of lean in some areas in the Kingdom is present but not practical as much as traditional methods.

Table 6 The **lack** of lean practice awareness

Agreement	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Responses	4	13	7	8	2
Responses (%)	12	38	21	24	6

Questions (7) and (10) are addressing the cost-effectiveness of lean if implemented and which tools of lean could the kingdom benefit from the majority of the respondents (91%) acknowledge the fact that the kingdom needs to invest in developing the knowledge and skills of the workforce, which will require a considerable amount of time and funds to be invested in training activities. No respondents disagreed with the affirmation, but 9% had a neutral perspective on this topic.

Table7 Lean cost and time needs for implementation in the Kingdom's housing sector

Agreement	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Responses	18	13	3	0	0
Responses (%)	53	38	9	0	0

Questions (5), (8) and (12) were designed to assess the level of impact of implementing such a concept in the kingdom and the benefits that it could gain in terms of sustainability, waste reduction, delivery of speed and work environment which also evolves around the 2nd objective of the study. About 91.2% of respondents concurred that the implementation of lean could be beneficial timewise and improve the work environment by fostering a highly efficient, collaborative work environment, thus increasing the quality of the work delivered. 9% of the respondents had a neutral position in regard to this topic, but none disagreed with the statement.

Table 8 Enhancement of projects' delivery in terms of speed, quality and enhancing the work environment

Agreement	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Responses	14	17	3	0	0
Responses (%)	41	50	9	0	0

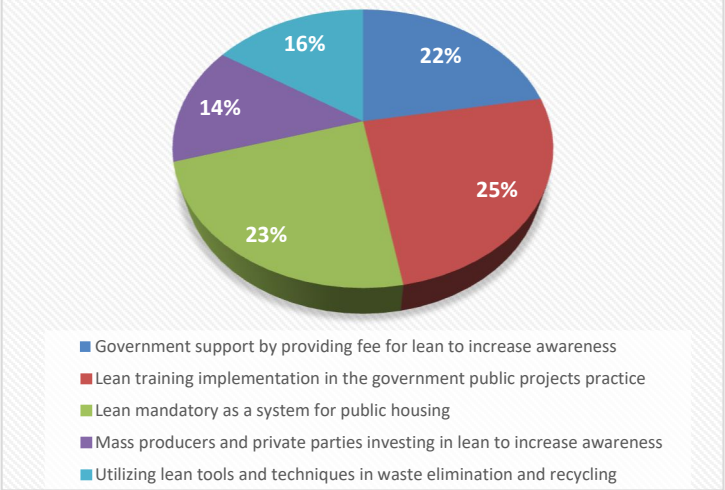

Figure 1. Keys to overcoming Lean barriers of implementation in the Kingdom of Saudi Arabia

Question (9) was designed for the participant to acquire their opinion and to address the keys to overcoming the barriers of implementing lean in Saudi Arabia which is also the last objective of the study. The results in Fig. 1. Illustrated that 79.4% of the respondents believe Government support paired with the implementation of lean training in the Government public projects practice could be beneficial in overcoming the barriers the method imposes, followed by 70.6% who are convinced that introducing lean as a mandatory system for public housing could contribute towards achieving the same goal. 61,8% of those who responded think that the recycling and elimination of construction waste through lean practice could also be beneficial, followed by 50% who consider that the investments of mass producers and private parties could boost the lean awareness campaign.

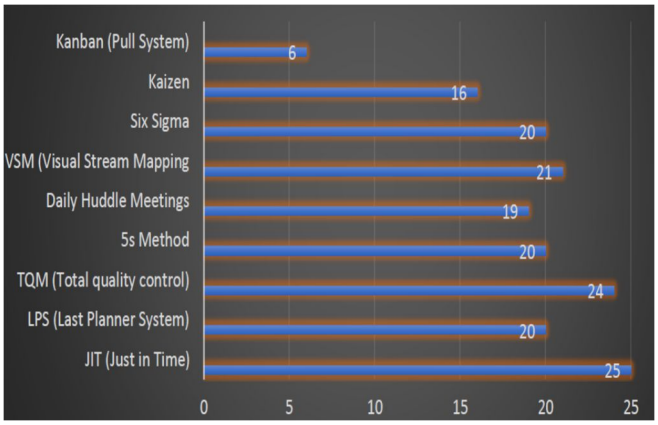

Figure 2. Assessing which tools and techniques of Lean could be beneficial to the housing sector

The result of Question (10) is shown in Fig. 2. The tool that has been voted as the most beneficial to Saudi Arabia's housing sector is Just In Time (JIT), followed by TQM (Total Quality Control), and then VSM (Visual Stream Mapping). A lower number of respondents have chosen the two tools that were voted equally, 5s Method and LPS (Last Planner System), as well as Daily Huddle Meetings which received 19 votes. The lowest percentage of respondents have chosen Kanban, followed by the tool Kaizen. Questions (4), (6) and (11) are covering the 4th objective of this study which is the impact of shifting to a new idea like lean in practice in construction as shown in Table 9. The results show that 88,2% of the respondents have concluded that Saudi Arabia may consider shifting to lean practices if they acquire full-spectrum knowledge about the features of lean construction and how it could benefit their aims. No respondents have disagreed, but 11.8% have decided to adopt a neutral position about this affirmation.

Table 9. Shifting to innovative ideas like Lean practice in the Kingdom

Agreement	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Responses	15	15	4	0	0
Responses (%)	44	44	12	0	0

Questions (5), (8) and (12) were designed to assess the level of impact of implementing such a concept in the kingdom and the benefits that it could gain in terms of sustainability, waste reduction, delivery of speed and work environment which also evolves around the 2nd objective of the study.

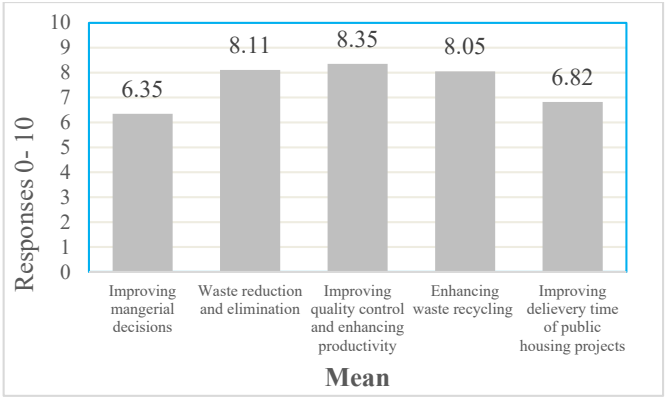

Figure 3. Key benefits of Lean tools and Techniques

4.2. Discussion

The results of this study faced some challenges in getting a high number of contributions from participants. The contribution of participants would be higher if COVID implications were not present. However, practical research relevant to the study was conducted to discuss the benefits of implementing lean in the construction industry of Saudi Arabia. Dr Sarhan Jamil studied addressing the benefits of implementing the concept, barriers and drawbacks that are facing lean. By surveying 282 participants, moreover, he demonstrated how lean tools and techniques such as Computed aided design, visual stream mapping, daily huddle meetings, total quality management (TQM), Just in time, Last planner system, 5s method and other lean tools and techniques could help in enhancing work productivity, waste elimination, speed of delivery, overall quality, waste elimination, minimizing risks and errors, fast production and maintaining the sustainable project. This concludes that it could be beneficial to the kingdom's housing industry in terms of managing projects, sustainability, and enhancing the quality of projects. Those employees' feedback matches the feedback of the participants who contributed in this study. Which concluded that implementing such a concept, and the benefits gained from it will help the Kingdom in not just the Saudi Vision, but future developments in the industry. It is however suggested by participants that overcoming barriers of implementation in the industry of Saudi Arabia as follows in this table:

Table 10 Keys to overcoming barriers of implementation of lean in the Kingdom of Saudi Arabia

Keys	**Respondents**
Lean mandatory as a system for public housing	24 (76.6%)
Lean training implementation in the government public projects practice	27 (79.4%)
Government support by providing a fee for lean to increase awareness	27 (79.4%)
Mass producers and private parties investing in lean to increase awareness	17 (50%)
Utilizing lean tools and techniques in waste elimination and recycling	21 (61.8 %)

Table 11. Lean tools in the Kingdom of Saudi Arabia

Lean tools	No of selection
JIT (Just In Time)	25 (73.5%)
LPS (Last Planner System)	20 (58.8%)
TQM (Total Quality Management)	24 (70.6%)
5s Method	20 (58.8%)
Daily Huddle Meetings	19 (55.9%)
VSM (Visual Stream Mapping)	21 (61.8%)
Six Sigma	20 (58.8%)
Kaizen	16 (47.11%)
Kanban (Pull system)	6 (17.6%)

It was also concluded that the tools of lean that could be beneficial for the housing program or any future plans for the housing sector are shown in Table 1, Lean is not a concept that is only used in construction, it is utilized in many sectors such as the automobile industry. The concept however requires a vast amount of time and money in its adaptation, learning and implementation. It is a challenging concept to accept especially since traditional methods are followed in the Kingdom and shifting to a new method of construction may require time. Since the Kingdom has the capability in conducting and finishing projects even mega ones, the consideration of time and cost is normally followed by traditional methods. The fact that a lot of projects undergo time and cost overruns in Saudi and the attention to it is seeking a true solution, this is where lean could be an innovative idea minimizing all these risks, achieving sustainable projects and progressively managing the cost, time and quality in projects. Lean practice is a topic that is still undergoing practical research however, it could be safely mentioned that it acquires tools and techniques that if implemented in a correct course in the housing sector of Saudi Arabia, could help achieve sustainability, increase homeownership percentage and contributing with future plans for the Saudi housing sector. The idea of lean according to interviews is not new but not practical in the kingdom. It is the mindset of the labourers, investors and traditional practices that are stopping the kingdom from exploring new ways that could help the kingdom in various ways. Exploring lean requires a huge amount of training and overcoming the challenges of adapting to a new concept. However, if implemented correctly which may require time, it can benefit not just the housing sector and the society but also the government, business owners, mass developers and any party that is contributing to the plans of the vision of Saudi Arabia 2030 or in a strong position of investing in the housing sector.

5. Conclusion

The Kingdom of Saudi Arabia faces challenges in the construction industry and construction projects experience significant delays and continuous resources. Various types of construction wastes could use the aid of lean techniques. Frontline workers and top management teams together are the core of an organizational structure, learning new skills will add to their knowledge and be able to enhance the entire process of the project from planning to delivering all in healthy, careful, and sustainable manners, which what lean production aims for in any project. With the findings of this study along with the data from the study of Dr Sarhan (2018), it can be agreed upon that the price change, the home-ownership percentage, and the waste elimination process are all queries that could be solved by introducing tools and techniques like JIT, LPS, TQM, DHM, VSM, SIX Sigma, Kaizen, and 5s method. These tools could be the solution to these queries, as well as more managerial tools that demonstrate their application in projects. With the presence of a waste recycling problem, the various construction waste types and the aid of lean tools, it could be safely mentioned that the Kingdom could use the support of implementing a concept like lean.

It is safe to say that the awareness of lean is not as low as expected to be but requires more application and practice. The suggested recommendations by participants after being asked about the key factors of overcoming the barriers of implementing the concept of lean were mainly focused on having lean mandatory as a system for public housing, this includes managerial decisions as well, the training of employees in the public housing projects. It is also vital for this idea to be acknowledged to have the contribution of the government to be able to spread the concept across the cities of Saudi Arabia and rural areas. Scholarly suggestions on lean could help outline lean principles (Gao, Low, 2014). In the construction sector of Saudi Arabia, it could be mentioned that the main principal factor of the barriers of implementing lean is traditional practices in the kingdom, followed by client-related queries, standardization, and technological and awareness barriers. As a result, industry experts believe that the application of lean construction in the Kingdom's housing sector may be impacted at the institutional, project, and industry levels. The findings of this study could be summarized as follow:

1. Defining client needs in lean and the suggestions needed to overcome the barriers of adapting the concept.
2. Aligning the implementation of the concept with consumers' needs. Civilians in Saudi are used to a certain traditional cultural but modern household.
3. Government support is an essential and lean implementation in organizations and must be introduced in any organization or sector within a simple and precise guideline.
4. Understanding the importance of lean tools and techniques in waste elimination and achieving sustainability.
5. Top management and frontline workers' performance are dependent on each other, and organizational structure must be open to innovative ideas.
6. Traditional methods of construction are considered a huge obstacle to the openness of adapting lean as well as the awareness of the lean concept is present in the KSA.

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