



## Impact of the Skill Shortage on the Construction Supply Chain Performance in Australia

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### Abstract

The purpose of this paper is to investigate how the skill shortage impacts the performance of the construction supply chain in Australia. The study has adopted a quantitative research method. The quantitative data were collected by conducting a survey of employees who work in construction companies in Australia. A regression analysis was used to analyze the data from 113 respondents. The findings of the study reveal that the construction sector in Australia has high labour costs, but workers are still thinking they are not getting paid enough and cannot invest more in themselves to improve their skills. There is a lack of academic and vocational training programs offered to them. Insufficient recruitment and incentive policies are also main barriers to attract talents to the construction industry in Australia. The situation became more serious during the COVID-19 period due to the lockdowns, lack of skilled migrants, and Government working visa policies. The study implies that firms should have a deeper understanding of the reasons for the skill shortage. Firms also need to devise strategies for hiring the right talent. Further, it was found that quality talent can come from the local or foreign markets. More effective selection criteria should be designed so that the best-fit approach can be implemented.

*Keywords:* Skilled Shortage; Construction Supply Chain Performance; Training; Recruitment.

### 1. Introduction

Skill shortage has become a major issue in many industries around the world in recent years. The construction industry is also facing this problem in different countries, especially developed countries such as the US, UK, and Australia [1]. The COVID-19 pandemic has even worsened the situation in the past three years due to the health and safety risks that have significantly impacted the industry [2]. From the perspective of the construction sector, the skills of the workers responsible for working at a construction site play an integral part in the project's success. As indicated by Silva et al. [3], there are various skills that many of the construction workers are not experts in, including problem solving, scheduling, monitoring, building and mechanical knowledge, etc. These skills are important as they directly impact the construction performance. Due to the pandemic, many construction firms started to pay more attention to incorporating innovative technologies and using the latest construction equipment to improve productivity and increase efficiency, which makes skilled labour become a more essential asset for companies. However, this shortage in skills is threatening the industry's future and is also detrimental to the country's economic growth. Further, the outbreak of COVID-19 has seriously disrupted the construction supply chain. The industry was affected by disruptions in the supply chain due to delayed supplies of construction equipment from overseas, increased building materials, and a shortage of skilled labour. It was reported that the revenue of the commercial and industrial building construction industry declined

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by 7.5% in Australia in 2020-2021 and is estimated to decline by 25.6% in 2022, which contributes to the industry revenue decreasing to USD 39.6 billion, falling by 1.9% over the recent five years through 2021-2022 [4]. Industry employment declined 0.4% annually in the recent five years [5].

The objective of the research is to investigate how the skill shortage impacts the performance of the construction supply chain in Australia. The project aims to analyze the skill shortage in Australia and its underlying causes from the perspective of the construction sector. The project also investigates the measures taken by the Australian Government to overcome the skill shortage in the construction sector. After conducting the literature review, it was found that there are limited studies focusing on the Asia Pacific region. There are many studies focused on the skill shortage issues in some countries such as the US and UK. However, there is limited research to focus on the major issue in the Asia Pacific Region like Australia [6]. Some countries, such as China and Malaysia, also face the similar issue due to aging populations or many companies moved their factories to Vietnam and India due to high labour costs in the domestic markets [7]. Therefore, this research will fill the research gap and focus on how the skill shortage issue impacts the construction supply chain's performance in Australia. The Australian construction sector generates around \$360 billion (about \$1,100 per person in the US) and contributes to about 9% of the overall GDP. The sector is projected to grow at an annual growth rate of 2.4% in the upcoming years [8].

This research contributes to the development of theory in this area. A conceptual model was developed which includes two main constructs: skill shortage and construction supply chain performance. The conceptual model contributes to the theory development in this area, which reveals that skill shortages include three key factors: a lack of expertise and experience, a lack of training, and insufficient recruitment and incentive policies. All these are key obstacles to improving the construction supply chain's performance. The survey results reveal that the three key factors have positive and significant relationships with construction supply chain performance.

The research also has practical implications for the industry because this study identified the key factors that lead to skill shortages, and some measures and strategies provide insights on how to solve the issue in the construction sector. The research findings imply that the construction companies in Australia should have a deeper understanding of the reasons for the skill shortage. Companies also need to devise strategies for hiring the right talent. Further, it was found that quality talent can come from local or foreign markets, but the right people should be placed in jobs that match their relevant technical skills and experience. More effective selection criteria should be designed so that the best-fit approach can be implemented. In contrast to this, construction companies can even make use of contingent workers in times of need. Companies should conduct the Skills Gap Analysis regularly so that they can identify the issue beforehand. Training and recruitment programs should be further developed in order to solve the problem.

## 2. Literature Review

### 2.1. Skill Shortage in the Construction Industry

Skill shortages have been becoming significant issues in construction all over the world. Olsen et al. [9] found that a lack of skilled workers is a major challenge in the construction industry in Sri Lanka. The shortage of labourers, craftsmen, and machine operators reduced the productivity of project firms in the market. Training programs are essential to improving the current situation. Olsen et al. [9] conducted a survey and found that lack of labour is a significant issue in the construction industry in the United States. In-house and outsourced training for constructors are solutions to the problem. Cerić & Ivic [10] also found that the shortage of skilled construction workers caused a major problem in Croatia. Hussain et al. [11] conducted a survey of 400 practitioners in the construction industry and found that skill shortages have negatively affected project performance in the public construction industry in the United States. The indistinguishable situation of skill shortage also happens in China or other South Pacific regions such as Malaysia [12].

The continuous improvement and development in the construction sector is a significant element in providing employment. Healey et al. [13] suggest that technical, conceptual, or provisional skills are essential for the success of construction projects within the industry. However, the service providers must be aware of the basic standards that aid in selecting a professional and competent skilled workforce that are crucial for improving the performance and efficiency of construction projects. Durdyev & Ismail [14] emphasized that for productivity enhancement, suitable knowledge, skills, and better mental and physical strength are required to grab the milestones of effectiveness. A knowledgeable worker will also possess sound psychological health, further supporting better performance. However, for proper project execution, strategic planning is required to lead to high-performing employees to support the efficiency of the project.

However, for achieving the desired outcome, both quality and quantity of labour are essential, as it is essential that the project comprises a team of professionals who have abundant knowledge regarding construction and its related components and take the project in the right direction. If an inexperienced and unskilled workforce leads the project, it will impact the project outcomes [15]. The delivery of the project, schedule overruns, inexperienced labour, and cost all affect the delivery of the project. Additionally, the lack of capability, knowledge, and maintenance is further hazardous to the project outcomes. According to Olanrewaju et al. [16], better skills are essential for achieving milestones, raising

productivity, and ensuring task effectiveness. Moreover, the fierce competition in the industry further emphasizes the need for a skilled workforce to attain a transition in the work patterns from solely technical workers to workers with a broader skill set.

Furthermore, incorporating innovative technologies and using the latest construction equipment is making it more challenging to operate everything and tackle the needs of skill shortages. However, this shortage in skills is threatening the industry's future and is also detrimental to the country's development and socio-economic growth. With the increase in demand for construction projects, the problem associated with skills shortages is also increasing. However, there are many risks associated with the construction industry, ranging from tight delivery schedules to finance-related issues and capacity constraints. However, these risks are further affected by the shortage of necessary skills and knowledge and affect the performance indices [17]. Besides this, Karimi et al. [17] suggest that if a project with unskilled workers reaches completion, the work quality is unsatisfying.

In many cases, the work is often delayed with additional cost and time, affecting the firm's reputation and performance. Moreover, the boom in construction projects further pressures the industry to keep up with the demands. Rework is also another common effect caused by adhering to an unskilled workforce. Besides this, enterprise failure is also an emerging issue related to the unskilled workforce. Loss of profits, organizational costs, organizational competitiveness, and other related issues are associated with skill shortages in the construction industry [18].

## 2.2. Factor to Skill Shortage in the Construction Industry in Australia

Compared with other countries such as US, China or Malaysia, Australia also faces the issue of lack of skilled workers in the construction industry, especially in the recent two years during the COVID-19 Pandemic period [8]. Health and safety issues also become a major challenge, due to the super-fast spread of Corona Virus such as Delta or Omicron. The Australian construction industry suffered from frequent lockdowns, increased building material costs, skill shortages and safety issues due to international students or overseas workers not being able to obtain student or working visa due to the closed border issues. The Australian Government has taken some measures to provide financial assistance to small businesses. Reverse Charge of Value Added Tax (VAT), Job Keeper Payments or Builder Grants were provided in the construction or other industries to maintain the economy of the country [19]. The following section will explore the main reasons for the skill shortage issues of the construction industry in Australia. The main reasons include: (1) disruptive global construction supply chain (2) lack of training programs (3) quality issues (4) health and safety issues.

### 2.2.1. Disruptive Global Construction Supply Chain

The outbreak of COVID-19 has seriously impacted on the commercial and industrial building construction in Australia. The revenue declined by 7.5% in 2020-2021 and was estimated to decline 25.6% in 2022, which contributes to the industry revenue decreasing to USD 39.6 billion falling by 1.9% over the recent five years through 2.21-2022 [4]. Industry employment declined 0.4% annually in the recent five years. The residential building construction also faced a decline of 6.8% and the industry revenue dropped down to USD 40 billion in 2022 [5]. The industry was affected by disruption in the supply chain for delayed supply of construction equipment from overseas, increased building materials and shortage of skilled labour. Sydney and Melbourne suffered from Stage 4 lockdowns in the recent two years. Many projects were delayed due to limited numbers of workers being allowed to work on worksites. Some large builders such as the South African-owned company Probuild, the Brisbane based Groncon and the Melbourne based ABD Group collapsed due to the significant increase of costs and pressure to deliver within constructed timeframes [4].

### 2.2.2. Lack of Training Programs

The construction industry is experiencing significant changes in terms of adopting innovative technologies. To improve productivity and solve the skill shortage problems, many firms started to adopt digital practices or advanced manufacturing practices and innovations have become major phenomena in the construction industry. Some Tier 1 companies applied some technologies such as BIM, simulation and comparative modelling. Robotics or Artificial intelligence is also a major trend in the industry [19]. There is an increased need to provide relevant training programs on job worksites to help workers to upgrade their skills of modern technology application.

### 2.2.3. Quality Issues

Compared with manufactured based companies, construction companies are often project based firms. *Quality, cost* and *time* are major indicators to measure project performance, however, *quality* is hard to define compared with *cost* and *time* based on the project-based nature [20]. Quality management is essential to the successful management of construction projects. There are two types of quality management systems which include *quality assurance* (QA) and *total quality management* (TQM) [21]. Quality problems have become a major issue in the construction industry in Australia. It was reported that a rising number of defects in apartment buildings has drawn concerns from owners and

communities [22]. Coelho et al. [1] found that companies in the Australian construction industry are dominated by hierarchical cultural characteristics which provide an unfavorable environment for implementing Total Quality Management systems. Inadequate quality and safety performance are director factors to increased cost and project delay [21]. Walker and Keniger [22] argue that organisational culture has a direct relationship with project quality. It is imperative for companies to develop a risk and reward structure to provide incentives to improve project quality.

#### 2.2.4. Health and Safety Issues

The construction industry depends heavily on equipment and machinery to handle the job tasks. Safe Work Australia [23] reported that on average 240 serious accidents were claimed annually which were related to crane lifting tasks in recent years. Lingard et al. [24] explored the key factors to crane safety and a total of 77 causal factors were identified. It is essential to implement robust safety management systems and take preventive measures to minimize crane safety incidents [25]. Health and safety issues became more serious during the COVID-19 pandemic period. Olanrewaju et al. [7] conducted a questionnaire survey and found that project cost can increase 20%, site productivity can drop by 50% due to frequent lockdowns and this research found that skill shortage increased 40% during the pandemic period.

### 3. Conceptual Model and Hypothesis

#### 3.1. Resource Based View Theory

Resource Based View (RBV) theory will be used as a theoretical foundation to develop a conceptual framework and hypotheses development. According to RBV theory, a firm's superior performance can be achieved by developing tangible resources such as physical resources and financial resources and intangible assets such as skills and knowledge, company intellectual property such as patents or trademarks [26]. Compared with tangible assets, intangible resources or capabilities such as skills and knowledge or human resource management practices can help firms to develop into competencies which are rare, valuable, and hard to imitate by competitors which lead to long term sustainable competitive advantage [27]. In the construction industry, skilled workers are rare and valuable assets for construction firms, as the skills to complete tasks in different expertise areas or capabilities of using advanced technologies such as BIM, simulation or AI takes many years to develop on the worksites or via designed training programs to implement the technologies [26]. Therefore, it is considered as rare, valuable and difficult to be imitated by other competing firms.

#### 3.2. Competency Theory

Competency is defined as the underlying characteristics of a person that leads to superior performance [28]. Based on the Iceberg Model which was developed by Spencer and Spencer [29], competency can be divided into visible and hidden elements. Visible elements consist of *skill and knowledge* and invisible hidden elements include *self-concept* such as *attitudes and values or self-image, traits, and motive*. *Motives* drive or direct to certain behaviours, while *traits* are related to physical characteristics and consistent response to certain behaviours. Knowledge is *information* that a person can acquire by learning in a particular area. Skills are certain abilities to fulfil some tasks [30]. As discussed previously, quality problems are serious in the construction sector and one major reason is due to unskilled labour and work also lack opportunities to attend training problems to improve the competencies, which lead to poor performance [31]. The hidden elements such as attitudes and values or self-images, traits and motives of workers also need to be considered, however, some studies (e.g., Walker and Keniger [22]) found that organisational culture has a direct relationship with project quality. It is imperative for companies to build up the right reward systems to motivate and encourage workers to improve their individual performance. Therefore, overall performance of companies can be improved.

#### 3.3. Supply Chain Performance in Construction Industry

There are two categories of supply chain performance methods in different sectors. First, supply chain performance methods are based on financial perspectives. They are the Balanced Scorecard (BSC), Activity Based Costing (ABC), and Economic Value Analysis (EVA) [32]. Second, supply chain performance methods are based on non-financial perspectives. They are the supply chain council's Supply Chain Operations Reference model (SCOR), the logistics scoreboard or the Balanced Scorecard, Multi-criteria Analysis (MCA), Life Cycle Analysis (LCA), Data Envelopment Analysis (DEA) [33]. Life Cycle Analysis, the supply chain council's Supply Chain Operations Reference model, the logistics scoreboard, or the Balanced Scorecard are qualitative supply chain performance methods. Most profit organisations (manufacturing, financial services, retailing and others) have applied these supply chain performance methods stated above [33]. However, there are few companies in the construction industry using supply chain performance methods to measure project performance.

Based on the advantages and disadvantages of supply chain performance methods information, it is useful for construction supply chain (manufacturers, suppliers, contractors, subcontractors, consumers, communities etc.) to understand which one supply chain performance method to use to measure their supply chain performance. It is

suggested that the supply chain council's Supply Chain Operations Reference model, the logistics scoreboard or the Balanced Scorecard, Activity Based Costing, and Economic Value Analysis might be useful to the Australian construction industry. A balanced Scorecard or logistics scoreboard might be useful for manufacturers or suppliers if they consider non-financial and financial perspective to measure their supply chain performance. It will reveal directly cost and business performance measures. The supply chain council's Supply Chain Operations Reference model, Activity Based Costing, and Economic Value Analysis might be suitable to measure construction performance. This research will use the triple constraint (time, cost, and quality) most related to the three methods to measure construction supply chain performance [34].

### 3.4. Hypotheses Development

Previous studies (e.g., Karimi et al. [35] found that skill shortages are key issues in the construction industries in different markets such as the US and China. Hussain et al. [36] revealed that skill shortages have negatively affected on the project performance in the public construction industry. Karimi et al. [37] claimed that labour costs account for a significant percentage (30-50%) of total project costs. Therefore, the project performance was negatively affected by the high labour costs which tremendously impacted on project productivity. Lack of experience and expertise or labour scarcities lead to project delays, cost overrun or quality issues during project implementation period which significantly impact on the overall supply chain performance in the industry [37].

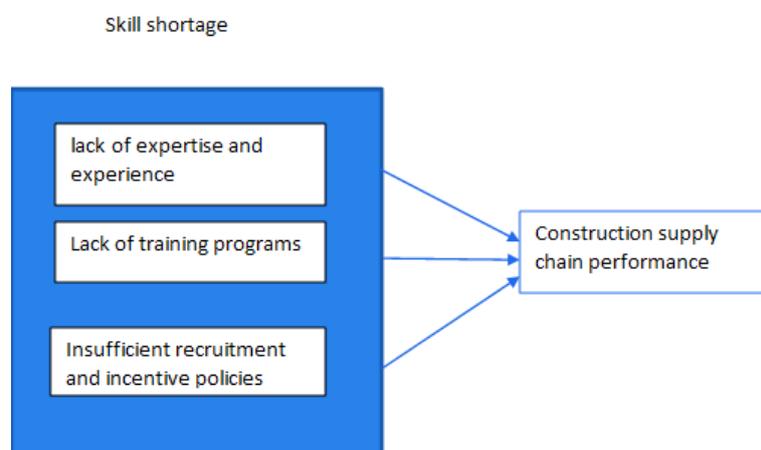
Vocational training programs, educational courses or on-the-job training are essential to solve the skill shortage issue as training programs or courses provide more opportunities for workers to improve their skills and competencies [36]. It was found that project safety performance was increased dramatically by providing the relevant training programs to improve the skills and competencies of workers and minimize the risks such as accidents occurring in construction sites [38]. Furthermore, incorporating innovative technologies and using the latest construction equipment is making it more challenging to operate everything and tackle the needs of skill shortages. With the increase in demand for construction projects, the problem associated with skills shortages is also increasing. However, there are many risks associated with the construction industry, ranging from tight delivery schedules to finance-related issues and capacity constraints. However, these risks are further affected by the shortage of necessary skills and knowledge and affect the performance indices [3].

Alduhoori et al. [39] found that there are direct positive relationships between recruitment process, selection, training and employee performance. Insufficient recruitment and incentive policies are also main barriers to recruitment staff in the construction industry in Australia. The apprentices and trainees declined 12.2% from 2018 to the fourth quarter of 2019 due to lack of insufficient subsidies or incentives from the Government [19]. The situation became more serious during the Covid-19 period due to the lockdowns, lack of skilled migrants and Government working visa policies [19]. Industry employment declined 0.4% annually in the recent five years [4]. Therefore, the following Hypothesis was developed:

**H0.** No causal relationship exists between skill shortages and construction supply chain performance in Australia.

**H1.** A causal relationship exists between skill shortages and construction supply chain performance in Australia.

After reviewing the literature, a conceptual model was developed which includes two main constructs: skill shortages and construction supply chain performance. The skill shortages are measured by three variables: lack of expertise, lack of training programs and insufficient recruitment and incentive policies to attract talents (Figure 1). Construction supply chain performance was measured with time, cost, and quality, which are three key components in project performance.



**Figure 1. Conceptual Model of Skill Shortages in Construction Industry**

## 4. Research Methods

The following section explains the research methods used to achieve the research objectives.

### 4.1. Research Philosophy

According to Esser & Vliegthart [40] research philosophy includes positivism, interpretivism, realism, etc. Each is selected based on research objectives. For the current study, the use of positivism as the research philosophy is made because the study is quantitative in nature. The collection of qualitative data is made with the help of a survey instrument, having closed-ended questions followed by a 5-point Likert scale. Qualitative data were also collected to understand the skill shortage situation of the construction industry in Australia. In contrast, research approaches as said by Stokes & Wall [41] are inductive and deductive. The deductive approach is used when the study is quantitative in nature and collection of data from primary sources is made. However, the inductive approach is followed by qualitative data collection and is backed by secondary data. In the current study, the deductive approach works well as quantitative data and helps test the hypothetical assumptions.

### 4.2. Research Strategies

Similarly, research strategies are another essential part of the research method as it explains how data will be collected. As per the research onion model, research strategies include survey, experiment, case study, grounded theory etc. for the study examining the skill-shortage impact on the construction performance in the construction sector of Australia, the use of survey as the research strategy has been used. On the other hand, research choices include selecting from mono method, mixed-method, or multi-method depending on qualitative or quantitative data [42]. The study assessing the skill-shortage impact on the construction performance, quantitative method has been used as the quantitative data was collected by a survey from 100 to 150 respondents. Time horizons are cross-sectional or longitudinal. A cross-sectional time horizon is used when the research studies are completed in a shorter period. Longitudinal studies are prolonged usually in the medical field. However, the current study is cross-sectional because it has to be completed within a given time frame. Figure 2 highlights the method used for the research.

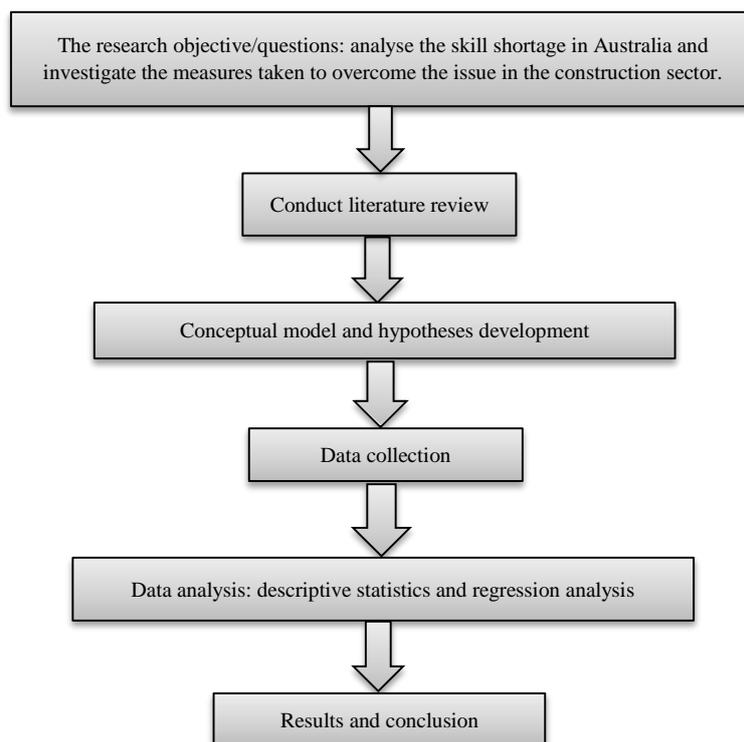


Figure 2. Flow diagram for the process for data collection and analysis

### 4.3. Data Collection

Primary and secondary data were collected. For the collection of secondary data, use of journal articles from "A" category journals was used, including articles from Emerald Insight, Jstor, Science Direct, Elsevier etc. Industry reports were also collected from Australian Government websites and industry association websites. Primary data was collected via a survey, as construction companies in Australia were surveyed. An online survey was conducted with the employees to know their skill set and the grey areas for this increasing issue. The sample of 100 to 150 was aimed as a large sample size that enables conducting an in-depth study and perform more powerful statistical analysis. There was a total of 120 respondents including 113 full and 7 partial respondents. This study only used the full responses for the data analysis. Participants.

#### 4.4. Data Analysis

Data collection includes primary and secondary data because online survey and qualitative data are utilized to attain research propositions. In addition to it, the data analysis as enunciated by Patten & Newhart [43], is the method in which the collected data is analysed. This can be done via SPSS, Excel, or thematic analysis. For the study on assessing the impact of skill shortage on construction performance in Australia, the use of SPSS has been made. SPSS is a complete package with the help of which inferential and descriptive statistics are considered to test the phenomena under study. The data of 113 respondents were used to perform the statistics analysis.

##### 4.4.1. Data Analysis and Findings

The following section unfolds the efforts entailed in collecting the data. The questionnaire utilized is placed in the appendix. To analyse the data, SPSS has been used to run statistical tests.

##### 4.4.2. Demographic Analysis

Figure 3 shows the demographic of participants. The age group of respondents taking an active part in the study belonged to different age groups. A total of 49.6% of respondents belonged to the age group of 18-24, 30% fall in age interval of 25-32 and just 14% belonged to 33-38 years.

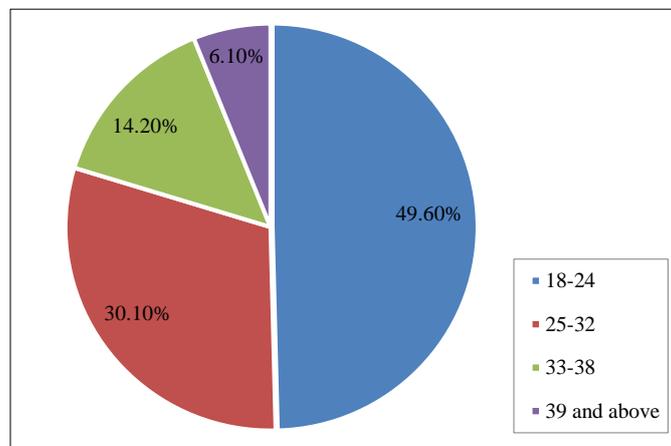


Figure 3. Demographic analysis based on ages

There were approximately 37% female and 63% male respondents have shared their responses (See Figure 4). The percentages imply that about two third of employees in the construction industry are male who accounts the large percentage of work forces.

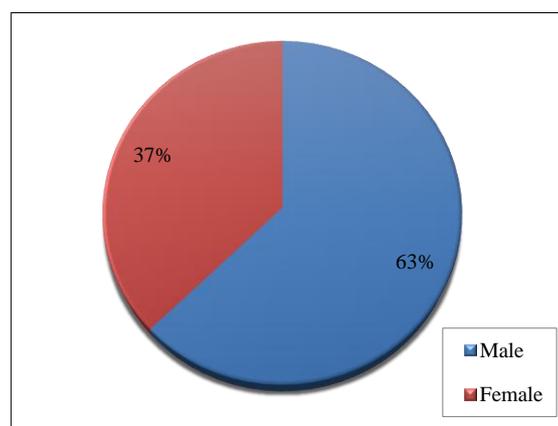


Figure 4. Demographic analysis based on gender

##### 4.4.3. Key Statements

The below figures show the analysis results of key variables. Figure 5 shows that 45% of respondents supported the fact that employees within the construction sector of Australia lack training. To this statement, just 43% normally agreed. 13% of respondents held a neutral position that they neither agree nor disagree with the statement. The analysis result indicates that majority of respondents consider lack training is a significant issue.

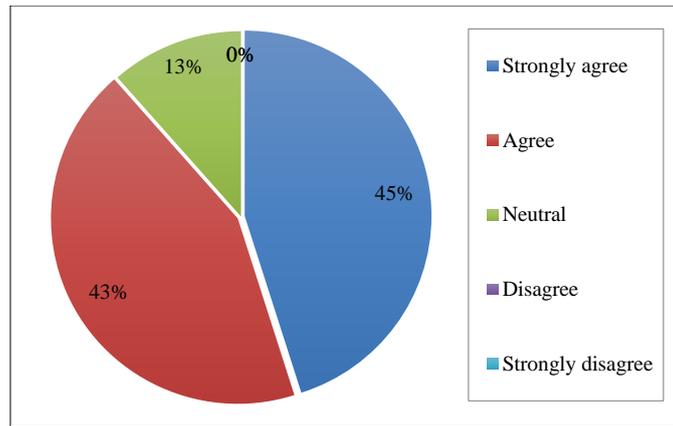


Figure 5. Training in the construction industry

Figure 6 shows that 53% of employees strongly agreed that a lack of construction knowledge influences the performance of construction projects. 28% agreed and the remaining 15% preferred to stay neutral towards the statement. This means that the lack of construction knowledge is an issue in the Australian construction sector.

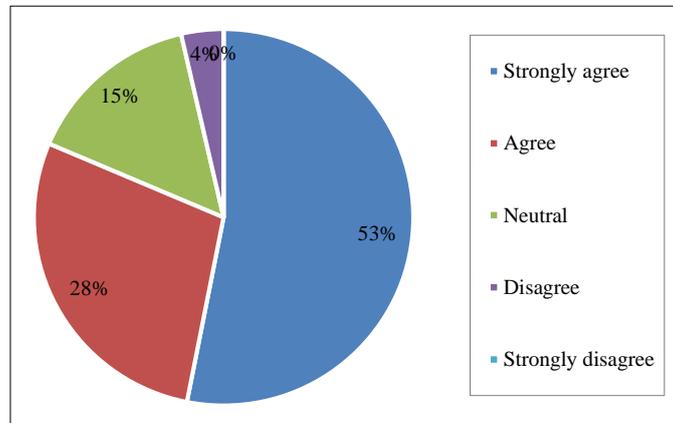


Figure 6. Knowledge of employees in the construction industry

The unmatched skill set is one problem, 56% of employees strongly agreed, 25% normally agreed and just 16% were neutral towards the statement (See Figure 7). The number of employees who agreed indicated that unmatched skill set impacts project outcome.

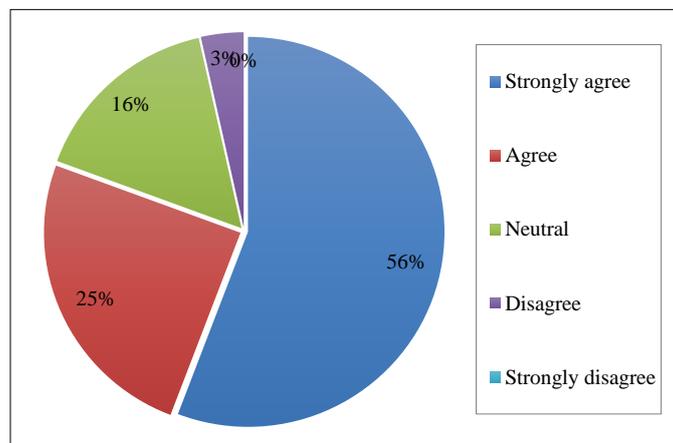


Figure 7. Skill of employees in the construction industry

Figure 8 suggests that around 50% of employees strongly agreed that lack of expertise and experience influences the construction performance. To this, only 11% remained neutral. This analysis showed that Australia's construction sector has inexperienced employees and don't possess sufficient expertise to work on construction projects.

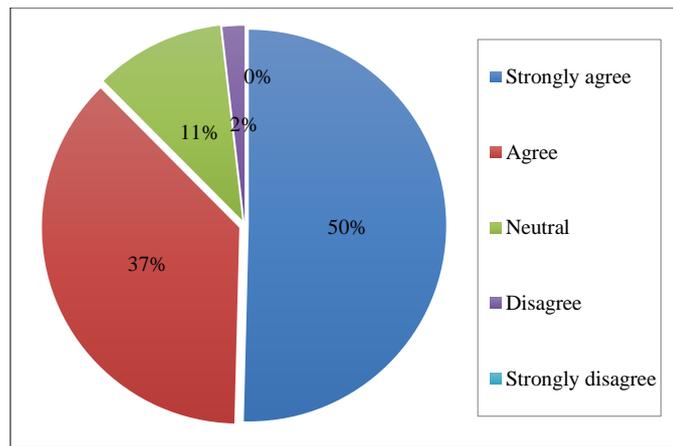


Figure 8. Expertise of employees in the construction industry

Figure 9 indicate that 66% supported the statement, which means skill shortage is an issue which led to delays in the construction projects. Only 20% negated and just 14% were unsure about their views. The result further proves that the skill shortage negatively impacts on the construction performance.

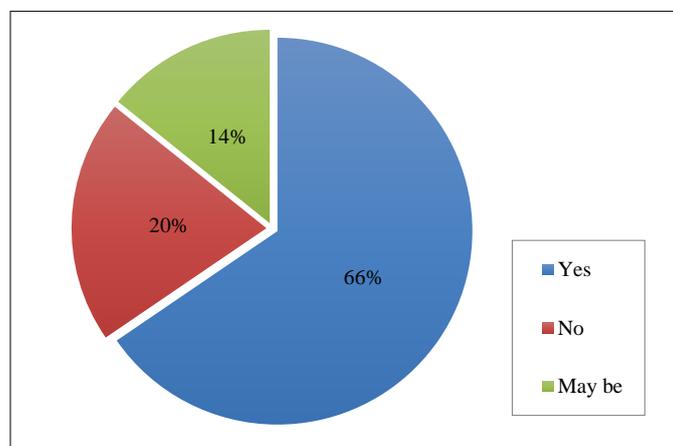


Figure 9. Impact of skill shortage on project delay

Figure 10 indicates that lack of sufficient skill acquisition programs imposed a direct impact on construction performance. 82% agreed with the statement. Respondents, when approached about this fact, averred that they lack skill acquisition centres to train employees, which impacts construction performance. Similarly, just 18% negated.

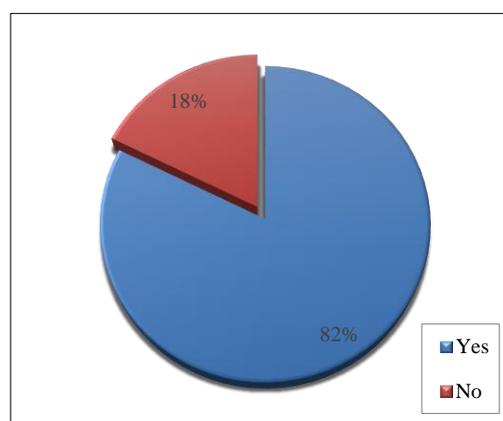
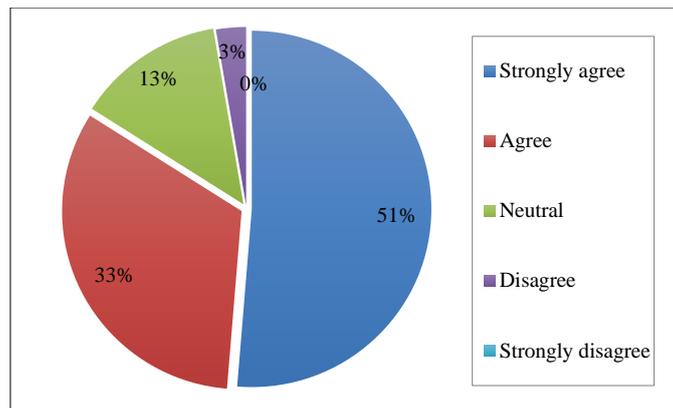


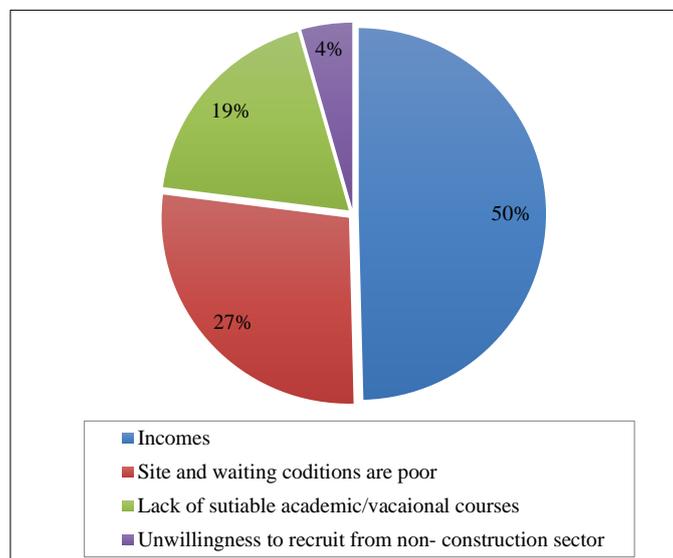
Figure 10. Impact of skill shortage on construction project performance

The only difference between the skilled and non-skilled labour is that they are more prone towards completing the task with high end expertise and that too on time. The skill shortage is a problem that is impacting the overall performance of the construction sector. Moreover, the survey results indicated 51% of respondents firmly agreed, 33% normally agreed whereas just 13% remained neutral (See Figure 11).



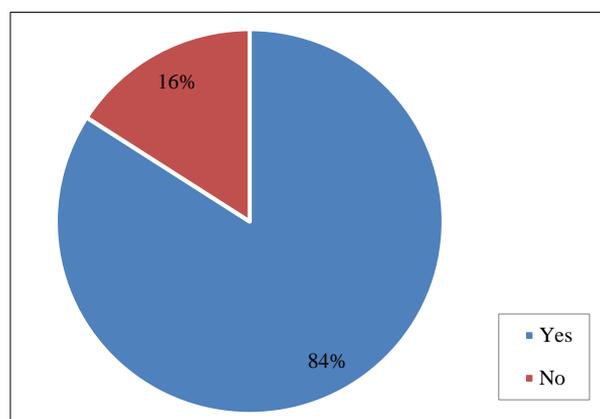
**Figure 11. The relationship between skilled labour and project performance**

During the survey, employees were asked to highlight the reason for skill shortage within Australia's construction sector. Figure 12 shows that 50% of respondents said income is because they do not get enough to invest in themselves and enhance their skill set. Site and working conditions are poor, which also does not motivate them to learn new skills as it makes them demotivated. 19% of the employees stated that there is a lack of suitable vocational and academic courses offered to them, which is another reason for them having a lack of skill set.



**Figure 12. Main reason for skill shortages**

Due to skill shortage in the construction of Australia, there are employees being recruited from overseas. During the survey, the employees said that they have noticed a significant increase in construction workers from outside Australia as 84% of employees supported this statement whereas just 16% negated (See Figure 13).



**Figure 13. Employment of overseas workers**

Figure 14 shows that 15% of employees denied that companies in the Australian construction sector are not taking measures to train their workforce. However, just 84% agreed, which means that measures like vocational training etc. are being put in place by companies in Australia to train employees to work effectively in the construction sector.

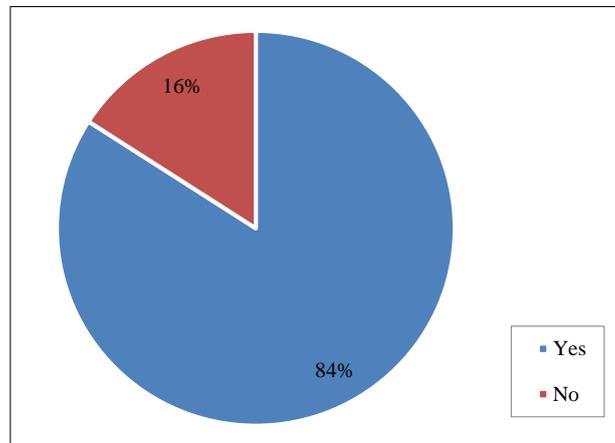


Figure 14. Training situations of current employees

#### 4.4.4. Descriptive Statistics

The following section explains the descriptive statistics explaining mean, standard deviation, minimum and maximum value for all the questions used during the survey (See Table 1).

Table 1. Descriptive statistics

	N	Min	Max	Mean	Std.Dev
Employees at construction sector of Australian lack training	113	1.00	5.00	1.725	0.848
Lack of construction knowledge impacts overall performance of construction projects	113	1.00	5.00	1.669	0.885
I think that unmatched skill set of those working on construction sights impacts overall project outcome	113	1.00	4.00	1.673	0.870
Skill shortage in construction sector led to delayed construction projects	113	1.00	3.00	1.486	0.733
I think that lack of sufficient skill acquisition centres imposes a direct impact on construction performance	113	1.00	2.00	1.177	0.834
Skilled labour impacts construction performance positively as they are better at addressing and meeting organisational goals	113	1.00	4.00	1.673	0.807
What according to you is the main reason for skills shortages?	113	1.00	4.00	1.779	0.904
Lack of construction expertise and experience contributes significantly to construction performance	113	1.00	4.00	1.637	0.745
Have you noticed increase in construction workers from outside of Australia?	113	1.00	2.00	1.159	0.368
Does construction sector in Australia is taking measure to train existing construction workforce	113	1.00	2.00	1.159	0.368

#### 4.4.5. Reliability Test

The reliability test was conducted to know whether the data collected is reliable and allows for conducting various statistical tests. The general rule is that the value of Cronbach’s Alpha should be greater than 0.50 to consider the data set reliable. As mentioned in the table above, the value of Cronbach’s Alpha is  $0.925 > 0.50$ . This indicates the data set collected is reliable and statistical tests can be conducted; if it was less than that, then data would have to be collected again.

#### 4.4.6. Regression Analysis

According to Patten & Newhart [43], a regression test is conducted to know the impact among the study's variables. The regression analysis result was presented in Table 2. The study's independent variable was 'skill shortage' whereas the dependent variable was 'construction performance'. Out of the model summary table, the value of R-square is interpreted. As observed, it is greater than 0.40, i.e., 0.565 which means there is a strong impact of skill shortage on the construction performance. This also indicates that a 1% change in the independent variable will lead to a similar change in the independent variable of the study. This impact is significant as sig value is less than 0.05, that is  $0.000 < 0.05$ , further affirming the impact.

**Table 2. Regression Analysis results**

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.7522 <sup>a</sup>	0.565	0.561	0.28594

a. Predictors: (Constant), Skill Shortage

ANOVA <sup>a</sup>					
Model	Sum Squares	df	Mean Square	F	Sig.
1 Regression	11.792	1	11.792	144.22	0.000b
Residual	9.076	111	0.82		
<b>Total</b>	<b>20.867</b>	<b>112</b>			

a. Dependent Variable: Construction Performance

b. Predictors: (Constant), Skill Shortage

Coefficients <sup>a</sup>					
Model	Unstandardised Coefficients B	Std. Error	Standardised Coefficients Beta	t	Sig.
1 (Constant)	0.594	0.071		8.307	0.000
Skill Shortage	0.484	0.040	0.752	12.009	0.000

a. Dependent Variable: Construction Performance

## 5. Discussion

Analysis of the results support the fact that employees lack training within the Australian construction sector. As discussed previously, the lack of construction knowledge especially the capabilities of using advanced manufacturing practices and innovations positively impacts on the performance of construction projects. The finding suggests that the lack of construction knowledge is an issue in the Australian construction sector. The unmatched skill set is one of the problems that impacts the project outcome as suggested by Industry Skill Forecast [19]. BIM, simulation, robotics or Artificial Intelligence are major trends in the industry [19]. Therefore, it is imperative for workers to upgrade their skills to use advanced technologies.

The literature review also highlights other various aspects and the importance of skills acquisition by construction workers. Healey et al. [13] enunciated that conceptual, technical, and provisional skills are essential for making construction projects successful. Construction workers should be highly skilled as this very sector serves as the key contributor to the country's GDP. The findings are in line with the literature reviewed, as they indicated that skill shortage is one of Australia's key issues as many respondents agreed to this aspect. The employees during the survey also indicated that a lack of sufficient skill acquisition centres affects the construction performance.

Lack of expertise and experience are positively influenced the construction performance. This indicates that Australia's construction sector has inexperienced employees who have insufficient expertise to work on construction projects. As discussed by Coelho et al. [1], quality problems have become a major issue in the construction industry in Australia. Inadequate quality and safety performance are key factors in increased project delay and increased cost [20]. It is a common approach for the construction companies to conduct skill acquisition programs for their employees to enhance their skill set. Further, it also can help to improve the health and safety performance and reduce incidents and serious accidents in construction sites [24]. Therefore, the lack of skill acquisition centres to train employees which impacts construction performance.

Oseghale et al. [15] averred that construction employees' lack of experience and expertise in performing their job adds no value to the construction project. Other impacts due to skill shortage within the construction sector include schedule overrun, delayed delivery of projects, inexperienced labour, etc. The critical reasons for skill shortage highlighted include the survey's income and site working conditions. This means that the construction sector in Australia faces high labour costs, but individual employees are still thinking they are not getting paid enough and cannot invest more in themselves. They are offered a lack of academic and vocational training, which is essential to enhance their overall skill set. During the survey, the respondents emphasized having skilled labour as they supported the fact that skilled employees help achieve the organizational goals.

The difference between the skilled and unskilled labour is that skilled workers are more prone towards completing the task with high end expertise. It was found that one reason for the skilled shortage is due to the current workers not being satisfied with their current income level and poor working conditions are obstacles to attract high quality talents in the domestic and overseas market [19]. Therefore, it is essential for companies to develop effective recruitment and

incentive policies to attract skilled talents to work in the industry, as suggested by Alduhoori et al. [39]. The Government also need to develop right working visa policies to attract skilled workers from the overseas market.

On the other hand, Karimi et al. [37] shared their views and stated that skills are essential for achieving project milestones; they raise productivity and thus complete the task on time. Fierce competition within the industry makes it essential for the companies to hire skilled employees who are more inclined to contribute positive work energy. In line with the survey results, it was found that the skill shortage affects the construction performance. Unmatched skill set is another issue leading to delayed construction projects. It is imperative for companies to have effective recruitment methods and policies to select talents from local and international markets to tackle the skill shortage problem.

## 6. Theoretical Contribution

The research under consideration has proven that the skill shortage has a significant impact on the construction supply chain performance in Australia. To examine this, firstly, the literature review was conducted. Secondly, hypotheses and a conceptual model were developed. The conceptual model contributes to the theory development in this area which reveals that skill shortage include three key factors: lack of experience and expertise, lack of training, and insufficient recruitment and incentive policies are key obstacles to the construction supply chain performance. Lastly, the survey results reveal that the three key factors have positive significant relationships with construction supply chain performance. Based on the RBV and Competency Theory, skilled workers are rare and valuable assets for companies in the construction industry, it is imperative for firms to pay attention to the three key factors as they directly impact on the construction supply chain performance. The research findings further prove the findings of Stone et al. [28].

## 7. Implications for Practice

The study conducted above has proven that skill shortage is an issue and, hence, impacts construction performance in Australia. Therefore, some recommendations are given to the companies functioning in the construction sector of Australia, which is affixed as under:

The companies should conduct training sessions to enhance employees' skill set. The focus should be placed on employees' hard and soft skills that are essential to work on the construction on-site and offsite. The construction companies in Australia should explore the reasons for the skill shortage further and identify the associated factors which caused the low attention and high turnover rate in the industry. Companies also need to devise strategies for hiring the right talents. Further, it was found whether the quality talent are locals or foreigners, the right people should be placed on jobs which match with the relevant technical skills to work. Selection criteria should be designed so that the best-fit approach can be implemented, and the right talent will be hired. In contrast to this, construction companies can even make use of contingent workers in a time of need. Companies should conduct the Skills Gap Analysis every 6 months so that they can identify the issue beforehand and their construction performance is not influenced.

## 8. Conclusion

The study results indicated that skill shortages are a significant issue being faced within the construction sector. The underlying reasons highlighted during the survey indicated that some construction workers are underpaid. After spending a major proportion to support families, and they have not enough income left to invest in getting themselves involved in the training courses to enhance their skill set. Further, the respondents agreed that lack of employee training is an issue that is imposing a direct impact on construction supply chain performance. The findings also prove that Australia's construction sector has inexperienced employees and doesn't possess sufficient expertise to work on construction projects.

In contrast to this, it was also found that employees are being recruited from overseas due to a skill shortage in the construction of Australia. It was also noted that a skills shortage is threatening the industry's future and is also detrimental to the country's development and socioeconomics. Overall, the research objectives developed have been attained and hence proved that skill shortage does impose a significant impact over construction performance because Australia lacks personnel who are experienced and experts in the technical tasks; they lack scheduling, technical, as well as hard and soft skills to carry out work on the construction sites.

### 8.1. Limitations and Future Scope of Work

The following are research limitations being considered that, if considered by future researchers, can add value to the data collection. A larger sample size can be considered when conducting further research in this area. Qualitative methods can also be used. Interviews can be conducted to generate further insights, as the current study is based on a quantitative method. Mixing methods can be used in future research. Further, comparative studies can be conducted by exploring the construction industry in other countries such as the U.S. and China, as the construction industries in these

countries have similar issues. More insights can be revealed by comparing the situation in the different countries, which not only can contribute to the knowledge development in this area, but also it can provide more valuable findings to help governments to develop more effective policies and strategies to solve the skill shortage problems in the industry and how to develop right policies to improve productivity and performance in the industry.

## 9. Declarations

### 9.1. Author Contributions

Conceptualization, M.J.D. and F.J.; methodology, M.J.D. and B.S.B.; software, B.S.B.; validation, F.J., M.J.D., and S.S.; formal analysis, B.S.B.; investigation, M.J.D.; resources, M.J.D.; data curation, B.S.B.; writing—original draft preparation, B.S.B.; writing—review and editing, M.J.D. and S.S.; visualization, B.S.B. and S.S.; supervision, M.J.D.; project administration, M.J.D.; funding acquisition, M.J.D. All authors have read and agreed to the published version of the manuscript.

### 9.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

### 9.3. Funding

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### 9.4. Conflicts of Interest

The authors declare no conflict of interest.

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