UTS ePRESS

Construction Economics and Building

Vol. 21, No. 3
September 2021



**Citation:** Demirkesen, S., Sadikoglu, E., and Jayamanne, E. 2021. Assessing Psychological Safety in Lean Construction Projects in the United States. *Construction Economics and Building*, 21:3, 159–175. http://dx.doi.org/10.5130/AJCEB.v21i3.7657

ISSN 2204-9029 | Published by UTS ePRESS | https://epress.lib.uts.edu.au/journals/index.php/AJCEB

ARTICLE (PEER REVIEWED)

# Assessing Psychological Safety in Lean Construction Projects in the United States

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**DOI:** http://dx.doi.org/10.5130/AJCEB.v21i3.7657
**Article History:** Received: 30/03/2021; Revised: 24/06/2021 & 20/07/2021; Accepted: 20/07/2021; Published: 10/09/2021

## Abstract

The construction industry is hazardous, which requires careful consideration of occupational health and safety measures. Among various strategies that are proposed to enhance construction safety, Lean construction practices were widely implied and proved to be effective. However, the link between Lean implementation and construction safety has not been completely studied yet in previous research in terms of psychological safety context. This study implies that psychological safety is of utmost importance in terms of explaining the association between Lean and safety. Lean implementation elements such as respect for people, trust, leadership, and continuous improvement positively affect employees' psychological safety. In this context, semi-structured interviews and a survey were conducted with employees working in U.S. construction companies. The interviews provided that the majority of the construction employees do not feel psychologically safe at their workplaces either in traditional or Lean construction projects due to a number of reasons such as heavy workload, and deadline pressures. However, it was found that construction workers feel safer psychologically in Lean construction projects compared to traditional projects. According to the interview results and literature review, a conceptual model was proposed. Therefore, this study can contribute to the research area of psychological safety in the construction industry.

**DECLARATION OF CONFLICTING INTEREST** The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. **FUNDING** The author(s) received no financial support for the research, authorship, and/or publication of this article.

## Keywords

**Psychological Safety; Lean Construction; Respect for People; Continuous Improvement; Construction Safety**

## Introduction

The construction industry is one of the most hazardous industries and it is highly prone to accidents, injuries, and safety risks (Khosravi, et al., 2014; Li, et al., 2015; Yiu, et al., 2019; Demirkesen, 2020). According to the report of the U.S. Bureau of Labor Statistics, 5,333 fatal occupational injuries in the private sector were reported in 2019 and 1,061 of those occurred in the construction industry (US Department of Labor, 2020). This tragedy continues to occur despite the efforts for promoting construction safety. Occupational safety is a significant concern that construction companies need to pay attention to sensitively. Hence, investigating the root causes of accidents, which help to prevent accidents, is sometimes troublesome (Khosravi, et al., 2014). Several studies implied that the majority of accidents occur because of the unsafe behaviour of human (Li, et al., 2015). An extensive literature review conducted by Khosravi et al. (2014) specified various key factors leading to unsafe behaviour and eventually to accidents in the construction industry. These factors were found to be associated with "individual characteristics, workgroup, supervision, project management, site condition, contractor, organization, society" (Khosravi, et al., 2014).

Effective safety management in construction projects helps to prevent accidents and injuries in addition to maintaining occupational health and safety (Loushine, et al., 2004). Besides, it results in improved morale of employees, safety awareness, high-quality project processes, increased productivity, and less direct and indirect costs (Levitt and Samelson, 1993; Yiu, et al., 2019). The construction firms completing projects with no work-related accidents or a low rate of accidents are likely to be recognized in the industry as trustworthy and highly reputed firms (Chileshe and Dzisi, 2012). This increases their chance of awarding more projects with a good record of safety performance (Levitt and Samelson, 1993).

The construction companies are seeking ways to improve their safety performance (Goh, et al., 2012). As a result, various strategies and techniques are proposed (Gambatese, Pestana and Lee, 2017). Among those, going Lean is of critical importance (Antillón, et al., 2011). The impact of Lean practices in promoting occupational health and safety has already been implied in various studies (Schafer, et al., 2008; Nahmens and Ikuma, 2009; Howell, Ballard and Demirkesen, 2017; Moaveni, Banihashemi and Mojtahedi, 2019; Demirkesen, 2020). For example, the use of Last Planner System, a Lean technique, was proposed for promoting safety planning (Saurin, et al., 2001). Moreover, Saurin, Formoso and Cambraia (2006) considered the application of autonomation and visual management to safety management. Mitropoulos, Cupido and Namboodiri (2007) examined Lean practices and concluded that they decrease the likelihood of accidents by reducing uncertainty, rework and matching competency, and task demand.

Even though previous studies proposed valid and appropriate implications, there is a missing link that mediates the relationship between Lean implementation and occupational health and safety. A major portion of studies mentioned that safety-related problems result in waste from the Lean perspective (Antillón, et al., 2011; Moaveni, Banihashemi and Mojtahedi, 2019). However, this is not the only synergy between Lean construction and safety. Gambatese, Pestana and Lee (2017) emphasized that Lean construction and safety management practices differ in terms of worker behaviour, which is emphasized as a gap in between. Therefore, this study hypothesizes that the missing link is the psychological safety of the construction workers. In order to hypothesize these relations, the association between Lean implementation and psychological safety is examined. The study proposed that Lean implementation promotes psychological safety. Further, psychological safety and construction safety are studied and proposed to be positively related. The aim of this study is to inspect the relationship of Lean implementation, psychological safety, and occupational health and safety in the construction industry context. In this respect, the objectives

of the study are to assess the level of psychological safety in Lean and non-Lean construction projects through interviews and a questionnaire, provide insights from the industry employees and develop strategies accordingly, and reveal different levels of psychological safety with respect to various categories such as age, position, gender, and Lean vs. traditional (non-Lean) projects. The main contribution of this study is to create awareness for psychological safety and encourage employers to address concerns for not feeling safe at work.

## Research Background

Based on an extensive literature review, psychological safety concept and related studies in the construction industry are presented. Moreover, relationships among psychological safety, Lean construction, and safety are investigated with respect to previous studies.

### PSYCHOLOGICAL SAFETY

Psychological safety was defined as "feeling able to show and employ one's self without fear of negative consequences to self-image, status, or career" by Kahn (1990, p. 708). Being as a seminal work, Edmondson (1999, p. 350) expressed psychological safety as a "shared belief held by members of a team that the team is safe for interpersonal risk-taking". Psychological safety facilitates the expression of ideas freely, speaking up about concerns, mistakes, and errors without fear (Edmondson, 2018).

In the existing literature, three levels of psychological safety were studied namely the organizational level, team level, and individual (dyadic) level (Newman, Donohue and Eva, 2017). Even though psychological safety has several levels, it is identified to be more important and meaningful at the team level (Newman, Donohue and Eva, 2017). Because, each team has different relationships among individuals which are mostly influenced by leaders within an organization (Edmondson, 2018).

An extensive literature review conducted by Edmondson (2018) specifies that previous studies can be grouped under different categories in terms of psychological safety. Some studies emphasized the lack of psychological safety leading to failures in the organizations (Carmeli and Gittell, 2009; O'Donovan and McAuliffe, 2020). Several studies revealed the positive relationship between psychological safety and organizational performance (Baer and Frese, 2003; Edmondson, 2004). A large number of studies investigated the effect of psychological safety on learning and found a positive relation (Edmondson, 2004; Carmeli and Gittell, 2009; Nembhard and Edmondson, 2012; Kumako and Asumeng, 2013; Ortega, et al., 2014; Roussin, MacLean and Rudolph, 2016; Frazier, et al., 2017; Kim, Lee and Connerton, 2020). Moreover, psychological safety was found to result in knowledge sharing, learning from failures, employee satisfaction, engagement, commitment, and creativity (May, Gilson and Harter, 2004; Carmeli and Gittell, 2009; Bornemisza, 2013; Ulusoy et al., 2016; Frazier et al., 2017). Besides, there are other studies identifying the role of psychological safety that weakens or strengthens other relationships (Edmondson, 2018). Ortega et al. (2014) investigated the mediator role of psychological safety for assessing the relation between change-oriented leadership, team learning, and team performance. Carmeli and Gittell (2009) revealed the mediating role of psychological safety between good relationships and learning from failures.

To measure psychological safety, Edmondson (2018) created a scale consisting of 7 items. In the previous studies, the scale of Edmondson (1999) was employed most often (Bornemisza, 2013; Kumako and Asumeng, 2013; Ortega, et al., 2014; Roussin, MacLean and Rudolph, 2016). In some studies, modified versions of the scale were utilized (Henrichs, 2009; Bilstad, 2016). Some other studies made modifications to measure organizational level psychological safety (Baer and Frese, 2003). On the other hand, several other studies developed their own scales (May, Gilson and Harter, 2004). Considering the wide and common use of Edmonson's scale, this study measures the psychological safety of construction employees in construction projects with an adapted version of this scale. Seven items were assessed to measure psychological safety.

A sample item is 'it is safe to take a risk on your team'. Responses were scored with a five-point scale from 'never' to 'always', where never=1 and always=5. High scores indicate that individuals feel comfortable with taking risks and do not fear being judged or isolated.

## PSYCHOLOGICAL SAFETY IN THE CONSTRUCTION INDUSTRY

Psychological safety is valuable and essential especially for risky and hazardous workplaces, where the safety of employees and customers is critical. It is important to decrease errors and increase occupational safety at work (Newman, Donohue and Eva, 2017). The significance of psychological safety was articulated by Edmondson (2018, p. xv) as "psychological safety can make the difference (…) between a near miss and a catastrophic industrial accident or between strong business performance and dramatic, headline-grabbing failure".

Psychological safety was studied in various industries such as health care, manufacturing and aviation. Similar to these industries, the construction industry is also hazardous and accident-prone, where safety is of critical importance. The main reason behind many of the accidents in the construction industry is reported as human behaviour (Li, et al., 2015). Accordingly, several researchers investigated behaviour-based safety during the past decades (Guo, Goh and Le Xin Wong, 2018). These studies assessed the role of human behaviour in accidents and aimed to eliminate unsafe behaviour (Li, et al., 2015).

Even though psychological safety considers the human aspect, it rather investigates people's perceptions of risks in sharing their ideas and disclosing errors. In this respect, one may assert that the number of studies related to psychological safety is limited (Gomez, et al., 2019, 2020) and more research needs to be developed (Xie, et al., 2020). On the other hand, the construction industry involving the riskiest task demands needs psychologically safer workplaces to improve productivity and reduce occupational health and safety risks. This in turn creates a research gap in the literature.

The construction industry is highly labour-intensive. Hence, the performance of construction projects depends on construction employees' productivity adding value to the process. In order to increase value, it is important to make employees feel psychologically safe (Gomez, et al., 2020). The latent but more important impact of psychological safety can be understood from the following statement of Edmondson (2018, p. 71) "A lack of psychological safety can create an illusion of success that eventually turns into serious business failures".

A large number of studies examined the psychological safety climate in the construction industry. Xie et al. (2020) approached psychological safety climate based on job demands and resources model. They used an existing psychological safety climate scale including four dimensions which are "management support, management priority, organizational communication and organizational participation" (Xie, et al., 2020). They compared two construction projects and found that in megaprojects psychological safety climate level is higher than in ordinary projects. On the other hand, they did not observe a statistically significant difference in the responses when compared in terms of position, age, gender, and marital status. Shen et al. (2015) investigated the contributors to psychological safety climate on a model, which is composed of "structural, perceptual, interactive and cultural perspectives" (Shen, et al., 2015, p.223) and further implied that the individual level has been examined rarely despite some studies are available on the subject matter.

Most of the studies referred to psychological safety climate as "employee's perception of the value or priority of safety at his or her workplace" (Morrow, et al., 2010, p. 1461). However, psychological safety and psychological safety climate should be distinguished. Psychological safety climate refers to the perceptions of employees about workplace safety (Schwatka, Hecker and Goldenhar, 2016), where psychological safety is more of like how employees feel about disclosing their opinions. The literature shows that very similar concepts have been investigated, however, psychological safety was not the main subject as a distinct concept.

## PSYCHOLOGICAL SAFETY, LEAN CONSTRUCTION AND CONSTRUCTION SAFETY

Reviewing studies that investigate psychological safety and Lean construction reveals the significant relation between them (Schafer, et al., 2008; Howell, Ballard and Demirkesen, 2017; Gomez, et al., 2019, 2020). Lean philosophy values people and puts them in the core (Liker and Convis, 2011). This shows respect for people which is one of the most significant elements of Lean implementation. Howell, Ballard and Demirkesen (2017) proposed that respect for people promotes psychological safety in Lean construction. Edmondson (2018, p. 18) also supported this view by stating that "Psychological safety thrives in an environment of mutual respect." In addition to mutual respect, trust also has a positive impact on psychological safety (Edmondson, 2004; May, Gilson and Harter, 2004; Cauwelier, Ribière and Bennet, 2016; Frazier, et al., 2017).

Communication is a source of motivation in Lean construction projects, where a collaborative environment is created through Lean philosophy and Lean tools such as the Last Planner System. At the same time, communication helps to increase psychological safety (Edmondson, 2018). Carmeli and Gittell (2009) implied that high-quality relationships are significantly related with psychological safety. For the management of relations among team members, Lean leadership plays an important role. Lean leadership helps to implement Lean principles, enhance communication and collaboration, promote culture of continuous improvement (Sadikoglu, et al., 2020). Team leader behaviour is also an antecedent to psychological safety and Lean leadership has potential to promote psychological safety (Cauwelier, Ribière and Bennet, 2016). Schöttle, Christensen and Arroyo (2019) investigated the inclusiveness during decision-making process through a case study in a Lean construction project. They proposed that choosing by advantages (CBA) method promotes inclusiveness, avoids group thinking, and develops psychological safety.

Problem-solving is another important aspect of Lean culture. In Lean philosophy, root cause analysis helps to tackle problems at the root before they turn into mistakes and continuous improvement helps to sustain the improvement. Similarly, a psychologically safe work environment helps to reduce workarounds, which are temporary solutions to problems. Teams with high psychological safety analyse problems and improve the processes to prevent them to occur again rather than relying on workarounds (Edmondson, 2018). Continuous improvement is a cornerstone in Lean philosophy that helps to consider the room for improvement (Liker and Convis, 2011). Considering a psychologically safe environment, sharing and discussing new ideas may help to achieve better ways of implementation leading to continuous improvement. Hence, one might conclude that psychologically safe employees can be motivated to adopt Lean concepts and apply tools and techniques for better performance. In that way of thinking, Lean thinking and psychological safety can be considered as mutually supporting concepts.

In Lean construction, people oftentimes act with self-confidence knowing that the responsibility is shared in case of success and failure. This is possible with no blame culture, where responsibility is shared among team members and team members feel safe about disclosing their ideas without the fear of being judged. This also coincides with some characteristics of a psychologically safe work environment, mentioned by Edmondson (2018). Error reporting and feeling safe to speak about mistakes help to learn from mistakes. Removing factors causing fear enhances learning and cooperation (Edmondson, 2018). Hence, it can be stated that the environment created by Lean philosophy helps to increase psychological safety.

Value creation and waste elimination are the main objectives of Lean construction. Waste is identified as anything that does not create value. Along with seven wastes of Ohno, (1988) namely "waiting, moving, transporting, inventory, over-processing, overproduction, defective production", loss of human potential was also considered as waste (Macomber and Howell, 2004). "Not listening" and "not speaking" were identified as two great wastes by Macomber and Howell (2004). In Lean culture, value is considered to be created primarily by employees. Considering the view of Lean in terms of human potential, value creation, and waste elimination can be associated with psychological safety. Given this background, the essentials of

Lean construction are emphasized. On the other hand, traditional construction projects oftentimes struggle with poor communication and collaboration, teams with a lack of problem-solving skills, and low respect for people. Koskela, et al. (2002) implied that conventional project management in construction fails to create value for the customer since it does not rely on a transformation-flow-value framework. Love, et al. (2018) further mentioned that successful safety management is strongly related to reducing rework, which is possible through early identification and elimination of errors. This becomes easier when communication channels are open between team members and adopting a 'no blame' culture by the organization. Hence, a shift in focus is required. This study investigates psychological safety in Lean construction projects in the U.S. The U.S. was selected as the region of origin for the study for a number of reasons. Firstly, U.S. contractors are highly experienced in Lean construction and psychological safety studies are broad in the U.S. (Edmondson and Lei, 2014). Hence, U.S. contractors are more familiar with the concept than other contractors in other regions worldwide. Below hypotheses were developed based on these findings.

## HYPOTHESIS DEVELOPMENT

Through the in-depth analysis of past studies and comparative assessment of findings of previous research, three hypotheses were developed. The first hypothesis proposed that Lean implementation has a positive impact on psychological safety. The second hypothesis proposed that psychological safety promotes construction safety. The third hypothesis reveals that psychological safety acts as a partial mediator between Lean implementation and construction safety.

*Hypothesis 1:* Lean implementation positively affects psychological safety through respect for people, trust, communication, lean leadership, problem-solving, continuous improvement, no blame culture, value creation, and waste elimination. In the construction industry, most of the incidents are caused by organizational, cultural, and human-related factors (Duryan, et al., 2020). To eliminate these factors, learning behaviour can have a critical role in enhancing construction safety. Duryan, et al., (2020) concluded that learning from previous events, managing and transferring the knowledge help to enhance health and safety performance in the construction companies. On the other hand, most of the psychological safety studies implied that a psychologically safe work environment facilitates learning (Edmondson, 1999, 2018; Kumako and Asumeng, 2013; Ortega, et al., 2014; Cauwelier, Ribière and Bennet, 2016). Edmondson, (1999, p. 351) mentioned some learning behaviours which are "sharing information, seeking feedback, asking for help, talking about errors and experimenting". These learning practices may help to reveal and discuss improper implementations, avoid errors, learn more about the way work is done, and develop new and better ways of work. In that sense, it can be proposed that psychological safety can promote construction safety through learning. This is in line with the proposition of Howell, Ballard and Demirkesen, (2017). They concluded that learning behaviour enhances occupational safety and the work performance of the team. Further, Gomez, et al. (2019) revealed that building a psychologically safe environment results in better team performance, high quality, and safety in construction projects.

Along with these studies, the below hypothesis was developed, as follows.

*Hypothesis 2:* Psychological safety promotes construction safety through learning.

There are plenty of studies examining the impact of Lean construction on construction safety (Schafer, et al., 2008; Nahmens and Ikuma, 2009; Howell, Ballard and Demirkesen, 2017; Moaveni, Banihashemi and Mojtahedi, 2019; Demirkesen, 2020). The main feature of this study that distinguishes it from other studies investigating the relation between Lean construction and construction safety is considering the worker aspects in terms of psychological safety.

Given this background, psychological safety is placed at the intersection of Lean construction and construction safety. The study proposes the below hypothesis to locate psychological safety in Lean construction and construction safety.

*Hypothesis 3:* Psychological safety acts as a partial mediator in the relationship between Lean implementation and construction safety.

## Methodology

The extensive review of literature provided that the number of studies investigating psychological safety in the Lean construction context is limited. Hence, this study aims to provide a basis for this research area. Newman, Donohue and Eva (2017) inspected in their systematic literature review that qualitative studies contribute to the explanation of the reasoning and mechanism of psychological safety, and its effects and outcomes. Hence, a qualitative approach is adopted in the scope of this study to better understand psychological safety in the construction industry context. In this respect, semi-structured interviews were conducted with construction employees, which is a common research technique in qualitative research. Following semi-structured interviews, a complementary quantitative survey was distributed to the same group of construction employees, who are experienced both in Lean and non-Lean construction projects. The data was collected from U.S. contractors that have a broader experience with Lean construction and psychological safety than other contractors operating in different locations worldwide. The U.S. contractors' experience and familiarity with Lean implementation methods also fostered researchers to conduct interviews with them to have more comprehensive responses. Moreover, the questionnaire survey was also sent out to the U.S. contractors that might provide more reliable responses regarding their work environment, which has already been familiar with both the psychological safety and Lean.

This study employed both qualitative and quantitative data collection to analyse results. In their systematic review of psychological safety literature, Newman, Donohue and Eva (2017) implied that qualitative research was used to explain the antecedents and outcomes of psychological safety. On the other hand, quantitative research helps understand the strength of the relations between them. In this study, hypotheses were tested using complementary qualitative and quantitative data. For instance, Cauwelier, Ribière and Bennet (2016) similarly utilized mixed method research using structured interviews and a quantitative instrument to investigate the links between psychological safety, learning behaviour, and team performance. Even though hypothesis testing with qualitative data is somewhat controversial, Chigbu (2019) provides evidence from the literature and reveals using qualitative data in hypotheses testing. Hence, the study rather adopted a mixed method of research.

### SEMI-STRUCTURED INTERVIEWS AND QUESTIONNAIRE STUDY

Semi-structured interviewing provides information that can be compared through identical questions; however, it also gives the flexibility to collect other significant information through additional questions according to the flow of the conversation (Saunders, Lewis and Thornhill, 2009). This method allows respondents to express themselves in a free environment, speak freely and open room for discussion. In this study, originally, face-to-face semi-structured interviews were planned. However, due to COVID-19 regulations, a self-administered interview methodology was employed. Even though there is a risk of a low response rate with this method, it may give more privacy to respondents (Amoah and Simpeh, 2020). For the interviewees, a prior investigation was collected to come up with a stratified sample. Interviews were conducted with the construction employees working at U.S. construction companies. The interviewees were selected among construction workers, engineers, architects, and managers (top, middle, and front). The interview consisted of three sections as general information about the interviewee, general information about the organization, and open-ended questions for psychological safety.

A total of 17 interviews were conducted to evaluate the impact of psychological safety in Lean construction projects. Even though the sample size is not large, it can be considered satisfactory for a qualitative study. Several studies report a saturation point where additional answers do not provide a

significant increase in information. Guest, Bunce and Johnson (2006) reached saturation point after 12 interviews which explained 92% of total produced codes in qualitative data analysis. Further, Amoah and Simpeh (2020) reported the 14th interview as a saturation point. The saturation point for this study was observed after 12th interview.

According to interview data, it was found that the average interviewee age was 37. It was observed that 65% of the interviewees were male, where 35% were female. The majority of the interviewees hold a BSc degree (70%). In terms of experience in the construction industry, it was revealed that the average experience was 12 years in the industry, where average experience in Lean construction was 4 years. Moreover, average experience in the current organization was found to be 9 years. Considering the current role of the interviewees in their organizations, the majority of the interviewees were workers (37%), where a considerable portion was engineers (30%). In Table 1, detailed information regarding interviewees can be seen. All participants were experienced in both traditional and Lean construction projects. Hence, they were able to compare Lean and non-Lean construction projects.

Table 1. General information regarding interviewees

| Interviewee | Role | Experience (number of years) | | |
|---|---|---|---|---|
| | | in the construction industry | in lean construction | in the current organization |
| 1 | Project Manager | 17 | 8 | 10 |
| 2 | Worker | 28 | 9 | 17 |
| 3 | Civil Engineer | 13 | 4 | 10 |
| 4 | Worker | 16 | 6 | 14 |
| 5 | Worker | 12 | 5 | 8 |
| 6 | Architect | 18 | 7 | 14 |
| 7 | General Manager | 16 | 4 | 12 |
| 8 | Project Manager | 8 | 2 | 6 |
| 9 | Civil Engineer | 10 | 2 | 8 |
| 10 | Civil Engineer | 17 | 3 | 15 |
| 11 | Worker | 6 | 1 | 5 |
| 12 | Lean Leader | 8 | 7 | 3 |
| 13 | Architect | 5 | 3 | 3 |
| 14 | Civil Engineer | 9 | 2 | 7 |
| 15 | Production Engineer | 5 | 2 | 4 |
| 16 | Worker | 10 | 7 | 5 |
| 17 | Worker | 5 | 2 | 3 |

In the second part of the interview, information regarding the organizations that interviewees work in was collected. According to the data, it was detected that the average experience of the organizations in the construction industry was found to be 52 years, where the average experience of the organization with Lean

construction was determined as 8 years. This shows that the responding companies are highly experienced in both the construction industry and Lean construction.

The third part of the interviews consisted of open-ended questions related to psychological safety at work. Team level psychological safety was studied with the help of items created by Edmondson (1999). These items were converted into questions to make room for further investigation. For instance, the item "If you make a mistake on this team, it is often held against you" was asked as "When you do a mistake, how your team members react to you?". Further, interviewees were asked to give examples that they did or did not feel safe to speak up (Edmondson, 2018). The main reasons of not speaking up were questioned and the potential consequences of speaking up that hindering them were discussed. The environment that makes them psychologically safe was enquired. Besides, the effect of psychological safety on productivity and construction safety performance was examined. Moreover, the relationship between Lean philosophy and psychological safety was evaluated.

In addition to the semi-structured interviews, a quantitative questionnaire was administered to same sample of respondents. The reason the research employed a mixed method of research rather than using qualitative or quantitative data only was to ensure comprehensiveness and reliability of findings. Previous research has already justified the use of mixed method of research in terms of comprehensiveness, enhanced confidence in research findings, facilitating one method over the other through sampling guidance, and increase reliability (O'Cathain, Murphy and Nicholl, 2007). Further, the quantitative survey helps researcher contextualize qualitative findings and enhance interpretations (Frels and Onwuegbuzie, 2013). A total of seven items were composed to measure psychological safety. Some of the items were 'when you make a mistake, your team members negatively react to you' and 'members of your team can bring up problems and tough issues'. The respondents were asked to assess these items on a five-point scale, where 1=never and 5=always. The responses to the questionnaire are presented in the findings section.

## Findings

The first question was "When you do a mistake at work, how your team members react to you? (negative or positive)". This question was perceived differently based on the current role of the interviewees. For example, the majority of the workers responded that their team members react in a bad manner when they commit an error at work. One worker expressed this as "I carry the feeling of being judged when I am about to speak up the errors I detect, this makes me feel very demotivated to talk about errors and findings ways to solve them with my colleagues. I also have the fear of losing my job in case I cannot fix my error if I am the responsible one for the error". The second question of the interview was "Do team members of your team can bring up problems and tough issues?". Most of the interviewees said no to this question indicating that their team members oftentimes avoid bringing tough issues into question. One interviewee expressed this as "Making things appear is sometimes misperceived in our organizations as if we are looking for a promotion or a reward by the top management. The essential purpose is to fix problems in the processes".

The third question of the interview was "Do people on your team isolate others for being different?". The answers differed to this question. One interviewee having a manager role replied to this question as "This is quite rare in my organization. In general, people value others' thoughts and opinions. Being different is not a matter of fact, where the essential purpose is to fix problems together." On the other hand, an interviewee working as an architect expressed those isolations sometimes happen when defending his ideas aloud. One other question in the interviews aimed to reveal whether it is safe to take a risk on the team. The majority of the interviewees implied that risk-taking behaviour mostly depends on the specific case. They further emphasized that it is sometimes possible to take a risk knowing the no-blame culture exists in the team, whereas it is sometimes not quite easy to take a risk in cases relating to serious risk potential.

A couple of interview questions aimed to reveal whether interviewees feel comfortable when asking their team members for help and whether the team members undermine their efforts. Almost half of the interviewees implied that they feel comfortable asking for help but also stated that this relies on team member's position from whom they asked for help.

Three interviewees expressed that some of their team members act in a way undermining their efforts to favour themselves. Some other interview questions aimed to gather information about cases when team members benefit from their colleagues' expertise and experience. Almost all interviewees listed cases, where team members benefit from their expertise.

Further, another interview question was posed to the interviewees asking cases, where interviewees did not feel comfortable to speak up to their managers and reasons for the discomfort. The interviewees further explained that trust and motivation are two important things that make them comfortable speaking up about errors at work. Similarly, Gomez, et al., (2019) reported that construction workers feel safe in cases of good communication and behaviour of people. The interviewees mentioned that psychological safety affects their performance and motivation at work implying that a psychologically safe environment makes them feel confident. They emphasized that Lean principles contribute to psychological safety especially respect for people and no blame culture. Finally, the same interviewees working in traditional construction projects expressed more concerns related to psychological safety as opposed to ones working in Lean projects. Members of Lean construction projects expressed that they feel safer in their work environment.

Finally, the quantitative survey resulted in important findings in terms of the psychological safety level of construction professionals for age, gender, position, and project type (Lean vs. traditional). The respondents were asked to rate the seven items developed adopting Edmondson's (1999) study. The average values were derived for each category. Table 2 presents this comparison concerning mentioned variables.

Table 2. Comparison of psychological safety levels concerning age, gender, position, and Lean vs. traditional projects

| Category | Psychological Safety Level (Average) |
|---|---|
| **Age** | |
| 25-35 yrs | 4.56 |
| 35-45 yrs | 4.78 |
| 45-55 | 3.90 |
| 55 and more | 4.01 |
| **Gender** | |
| Male | 3.85 |
| Female | 3.60 |
| **Position** | |
| Engineer | 3.15 |
| Architect | 3.02 |
| Project Manager | 4.06 |
| General Manager | 4.51 |
| Lean Leader | 4.70 |
| Worker | 2.89 |
| **Type of Project** | |
| Lean | 4.10 |
| Traditional | 2.71 |

### CONCEPTUAL MODEL

According to the interview results and the extensive literature review, a conceptual model was proposed introducing factors affecting psychological safety and its possible outcomes in Lean construction projects. Figure 4 presents the conceptual framework developed in this context. Three hypotheses are shown on the model. According to this figure, it is observed that respect for people, trust, communication, leadership, problem-solving, continuous improvement, no blame culture, value creation, and waste elimination are essential and explanatory elements of Lean implementation impacting psychological safety. It is further indicated that psychological safety positively affects construction safety, which comprises elements like risk-taking behaviour, safety awareness, motivation, planning, and work safe culture context. The explanatory items of Lean implementation and construction safety were developed based on the most cited indicators in the literature. The conceptual model developed was composed based on the insights provided by the interviewees and feedback provided by the participants was aligned with the findings of previous studies.

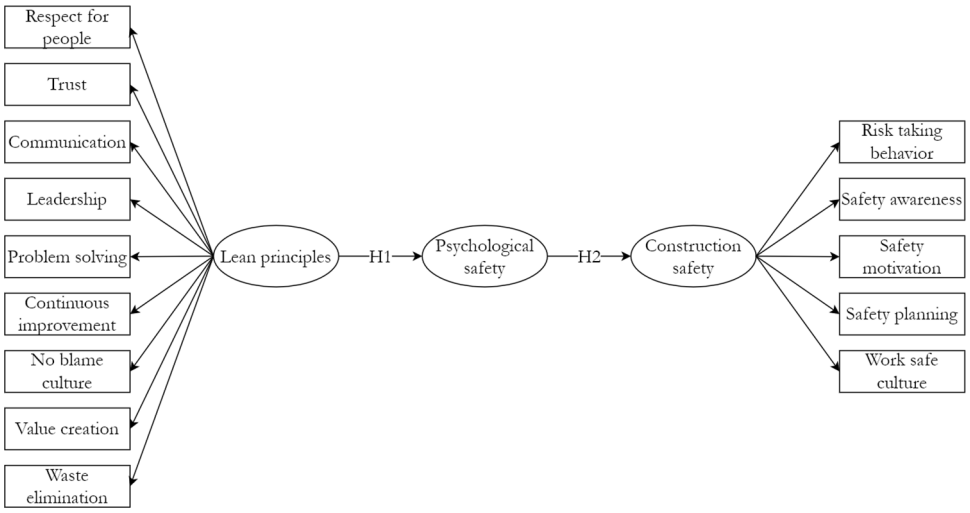


Figure 4. Conceptual Framework

## Analysis and Discussion of Hypotheses

This study aimed to explain how psychological safety and Lean construction principles are interrelated in the construction safety context. It further aimed to reveal why construction workers may not feel psychologically safe in traditional construction projects, as opposed to feeling safer in Lean construction projects. This might be well explained with the hypothesis that Lean implementation positively affects psychological safety through respect for people, trust, communication, lean leadership, problem-solving, continuous improvement, no blame culture, value creation, and waste elimination. As the interviewee emphasized, Lean implementation focuses on process improvement, which potentially encourages workers to use their problem-solving skills and make errors visible through enhanced communication and trust. To assess the relations behind that, semi-structured interviews were conducted with construction industry members. The interviews were inspected in several aspects. For example, the interviewees were detected to answer interview questions differently especially based on their positions at their organizations. Gomez, et al., (2020) mentioned that differences in hierarchy and status might affect employees the way to speak up and disclose concerns. Lower-status employees are likely to feel less psychologically safe than higher-status employees in the organization's hierarchical structure. People may hesitate to reveal their opinions, consciously or unconsciously to protect their image, prevent negative career consequences (Edmondson, 2018).

Most of the interviewees reported that they stayed silent in the case of detecting errors or unwanted cases. On the other hand, staying silent is very common, even if the idea or question is important (Edmondson, 2018). The main reasons for silence are thinking that it is not necessary to embarrass others and be worried about being perceived as negative (Edmondson, 2018). Employees are likely to think that being quiet is safer than speaking up; since "no one was ever fired for silence" (Edmondson, 2018, p. 34). The interview results further indicated that employees consider being silent depending on their status as well. Higher status employees raised fewer concerns about staying silent, where lower status employees emphasized that they mostly stay silent in serious cases, which might cause them to be fired if they speak up about the errors. This also shows that the level of psychological safety affects the level of employee satisfaction (Edmondson, 2018). May, Gilson and Harter (2004) revealed that psychological safety is associated with job enrichment and work role. They further implied that supportive supervisor relations and rewarding employees are positively associated with psychological safety. This finding might be attributed to the hypothesis that psychological safety promotes construction safety through learning. In a psychologically safe environment, people are more willing to disclose errors and ask for help in a more comfortable way. This in turn leads to enhanced construction safety through learning, where a safe environment is key to conceive and practice things.

Further analysis of the interview results indicated that the majority of the interviewees do not feel safe to raise concerns about upper-level managers' errors or organization-related problems. They also added that they oftentimes hesitate to speak up about the ideas for improvement. Milliken, Morrison and Hewlin's (2003) study mentioned that silence is related to a set of organizational issues and respondents of this study mostly emphasized that they were not comfortable with raising concerns and speaking about those to the people above them. Female interviewees of this study even raised more concerns for the reason of silence because they might be exposed to 'mobbing' for voicing errors observed by them. This might be attributed to the hypothesis that psychological safety acts as a partial mediator in the relationship between Lean implementation and construction safety. The essential value in Lean implementation is to create a collaborative environment for making errors visible, which reinforces the safety perception of construction employees.

Interviews were also inspected in terms of respondent's age. Young interviewees were detected to have more courage for uttering what they see wrong, whereas middle-aged or old employees feel more fear about losing their job for disclosing mistakes. This might stem from the fact that young employees feel more comfortable raising concerns knowing that they are at the beginning of their career journey, where middle-aged or old employees whose status is upper are more concerned with losing their jobs. Hence, psychological safety was observed to be higher for the young employees.

Moreover, thirteen employees working in Lean construction projects implied that they feel safer in their projects, where respect for people is the organization's vision and continuous improvement is the main motivation. On the other hand, four employees, who worked in non-Lean projects before mentioned that traditional construction has several drawbacks such as heavy workload, unorganized workplace, and deadline pressures which might result in increased workplace accidents.

## Conclusions

This study investigated the interaction between Lean principles, psychological safety, and occupational health and safety in construction projects. In this context, the study provides a basis for psychological safety in the construction industry. The interactions among Lean, psychological safety, and occupational health and safety were hypothesized. To assess the level of psychological safety in Lean and non-Lean projects and assessing the effect of psychological safety on occupational health and safety practices, interviews and a survey with construction employees were conducted. The major takeaways from the interviews were that

more psychological safety is observed in Lean projects, where Lean principles play a major role in improved occupational health and safety practices. Moreover, it was detected that psychological safety perceptions were different for male and female employees, where female employees feel more pressure at work. Another important finding was that lower-status employees feel less psychologically safe than their upper-status colleagues. This might require that organizations consider different strategies to assess psychological safety in terms of employment status.

This study presented empirical evidence that psychological safety is problematic within teams in the construction industry. Both the interviews and the quantitative survey indicated that awareness must be developed regarding psychological safety in construction. Moreover, the study provides insights for companies to lead them in terms of measuring psychological safety for better managing its impacts and develop actions accordingly. Moreover, the study proves that companies adopting the Lean philosophy are more successful in managing psychological safety through integrating the core values of Lean with psychological safety. On the other hand, the study had some limitations such as sample size, lack of previous studies on the topic, and time constraints. The study reflected the data collected from a small sample of U.S. construction industry practitioners. Hence, the results may not be representative for other countries. Moreover, the relatively low sample size may lead to less reliable conclusions. More empirical studies are needed to validate and generalise the findings of this study. Therefore, a mixed method of research could at least help compare the responses gathered through interviews and the questionnaire to come up with better arguments.

This study may lead to further research to reveal the strength of the relations between psychological safety and other concepts. Being one of the most referenced relations, the effect of psychological safety on performance may be investigated. The main limitation of this study was the relatively low sample size for the interviews. Hence, future studies may investigate the effect of psychological safety on other concepts such as employee satisfaction, engagement, or creativity by using quantitative data with a larger sample size, in the construction industry. Moreover, construction companies are recommended to develop departments for assessing psychological safety with its considerable importance in construction safety and learning. The construction sector might benefit from the integration of Lean and psychological safety to achieve process improvement and employee satisfaction. The sector might also benefit from the findings of this study to revisit and reshape their strategies for psychological safety.

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