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Implementation of Lean Construction in the Kuwaiti Oil and Gas Industry

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ABSTRACT

Although lean construction has been recognised for over two decades, the uptake of lean in Kuwait seems to be scarce. The understanding parties of lean construction management seem to have faced difficulty in its implementation. This study aimed to assess how effective implementation of lean construction management had been in Kuwaiti Oil and Gas construction industry. This study assessed challenges faced during implementation processes and assess the variance of understanding within hierarchies of organisations. It also assessed the performance of current construction methods in Kuwait's oil and gas industry. A mixed qualitative and quantitative research approach had been adopted with semi-structured interviews and questionnaires with a mixture of open-ended and closed ended questions. A challenge in data collection was found due to the Wasta culture in Kuwait. Challenges faced during lean implementation construction management had been identified as negative attitudes of employees, poor client-contractor communication, lack of lean knowledge and management issues. Lean knowledge varied in levels of the hierarchy. Lean Construction Management construction companies showed a better performance in delivering projects and that if companies have not effectively utilised lean tools, it will result in more reduced performance than traditional management and lean construction management companies.

Keywords: Lean, Construction, Management, Kuwait

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1 BACKGROUND

Construction companies have seen the need to make their practices more efficient and greener. Kuwait had £116.9bn projects under construction in January 2019, of which £51bn are in oil and gas sector, there will be a further £277.93bn of upcoming construction projects within the year (Ojha, 2019). Most construction companies in Kuwait deliver their projects using Traditional Construction Management (TCM) approach (Soliman, 2017). Following TCM approach, many projects exceeded their deadline by 100% and their budget (Kartam, Al-Daihani and Al-Bahar, 2000).

Lean Construction Management (LCM) has been introduced to improve productivity in construction industry as a new management approach (Kim and Park, 2006). Although lean theory was introduced in 1992, its implementation has been slow (LCI, 2019). Lean Construction Institute currently has 220 members (including corporate members, contractors, subcontractors and consultants) (LCI, 2019), this is a tiny fraction of the number of construction companies worldwide. The understanding parties of LCM concept have faced difficulty in its implementation (Monyane et al., 2019).

1.1 Aims and Objectives

This dissertation aimed to assess the effectiveness of the implementation of LCM in Kuwait's Oil and Gas construction industry. The objectives to satisfy this aim were as follows:

1. Identify the challenges faced during lean implementation and strategies to overcome them.
2. Assess the attitude and comprehension toward lean ideas within various hierarchies within the organisation.
3. Compare the performance of construction companies using LCM against TCM.

2 REVIEW OF LITERATURE

2.1 Lean Production History

Krafcik (1988) defined lean production as a strategy that allows minimal amount of resources to be involved in manufacturing. Engineers of Toyota Auto Company developed Toyota Production System (TPS) for minimal inventory and waste to ensure customer satisfaction and perfection. Ohno and Shingo defined waste (Muda) as follows (Womack and Jones, 1996):

- Defects in products
- Overproduction of goods
- Inventories of goods awaiting further processing or consumption
- Unnecessary processing
- Unnecessary movement of people
- Unnecessary transport of goods
- Time spent waiting by employees or process equipment to finish work or an upstream activity to be completed

Figure 1 shows a visual representation of critical elements of TPS. TPS 'house' has been represented this way to show that the system is as secure as its weakest part of the system (Fritze, 2016). The roof represents goals of TPS, pillars in the middle indicates core activities of the system, and the bottom shows the foundation of the house (Liker, 2004).

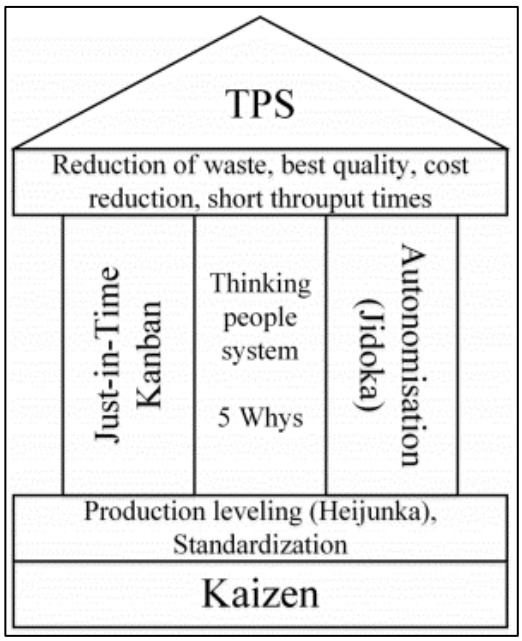


Figure 1 - TPS Elements (Fritze, 2016)

2.2 Lean Principles

Lean approach was developed using two methods; decreasing inventory to minimal aspect; and considering a pull-type production system (MacCarthy, 2006). Lean ideas are focused on meeting requirements of customers by delivering products as soon as possible, maintaining minimal inventory (JIT) and removing waste from work processes. Principles of lean thinking are shown in **Figure 2**.

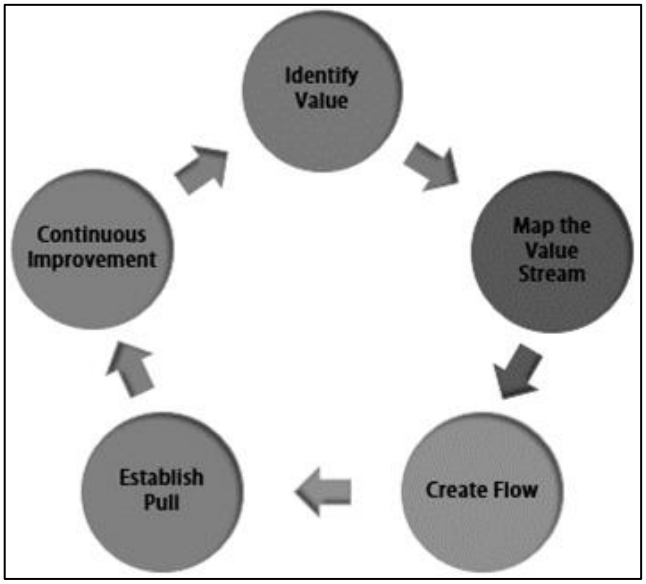


Figure 2 - Principles of Lean adapted from (Shmula, 2019)

2.3 LCM Concept

The definition of LCM is 'LCM extends from the objectives of a Lean production system maximise value and minimise waste to specific techniques and applies them in a new project delivery process' (Marhani et al.,2012). LCM is a production management-based project delivery system emphasising the reliable and speedy delivery of value. **Table 1** shows the key differences between LCM and TCM.

Table 1 - Traditional vs Lean (Abdelhamid and Salem, 2005)

	TCM	**LCM**
Control	Monitoring against schedule and budget projections	Causing events to conform to plan – steering
Optimisation	Specific activity	Entire project
Scheduling Viewpoint	Push Work Schedule Based on emphasis of start dates of activities	Pull work schedule Based on when its completion required of the successor of activity
Production System	Conversion Production System	Flow Production System
Production Process	Efficiency	Effectiveness
Performance Measurement	Work Base Schedule, Critical Path Method, Earned Value	Percent Plan Complete (PPC)
Customer Satisfaction	Owner or final customer satisfaction	Successor process satisfaction
Planning	Knowing	Learning
Uncertainty	External	Internal

Coordination	Following Orders	Keeping a promise
Goal of Supervision	Point Speed and Productivity	Reduce variation & Manage Flow

2.4 Essential Lean Tools

5S - 5S is an organisational method for the workplace to improve efficiency (Kobayashi et al. 2008). It uses 5 Japanese steps; Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardise) and Shitsuke (Sustain). **Table 2** provides the Japanese context in the working environment.

Table 2 - 5S adapted from (Kobayashi et al. 2008).

Japanese Term	English Equivalent	Meaning in Japanese Context
Seiri	Sort	Remove unnecessary items or processes in the workplace for production or operations.
Seiton	Set in order	Arrange the remaining items in the workplace to be accessible and labelled.
Seiso	Shine	Sweep and clean the workplace.
Seiketsu	Standardise	Process of documenting the improvements made in the workplace.
Shitsuke	Sustain	Ensure the self-discipline of the workers sustains the 5S approach

Kaizen - Kaizen is a Japanese term for 'change for better' (Wittenberg, 1994). The philosophy behind Kaizen is that continual small positive changes lead to major improvements. Kaizen could be done using Kaizen Events or Kaizen Blitz. These are projects that address an issue over the course of a week by utilising available resources to gain rapid results. The results will be significant and will promote enthusiasm for further improvement and satisfaction.

Kanban - Kanban is a Japanese term for 'Signboard' or 'Billboard' which refers to signalling. (Gross, 2003). It is a visual management method of following processes. It is used to improve flow, reduce lead-time, deliver value to customers faster and to improve predictability and quality. Kanban system utilises visual cues that show what products need to be produced, how much needs to be produced, and when it is needed. It is effectively utilised using Kanban board, which shows four columns that represents backlog of processes needed to be completed, to-do activities, ongoing activities and completed activities.

Six Sigma - This is a framework used to improve customer experience and eliminate waste. (Apte, 2006). The framework could be implemented using DMAIC. DMAIC stands for Design, Measure, Analyse, Improvement and Control. Design phase identifies problems, sets goals and evaluates available tools and resources. Measurement phase measures the performance of processes, which helps understand

what exactly needs to be improved. Analysis phase analyses the root problems of processes. Improvement phase brainstorms for solutions and places a plan for improvement of processes. The most critical phase, Control phase, is the process for creating the system to control process performance.

Value Stream Mapping (VSM) - VSM is a process improvement technique to understand value-added and non-value-added activities by reviewing information and resources passed on the value stream (Seth and Gupta, 2005). VSM has shown to improve process visibility and reduce inventory and lead time. It presents a graphical overview of the flow of materials and information in the process. VSM methodology for improvement of processes can be followed in 5 steps shown in **Figure 3**.

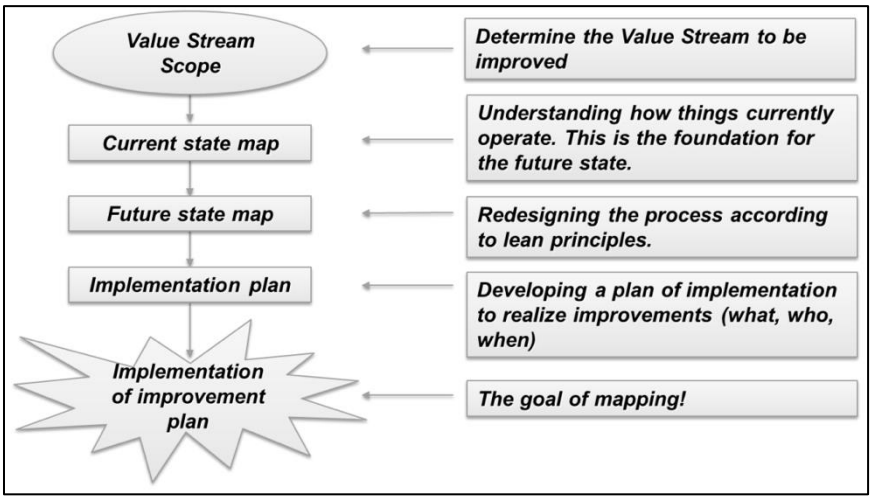


Figure 3 - VSM Methodology (Langstrand, 2016)

3 METHODOLOGY

3.1 Research Structure

The objectives were studied by collecting primary and secondary information. Primary information was collected through interviews and questionnaires, while secondary information was collected from scholarly books and articles. **Figure 4** displays a visual representation of the research structure.

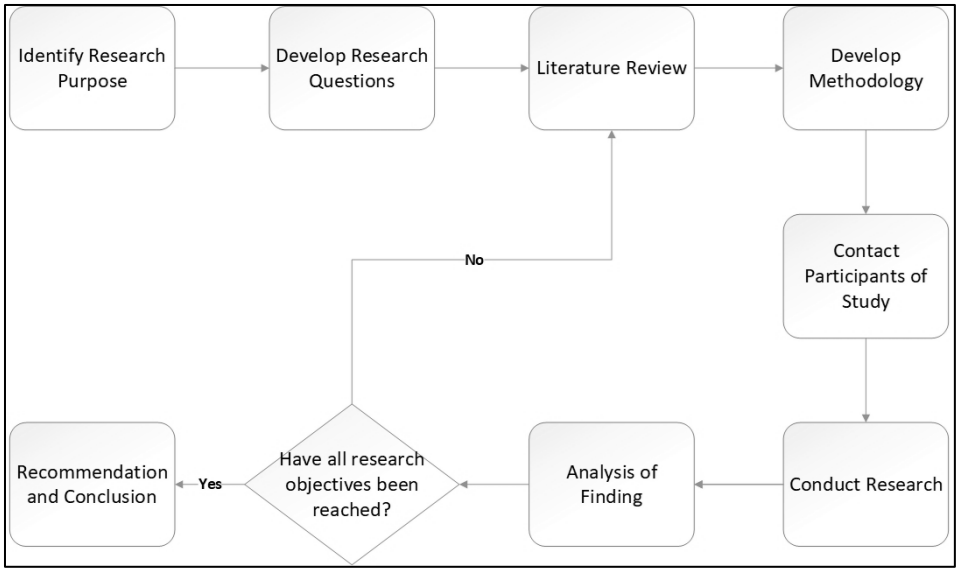


Figure 4 - Research Structure

3.2 Target Companies

The target companies for the study were Oil and Gas related construction companies that were based in Kuwait. Snowball (Goodman, 1961) and random sampling (Cohen et al. 2000) approach were used for selection. **Table 3** shows the list of construction companies who participated; however, their names are not included for confidentiality reasons.

Company	Knows the Concept of LCM	Uses Concepts of LCM	Uses LCM by Certified Authority
Company A	No	No	No
Company B	Yes	No	No
Company C	Yes	No	No
Company D	Yes	Yes	No
Company E	Yes	Yes	Yes

Table 3 - List of companies and their management style

3.3 Interviews - 1st study

Qualitative data could be gained from many approaches such as interviews, questionnaires, observations and tests. The data collection methodology chosen for the

first two objectives was interviews. This was ideal as it allowed an in-depth understanding, exposure to opinions and experiences of participants in the study (Legard et al., 2003). A semi-structured interview style with open-ended questions, which allowed follow-up on questions, was used. Five respondents from each organisation with varied positions within the hierarchy were selected. **Table 4** indicates the list of participants who took part in interviews and their positions during the study. Questions asked were aimed to help understand their knowledge of LCM, methodology of implementation and the difficulties faced during implementation. This study took a thematic analysis approach (Boyatzis, 1998) using a software called NVivo 12.

Table 4 - List of participants and their position

Participant No	Company	Position
P1	Company D	Executive Vice President
P2	Company D	Project Manager
P3	Company E	General Manager
P4	Company E	Lean Leader

3.4 **Questionnaire**

Objective 3 was studied using quantitative analysis by questionnaires. Questionnaires were ideal for this study as participants of the study were remote and responses could be received quicker than other methods, such as observations, interviews and tests. To analyse project performance, four Key Performance Indicators (KPI's) were identified: time, cost, job satisfaction and health & safety (Ali and Rahmat, 2010). To gain a straightforward and objective analysis, the questionnaire was structured with closed-ended questions that could be answered with rating scales of 1 to 5, where 1 express 'very low' and 5 expressing 'very high'. The questionnaire was developed using 'Google Forms' and was sent to the participant's preferred means of contact. Once completed, data was imported to Excel for statistical analysis that converted numerical data to tables and graphs (Teddlie & Tashakkori, 2009). The list of questions sent of the first study questionnaire can be seen in Appendix **7.3**.

3.4.1 Challenges faced with data gathering.

Post-analysis of the questionnaire's results showed that initial study of the third objective had been inconclusive. This was due to two reasons:

1. The questionnaire was structured for both LCM and TCM companies, and so respondents who were members of TCM companies could have misinterpreted the questions that were directed to participants in the LCM companies, which resulted in responses outside the level of their expertise. The complete responses of the first study questionnaire are presented in **Appendix 7.7**.
2. Although the University's ethical procedure was followed, respondents perceived too much risk due to sensitivity of the topic. This resulted in respondents not feeling comfortable answering questions. Additionally, majority of respondents

advised that they would answer questions but would not sign the information and consent form to permit usage of their data. This could be due to the deeply rooted 'Wasta' culture that is perceived by respondents in Kuwait. Abrar Al-Enzi (2017) stated that 'Wasta', an Arabic word for the use of one's social or personal connections or influence to accomplish things, plays a significant influence not just in knowledge sharing, but also human resource management, innovation and organisational commitment.

3.4.2 Second Study Questionnaire

A second study was hence deemed necessary and was formulated to answer the 3rd hypothesis. The updated questionnaire first identified what style of management the company practiced, i.e. whether they are TCM, LCM company or a TCM company that utilises certain lean principles. Sudman and Bradburn (2004) suggested that sensitive questions could be approached easier with open-ended questions rather than closed questions and so the revised approach was developed with a mix of closed-ended and open-ended questions, giving it a semi-structured format. The list of questions sent from the second study questionnaire could be seen in Appendix **7.4.**

To gain sufficient respondents, Abrar Al-Enzi (2017) suggested that a favour, which in this case was to complete questionnaires, would be more likely achieved through approaching the right individual (the Wasta provider). Therefore identifying the Wasta provider was essential to pass the questionnaire to relevant members of the organisation. Additionally, the questionnaire was posted in professional social media platforms and on some Kuwaiti Online forums to gain further respondents.

4 RESULTS, ANALYSIS AND DISCUSSION

4.1 Objective 1 – Critical Success Factors for Implementation

To discuss critical success factors for the implementation of LCM, participants were asked about challenges they faced during the implementation and what was done to overcome those challenges. All four participants were asked this; however, P2 did not provide any information in response. **Figure 5** shows the challenges that were discussed by them.

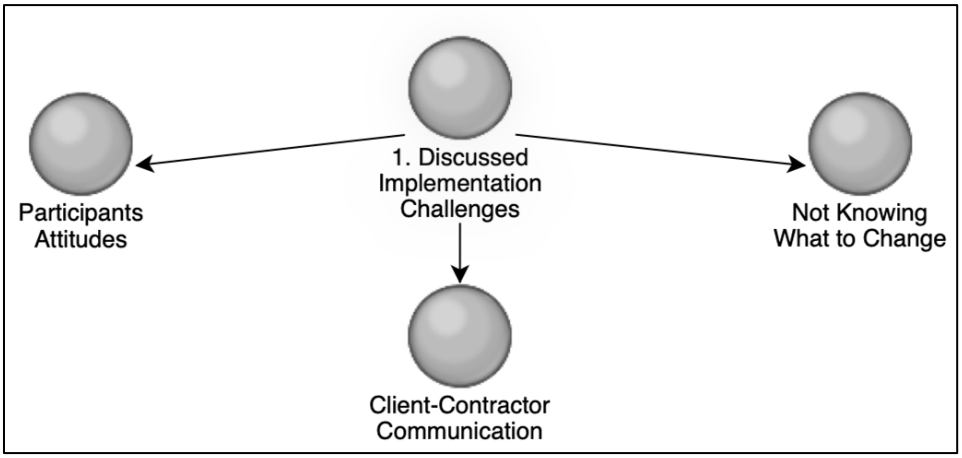


Figure 5 – Initial Challenges Discussed with Participants

P1 from Company D stated two main barriers that were faced during implementation of LCM. First challenge was the negative mind-set of employees during implementation. P1 gave four strategies to overcome this. First was that employees had to understand the need for change. Second was to set goals to motivate employees. Third was to make incremental changes as employees would be more susceptible to change as well as to measure its performance. Last was to have patience, as implementation cannot just be rolled out overnight.
The second challenge faced was communication between client and contractor and to overcome the barrier, P1 suggested that specifications of details and tools needed in the contract would help deliver the project at desired quality of clients.

P3 and P4 from Company E also mentioned that there was a negative mindset from the experienced employees. They gave six strategies to overcome the barrier. First was that employees have to understand the need for change. Second solution was to make incremental changes. Third resolution was to have patience for implementation. Fourth was to include top-down management involvement, which will then help other employees to take part in change. Fifth was to utilise change management to ensure that change had been standardised. The last was to adopt lean within daily routine. The second challenge was that they didn't know what processes needed to be changed. To resolve this challenge, the company brought an external consultant to identify processes, gain appropriate documentation for showing personnel the need for change, and train company members as per lean culture.

4.1.1 Objective 1 Discussion

Although the participants had mentioned that there were three challenges faced during the implementation, the analysis process (Appendix **7.6)** identified five challenges.

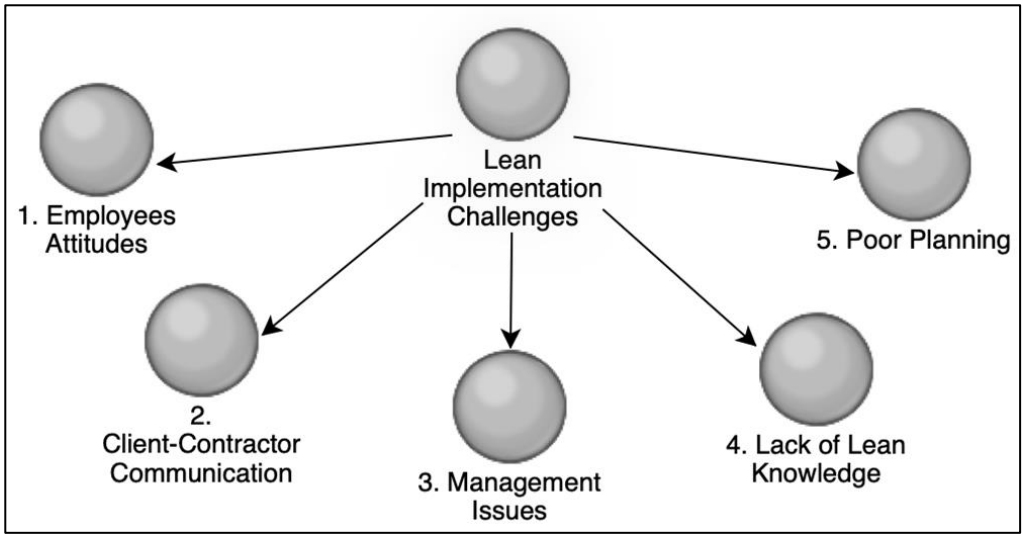


Figure 6 - LCM Challenges Post-Analysis

As shown in **Figure 6**, the challenge 'not knowing what to change' was due to the company E's lack of lean expertise, which had been overcome by hiring the external consultant to assess the company's non-value processes and to identify the needed change. Poor planning barrier was recognised when discussing with P4 about lean tools that were utilised in projects and office. The strategy to overcome 'poor planning' could be achieved by utilising effective planning systems. Company E had overcome poor planning by developing a planning tool called 5R.

The strategies *'adopting change management, making incremental changes and utilising a top-down management approach'* which had initially been for overcoming the 'negative attitude of the employees', had been re-evaluated to be placed into the challenge 'management issues' as only higher-level management staff could utilise these strategies. A potential explanation that participants had not identified this challenge could be due to participants themselves being higher-level management. Further research had showed that 'Negative Attitudes' and 'Management Issues' were prevalent challenges that were faced in the UK for implementation of LCM (Bashir et al., 2015). Bashir had also mentioned that the government and finance available could be a challenge during implementation.

4.2 Objective 2 – Variance of Understanding within Hierarchy

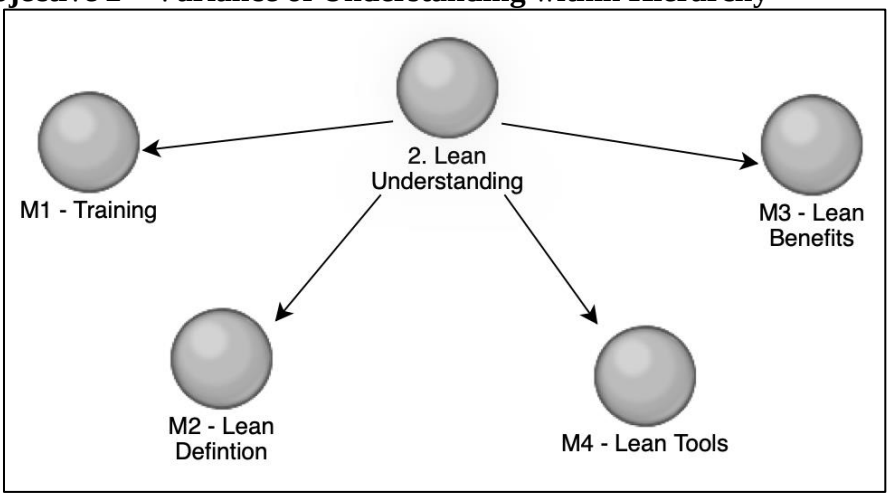


Figure 7 – Lean Characteristics Discussed

As shown in **Figure 7**, there were four themes during the interview to help understand the level of lean understanding.

4.2.1 Company D's Participants Understanding of Lean

Training – Both Participants had no training on LCM, however P1 stated that human resources division has been developing a training programme to effectively utilise lean tools such as Waste Identification, Internal Benchmarking, Quality Management and Continuous Improvement Cycles, all of which are characteristics of Kaizen.

Definition – P1 stated the definition of LCM as "LCM is the implementation of certain procedures or processes to help achieve value or maximise value in an organisation". P2 stated the definition as "It could be something related to the effective utilisation of time and the programme". It could be seen that participant 1 had a better understanding of LCM definition.

Lean Benefits – P1 gave the benefits as "reduced costs, increased motivation, optimised processes and safer environment, all of which would manifest in terms of higher value". P2 stated benefits as 'the effective utilisation of available facilities'. Again, P1 had given a more valid response when asked for benefits, whereas P2 had given an ambiguous response. Although it should be noted that the statement could be challenged as P2 had stated some benefits when asked for the definition of LCM.

Lean Tools – P1 mentioned many utilised tools. The first was concurrent engineering, where different stages of the project will be run simultaneously and also in hiring multitask and responsible personnel for at least two disciplines. Second was the modularisation of equipment, where it will be fabricated in a controlled environment rather than on site. Third was implementing lessons learnt from previous projects, which is a part of a lean principle to pursue perfection. Fourth tool was quality management in terms of picking vendors and maintaining quality of fabricated materials. The last two were setting KPI's and benchmarking. P2 stated that the company only looks at identifying waste in terms of lean tools that were utilised in the

company. Further discussion showed that P2 had utilised previously stated tools in projects; however, the participant could not recognise that they were lean tools.

4.2.2 Company E's Participants level of Understanding

Training – P3 stated that 'the lean training, developed by a consultant, was initially given to key management and the lean company leaders who then trained lower-level employees. The training is not the same for every employee, as every employee has a different role in the organisation. The blue collared workforce focused on how to use the tool, while managers and supervisors focused on lean tools necessary for delivery of the project, higher-level managers focused on effective analysis of monthly reports and how to motivate employees'. P3 also said that it was necessary to give different levels of training to different personnel 'as most of them will not understand it while costing a lot and taking much time'. P4 also had given a similar statement to P3 but also focused on the time taken for each level of training and the training for the maintenance of the improvements made in Kaizen events. Both P3 and P4 showed a high level of understanding in lean training; however, P4 showed more in-depth understanding. This could be due to P4's responsibility for training other lower-level employees in the company.

Definition – Both P3 and P4 had shown same level of understanding as they both gave the same definition which was "LCM is the process that helps to identify and eliminate waste in processes and in the workplace".

Lean Benefits – P3 had stated following benefits; improvement in productivity which relates to hourly labour cost; Gained popularity from several significant clients as the salvager of failing projects; gained many appraisals from clients who stated that the projects had been delivered in an innovative and professional manner; higher weight when bidding on projects; many projects delivered at an earlier time than expected by clients; positive change in company culture; contracted workforces who had previous lean training from the company would be more likely to be hired than new employees. P4 had given the following benefits; reduced time; reduced cost; improved quality; improved safety; positive personnel mindset; increased stakeholder involvement in planning which leads to team responsibility; multiple risk resolutions; increased transparency on construction site. The benefits P3 had stated related more towards the clients, which could be due to higher contact time with clients than P4. P4's benefits were related in terms of the organisation and on-site, which could be related to the higher involvement with other employees in office and on-site. Both P3 and P4 had shown an adequate amount of understanding in how LCM had benefited their roles in the organisation

Lean Tools – Lean tools P3 had stated were VSM to identify useful activities and non-value adding activities, waste elimination of non-value added activities, Kaizen Blitz as events for developing new ideas, continuous improvement in terms of the perfecting implemented ideas during Kaizen Blitz, and Kanban in terms of tracking

the status of activities and tasks. P4 had also stated the above tools utilised but also mentioned about 5S, 5R and time & motion study. 5S was the organisational method for improving efficiency in the workplace. 5R was a planning tool their company had developed. The time and motion study looked at the most effective way to operate the tools.

4.2.3 Objective 2 Discussion

Both companies had given statements in terms of the themes discussed; however, analysis showed that there was a variance in the number of instances that the participants had discussed for each theme, which could be seen in **Figure 8**. The coded references refer to the number of examples the participants had discussed the themes in the interview.

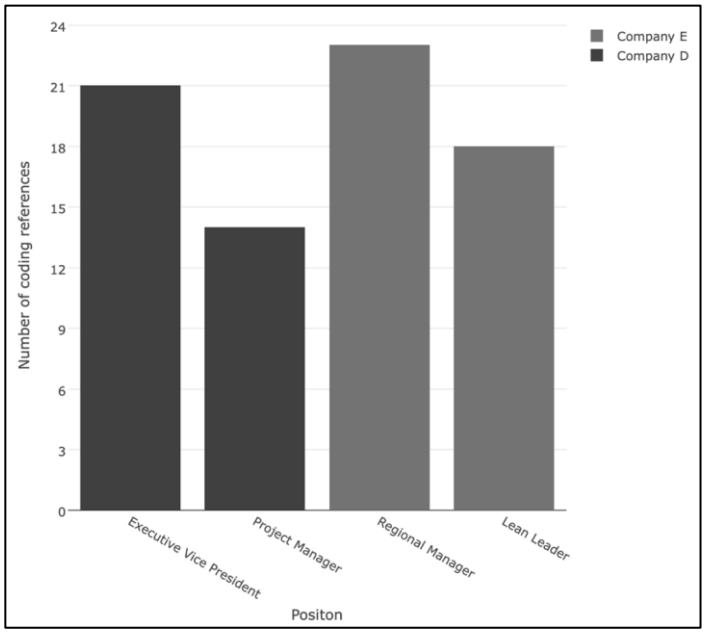


Figure 8 - Graph of Coded References

In terms of quantity of statements provided about LCM, P1 (Executive Vice President of company D) provided a large number of statements in terms of understanding in LCM whereas P2 (Project Manager of Company D) didn't provide as many references. Company E participants also provided ample statements in terms of how they and the company utilise LCM in the organisation, not just for delivery of projects but also in terms of how they utilised lean principles in office for their daily work. In terms of number of statements, P3 (Regional Manager of Company E) had provided a higher amount of statements than P4.

In terms of quality of statements provided during the interview, P1 showed a higher level of understanding when compared to P2. Company E had shown a higher level of understanding in LCM when compared to Company D. Although P3 had provided more statements than P4, both participants showed an equivalent level of understanding in LCM. P3's level of understanding in LCM was focused on lower-level management, such as project managers, supervisors and blue-collar labour. P4's

level of understanding was based on the management position of the organisation. P3 provided significant insight for this objective as the participant had stated *"the level of lean understanding differs within the different levels of the hierarchy of the organisation as it is necessary. Had all personnel been trained with the same level of understanding for LCM, it would be ineffective as personnel such as the labourers would not need the extent of the management's understanding of lean as they would not require it as well as the training for it would take much more time as well as money".*

4.3 Objective 3 – Comparison of Project Delivery Performance

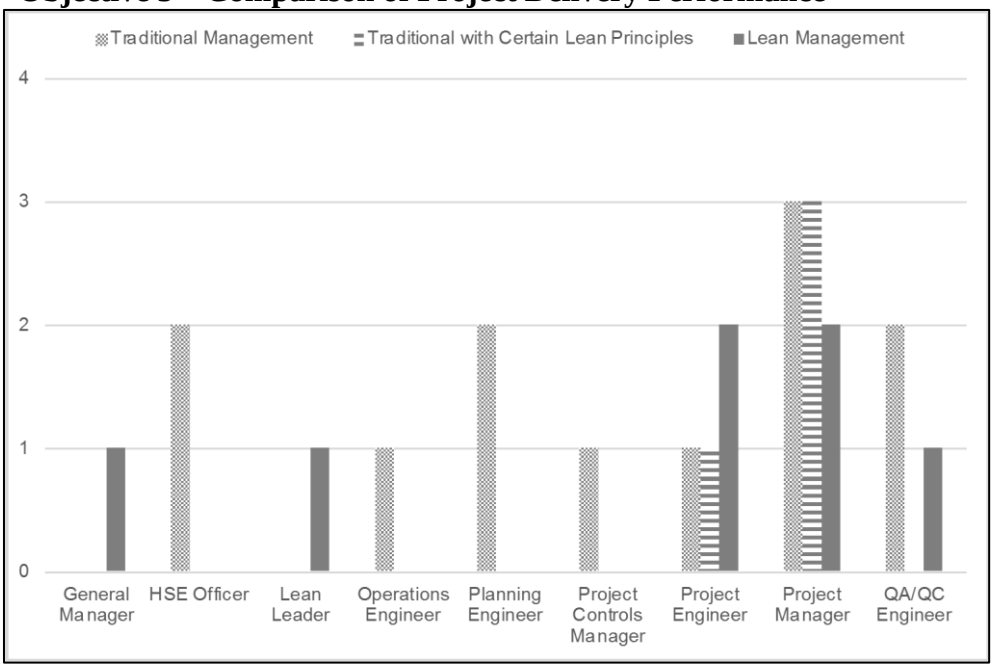


Figure 9 - Roles of Respondents

To measure the delivered projects' performance for each management style, participants were asked about four KPI's, which were time, cost, job satisfaction and the health and safety. Second study questionnaire gained 25 responses. The respondents were first asked about the management style of their company. Participants provided three different responses in terms of the management style. A total of twelve respondents had stated that their company's management style was with TCM. Seven respondents had stated that their company used LCM. Four respondents had stated that their company was a TCM company but utilised certain lean principles (TWL). The complete processed response from the second study could be seen in Appendix **7.8**. **Figure 9** illustrates the role of the respondents during delivery of the project.

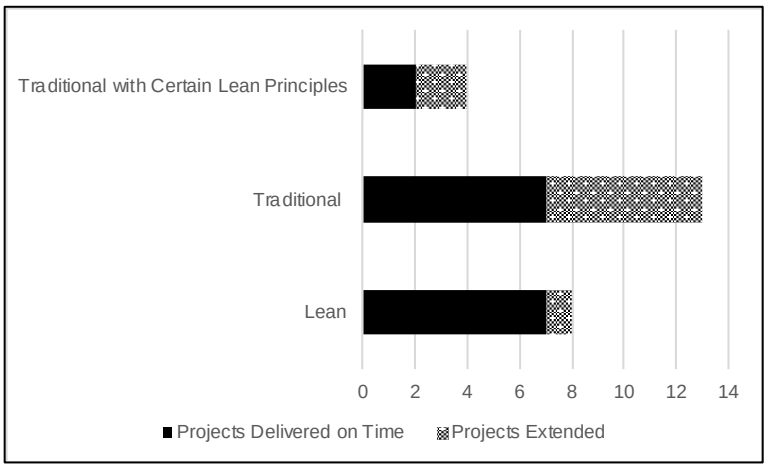


Figure 10 - Time Performance Comparison

The time performance was measured by studying number of projects that were delayed. **Figure 10** illustrates the number of projects that had been delivered on time versus number of projects that had been delayed. 13% of LCM respondents had stated that the project had been extended, 46% of TM respondents had stated that the project had been delayed and 50% of TWL respondents had stated that their project had been delayed.

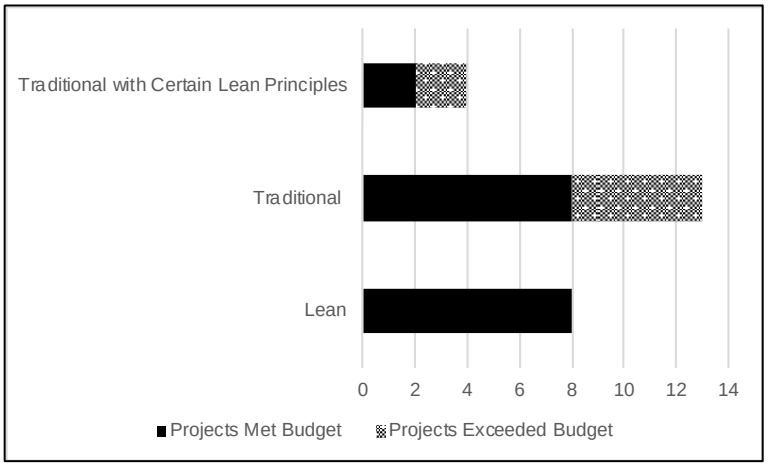


Figure 11 - Cost Performance Comparison

The cost performance was measured by studying number of projects that exceeded the budget and additional cost needed to deliver the project. **Figure 11** illustrates the number of projects that had met budget versus number of projects that exceeded the budget. 100% of LCM respondents had stated that the project budget had not been exceeded, 38% of TM respondents had stated that the project budget had been exceeded and 50% TWL respondents had stated that their project budget had been exceeded.

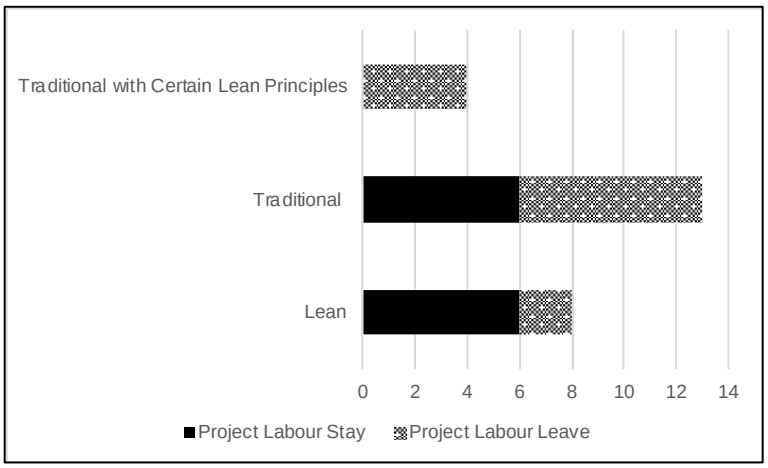


Figure 12 - Job Satisfaction Comparison

The employee turnover rate was measured using equation 1 to measure the job satisfaction performance indicator. **Figure 12** illustrates the number of projects that had employees' leave during the project versus the number of projects that did not leave. 25% of LCM respondents had stated that employees had left during the project with an average turnover of 1.3%, 54% of TM respondents had stated that employees had left during the project with an average turnover of 6.4% and 100% of TWL respondents had stated that employees had left with an average turnover of 9.4%.

$$Employee\ Turnover\ Ratio = \frac{Number\ of\ Employee's\ Left}{Total\ Employees\ in\ Project} \quad (1)$$

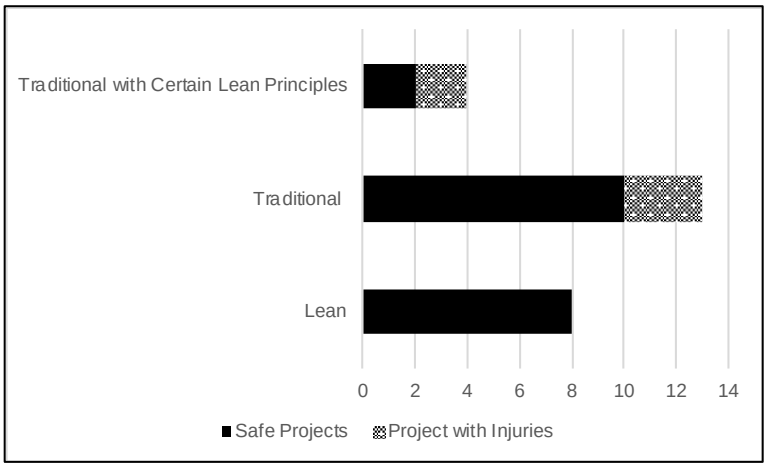


Figure 13 - Health and Safety Comparison

The number of injured staff instances was used to measure health and safety. **Figure 13** illustrates the number of projects that had no injuries versus number of projects that had injuries. 0% of LCM respondents had stated that there were injuries in the projects delivered with an average of 188 employed staff, 23% of TM respondents had stated that there were injuries in the projects with an average of 15 staff injured out of an average of 802 employed staff and 50% of TWL respondents had stated that there

were injuries in projects with an average of 28 injuries out of an average of 680 employed staff.

4.3.1 Objective 3 Discussion

The lean practising participants had consistently shown to be having better performance in terms of all the KPI's measured. Traditional Companies that utilised lean tools had more reduced performance when compared to both lean and traditional management style companies. This could be due to poor planning and ineffectively utilised lean tools. The evidence of the results shows that LCM has a higher performance when delivering projects.

5 CONCLUSION

The first two objectives, which initially aimed to study 20 participants, had not reached the theoretical saturation point as most participants did not wish to sign the I&C form. This was found to be due to a cultural barrier known as the Wasta culture in Kuwait. The expert roles of the four participants who signed to participate in the first study should justify the validity of the response and analysis of the first two objectives. Challenges faced during implementation of LCM had been identified as negative attitudes of employees, poor client-contractor communication, lack of lean knowledge and management issues. Lean knowledge in levels of the hierarchy had shown to be different as Company D's P1 had shown a higher level of understanding when compared to P2. In terms of Company E, P3's understanding of LCM had shown to be more relative towards higher management whereas P4's level of understanding was towards more for delivery of projects and training employees. The third objective showed that LCM construction companies showed a better performance in delivering projects and that if companies have not effectively utilised lean tools, it will result in more reduced performance than TCM and LCM companies. Findings in the study will help practitioners understand the need to develop LCM practices as it provides higher performance than traditional management and shows challenges faced during implementation of LCM in Kuwaiti oil and gas industry and strategies needed to overcome them. The paper also shows the need to train practitioners only in their relative role as it would be ineffective and costly to educate them about the whole LCM practice.

5.1 FUTURE WORK

As the Wasta barrier in the Kuwaiti culture of had been recognised in, further research could be looked on to the implementation of the LCM in other Kuwaiti industries such as real estate construction industry or other construction-related industries. Furthermore, some of the strategies had not explicitly focused on each challenge, and so further research could be looked on to providing solid proof for placing strategies for the specified challenges.

6 REFERENCES

Abdelhamid, T. and Salem, S. (2005). Lean Construction: A New Paradigm for Managing Construction Projects. *International Workshop on Innovations in Materials and Design of Civil Infrastructure*.

Ali, A. and Rahmat, I. (2010). The performance measurement of construction projects managed by ISO-certified contractors in Malaysia. Journal of Retail & Leisure Property, 9(1).

Apte, U. and Kang, K., 2006. Lean six sigma for reduced cycle costs and improved readiness (No. NPS-GSBPP-06-019). NAVAL POSTGRADUATE SCHOOL MONTEREY CA GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY.

Bajjou, M., Chafi, A. and En-Nadi, A. (2017). The Potential Effectiveness of Lean Construction Tools in Promoting Safety on Construction Sites. *International Journal of Engineering Research in Africa*, 33, pp.179-193.

Ballard, G. and Tommelein, I. (2012). Lean management methods for complex projects. *Engineering Project Organization Journal*, 2(1-2), pp.85-96.

Bashir, A., Suresh, S., Oloke, D., Proverbs, D. and Gameson, R. (2015). Overcoming the Challenges facing Lean Construction Practice in the UK Contracting Organizations. *International Journal of Architecture, Engineering and Construction*, 4(1).

Bertelsen, S. and Simonsen, R. (2012). *Håndbog i Trimmet Byggeri*. 2nd ed. Foreningen Lean Construction-DK.

Boyatzis, R. E. (1998). Transforming Qualitative Information: Thematic Analysis and Code Development. SAGE Publications, Thousand Oaks.

Bradburn, N., Sudman, S. and Wansink, B. (2004). Asking questions: A practical guide to questionnaire design. San Francisco, CA: Jossey-Bass.

Cohen, L., Manion, L. and Morrison, K. (2000). Research methods in education. 5th ed. New York: Routledge.

Davidson, R. (2015). *Last Planner® System - Business Process Standard and Guidelines*. 6th ed. [ebook] LCI Israel. Available at: https://www.leanconstruction.org/media/docs/chapterpdf/israel/Last_Planner_System_Business_Process_Standard_and_Guidelines.pdf [Accessed 9 Aug. 2019].

Fritze, C. (2016). *The Toyota Production System - The Key Elements and the Role of Kaizen within the System.* [online] Available at: https://www.researchgate.net/publication/289519018_The_Toyota_Production_S

ystem_-_The_Key_Elements_and_the_Role_of_Kaizen_within_the_System [Accessed 6 Aug. 2019].

Goodman, L.A., 1961. Snowball sampling. The annals of mathematical statistics, pp.148-170.

Green, S. (2002). *The Human Resource Management Implications Of Lean Construction: Critical Perspectives And Conceptual Chasms*. *Journal of Construction Research*, 03(01), pp.147-165.

Gross, J.M. and McInnis, K.R., 2003. Kanban made simple: demystifying and applying Toyota's legendary manufacturing process. Amacom.

Kartam, N., Al-Daihani, T. and Al-Bahar, J. (2000). Professional project management practices in Kuwait: issues, difficulties and recommendations. *International Journal of Project Management*, 18(4), pp.281-296.

Kim, D. and Park, H. (2006). Innovative construction management method: Assessment of lean construction implementation. *KSCE Journal of Civil Engineering*, [online] 10(6), pp.381-388. Available at: https://link.springer.com/article/10.1007/BF02823976.

Kobayashi, K., Fisher, R. and Gapp, R., 2008. Business improvement strategy or useful tool? Analysis of the application of the 5S concept in Japan, the UK and the US. Total Quality Management, 19(3), pp.245-262.

Krafcik, J.F., 1988. Triumph of the lean production system. MIT Sloan Management Review, 30(1), p.41.

Langstrand, J., 2016. An introduction to value stream mapping and analysis.

LCI (2019). *Members & Sponsors | Lean Construction Institute | Project Delivery*. [online] Lean Construction Institute. Available at: https://www.leanconstruction.org/membership/members-sponsors/ [Accessed 3 Aug. 2019].

Legard, R., Keegan, J., and Ward, K., 2003. In-depth interview. In J. Ritchie and J. Lewis, eds. Qualitative Research Practice: A Guide for Social Science Students and Researchers. Sage Publications, pp. 138-169.

Liker, J. (2004). *The Toyota way*. New York: McGraw-Hill.

Lu, J.C., Yang, T. and Wang, C.Y., 2011. A lean pull system design analysed by value stream mapping and multiple criteria decision-making method under demand uncertainty. International Journal of Computer Integrated Manufacturing, 24(3), pp.211-228.

MacCarthy, B., 2006. Organizational, systems and human issues in production planning, scheduling and control. In Handbook of production scheduling (pp. 59-90). Springer, Boston, MA.

Marhani, M.A., Jaapar, A. and Bari, N.A.A., 2012. Lean Construction: Towards enhancing sustainable construction in Malaysia. Procedia-social and behavioral sciences, 68, pp.87-98.

Monyane, T., Emuze, F., Awuzie, B. and Crafford, G., 2019, July. Challenges to Lean Construction Implementation in South Africa. In Construction Industry Development Board Postgraduate Research Conference (pp. 337-344). Springer, Cham.

Ojha, A. (2019). *Kuwait construction projects valued at $494bn in Q2 2019*. [online] Construction Week Online Middle East. Available at: https://www.constructionweekonline.com/projects-tenders/255680-kuwait-construction-projects-valued-at-494bn-in-q2-2019 [Accessed 3 Aug. 2019].

Rand, G., Womack, J. and Jones, D. (1997). Lean Thinking-Banish Waste and Create Wealth in Your Corporation. *The Journal of the Operational Research Society*, 48(11), p.1148.

Saunders, M., Lewis, P., and Thornhill, A., 2009. Research methods for business students, 5th ed. Harlow, England, U.K: Prentice Hall.

Seth, D. and Gupta, V., 2005. Application of value stream mapping for lean operations and cycle time reduction: an Indian case study. Production Planning & Control, 16(1), pp.44-59.

Shmula. (2019). 5 Principles of Lean Thinking. [online] Available at: https://www.shmula.com/28583-2/28583/ [Accessed 18 Jul. 2019].

Soliman, E. (2017). Recommendations to Mitigate Delay Causes in Kuwait Construction Projects. *American Journal of Civil Engineering and Architecture*, 5(6), pp.253-262.

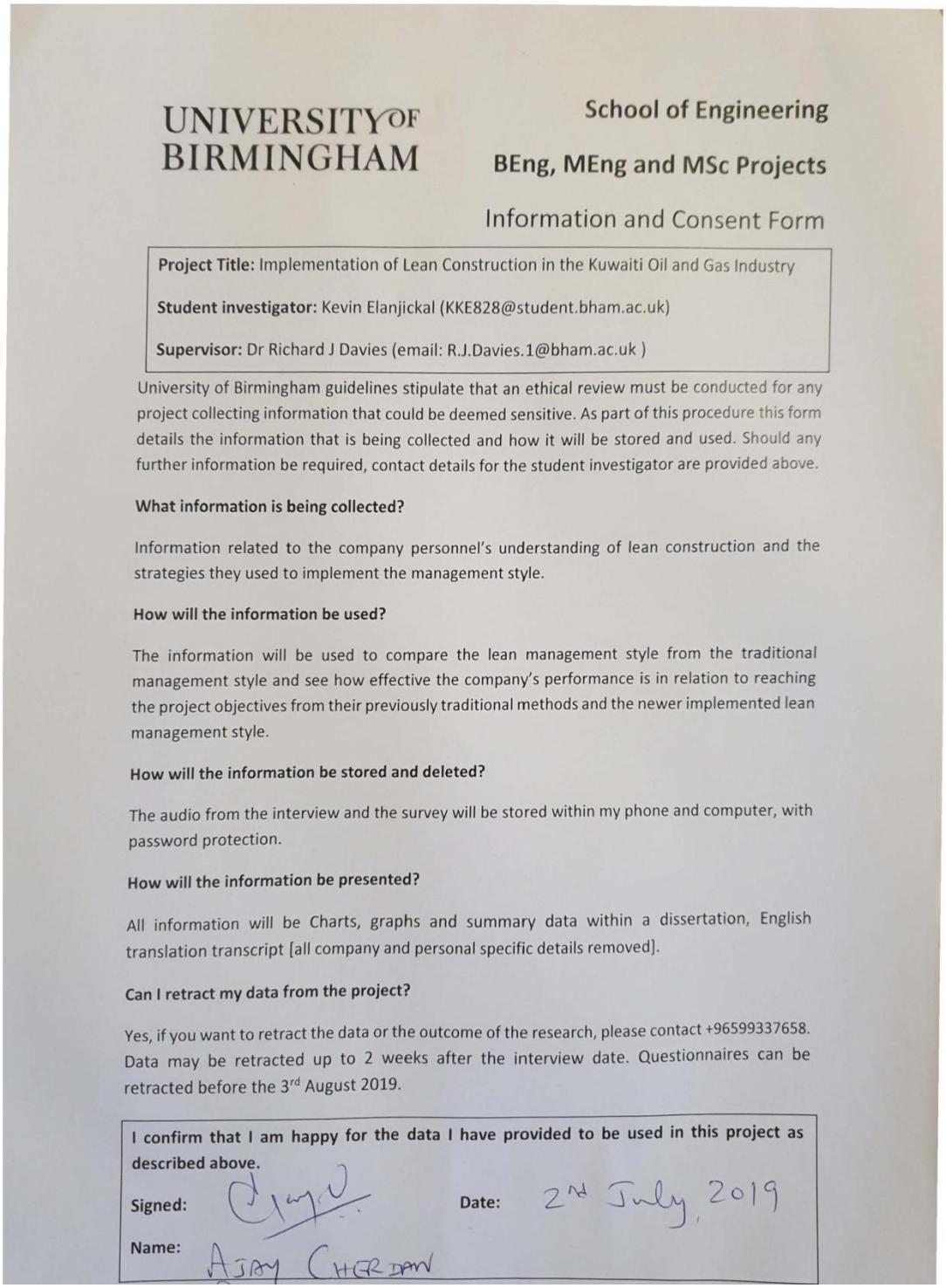
Teddlie, C., and Tashakkori, A., 2009. Foundations of mixed methods research: integrating quantitative and qualitative approaches in the social and behavioral sciences. Los Angeles: Sage Publications.

Wittenberg, G., 1994. Kaizen—The many ways of getting better. Assembly Automation, 14(4), pp.12-17.

7 APPENDIX

7.1 First Study Participant Consent

Participant 1 Sign



UNIVERSITY OF BIRMINGHAM

School of Engineering

BEng, MEng and MSc Projects

Information and Consent Form

Project Title: Implementation of Lean Construction in the Kuwaiti Oil and Gas Industry

Student investigator: Kevin Elanjickal (KKE828@student.bham.ac.uk)

Supervisor: Dr Richard J Davies (email: R.J.Davies.1@bham.ac.uk)

University of Birmingham guidelines stipulate that an ethical review must be conducted for any project collecting information that could be deemed sensitive. As part of this procedure this form details the information that is being collected and how it will be stored and used. Should any further information be required, contact details for the student investigator are provided above.

What information is being collected?

Information related to the company personnel's understanding of lean construction and the strategies they used to implement the management style.

How will the information be used?

The information will be used to compare the lean management style from the traditional management style and see how effective the company's performance is in relation to reaching the project objectives from their previously traditional methods and the newer implemented lean management style.

How will the information be stored and deleted?

The audio from the interview and the survey will be stored within my phone and computer, with password protection.

How will the information be presented?

All information will be Charts, graphs and summary data within a dissertation, English translation transcript [all company and personal specific details removed].

Can I retract my data from the project?

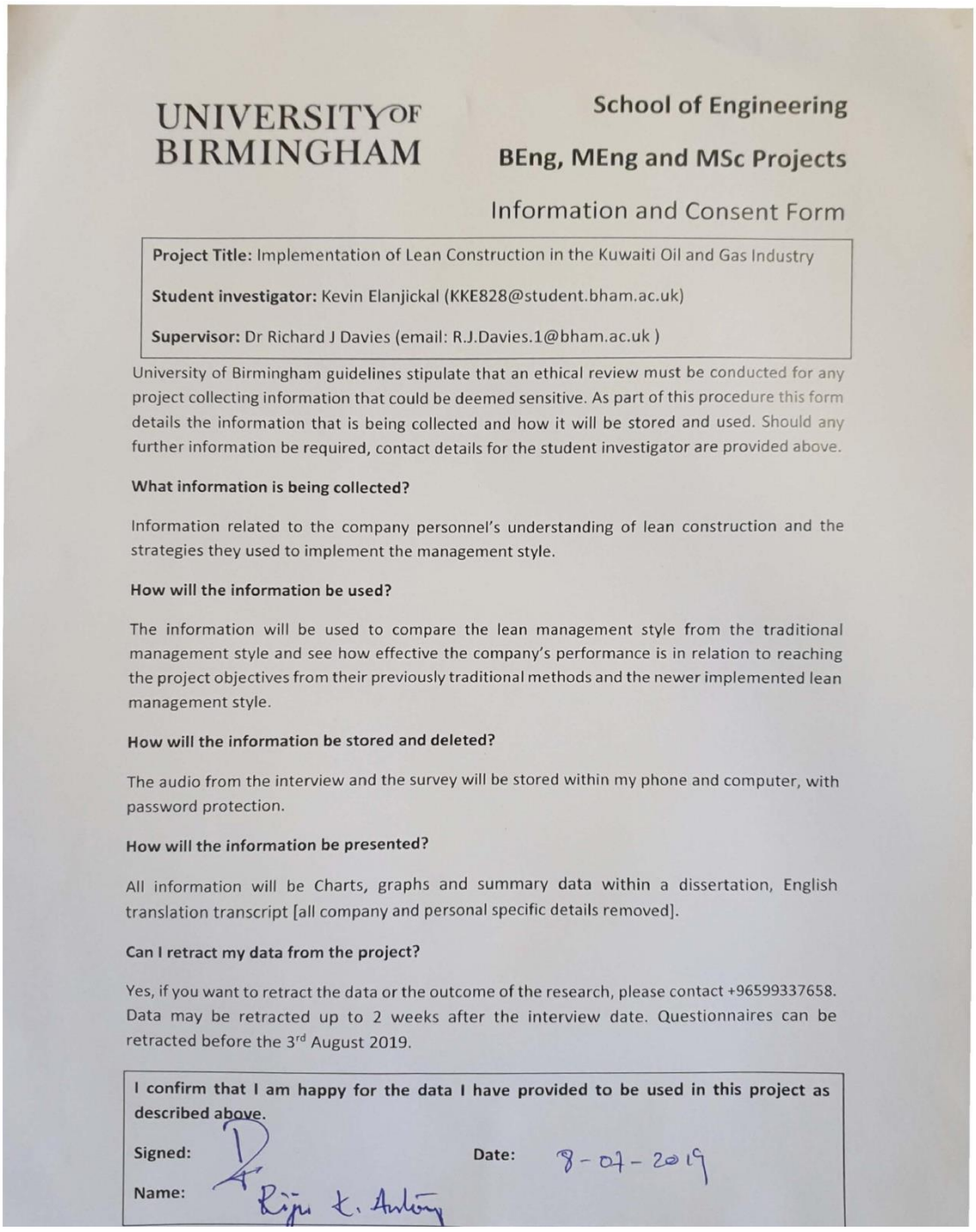
Yes, if you want to retract the data or the outcome of the research, please contact +96599337658. Data may be retracted up to 2 weeks after the interview date. Questionnaires can be retracted before the 3rd August 2019.

I confirm that I am happy for the data I have provided to be used in this project as described above.

Signed: [signature] **Date:** 2nd July 2019

Name: AJAY CHERIAN

Participant 2 Sign



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Signed: **Date:** 8-07-2019

Name: Riju K. Antony

Participant 3 Sign

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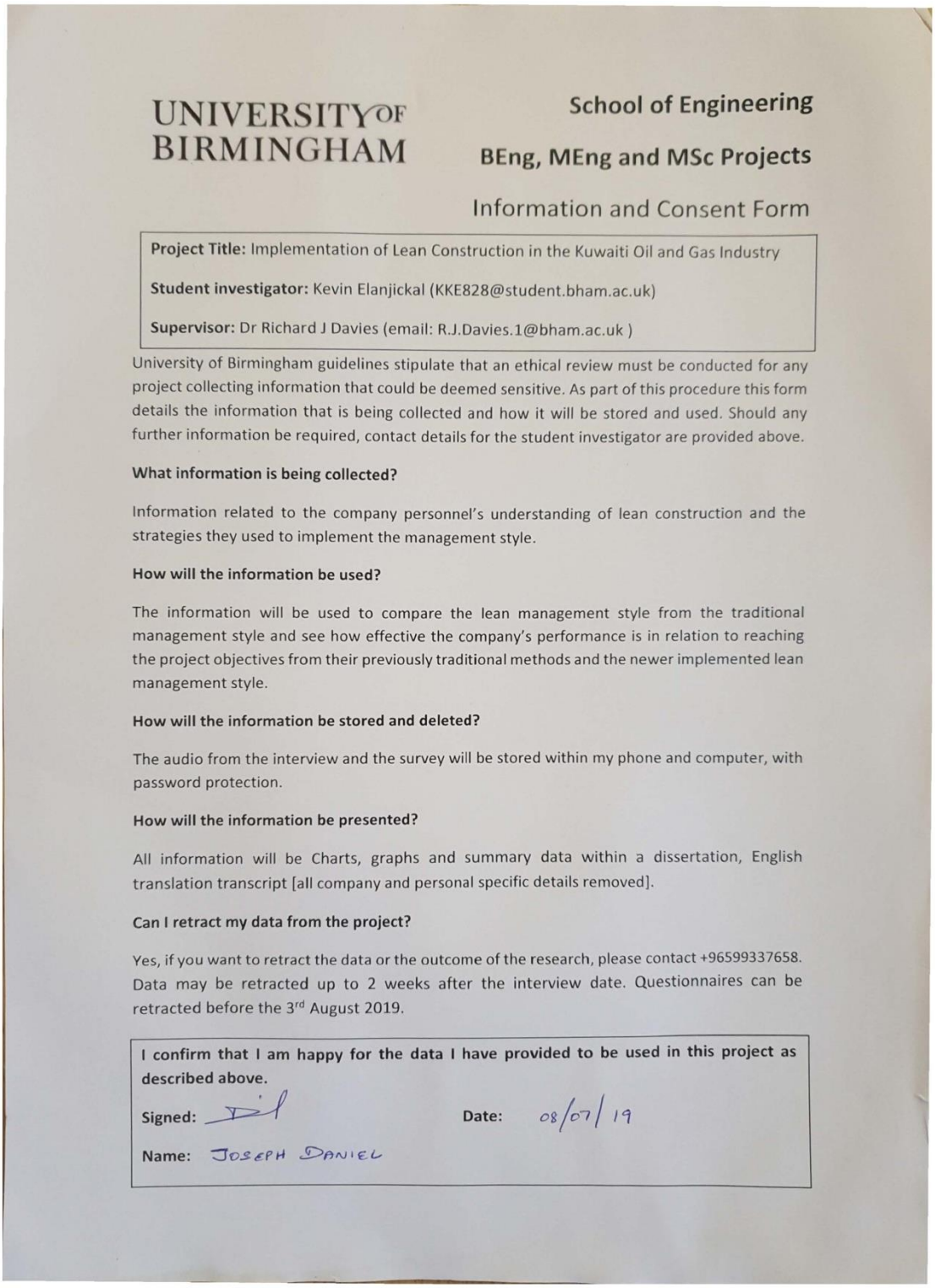
I confirm that I am happy for the data I have provided to be used in this project as described above.

Signed: [signature] **Date:** 08/02/19

Name: R. Anwar

Participant 4 Sign



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I confirm that I am happy for the data I have provided to be used in this project as described above.

Signed: [signature] **Date:** 08/07/19

Name: JOSEPH DANIEL

7.2 **Interview Questions**

The participants will be asked questions such as:

- Could you state your position within the organisation itself?

- What would you define lean management as?
- What do you think about lean construction?
- Have you had any training in lean management?
- Do you have any experience with lean construction?
- What is the major difference perceived between traditional construction and lean construction?
- What would you say were the barriers when implementing lean management?
- What would you say are the key success factors for implementing lean principles?
- What are the benefits and falls in implementing lean construction?
- What would you say was the biggest difference from the traditional management style and the new implemented lean management style?
- Does the company have any lean accreditations?
- Do you think there are any problems with your current management style within the organisation that lean may actually overcome?
- What opportunities have you guys identified with the implementation of lean?
- Have you heard of the last planner system?
- What are the opportunities for improvement in lean construction?
- Do you have any other comments related to lean construction?

7.3 First Study Questionnaire Questions

The participants were provided the following questions in the questionnaires in which each question had to be answered on a scale of 1 to 5, where 1 express ‘very low’ and 5 expressing ‘very high’:

1. In project(s) that used the lean construction management style, how well were the time and attention spent on meeting for the preparation of the project?
2. In project(s) that used traditional construction management style, how well were the time and attention spent on meetings for the preparation of the project?
3. In project(s) that used a lean construction management style, how would you consider the job satisfaction towards the work done in the project?
4. In project(s) that used a traditional construction management style, how would you consider job satisfaction towards the work done in the project?
5. In project(s) that used the lean construction management style, how was the turnover in relation to the financial aspect?
6. In project(s) that used the traditional construction management style, how was the turnover in relation to the financial aspect?
7. In project(s) that used the lean construction management style, how was the turnover in relation to the employee aspect?
8. In project(s) that used the traditional construction management style, how was the turnover in relation to the employee aspect?
9. Do you think the company that employs lean construction is more competitive in the construction market compared to companies not employing lean construction?

10. Please identify a project that was completed using lean construction management principles.
11. What was the size of the project in terms of finance and project duration?
12. To compare, please identify a completed project that used traditional construction management principles.
13. What was the size of the project in terms of finance and project duration?

7.4 Second Study Questionnaire Questions

Questions asked were a mix of open-ended and closed questions.

1. How would you define the company's current management style?
1. Please state the role you had during the delivery of the project.
2. What was the project duration?
3. Did the project meet the expected deadline?
4. If stated No, how long after was the project completed?
5. What was the size of the project in terms of budget?
6. Did the project meet the expected budget?
7. If stated No, by how much had the project cost exceeded the budget?
8. Approximately, how many people were employed in the project? (management + labour)
9. Did any employees leave during the project?
10. If stated yes, how many personnel left during the project?
11. Were there any injuries occurred during the project?
12. If stated yes, please state the number of personnel affected in the project.
13. How often did you have progress meetings?
14. Did the client have any complaints about the project?
15. Did the project meet the expected quality standards of the client, i.e. had any aspects of the project go through rework?
16. If states yes, what percentage of re-work was required?

7.5 Interview Transcripts

1. Interview 1

Interviewer: What would you define lean management as?

Participant 1: Lean management is the implementation of certain procedures or processes to help achieve value or maximise value in an organisation, whether it's in the manufacturing process or whether it's in the construction or project. It's all about value and to attain the value or maximise the value for the organisation or for the customer I believe that lean management principles support them. You can add value in the various elements within the organisation such as safety, quality, cost, HR and engineering. So in each element of execution you could implement these lean principles in order to maximise the value which overall compounds into a value for the company.

Interviewer: What would you say are the benefits of lean management?

Participant 1: The benefits of lean manifests in reduced cost, increased motivation in an organisation. I would say optimised processes and making the environment safer, for example, in construction, optimising the construction safety elements naturally helps make it a safer environment. So the benefits of lean principles or lean implementation would manifest itself in terms of value at the end of the day from all of these factors.

Interviewer: So, have you had any training in lean management?

Participant 1: Not in a structured manner. But, one of the principles that we have adopted in our company, is the continuous improvement cycle. So with the focus off, you know, managing the various elements of the life cycle of a project execution, implementing the lessons learned from each execution back into a new project and thereby continuously improving. So, continual improvement I would say is probably one of the elements of making an organization of increasing the value within an organization.

Interviewer: What do you think about your own opinion with lean construction?

Participant 1: You basically start with designing a system, where you can reduce the overall effort that is required to achieve your end objective. Basically, you put together a system in place which helps reduce the overall cost and maximise the value but safely. And how we mostly achieved that in projects is by first of all starting with developing roles and responsibilities where a person probably multitasks, for example, we would find the core competencies of a person can go beyond probably just one single responsibility or discipline. He may be able to deliver, two disciplines while in the same role. So there we see it as hiring and finding personnel who are capable of multitasking and safely managing and having done such projects in the past. So the overall number of personnel that is to be deployed into the project. It is, we look for quality in the person than the quantity there. So instead of 5% to be fulfilling a couple of tasks, we may find two people who are competent enough and have had the experience to manage that and deliver that. So first in the recruitment phase itself, we look for, such people. So you have a much more leaner project execution team and that also helps reduce the cost. And you need to look for optimisation in each phase of your project implementation starting with engineering. So you adopt certain principles in engineering, for example, one

very specific application or methodology we have adopted in our projects here in Kuwait is using modularisation of equipment.

Interviewer: What does modularisation do?

Participant 1: We maximise the fabrication or packaging in a controlled environment in a shop, instead of just leaving it to be done at site. So what that does is that you are in a controlled environment within a shop floor where, you have defined the shifts for working, you have all access to all equipment and tools around you and we try to maximise the fabrication of the packaging within that shop so that when it comes to site, you have very minimal hook-up to this package to get the facility into operation. The alternative or the conventional approach used to be, shipping all your raw materials to the site and you assemble it there. And that is called as a stick build approach. So stick built approach versus modular approach.

Interviewer: The modular approach seems very much like the just in time approach.

Participant 1: Probably more than just in time. I would say you manage the outcome in a controlled environment rather than in an uncontrolled environment. So, within a shop floor, you know, so a shop floor would be located somewhere within, let's say close to an accessible city limits or something that has your site is very remote. So rather than sending a hundred people over to site to do that specific aspect, 50 people probably in a controlled environment in a shop can generate the same outcome. In that shop than having or exposing yourself to the site risks. So at the site, inclement weather is something beyond control. Whereas in a shop environment, you know that the weather is controlled or so you're not affected by inclement weather. You won't be not affected by lack of lifting equipment or something which needs to be brought in from a remote location to the sites. So there are various elements which, which have to go, right in a site environment for an activity to be achieved. But as the risk of that is very minimal when done in our fabrication shop. So, stick built at site, loose components are sent versus packaged and then transported to site and easy lead. So it's like a plug and play basically. So that's one key element that we have implemented, towards lean, approach in managing our fast track.

Interviewer: All right from initial findings, I thought like there wasn't any lean principles involved at all, but it seems that you guys have actually been using certain lean principles and facts.

Participant 1: But, yeah, that was just in the execution. So even in engineering, I would say that we, again, optimise the engineering phase of facilities with each project. So lessons learned from a previous project are definitely implemented into a new project, which goes a long way, and again, ensuring that your design is improved from the past. So you know, you do not let's say make the same mistakes again you know, what to look out for. Then another aspect of lean implementation is in the quality management. So, using certified vendors with who you are worked in the past again and again, means that you save or reduce your time in, assessing the quality of a new vendor that you have to go to. So repeatability of processes we look for or repeatability of vendors is, so that helps us managing the quality element. And, we spoke about how we manage construction and then, the commissioning and operations and

maintenance, basically, it's all about, implementation of lessons learned from your past project into this to help you get over the, objective of the project.

Interviewer: Okay. So, since you guys already have used, you've been using a lot of lean principles, would you ever consider using any like lean accreditation's or certifications?

Participant 1: Based on the current market conditions in Kuwait, the lean principles are mostly in a manufacturing industry at this point in time. I have not seen it, or personally, at least I have not seen it being implemented. In a project site, but, for sure, it's all about the principles that you adopt, to reduce waste, increase productivity and efficiency in construction. So, absolutely. I mean, I can see it coming, but maybe it's a good initiative for you, Interviewer, to try to roll it out in an organisation that you get into and yeah I can see that it will provide a tremendous benefit because it's all about fundamental principles that are employed to increase efficiency and productivity and reduced the waste. So it goes without saying it can be implemented even at home.

Interviewer: Do you think there would be any barriers within lean management?

Participant 1: See, to me, barriers are always created by personalities or individuals and not, implementation of a certain program or implementation of a change. Always when implementing there should first be a mentality shift within the team or the personnel who are or who intend to adopt it. So as long as the personnel and the team are receptive to change, and if they understand that the change is for a benefit, which will translate into probably reduce cost and probably more profitability. And then if you can share that incentive with the team I think all the barriers go away. So, you may have some you may take some time in implementing these procedures because obviously it cannot be rolled out overnight. You would have to make a gradual change, but you have to take your people along or the team along on such change or journeys of change. And then I think all your barriers disappear. There's really is no limit to how much efficient you could make an organization.

Interviewer: Right, there’s never such a thing as reaching at a 100 present. Do you think there are any problems with your current management style within the organisation that lean may actually overcome?

Participant 1: Oh Absolutely. You know, we execute fast track projects in Kuwait. And one of the key elements of fast track execution is concurrent engineering. And so, in a typical EPC project, you always have a front end engineering and design phase where you detailed or you develop your concept into a feed and then you have a detailed engineering phase for where you detailed out everything generate your bill of quantities, your construction elements, and then you actually execute. Whereas in our project world here, for where we implement fast track projects. We don't have the liberty of so much time in the project life cycle. So what happens is we overlap a lot of phases concurrently. Even within engineering, we do front end engineering and detailed engineering concurrently. And then while we're doing detailed engineering, we already commenced procurement and while procurement is ongoing, we start the field preparation for the equipment to arrive et cetera so concurrent engineering and concurrent overlap of phases is a real issue to manage today in fast track execution. So to me, I feel that implementing lean principles like I would say modularisation which I mentioned earlier, which we have already embarked

on then in probably in manufacturing processes where repeatability or same vendors that you've used in the past who know sure can deliver quality products, et Cetera. So lots of things can come into implementation in fast track projects, which lean concepts, can be adopted, to where fast track projects would tremendously benefit. So I see a big room for improvement by implementing lean principles.

Interviewer: Okay. So last, uh, four questions, but these last four, I was just hoping to get you to rate it. And explain why you put it in that region. So it's going to be like a rating out of five. Okay and I'm just going to be giving you a sentence and I want you to relate this sentence to your company. Okay. And that's how you can give you a rating too. So one to five, meaning five is 100% like understood and one is not relative, three means it needs improvement. Okay sentence one. You guys have a clear set of objectives to be established for the delivery process and the customer needs and requirements are well understood.

Participant 1: I would say a four. You see communication is probably always the biggest gap that exists between two parties. The client always wants an excellent product or objectives. They may not communicate it very clearly in the contract document or specifications. And we assume something different. So as a contractor, our assumption is a minimum standards that need to be obtained to satisfy the client, whereas the client may have had a much higher expectation and there is always a gap in that perception of that assumption. So unless a document was very clearly specific that I need exactly this down to the nut and bolt detail, there could be a difference or, so that is why I rate it a four is that we mostly understand and we deliver to not to, I wouldn't say 100% expectation but at least probably 90 plus percent expectation on most projects.

Interviewer: Okay. So sentence two, you guys have a cross functional team that designs products and processes concurrently to give more value to the customer needs - This process of parallel design helps positive iteration within the process and negative iteration is reduced.

Participant 1: So, we do have a cross functional team and that is so I would say on this one again, I rate it a four. We certainly do have a cross functional team and that's been one of our strengths in fast track execution actually. So the competencies of the personnel we select extend to beyond just the core subjects that they are masters in. They do understand the whole value chain of a project and hence cross functional integration or communication is certainly a big part of our project execution. Now, how we can probably increase the value and reduce the iterations basically is by reducing the cycle time between evens. So, and by continuous improvement of the processes. So, each project we improve the workflow, we improved the communication and even the transparency of the processes we improve to where we think that a very strong cross functional and multi-disciplinary team benefits such a project execution.

Interviewer: So, sentence three, there's a shifting design work along the supply chain to reduce the variation and match the work content.

Participant 1: Yes, absolutely. We strive for that. I very much relate to this topic because it's all about managing your supply chain to achieve the end objective with

minimal changes. So we do manage change in a structured way during the course of the project, but ideally we do not want a change to occur, however if there is a change, we do manage it through a defined process, but reducing the variability within a project is one of the key goals. And it always starts with the supply chain going to consistent vendors who have delivered in the past, delivered consistent quality. So we always tried to, the supply chain group carries a huge role in ensuring that the variability in the project execution is minimised to the maximum extent but if there are changes imposed by the client doing the project execution, obviously, that change has to be managed and that is normally managed under a separate process by itself.

Interviewer: Okay. So what, what rating would you give?

Participant 1: I would say I fully agree with this. I would say five.

Interviewer: Okay. Sentence 4, work structure of the entire work process increases value and reduces waste at the project delivery level. And there are efforts to improve performance at the planning level, which increases performance at the project level.

Participant 1: Absolutely goes without saying, but I'd give it four because we have room for improvement still, so it's not fully implemented. But the concept is very well understood that it's all about planning and nothing can beat planning. So you have to plan and your outcome depends on how we plan. We've progressed as a company over the years to the understanding that it's all about planning and we do take it seriously right in the definition stage of the project to where we create a work breakdown structure and we plan each element of this work breakdown structure and set targets, set goals, set KPIs, which would help us to monitor and measure the targets and continual monitoring of these targets and the KPIs help us to ensure that the plan gets converted into an effective delivery.

Interviewer: Great. Okay. Awesome. Actually just one last thing. So you said there's room for improvement, right? So which aspects within the organisation would you say or the work structure would you say needs the improvement to the most part?

Participant 1: See, for us, I think it is about the concurrent overlap for the stages, because that's the nature of the projects we deliver is extremely fast track project delivery versus a conventional approach. So there is a lot more optimisation and efficiency that that can or could go into ensuring that you manage the concurrent stages in a project more efficiently. So to me, that is the biggest objective within the company today.

Interviewer: Okay, great. Yeah, that's it. Thank you so much. It's a very great, I really appreciate all the help.

2. Interview 2

Interviewer: Could you please state how long have you been with COMPANY D?

Participant 2: From 2006 to 2019, so 13 years and I went to another company for 3 years.

Interviewer: What are you doing currently with COMPANY D right now as in your position?

Participant 2: Currently I've been given project management responsibilities with regards to KOC Projects.

Interviewer: What would you define lean management as?

Participant 2: It could be something related to the effective utilisation of time and the programme to bring more productivity and efficiency as well as to deliver products at less cost, less time and higher quality.

Interviewer: Would you say it would be beneficial to use lean management in the company?

Participant 2: It should be.

Interviewer: Could you see where the can see benefits can come from?

Participant 2: Because of effective utilisation of available facilities.

Interviewer: Okay. So would you say that the company has enough certifications like ISO certifications and stuff like that?

Participant 2: Yes, we do. Our company has got the 14001 and 9001 ISO 2015 certifications. These are the 2 certifications we always go for. We also go for the internal high quality HSE performance certifications to do businesses with K Companies.

Interviewer: Okay. So would you guys say that the company's using currently traditional management with certain lean principles or is it just traditional construction management?

Participant 2: I think it's a mix of both practices, we try to adopt a mix of strategies. As it depends on the nature of the projects, we adopt different parts of lean concepts.

Interviewer: Yeah, I've heard you guys look into like things like continuous improvement cycles within the organisation.

Participant 2: Yeah so we have every year, all the managers have to give a performance evaluation program and we also hold KPIs set for the project activities as well as the leaves, feedback control and goals program. Then hold client interviews for feedback and checks for performance.

Interviewer: Okay. So how would you say the company's performance is when delivering project?

Participant 2: Do you mean in an overall aspect?

Interviewer: Yeah

Participant 2: Well I'd say we're working at an 100% effectiveness in terms of the contracts terms and conditions. Almost all the projects we handle, are delivered within the time limit and budget. As a company we're doing really well.

Interviewer: Okay. I mean would you see it as no need for improvement at all?

Participant 2: Well for the most of it we're good but there are about 2 or 3 projects we completed before 2015 had undergone financial and delivery issues and currently we do have a major project that is ongoing is also suffering from cashflow and it also has some delay also. But that reason is not totally contributed to COMPANY D, but also contributed to the uncontrolled parameters to the main contractor that goes back to the client that is in negotiation with KOC. So once that dispute is resolved, again that will become a profitable project. At present, the project is delayed and in loss. Again, when we say all the outstanding issues with the client the project will become profitable .

Interviewer: So what would you say the main cause of the cashflow issue?

Participant 2: Most of the capital of the projects we use with are received by loan and almost all the loans have got EMI to start at some point of time. And the because the main projects that we are doing has got around three to four phases such as engineering phase, procurement phase, construction and commissioning and operations and maintenance.

Interviewer: I mean thats what COMPANY D does right, they're an EPC company right?

Participant 2: Not EPC. So recently we have been doing BOOT projects, Built Own Operate Transfer. So the last few major projects we have been doing have been doing with KOC were this type of projects. So with regards to the cashflow in this project, some value of contract will be given back by KOC in a progressive measurement basis. So if you complete the procurements in time, then they will give this much percentage of money that can be invoiced to the government and the construction also but good amount of money will be held back at KOC, and it will be given back to us as a daily fact rate. That means if you have a contractor for five years, the total investment will be divided into that many number of days. And if you produce the full required production you will get receive the required money everyday. So there are a lot of finances involved with the bank, because we are investing 5 years ahead and the return comes to the end of the fifth year. So you have a lot of finances help up, so if you are keeping the invoice tracked accurately where everything is invoiced on time, you get it done, then you have a good cashflow. But otherwise the investment will be accumulated, then the project will have cashflow issues. So if we have multiple projects in a time we may have some limitations.

Interviewer: Alright, so you guys mentioned BOOT before, could you please explain some more about that?

Participant 2: See we receive the RFQ from KOC, we should understand the scope of work and we need to do the engineering for the scope of work. Then we need to procure the scope of work for the delivery of the plant. Yeah. Then we need to construct the plant at site. Then we need to commission then operate for four or five years or any years that is defined as the period of the time , so that is the major difference between the conventional EPC project. EPC stands for stands for engineering, procurement and construct, then transfer. Immediately construct then perform the stem transfer. With BOOT, we need to operate the facility, that is one of the fundamental differences the EPC and the BOOT.

Interviewer: Okay. So, within your company itself, how does the company actually aim to, eliminate waste?

Participant 2: One of the strategies we're doing, so for us there are two types of waste we usually see, one is actually the ideal man hours. See for us that is one of the fundamental areas we are normally we are looking, for that we have a multiple hat responsibility system, so the key persons depends upon the job nature and face of the project to see if you will need to have multiple responsibilities. So we will sometimes be making a mechanical engineer as a piping engineer, sometimes as a commissioning engineer, so we have to give the multiple roles at times. Okay. So by this, we eliminate a lot of ideal man hours.

Interviewer: But does that affect the quality of the work done?

Participant 2: Well that depends on the way the staff is handled, if not then of course. That's why we try to bring mostly experienced staff and for the trainees it will be a journey. We also include operations' representatives from the start of engineering, sometimes the commissioning representatives will be included from the engineering phase. And we also invite our own operation team into the engineering phase, not all of them but a few in the middle of construction. So like we will share the experiences.

Interviewer: Okay. You mentioned that there were two types of waste and the first one was ideal man hours.

Participant 2: Yes.

Interviewer: What would you say is the second one?

Participant 2: The second one can be said as un-utilised equipments. So you see we have different projects running for KOC in different locations of Kuwait. So one project normally has got a lot of assets. That's, installed assess and mobile assets. So we are trying to utilise the mobile assets by centralising the tolls, by centralising the equipment's logistics. So sometimes we have to hire additional equipment to manage the different inquiries in the same time.

Interviewer: Okay, perfect. So what else do you guys do for maximising value in the company or operations? Or what would you define as value first?

Participant 2: See value for us actually would be defined as money, as everything drives with money. Yeah. So every dollar we save from anywhere, we see that as a value. Sometimes we'll invest into as much as we can for our staff's safety. Many would say that it would be an additional cost, a lot of people say that

investing in HSE is an additional cost, as it will not directly produce anything but we've seen COMPANY D as for investing into HSE and quality controls, quality assessment system, quality assurance programmes. We've seen that it retains back in years, as a value in the utilisation of the assets. So you see we value money to see how we can make it something that can provide the better delivery from what we have. Also I previously mentioned that we have personal evaluation programs. We also have equipment utilisation checks and we have IBM installed on the company cars. SO IBM assist checks if driver drives for more than 120 kilo-meters per hour, the car will start beeping. So the device tracks how often we've driven past the limit, how many turns you've taken, how you're applying the brakes. You see after 13 years of my time with COMPANY D, this was the first month where I got the excellent driver appreciation certificate from the company.

Interviewer: So the car's being monitored with the speed and everything?

Participant 2: Yes. And if someone had gone to the site with their company car, the company will know their exact location as well. So we have a lot of monitoring programs.

Interviewer: What kind of planning systems you use?

Participant 2: So for the project planning, we use PRIMAVERA P6, which is our major planning tool. And recently for our next project, we are trying to implement Primavera with another overall management tool called Branch, and also there are two more products that we are testing currently. You see Primavera will give the baseline schedule, the resource allocations, whatever we need in the projects. And we use another software for procurement control, but I forgot the name of it. And we have Maxima in the plant to plan the maintenance, such as preventive maintenance, collective maintenance, whatever maintenance which is needed for the operation of a plant. The software also provides information related to the in-store, management of the store programs. So these are all the features provided by the Maxima program. So we know what material is being used from the store, what is required to pump up. And what kind of processes belongs to the plant, how many maintenance that's currently been taking place in that centre, because everything there for us, the plant is a cost centre, even the one pump will be classed as a cost centre. So it has worked out the predefined number of spares for five years. If someone is utilising more than that, we know that there is a problem with the pump. So now we are using a project management program on that and that software is called Branch, which I previously mentioned. It will give a pie chart to show the effective utilisation of the whole plant by comparing all the data collected by the programme. You see, this tool is actually quite useful for us as we don't produce our own daily reports from the site, so this programme allows us to even see the progress measurements, and the manpower is given to show how many mechanical engineers, HSE officers, electrical engineers, welders, fabricators, so you see everything is listed. So from all that data, the programme will process the data to see the ideal number of assets needed in the field well, and will show how many generated per day. So it gives us a benchmark. Every area that they've been benchmarked is not reached. The graph will change the colour from green to yellow to Red. So the programme shows a multiple levels of information. The president can see the high level cashflow. The manager can see his own level,

the project lead can see his own level. So this, this is a very effective tool. We are going to implement that as we already budgeted for that.

Interviewer: Alright great thank you so much, I don't think I have anything else to ask.

3. Transcript of Interview with Participant 3

Interviewer: I'm just going to ask you a few questions about the company, about yourself, and about how the management is, is that okay? Could you state your position within the organisation itself?

Participant 3: Yeah, I'm working as an assistant general manager.

Interviewer: All right. How many years of experience have you had so far within the company?

Participant 3: 14 years.

Interviewer: As the assistant general manager?

Participant 3: Three years.

Interviewer: Perfect. Okay. So what would you say were the barriers when implementing lean management?

Participant 3: When implementing lean management there was initially a lot of reluctance from many of our colleagues, especially from those who were very experienced, they always that believed in their traditional style of management and so they didn't want to change. And if you're asking them to change their way of working, then their ego hurts because, you see it's human nature. So that's a big problem. We had a lot of problems with that but once we showed them the uses of it, people slowly started to understand the logic of it, but it takes time. You cannot just push them, lean is pull not push.

Interviewer: Yeah okay, what would you say are the benefits of lean management?

Participant 3: The use of lean management allows the elimination of waste. So it allows to identify waste and eliminate it. Which helps the company to improve productivity which in the end allows to increase money. The impact is much more in Europe than the Middle East. You see in the Middle East; the labour cost is much cheaper than the European countries. Still we've have an improvement in productivity which relates to the man hour, hourly cost, because here majority of the workforce consists of expatriates. So working we are bring our employees from other countries.

Interviewer: Okay so, how did you guys improve the productivity? Was it using lean tools?

Participant 3: Yes. Okay. We have tools which help us to identify each processes, then we have to look closely at each activity to identify each activity to see if they will be value added, non-value added and ones that are not necessarily cool. Okay. So then we eliminate those activities that are unnecessary.

Interviewer: Since you've been here for 13 years, what would you say was the biggest difference from the traditional management style and the new implemented lean management style?

Participant 3: So when we were following the traditional management, there were many things we didn't notice that was inefficient as we just followed our experience or our superiors instead of actually finding the most effective way. When we used to follow those previous methods, we never actually looked for the unwanted or wasteful activities, so we then had to get a professional approach, like a consultant, was needed to identify those wasteful activities or processes. So getting the professional approach allowed us to get proven methods of research and they documentations to show us what was necessary to be removed or to be changed. This allowed our employees and management to understand the need for the change. See if you approach personnel and tell them without valid proof, such as documentations or scientifically backed research, that what they're doing is not an effective means of work being done, they wont see where the inefficiency is being occurred and so they will not accept the need for change. So yeah, the need for bringing a consultant allowed us to gain that proper analysis, allowing our personnel to discuss with them and gain their confidence. It takes time to establish an organisation, is not very easy. We cannot put a target of one year six months, no, it's a slow progress. We're trying to change the culture. If it was just a new training for a new activity, you can train the personnel. But if you want way to change their style of work on the same working category. Then adopting that isn't really easy. You see, most of our personnel have grown with the conventional style of work, so we have to slowly penetrate and slowly get into their system.

Interviewer: Okay. Great. so Since you guys have already mentioned the training, could you explain what training you guys have had for lean management?

Participant 3: We have a consultant from X University.

Interviewer: So how did the consultant help?

Participant 3: They gave training to the key management and the lean leaders. We have appointed lean leaders in every country. The lean leader first get's the basic training to get the six sigma certification. There's the course available already for their training. So once the leader get the training and certification from the consultant, who's understood our developed working culture. He can then give training to the line managers and the lower level blue collars.

Interviewer: Alright, would you say like as the training and experience is being passed down from the lean leaders to the other personnel in the organisation, is there a big difference and understanding within each lean? Like within each hierarchy level for the understanding of lean?

Participant 3: Yes that's right. We've designed the training tool in that way. It's not that same training is given because within the different levels of the hierarchy, everyone gotten their own different role. The blue collars have only to focus on the tools and so you have to simplify it for them to understand. They might not be able understand the presentations of the whole training itself. So we give them training on the actual use of tools only, whereas their supervisors or managers will have to understand the whole analysis process, how to identify

waste and all the other necessary tools needed to run the project. Then above these managers and supervisors, come people in my level of hierarchy, where I look at monthly reports, follow up reports, financial reports, financial benefits of every months. So I need to look at the lean impact and see how I can motivate them to be more effective. So you see, the need for having different levels of understanding in lean is necessary for the different personnel, So if we gave all our personnel the same training, most of them will not understand it as well as it will cost a lot and take a lot of time. So we have a motivational program that allows our employees to come up with new ideas, so we encourage Kaizen.

Interviewer: Actually that was something I wanted to ask about Kaizen. I saw that there was a Kaizen column against all the employees on the board. How do you guys measure the level of Kaizen or unit for Kaizen?

Participant 3: In our case Kaizen is an improvement idea. So we encourage people to come with new ideas, and we will reward them. So it allows to compare between what was done earlier, what is the new idea and how is it going to benefit? So they will demonstrate with a picture or video and they will have to give the calculations as well, like how many man hours earlier or what material is currently used and what will be saved, the commercial impact. Then we will review, to see if it is really adoptable, then we'll change it as Kaizen. Then that Kaizen will be distributed and documented, so that the next project can be implemented by the same project that the new principles were used.

Interviewer: Okay, perfect. Do you guys get certifications or accreditation, towards being lean?

Participant 3: We've got internal certifications for staffs for different levels of training. So after each level of training there would be a certificate issued. So I have a lean practitioners certificate. For this level I had to complete a project independently.

Interviewer: Okay, perfect. What kind of lean tools do you use within the construction site and could you explain it?

Participant 3: I can't say specifically to be honest as that is something confidential or what we call our trade secret.

Interviewer: Okay. So what opportunities have you guys identified with the implementation of lean?

Participant 3: Opportunities?

Interviewer: Yeah, have you seen, because you have this new adopted management style, have you seen that there are like something so new and different and you can make a profit out of, or not a profit against but like seem to improve operations because of the implementation of lean?

Participant 3: Yeah. So all the projects we do have to be done in the lean way and all of these projects are major projects. So some projects that has been done by our competitors have been facing a bad situation, such as making a loss or not going as per schedule, the clients of these projects will be handing the projects to us or for certain aspects of the project. So this opportunity for us

allows us to show these clients how lean can contribute on this project or how it can improve.

Interviewer: All right. Cool. So have you ever heard of the last planner system?

Participant 3: No.

Interviewer: So it's also a lean tool. So I've actually been focusing on the last planner system as one of the main tools used by many companies. So, I've been reading a lot of thesis' and a lot of past research papers about lean management and I've identified a lot of companies have used the last planner system.

Participant 3: Well from what I've seen is that, lean is really new and most organisations are not aware of it.

Interviewer: That is true. Yes. So, but that's the thing in the Middle East, it's very new. And like unknown, however, and East Asia or in the West, like America or UK, Europe or even South America. In fact, they actually have licensed boards who certify them and accredit them for using lean management. So there's one called the lean construction institute and they give you an accreditation issue that you guys remember and you guys have been practicing lean management for so and so years. And you guys can do these annual forums where you can meet up and talk about how you guys have identified new trades or new tools that can help benefit the operation and organisation. The last planner system was one of the things that a lot of these companies and the organisations spoke about. So it's about the whole overall lean management itself and how it is used. So you know how you said lean is about pull, right? So you move backwards from the end date to the start date, and then you identify each stakeholder and supply chain. Yeah. You know, and, um, yeah, I was just wondering like, you know, do you guys involve your management strategies using that or like using any principles of involving stakeholders within each meetings or when planning?

Participant 3: Using lean?.

Interviewer: Yeah.

Participant 3: Yeah

Interviewer: Do you want to specify a little bit?

Participant 3: The principles?

Interviewer: Well yeah, like how you guys have involved it, or if you can identify any principles of it or within involving the supply chain or how you identified doing continuous improvements.

Participant 3: Continuous improvement is one thing because it is a potential for improvement. You are not going to stop at an end point, there is always room for improvement. It's really important that we grow step by step. So you improve and standardise. So the standardisation is a rock as otherwise it will roll back. It's like a wheel, so it climbs a certain height. Then you have to standardise it before climbing to the next step.

Interviewer: Yeah. That's actually Taylor's scientific principles of standardisation.

Participant 3: Yeah, exactly. Yes. So that, that is very important. Otherwise it would roll back anytime.

Interviewer: Yeah. Perfect. So what would you define the success factors of the implementation of lean?

Participant 3: Success factors? I measure commercially. End of the day, I see what money is made. Or by improving but improving is measured by two things; one is productivity and the second is material. So the more we save material and increase productivity, the higher improvement has been done. So what we normally do, we fixed a margin when a contract has been signed When I get a contract, we have a month with a percentage, then we'll involve lean, then on account of lean, we will keep it a track separately of the progress. We measure how much has been improved by multiplying the factor or percentage. So that is basically how we've been measuring lean management.

Interviewer: Okay. There's one major thing which I feel like has not been really included within the management and it's to involve the HR, with lean management. So several researchers have strongly regarded lean construction as one sided by insisting on the lack of consideration for human resource management.

Participant 3: Well with HR management, I'd say its all about training.

Interviewer: It is about training, but I think that's the thing, you know, with HRM, human resource management training the HR for lean will help benefit a lot more as a initial training stage for future employees. And I think a lot of companies have been lacking that within their organisation.

Participant 3: The organisation which plans the training. So they give a basic induction when the new member joins. So our HR monitors all this. They keep a database to see how much training has been given to members who were contracted by us and so if we were to hire these guys, they would get the priority over others.

Interviewer: Perfect. Okay. So yeah, there were, so when I did my own research identified, there were like four success factors for the implementation of lean. Yeah. Right. So the first one was the planning systems. The second one was the organisation. The third was the attitudes towards the participants who had tried to involve the change. And the last was the contracts. So I think like from my previous interview with Mr. Joseph and you, I've seen that there were three success factors mentioned primarily, and you guys have used it really well, you know, how should the lean within the organisations is going pretty well. Attitudes like you mentioned, people have that, worries that, they don't really like to change and everything, but if, you know, involved change management and uh, allow them to understand what the importance is is actually quite important as well, which worked out pretty well. And the planning systems, which you guys said was, you know, important as well. Yeah. So the contracts I think is also something that you guys, could include, you know, as recommendation. So allowing stakeholders or future employees about letting them know what they're getting into, how they can benefit from it.

Participant 3: Oh, following the lean standard and we are also using this monitoring method. At the site, they have a lean board, where discussions happen and there's a display board. And so, whenever the clients come and say see those system and it's something new for them. So, we always get some credit from these clients as they think it's very professional. We used to get these kinds of appreciations from them. I feel this gives a weightage when we do our bidding or negotiating a job as they think this company is different compared to the others. This also allows the client to gain a benefit, as we could save them a month before the work was supposed to be finished.

Interviewer: So do you think it is possible to include it within the contract itself?

Participant 3: No, because it's something we do internally and this is what we use as our own internal tool. So, it got nothing to do with the stakeholders. But, maybe after 10, 20 years, this could be a required standard needed by most companies like the ISO certification before. The ISO certification was just a standard that was barely known as now it's compulsory. So most of the clients as whether the company's got pre-qualifications like ISO. So I can see later on, that companies will require a lean certification as a compulsory certified system.

Interviewer: Yeah. That's great. So I think that most of it, that is everything. Do you have any other comments about lean managing or about how lean has helped the company?

Participant 3: Yeah. So lean has given us only benefits, nothing wrong. It's a matter how the management drives it. You have to involve all the members of the company and yourself for running this. Then only the culture will grow. You see if you don't involve yourself with the change, you're not setting a good example to your colleagues. If change first everyone else will follow. Everyone will initially think that this is some kind of additional thing I had to do apart from my routine. Actually. It's nothing additional, just it becomes a part of your routine. You have to go over that step. Then everything goes by its own. Until then you have to put a lot of effort.

Interviewer: Okay.

Participant 3: This is, you can say is a learning period. It's was a really challenging time period, but now, we, I think it's become sustained for the most parts you can say.

Interviewer: Yeah. Perfect. Great. Thank you very much.

4. Transcript of Interview with Participant 4

Interviewer: So first question, what would you guys define lean management as?

Participant 4: Lean management is something that will help us to identify and eliminate any sorts of waste in your processes or in your workplace.

Interviewer: Okay. What would you say that the benefits of lean management?

Participant 4: A lot of benefits, one is definitely so when we implement lean, first of all we look at it in the terms of how we can provide value to our customer. So the four benefits we always look at is how we can reduce time, how we can reduce cost, how we can improve our quality, and also how we can improve our safety. So these are the four factors we are always looking at when we want to be implement lean.

Interviewer: Have you guys ever had any barriers when you've been trying to implement lean within the company or project?

Participant 4: Definitely. So first thing is the mindset. Definitely a lot of resistance, initially because most of the people have that status quo. If you look at some employees who were working for more than 10 years, they're already comfortable with what they're doing on a daily basis. And then when it comes to implementation of lean, this is something that they look at that as a threat because this is a new area that they're venturing into. And then the field that they are already very comfortable with what they're doing, they're called experts of the trade and then they look at it as something that if they fail, then that's affecting their status quo. So that's a major barrier that we had. And then there's a lot of change management that is required for us to implement lean. And then there are different stages where they move from rejection to resistance. And on to acceptance mode. And then there are different phases in the change management cycle you go through.

Interviewer: Okay. Cool. So I know you guys have only started you lean journey about five years ago. 2013. Okay. So six years. Wow. So if you guys have been with Company E before that I just wanted to know how would you compare the traditional management style compared to the lean management style within the company and operations?

Participant 4: Well the thing is I joined in 2016 so I wouldn't have that experience. But then compared 2016, there's a lot of change. Again, I can see the, a lot of it evolution that I've seen in Company E. So 2016 years was the very initial stage of lean implementation. And even at that stage there were a lot of resistance from the employees and compared to how it was in 2016, there's a improvement in the acceptance factor of all of the employees because now they really understand the value of using lean methodologies in their day to day works.

Interviewer: So have you guys had any training in lean management?

Participant 4: Yes. So that's a compulsory training. There are different levels of training that we provide based on the designation and the work profile of the employees. So for us as lean leaders, when we joined the company, there was also a specific lean leader classroom training program that was given by our head office. We have a standard training curriculum for all the employees. So for the lean leaders, there was one curriculum, which was provided by the head office. We had the training in Germany. And then we also have a lean site management training for line managers, project managers and site managers, which is a five-day training. They have theoretical as well as practical training concepts. Then they'll also go through another module two training, which is three days, which is how do we sustain the improvements. Because most of the times we see that the major challenge in applying lean is we can do improvements very quick. But then sustaining those improvements is one

of the major challenges. So, we also have training on how do we sustain lean improvements. And then for supervisors and workers, we have a two-day training. And then for everyone who's joining the organisation, we have lean induction training, which is a one-hour training that is provided.

Interviewer: So within, so since you've had a lot of training, how have you actually used it within any projects or like by yourself?

Participant 4: Yeah, so definitely there a lot of lean tools that are being used. These are Company E's specific lean tools we have adapted by taking in consideration of the global lean concepts if customers do for the construction industry. And then these lean tools and applied on the projects based on which we can see how we are doing the value streaming of the processes and seeing how we can get the value added from these improvements.

Interviewer: I was actually going to ask about the lean tools. But, um, so when you guys use lean tools, I've seen certain things on the board such as using Kaizen the five S, so could you explain more about it?

Participant 4: These are the basic lean tools that we use. How do we use 5S? In our work basis tours because while we're dealing with construction but a lot of materials that we deal with. So how do we make sure that we maintain the materials properly and also how we avoid, all sorts of waiting or searching times. So five S, this is a very good tool that we use. And we also to use one planning tool, which is called 5 R. How we plan our work effectively. And then definitely the different types of waste that people are educated on. And globally there are eight types of waste known and we've added one more, which is called energy so now in Company E we have nine types of waste. Because our vision is also attached to that. So our vision is used to eliminate energy waste on one off projects. And apart from these tools we also have different tools where we can map out processes. One is a process mapping tool that we use and another is the time and motion study tools and also how we can identify and eliminate non valued activities.

Interviewer: Thank you. So have you guys had any opportunities that you've seen since for improving within lean construction from the traditional style?

Participant 4: Definitely. Yeah, First thing is the culture change. You'll see is the mindset of the people, they are now more positive. So usually, as soon as you get a job it's just about going and executing it. But now after, after you get into that lean mode, you first sit back and plan for the job. And because one thing that we mainly discuss, and one thing that we also realised is that most of the waste that we've seen in the processes because of poor planning. So that is something with which we emphasise on and say that as soon as you get something to do, don't just jump into action, first do a plan, plan yourself for better and discuss what are the hurdles that might come up. We prepared for those. If you have a resolution already, provide solution for those hurdles, which might come up and then you can your work will be smooth.

Interviewer: Okay. So within the planning itself I'm, this is something I'm researching in to myself. It's called the last planner system. Have you guys heard of the last planner system? And so do you guys use it?

Participant 4: We don't use that. For us the planning tools that we use are 5-R, which I've mentioned already. That is one planning tool that we use. And there's also an action list that we already keep in place so that it's easy for us to track problems and also see what is the status of the implementation.

Interviewer: So what would you say is the biggest difference between lean construction and traditional construction management?

Participant 4: The biggest difference with traditional construction, is that it is more hierarchal based. It's more of authoritative, where one person takes charge and tries to run show. But then in lean construction site, we have more transparent. People take it as a team responsibility and then the results are shared with everyone, it's very open. Whatever is happening, everyone knows what's happening and you don't hide the problems under the table, everything is exposed so that you don't know from whom you'll get the best idea.

Interviewer: So that's like a team involvement thing. So as I mentioned the success factors, what would you guys define as success factors for implementing lean?

Participant 4: With lean, one thing that we've observed is it's definitely a top down approach always. Because if your management is not interested in as an employee, there's no way you can go and do things successfully, especially with lean and told with a top down approach. So the best thing or the success factor for the lead project is for a positive project manager who is interested in lean. Who is more positive about lean. That's what makes, that's the starting point. And then that's the way he follows up and ask his employees educated employees on lean concepts and the way he ensures that everyone is following lean is the biggest success factor.

Interviewer: Okay. Do you have any other comments?

Participant 4: As of one thing is, we have no comments as such, but then I will take this opportunity to thank you for giving us the opportunity to explain what we're doing better.

Interviewer: Yeah, absolutely. It's actually something I've always been fascinated about, you know. So one thing I've seen about lean itself is the continuous improvement. And it's just one thing that always caught my eye. They don't always look at what is a 100%, but it's more about achieving the best practice for the moment, which is a bigger difference. So, I just always found that fascinating. So another thing was when I was talking about success factors, there were actually four things that I saw within the implementation of lean as a success factors and you guys have actually mentioned most of these factors such as planning systems, the attitudes towards the project participants, the organisation itself and contracts. But you haven't mentioned contracts much but yeah.

Participant 4: As of now, I don't think we are mentioning lean in our contracts, but then that is what we are looking at in the future that we definitely want to incorporate this lean factor to introduce it to our clients as well. And we are going a stage where we want the future state where we want our clients to be rewarded in our lean journey so that they really understand what's the benefit that they're getting. And that's also something that we do want to show is the value added along with the regular work that we are doing here.

Interviewer: Okay. Yeah. Actually that's something about the last planner system itself. That's why I've been mentioning it. So I've really been focusing a lot on the last planner system. And one thing about the last planner system itself is the fact that you involve every member in the supply chain. Yes. So that means your clients, your external subcontractors or your vendors or whoever you know. So that's, I found that quite interesting.

Participant 4: So we use one tool, which is called the overall process analysis, which is similar to a planning system where you, you start to map your process and see what are the stakeholders involved at each process step. So this is done even before the start of the project so that you have a virtual idea of what the project looks like. What are the different steps that you fall in the project and who are all the key stakeholders that you are already aligned with them even before the actual project starts.

Interviewer: Alright. Okay. Fair enough. Great. Thank you. This has been great. Yeah, it's been very good.

7.6 **Interview Analysis Process**

Thematic Analysis Process:

1. Transcribe Interview
2. Build up a set of codes that capture the main ideas/themes in the text
3. Code each text to relevant ideas/themes
4. Sort Codes into themes
5. Identify what themes are relevant
6. Create Narratives from codes/data
7. Building stories by how each code relate to each other,
8. Find Supporting Evidence
9. Find any potential contradictory evidence (searching for data that doesn't oppose the narrative/theme) for which doesn't correlate with the story and figure out why (Maybe due to different background, different experience, different role,), and see how it affects the generalizability of conclusions (Scope of work/applicability) or
10. Find evidence for any explanations for the data (Illustrations/Quotations from transcript)
11. Understand why the results are the way they are
12. Explain anything else that aren't available in the data that you realised because of your insights such as what has driven them to say what they are saying and the account of the use of technology or the way that the technology was designed.

*Adapted from https://www.interaction-design.org/literature/article/how-to-do-a-thematic-analysis-of-user-interviews

7.7 First Study Questionnaire Data

Timestamp	Response 1 7/2/2019 12:03:17
What do you think is the use of lean management? (Please tick the boxes you think relate to lean management)	Increase value, Eliminate waste, To ensure continuous improvement, To maximise efficiency
What would you define lean management as?	Enhancing value through optimized processes
In your opinion, what types of construction projects can be used with lean management?	Every sector available
If known, please state any lean strategies employed within the company.	Modular fabrication and packaging versus conventional site based stick built approach
To what extent do you think lean management can be used in the projects?	To some aspects
Please specify the sector(s) considered in the above question and explain your answer.	Design, Fabrication, Construction
In project(s) that used the lean construction management style, how well were the time and attention spent on meeting for the preparation of the project?	4
In project(s) that used traditional construction management style, how well were the time and attention spent on meetings for the preparation of the project?	3
In project(s) that used a lean construction management style, how would you consider the job satisfaction towards the work done in the project?	4
In project(s) that used a traditional construction management style, how would you consider job satisfaction towards the work done in the project?	3
In project(s) that used the lean construction management style, how was the turnover in relation to the financial aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the financial aspect?	3
In project(s) that used the lean construction management style, how was the turnover in relation to the employee aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the employee aspect?	2

Timestamp	Response 1 7/2/2019 12:03:17
Do you think the company that employs lean construction is more competitive in the construction market compared to companies not employing lean construction?	3
Please identify a project that was completed using lean construction management principles.	JPF 3 at WR for Kuwait Oil Company on a Build Own Operate Basis
What was the size of the project in terms of finance and project duration?	$260 Million, 18 months
To compare, please identify a completed project that used traditional construction management principles.	GC16 project on EPCC basis
What was the size of the project in terms of finance and project duration?	$300 Million and 32 months

Timestamp	Response 2 7/8/2019 5:21:26
What do you think is the use of lean management? (Please tick the boxes you think relate to lean management)	Increase value, Eliminate waste, To ensure continuous improvement, To maximise efficiency
What would you define lean management as?	Lean management in simple terms is identifying & eliminating waste
In your opinion, what types of construction projects can be used with lean management?	Every sector available
If known, please state any lean strategies employed within the company.	Providing customer value through improved efficiency
To what extent do you think lean management can be used in the projects?	Every aspect
Please specify the sector(s) considered in the above question and explain your answer.	Lean can be applied to every sector where there is a process / sequence of steps involved to get the final result.
In project(s) that used the lean construction management style, how well were the time and attention spent on meeting for the preparation of the project?	4
In project(s) that used traditional construction management style, how well were the time and attention spent on meetings for the preparation of the project?	2
In project(s) that used a lean	4

Timestamp	Response 2 7/8/2019 5:21:26
construction management style, how would you consider the job satisfaction towards the work done in the project?	
In project(s) that used a traditional construction management style, how would you consider job satisfaction towards the work done in the project?	2
In project(s) that used the lean construction management style, how was the turnover in relation to the financial aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the financial aspect?	3
In project(s) that used the lean construction management style, how was the turnover in relation to the employee aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the employee aspect?	2
Do you think the company that employs lean construction is more competitive in the construction market compared to companies not employing lean construction?	5
Please identify a project that was completed using lean construction management principles.	LFHOD
What was the size of the project in terms of finance and project duration?	Project duration is 1.5 years with a TO of 7 Mio Kwd
To compare, please identify a completed project that used traditional construction management principles.	Presently there are no projects which are are run with the traditional principles
What was the size of the project in terms of finance and project duration?	NA

Timestamp	Response 3 7/11/2019 14:13:58
What do you think is the use of lean management? (Please tick the boxes you think relate to lean management)	Increase value, Eliminate waste, To ensure continuous improvement, To maximise efficiency

Timestamp	Response 3 7/11/2019 14:13:58
What would you define lean management as?	It is the mode of effective utilisation of the management programme of any job with well defined objectives, targets, time schedule and work programs, etc. to deliver the Job with high quality, less time, and less cost.
In your opinion, what types of construction projects can be used with lean management?	Every sector available
If known, please state any lean strategies employed within the company.	
To what extent do you think lean management can be used in the projects?	Every aspect
Please specify the sector(s) considered in the above question and explain your answer.	
In project(s) that used the lean construction management style, how well were the time and attention spent on meeting for the preparation of the project?	4
In project(s) that used traditional construction management style, how well were the time and attention spent on meetings for the preparation of the project?	3
In project(s) that used a lean construction management style, how would you consider the job satisfaction towards the work done in the project?	4
In project(s) that used a traditional construction management style, how would you consider job satisfaction towards the work done in the project?	2
In project(s) that used the lean construction management style, how was the turnover in relation to the financial aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the financial aspect?	3
In project(s) that used the lean construction management style, how was the turnover in relation to the employee aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the employee aspect?	3

Timestamp	Response 3 7/11/2019 14:13:58
Do you think the company that employs lean construction is more competitive in the construction market compared to companies not employing lean construction?	4
Please identify a project that was completed using lean construction management principles.	JPF-3
What was the size of the project in terms of finance and project duration?	400MUSD, 24 Months EPC
To compare, please identify a completed project that used traditional construction management principles.	GCP-GRIP
What was the size of the project in terms of finance and project duration?	82MUSD, 18 Months EPC

Timestamp	Response 4 7/16/2019 14:13:48
What do you think is the use of lean management? (Please tick the boxes you think relate to lean management)	Increase value, Eliminate waste, To ensure continuous improvement, To maximise efficiency
What would you define lean management as?	Lean management helps us to identify any form of non-value items & eliminate them
In your opinion, what types of construction projects can be used with lean management?	Every sector available
If known, please state any lean strategies employed within the company.	Efficiency Improvement workshops
To what extent do you think lean management can be used in the projects?	Every aspect
Please specify the sector(s) considered in the above question and explain your answer.	Lean can be applied to all the sectors
In project(s) that used the lean construction management style, how well were the time and attention spent on meeting for the preparation of the project?	4
In project(s) that used traditional construction management style, how well were the time and attention spent on meetings for the preparation of the project?	1
In project(s) that used a lean construction management style, how would you consider the job satisfaction	4

Timestamp	Response 4 7/16/2019 14:13:48
towards the work done in the project?	
In project(s) that used a traditional construction management style, how would you consider job satisfaction towards the work done in the project?	2
In project(s) that used the lean construction management style, how was the turnover in relation to the financial aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the financial aspect?	3
In project(s) that used the lean construction management style, how was the turnover in relation to the employee aspect?	4
In project(s) that used the traditional construction management style, how was the turnover in relation to the employee aspect?	2
Do you think the company that employs lean construction is more competitive in the construction market compared to companies not employing lean construction?	5
Please identify a project that was completed using lean construction management principles.	LFHOD
What was the size of the project in terms of finance and project duration?	1 year duration with a Turnover of 7 Mio Kwd
To compare, please identify a completed project that used traditional construction management principles.	Insulation Project
What was the size of the project in terms of finance and project duration?	1 year with a Turnover of 2 Mio Kwd

7.8 Second Study Questionnaire Data

The raw data of the second study can be found in the following link: https://docs.google.com/spreadsheets/d/140WUS010NczVWbFs1Z-y7rRLbg7jwa5GCQRjZsRSM6E/edit?usp=sharing

The company style T stands for traditional, TWL stands for Traditional with certain lean principles and L stands for lean management style.

Respondent	1	2	3	4
Company Management Style	T	LWT	T	T
Role	Planning Engineer	Project Manager	Project Manager	Operations Engineer
Deadline Met	Yes	No	Yes	Yes
Project Duration/ Months	6	12	8	16
Extended Time/ Months	0	3	0	0
Budget Met	Yes	No	Yes	Yes
Project Budget	KWD500,000	KWD300,000	KWD20,000,000	KWD15,200,000
Extended Project Budget	0	KWD12,000	0	0
Employees Left	No	Yes	No	Yes
Project Labour	120	480	3500	1700
Employee Leave Number	0	2	0	60
Injuries	No	Yes	No	Yes
Project Labour	120	480	3500	1700
Affected Number	0	6	0	30
Client Complained	No	No	No	No
Client Meeting Frequency	Weekly	Fortnightly	Weekly	Weekly
Re-Work Percentage	0%	0%	0%	0%

Respondent	**5**	**6**	**7**	**8**
Company Management Style	LWT	T	LWT	T
Role	Project Engineer	Planning Engineer	Project Manager	QA/QC Engineer
Deadline Met	No	No	Yes	Yes
Project Duration/ Months	36	60	24	6
Extended Time/ Months	6	9	0	0
Budget Met	Yes	No	No	Yes
Project Budget	KWD6,000,000	KWD20,000,000	KWD15,200,000	KWD375,000
Extended Project Budget	0	KWD2,500,000	KWD1,200,000	0
Employees Left	Yes	Yes	Yes	No
Project Labour	1200	450	1000	850
Employee Leave Number	85	4	100	0
Injuries	No	Yes	Yes	No
Project Labour	1200	450	1000	850
Affected Number	0	3	50	0
Client Complained	No	No	Yes	No
Client Meeting Frequency	Weekly	Fortnightly	Monthly	Fortnightly
Re-Work Percentage	0%	0%	40%	0%
Respondent	**9**	**10**	**11**	**12**

Company Management Style	L	T	T	T
Role	Project Manager	QA/QC Engineer	Project Engineer	Project Manager
Deadline Met	Yes	No	Yes	Yes
Project Duration/ Months	6	18	6	12
Extended Time/ Months	0	5	0	0
Budget Met	Yes	No	Yes	Yes
Project Budget	KWD524,000	KWD1,500,000	KWD50,000	KWD375,000
Extended Project Budget	0	KWD100,000	0	0
Employees Left	No	No	Yes	No
Project Labour	60	600	50	650
Employee Leave Number	0	0	5	0
Injuries	No	No	No	Yes
Project Labour	60	600	50	650
Affected Number	0	0	0	13
Client Complained	Yes	Yes	Yes	No
Client Meeting Frequency	Weekly	Weekly	Fortnightly	Weekly
Re-Work Percentage	20%	20%	40%	0%

Respondent	**13**	**14**	**15**	**16**
Company Management Style	LWT	T	T	T
Role	Project Manager	Project Manager	Project Manager	HSE Officer
Deadline Met	Yes	No	No	No
Project Duration/ Months	6	26	24	24
Extended Time/ Months	0	5	8	8
Budget Met	Yes	Yes	No	No
Project Budget	KWD120,000	KWD764,000	KWD26,500,000	KWD26,500,000
Extended Project Budget	0	0	KWD750,000	KWD750,000
Employees Left	Yes	Yes	Yes	Yes
Project Labour	40	360	550	550
Employee Leave Number	8	80	16	16
Injuries	No	No	No	No
Project Labour	40	360	550	550
Affected Number	0	0	0	0
Client Complained	Yes	No	Yes	Yes
Client Meeting Frequency	Fortnightly	Weekly	Weekly	Weekly
Re-Work Percentage	20%	0%	20%	20%

Respondent	17	18	19	20
Company Management Style	T	L	L	L
Role	Project Controls Manager	Lean Leader	QA/QC Engineer	General Manager
Deadline Met	No	No	Yes	Yes
Project Duration/ Months	17	9	22	24
Extended Time/ Months	4	2	0	0
Budget Met	No	Yes	Yes	Yes
Project Budget	KWD15,200,000	KWD336,000	KWD26,000,000	KWD972,800
Extended Project Budget	KWD2,280,000	0	0	0
Employees Left	Yes	No	Yes	No
Project Labour	900	45	150	150
Employee Leave Number	25	0	1	0
Injuries	No	No	No	No
Project Labour	900	45	150	150
Affected Number	0	0	0	0
Client Complained	Yes	No	No	No
Client Meeting Frequency	Weekly	Weekly	Weekly	Weekly
Re-Work Percentage	20%	0%	0%	0%

Respondent	21	22	23	24	25
Company Management Style	L	L	L	L	T
Role	Project Manager	Project Manager	Project Engineer	Project Engineer	HSE Officer
Deadline Met	Yes	Yes	Yes	Yes	Yes
Project Duration/ Months	24	12	8	12	5
Extended Time/ Months	0	0	0	0	0
Budget Met	Yes	Yes	Yes	Yes	Yes
Project Budget	KWD972,800	KWD1,520,000	KWD300,000	KWD1,520,000	KWD992,000
Extended Project Budget	0	0	0	0	0
Client Meeting Frequency	No	No	Yes	No	No
Client Complained	150	350	250	350	150
Employees Left	0	0	5	0	0
Project Labour	No	No	No	No	No
Employee Leave Number	150	350	250	350	150
Re-Work Done	0	0	0	0	0
Re-Work Percentage	0%	0%	0%	0%	20%