How Can the Irish Construction Industry Become Less Fragmented and More Productive?

Philip Toland and David Collery
Atlantic Technological University, Sligo, Ireland

philiptoland@gmail.com
david.collery@atu.ie

Abstract: Globally the Construction Industry is in a fragmented state and the Irish Construction Industry (ICI) is no exception. The ICI has a history of delivering National infrastructure projects over time and over budget. Irish Government publications have identified that low productivity within the ICI is a prevalent issue. Lean construction (LC) is proposed in this research as an antidote to assist the ICI in becoming less fragmented and more productive. Research indicates that successful incorporation of lean methodologies can cut completion times by 30% and costs by 15%. Further research demonstrates that Construction Industries (CI) are lacking the education required to implement lean methodologies. There is a lack of awareness within the ICI regarding the principles and benefits of lean. Lean Construction Ireland (LCI) membership numbers are increasing at a glacial pace. Traditional project management techniques that are autocratic in nature and focus on critical path items and milestones are extensively used in the ICI. These techniques prioritize measuring metrics such as commercial performance which means measuring other performance related metrics such as workflows slip down the order of seniority. This approach conflicts with the principles of lean and limits the opportunity for continual improvement. There is therefore a requirement for government, management, leaders and all project stakeholders to change their way of thinking regarding their project management techniques and embrace change. Aligning these stakeholders will strengthen the entire Irish Construction Supply Chain and only then will the benefits of lean be fully realized. Building Information Modelling (BIM), whilst not technically a lean tool shares multiple characteristics of lean and is further vehicle that can assist in this transition. The results suggest that with enhanced education in lean, alignment of project stakeholders, an overhaul of traditional project management techniques and heavier incorporation of BIM that a shift towards lean and higher productivity is possible for the ICI.

Keywords: Lean, Education, Barriers, Project management, Irish construction industry

1. Introduction to Lean

The lean philosophy was pioneered by the Japanese in the 1950s by the manufacturing industry (Womack, Jones and Roos, 1990). The lean ethos has a very detailed structure, it does not have limitations and can evolve to incorporate other mechanisms as required. The principles of lean are to reduce waste, increase productivity, value and profitability which requires close collaboration between all involved parties in the supply chain from the design stage all way to the end user (Pheng, Gao and Lin, 2015). From its inception and success in manufacturing it has made advances in the CI whereby clients and contractors are trying to incorporate the lean techniques traditionally used in a controlled and repetitive manufacturing environment into the less controlled environment of construction sites. Introducing these techniques from the predictive environment of the manufacturing industry into the unpredictable environment of the construction world is a challenging undertaking. Whilst acknowledging the difficulties that exist between these industries Koskela, (1992) contributed to this transition by suggesting an alternative way of thinking that puts a focus on the flow of information, material, construction activities and how these flows are measured. It has been recognised in previous research that there is a difficulty marrying lean to CIs (Cano *et al.*, 2015; Hines, Taylor and Walsh, 2020; Mano, Gouvea da Costa and Pinheiro de Lima, 2021).

2. Literature Review

The CI globally has an issue delivering projects on time and within budget (Bertelsen and Koskela, 2003; Flyvbjerg, Bruzelius and Rothengatter, 2003; Fraser, 2004; Flyvbjerg, 2011; CNN, 2020; Steininger, Groth and Weber, 2021). A trend of underperformance and low productivity has been set and maintained and it is one this sector is struggling to shake. The ICI is no exception in this regard and has its own demons relative to time and budget on major projects (Cunningham, 2017; Engineers Ireland, 2018; McGee, 2019; Department of Public Expenditure and Reform, 2020)

Literature examined indicates that CIs are uneducated on the concepts of LC and a lack of understanding exists (Sarhan and Fox, 2013a, 2013b; Ahmed and Sobuz, 2020; Albalkhy and Sweis, 2020). The ICI is not unlike its global counterparts and also suffers from a lack of education in this area (Ebbs et al., 2015; Power and Taylor, 2019).Membership numbers of Lean Construction Ireland (LCI) are low (Lean Construction Ireland, 2022) and despite government publications identifying poor productivity issues within the ICI and LC being a potential

remedy (Department of Public Expenditure and Reform, 2020; Construction Industry Federation, 2021) it would appear that little progress has been made.

There is a reluctance for stakeholders to move from traditional project management techniques towards the process based collaborative approach that fuels the lean ethos (Nesensohn, Demir and Bryde, 2013; Ghannoum et al., 2019; Hettiaarachchige *et al.*, 2022) which may be compounding the fact that global productivity of CIs is increasing at a lethargic rate (Barbosa et al., 2017).

Industry needs to put a stronger focus on measuring items that fall outside of the commercial remit (Ghannoum *et al.*, 2019). Continual improvement revolves around measuring and monitoring performance on an ongoing basis which therefore requires that processes and workflows should also be considered thus exposing opportunities for improvement (Koskela, 1992). Each workflow in a process is dependent on another and the consequences of one failing can cause a domino effect that causes the next to fail (Wernicke, Lidelöw and Simu, 2019) meaning it is critical to gather data on these workflows throughout the entire process and create opportunity for intervention. Autonomy and leadership are critical qualities to assist in a shift towards continuous improvement (Kelly, 2016).

The manufacturing industry has proven that lean is a vehicle for success (Singh, Singh and Singh, 2018; Kelly and Hines, 2019; McKie et al., 2021). The CI has also demonstrated that LC can help to deliver impressive results (Andersen, Belay and Seim, 2012; Maraqa, Sacks and Spatari, 2021).

A strong Construction Supply Chain is critical in order for project stakeholders to harnesses long term relationships with their suppliers, engage with them collaboratively and form partnerships that develop mutually beneficial strategies (Ewuga and Adesi, 2022). However, stakeholders operating in the commercial remit of projects can be detrimental to these relationships being formed (Ahmed, Pasquire and Manu, 2022).

Building Information Modelling (BIM) by default is a lean tool. BIM and lean methodologies share similar principles and lean is indirectly embedded in BIM. These approaches when combined complement each other and are proven methods of achieving higher quality structures that are produced quicker and cheaper in a more collaborative environment (Sarhan, Olanipekun and Xia, 2016; World Economic Forum, 2016; Koseoglu, Sakin and Arayici, 2018; Meng, 2019; Ahmed and Sobuz, 2020; Albalkhy and Sweis, 2020; Evans *et al.*, 2021; Maraqa, Sacks and Spatari, 2021).

3. Methodology

Quantitative and qualitative data collection methods were used in this exploratory research which required the adaptation of a positivist approach for quantitative and an interpretive approach for qualitative. The mixed methods approach was deemed by the Author as being the best equipped mechanism to provide reliable and valid results in the following areas of interest:

- Determining the current levels of productivity within the ICI.
- Establish the ICIs level of education regarding LC.
- Determine the ICIs current level of engagement in LC.
- Demonstrate how the ICI can learn from the lean experiences of other industries and countries.

3.1 Quantitative Methodology

Purposive sampling was used to identify the target population for the Quantitative research. The target population was deemed to be 239 construction professionals. By using a 6% confidence interval and the target population figure of 239, the Author established that a sample size of 126 respondents was necessary to achieve a 95% confidence level. 131 valid responses were gathered. By using the findings from the literature review the Author compiled a survey consisting of 22 questions. The survey questions employed different formats including multiple choice, some of which offered the “other” option which allowed respondents to engage more precisely when appropriate. The Likert scale method was used in 3 of the questions to extract the attitude of the respondents relative to the research topic.

3.2 Qualitative Methodology

A semi state organisation (Company X) that employs more than 7000 people in the energy sector was identified by the Author as being a suitable source of data. This organisation has in excess of 5 years’ experience in lean and has developed a thriving lean academy. As this organisation operates in an industry not

dissimilar to the ICI and considering their experience in lean, Company X was deemed a source that could provide valuable knowledge to the ICI.

Semi structured interviews were employed for the qualitative element of this study. The information gathered in the literature review and data collected from the quantitative element of this study presented crucial information that was necessary in designing the interview questions. The interviews consisted of a series of open and closed questions. Three interviewees were selected that had successfully passed predetermined criteria.

3.3 Quantitative Data Analysis

Statistical Package for the Social Sciences software was the primary tool used to assist the Author in verifying relationships between variables and extract common trends from gathered data. Cronbach's Alpha was also used to analyse Quantitative data. Cronbach's Alpha is a data analysis technique used to measure and determine the reliability of results gathered from summated rating scales (Cronbach, 1951). This methodology is amongst the most commonly used approaches to determine consistency amongst items in a scale and measures what degree of correlation exists between question responses.

3.4 Qualitative Data Analysis

Upon completion of all semi structured interviews the gathered data was analysed using thematic analysis. In order for qualitative research to be credible, research must be conducted in a systematic manner. It is therefore critical that the consequential data analysis also be conducted systematically in a robust manner that acknowledges the methodologies used are credible (Nowell et al., 2017). Braun and Clarke, (2006) recommend that the steps shown in Figure 1 be followed when using thematic analysis.

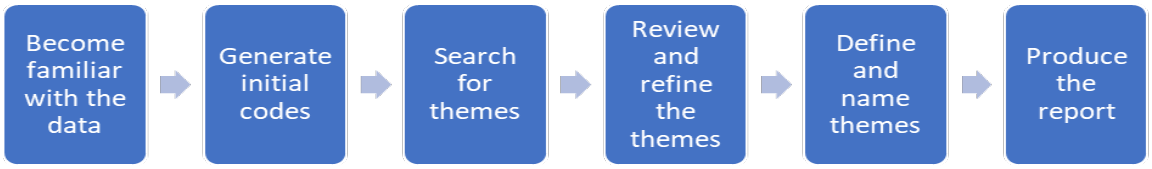

Figure 1: Sequence for the Completion of Thematic Analysis (Braun and Clarke, 2006)

4. Discussion of the Findings

The literature review of this research demonstrated that the ICI is fragmented, underperforming and has a history of delivering projects over time and over budget. The quantitative research element of this study tested the above findings within the ICI and the results resonated with those that emerged in the literature review as 39.7% (n = 52) of survey participants said they are delivering their projects over budget and 40.5% (n = 53) of survey participants said they are delivering their projects late. It would appear that the ICI is explicitly aware of its unproductive status as 76.3% (n = 100) of survey participants feel that their respective organisations could improve regarding the identification and elimination of waste. Multiple factors were proposed by participants as to why projects run over budget and over on time. The common contributing factor that emerged is that poor design leading to excessive variations has a significant negative effect on productivity levels in the ICI.

Despite limited availability of Secondary data applicable to lean in the ICI, the literature review identified that there is a lack of knowledge and education in the ICI regarding lean. Low membership numbers in LCI also outlined in the literature review indicates a lack of belief or interest in this area. The literature examined has recommended that campaigns to educate the ICI in lean are required. The quantitative element of this study tested the above findings and strong correlations emerged such as only 28.2% (n = 37) of survey participants practice LC methodologies and only 26.7% (n = 35) of survey participants employers have considered adopting LC which indicates a lack of knowledge and possibly a lack of faith in lean. The vast majority of participants are not familiar with five of the primary lean methodologies indicating a lack of knowledge in lean. This indication was strengthened by 77.1% (n = 101) of survey participants feeling there is inadequate awareness and knowledge of lean within the ICI. Interviewees that participated in the qualitative element of this research demonstrated a thorough understanding of lean and continuous development in this area through their Lean Academy. Company X are seeing positive results through the education they are providing.

The literature review identified multiple incumbent barriers to lean and these barriers were tested in the Quantitative element of this study. Table 1 presents the top ten barriers to LC in the ICI identified in the Quantitative element of this study.

Table 1: Top 10 Barriers to Lean Construction in the Irish construction industry

Rank	Barrier
1	Lack of education
2	Clients over use of lowest price tendering
3	Traditional Project Management techniques
4	Reluctance from Management to change
5	Poor design making efficient delivery difficult
6	Lean not being a requirement on public contracts
7	Lean not being a requirement on private contracts
8	Lack of Government support
9	Reluctance from Employees to change
10	High turnover of workforce

The barrier related findings shown in Table 1 were used as a basis for further investigation throughout the qualitative element of this research. Data comparison opportunities were limited between the findings shown in Table 1 and that of the qualitative findings. However, some comparisons could be made where learnings can be extracted such as:

- Company X are educating and training their staff to a high level through the establishment of a Lean Academy. It is evident from the findings that this has been a crucial component on their lean journey. The ICI can learn from this, furthermore heeding publications recommending improvement in this area may be a strong starting point in overcoming what appears to be the biggest barrier to lean in the ICI.
- Traditional project management techniques were identified in the literature review as a barrier to lean implementation and this correlated with the findings in Table 1. However, findings from the qualitative element of this study suggest that traditional project management techniques can be successfully blended with lean if used in the right measures.
- Reluctance to change was an additional barrier that emerged from the literature review. This correlated strongly with the findings in Table 1. These findings were further strengthened in the qualitative findings of this research where Company X interviewees stated that they have not fully overcome this barrier and getting buy in from staff presents an ongoing challenge. These correlations indicate that a reluctance to change and achieving buy in from staff is a challenge for more industries than just construction.

Correlations were identified between Table 1 and findings regarding productivity issues discussed earlier. These correlations are shown in Table 2.

Table 2: Correlating Factors Between Lean Barriers and Productivity Issues in the Irish Construction Industry

Barriers	Productivity issues
Clients over use of lowest price tendering. **Lean not being a requirement on public contracts.** **Lean not being a requirement on private contracts.**	Unrealistically low tenders being submitted by Contractors at tender stage.
Poor design making efficient delivery difficult.	Poor design leading to excessive variations.

Table 2 indicates that there may be issues with the procurement mechanisms being employed by the ICI. It would appear that there is an over reliance on lowest price tendering in the ICI. The result of these procurement mechanisms seems to have created an aggressive market where contractors are being awarded contracts at unrealistically low prices which is apparently having a negative effect on budgets and programmes. Table 2 further suggests that the most economically advantageous tender format (De Giacomo *et al.*, 2019) may not be getting utilised as a vehicle to incorporate lean into tenders. The fundamental principle of lean is to reduce waste and increase productivity & profitability. Incorporating lean into Irish tenders and the tender evaluation process would seem to be a prudent choice to encourage lean, increase productivity and create a shift away from the commercial focus currently being put on tenders. Table 2 also indicates that poor design appears to be a barrier to lean and may be a contributing factor to poor productivity within the ICI. As mentioned in the literature review, the flow of information is critical for projects to succeed. The apparent prevalence of poor design in the ICI contradicts the principles of lean and will continue to hamper its progress if not addressed.

An important finding from the literature review was the importance of a strong Construction Supply Chain and long-term working relationships between project stakeholders These strengths combined can contribute to the creation of an environment that allows lean to thrive. The quantitative findings from this research would suggest that there is generally a strong relationship between project stakeholders within the ICI. 51% (n = 67) of survey respondents are maintaining long term relationships with suppliers and Sub Contractors. These findings should be viewed as positive and need to be harnessed, they may help to form a foundation for the ICI to build on and shift towards lean. An additional positive finding from the quantitative research suggests that 70.2% (n = 92) of participants believes collaboration could be further improved upon with stronger adaptation of lean methodologies.

Relationship findings from the qualitative research findings indicate lean has helped Company X break down siloes, improved knowledge sharing and collaboration. This was further complimented by other qualitative findings which indicated lean has positively influenced decision making in Company X. The need for an element of autonomy emerged in the literature review and this is a characteristic that is aligned with the values of lean that promotes continuous improvement. Autonomy was also discussed with Company X and it was felt that an element of employee autonomy was important. The above data is valuable information that the ICI can use to build on the earlier mentioned positives and transition towards lean.

A significant theme that bled through in the literature review is the benefits on offer when implementing BIM and lean concurrently in construction projects and the positive influence that the digitalisation of processes and procedures can have. Interviewees from Company X had not heard of BIM as their core discipline of business is not construction. When asked if they felt Company X had fully benefitted from the digitalisation of processes and procedures responses were quite mixed. Some strong points were made that evidenced digitalisation within Company X, however it was also evident that improvement can be made. This finding correlated with the findings in the quantitative research where 48.1% (n = 63) of survey participants felt they were not maximising the benefits on offer to them through the digitalisation of processes and procedures. Furthermore, findings in this area demonstrated that only 37.4% (n = 49) of survey participants use BIM. These findings suggest that the digitalisation of processes and procedures is a challenging undertaking for more disciplines than construction, however it also suggests that the ICI is implementing BIM on quite a small scale.

Further findings from Company X indicated that interviewees felt lean helped them to complete projects quicker and more cost efficiently, that lean is not restricted to the repetitive environment of a production line which was substantiated by confirmation that lean was successfully being applied throughout many areas of their business.

5. Conclusion

5.1 Limitations of the Research

Several limitations became apparent to the Author throughout this research process such as:

- Limited Irish Literature - Secondary data specific to LC in the ICI was limited. This created an unanticipated gap in the literature which steered the Author to rely quite heavily on LC literature produced outside of Ireland.
- Survey responses – The target audience for the collection of Primary data was created based on a balanced volume of professionals from three categories being contractors, designers and public body

representatives. The number of responses received were not equally balanced between the three categories and contractors were responsible for the majority of responses. A more balanced response rate between the categories would have provided a more accurate representation of the ICI. Additionally, the population sample was skewed towards professionals based in the Leinster area so therefore the findings are somewhat limited to the opinion of Leinster based professionals.

- Semi Structured Interviews – Three strong candidates were interviewed as part of the Qualitative research. Had more candidates been available for interview this may have provided additional information to complement and thicken the valuable data extracted from Company X.

5.2 Further Research

This study has presented multiple opportunities for further research that could provide the ICI with additional knowledge and data to further assist it in becoming a more productive industry such as:

- Poor design – Design issues within the ICI has been suggested in this study as a contributing factor that is hampering productivity levels within the ICI. It is also suggested that poor design is making the implementation of LC difficult. A study to investigate how the ICI can improve in this area could be a worthy area of research.
- Traditional project management techniques – This study identified conflicting opinions regarding the combination of traditional project management techniques with LC. A thorough study to determine how or if these methods should be combined is worth considering.
- Procurement – This study suggests that lowest price tendering is having a negative effect on productivity levels within the ICI and the implementation of LC. Further study in this area could be a valuable exercise that may confirm or refute this indication.
- Digitalisation – This study suggests that it is not only the ICI that is struggling to master the digitalisation of processes and procedures. Further study should be considered in this area to try and establish what the existing barriers are and how they can be overcome.
- BIM and lean – This study suggests that BIM and lean complement each other when implemented concurrently. If the ICI can successfully incorporate LC more heavily into its regime, it could be very valuable in the future to carry out a study to identify a strategy that could assist the ICI in successfully marrying these mechanisms.

6. Conclusion

The findings from this study suggest that the ICI is fragmented and operating in a wasteful and unproductive manner. Stakeholders within the ICI are aware of this deficiency and are also aware that improvement is needed. LC is proposed in this study as a remedy that can contribute to the ICI transitioning from its current state towards a lean and productive state. This study has demonstrated that lean can produce impressive results when implemented and this has been historically proven in the manufacturing industry and more recently in the construction industry. The myth that lean cannot be implemented outside of a repetitive environment is a weak argument and one that must be extinguished.

However, in order for this transition to be possible the ICI must be willing to embrace change and adopt a new way of thinking. The ICI should consider accepting the recommendations proposed in this research and previous publications and become educated on the principles and merits of lean. A lack of education is suggested as being the biggest barrier to LC in the ICI, but many others exist. Leadership, experience and a hunger for cultural change are required to promote an initiative to combat the lack of education barrier, however these qualities will also be crucial in overcoming the other barriers outlined in this study.

6.1 Recommendations

Subsequent to the analysis of the findings in this research the Author recommends the following:

In the interest of creating a more productive industry, all stakeholders involved in the ICI must come together to formulate a mechanism or campaign that will promote and educate the ICI on the principles and merits of LC. LCI currently provides white, yellow and green belt lean training (*Books - LCi Lean Construction Ireland*, 2023) and Atlantic Technological University currently offer a free lean six sigma white belt course (*Free Online Courses - Atlantic Technological University Sligo*, 2023). Such resources are very valuable to the ICI and should

be harnessed to help break down the lack of education barrier that exists. Financial support may be required from government to assist such a campaign but support of this kind must be viewed as an investment that will be reimbursed to the state over time. Successful roll out of such a campaign will also play its role in protecting public funds that are invested in public capital projects and promote value for money within the ICI.

As lean is a proven mechanism for increasing productivity and reducing waste in the construction industry and other industries the government should consider investigating ways to incentivise its use. This should be done in conjunction with the incentivisation of BIM, modern methods of construction and digitalisation in general.

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