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Assessing the effects of workforce diversity on project productivity performance for sustainable workplace in the construction industry

Daeyoun Won[1] | Bon-Gang Hwang[2] | Soo Jing Chng[2]

[1]Department of Civil and Environmental Engineering, Seoul National University, Seoul, South Korea

[2]Department of Building, National University of Singapore, Singapore, Singapore

Correspondence
Bon-Gang Hwang, Department of Building, National University of Singapore, Singapore 117566, Singapore.
Email: bdghbg@nus.edu.sg

Abstract

Recent studies on workforce diversity have preached that workforce diversity could have a positive impact on productivity if it is managed and utilized well. Due to the global trend of increasing workforce diversity in construction projects, it is crucial to understand the factors affecting workforce diversity and their impact on productivity for developing a sustainable environment for workforce diversity. However, little attention has been given to how workforce diversity may affect productivity performance in the construction industry. Thus, this study aims to assess the impact of workforce diversity on project productivity performance (PPP). Twenty-one diversity factors were identified via literature review and validated by industry experts, followed by a survey conducted with 58 firms working in Singapore. The responses were analyzed and used to develop a partial least squares structural equation model. The outcomes from the model signified that the diversity aspects such as efficient decision-making and countering the issue of skilled labor shortages had the highest impact in their respective categories of "Skill and education" and "Age and experience." Therefore, this study contributes to the core body of knowledge and practice both in defining workforce diversity factors and in assessing the relationship between diversity factors and productivity. Furthermore, feasible strategies that match the factors prioritized by the level of the impact on PPP were proposed. These can help construction organizations to understand the untapped potential of workforce diversity and its impact on PPP, ultimately enhancing the productivity of the industry and sustainable diversity in the workplace.

KEYWORDS

built environment, construction industry, project productivity performance, structural equation modeling (SEM), sustainable workplace, workforce diversity

1 | INTRODUCTION

Recently, Singapore has made an effort to promote the productivity of the entire industry; however, productivity in the construction industry is still in recession. In 2017, Singapore's overall productivity grew by 4.5%, which was the highest recorded since 2010, following the Global Financial Crisis (Ministry of Trade and Industry Republic of Singapore [MTI], 2018). However, this productivity growth was primarily driven by sectors such as manufacturing, accommodation, food, and finance instead of construction (MTI, 2019). Therefore, these sectors increased their productivity while the construction sector was less productive—even underperforming expectations. Although not the worst-performing industry, the construction sector is still deemed as weak in productivity, negatively impacting the country's overall

productivity. In addition, the construction sector is also seen to be underperforming due to its predicted failure to meet the target of a 2–3% productivity growth by 2020 set by the government.

On the other hand, Singapore has been encouraging more talent from abroad, with a highly diverse workforce in terms of culture and race. It is also a multi-ethnic and multi-racial society with a significant foreign population. In Singapore, there are four major ethnic groups: Chinese, Malay, Indian, and others (MTI, 2018)—showing just how diverse Singapore's society is in terms of ethnicity and religion, particularly in comparison to other countries such as Japan, which has an ethnic breakdown of 98.5% Japanese, 0.5% Koreans, 0.4% Chinese, and 0.6% other (Mundi, 2018). Singapore is also an immigrant-seeking country, aiming to attract foreign talent to boost its human resource capability in line with Singapore's white paper prediction of an influx of foreigners. Thus, the growth potential and significance of diversity in the population encapsulate the labor force of Singapore (National Population and Talent Division, 2013).

Many studies on workforce diversity have been conducted in recent years, highlighting that workforce diversity could have a positive impact on productivity and workplace sustainability if it is managed and utilized well (Gladwin, Krause, & Kennelly, 1995; Plummer, 2006; Saxena, 2014; Scholtens & Zhou, 2008). As such, the construction industry also has a high level of workforce diversity, and taking full advantage of this workforce diversity could have a positive impact on project productivity (Loosemore, 2014; Shifnas and Sutha, 2016). Therefore, by tapping into Singapore's diverse labor force, there could be a potential impact on project productivity growth and sustainable production in the construction industry. Through more skilled and diverse workers from various sectors, their experiences, culture, skills, and professional ambition across firms and industries could be transplanted into Singapore. To this end, it is imperative to understand the relationship between workforce diversity and project productivity correctly. However, studies on the relationships existing in Singapore's construction industry are still insufficient.

Also, not much attention has been given to how worker diversity may affect project productivity, although Singapore's focus on increasing productivity mostly falls on skills training, implementing new construction technology, and workforce health and environment. In a country as diverse as Singapore, it should fully capitalize on its labor force diversity to boost productivity (Selvaraj, 2015). Although there are guidelines and specific laws in place to maintain age and gender quotas in the workforce, these are mostly to prevent unfair dismissal instead of looking at how they can increase productivity (Ministry of Manpower [MOM], 2011). There are also not enough studies on both Singapore's and the construction industry's context. Given the weak performance regarding project productivity and Singapore's position as a uniquely diverse society, there is a greater need better to understand the relationship between workforce diversity and productivity to develop proposals. This study thus aimed to bridge the research gap and solidify a model of construction labor diversity productivity that will enable industry stakeholders to understand how labor diversity can cause productivity to change and to propose solutions by capitalizing on this model. Therefore, the results of this study can contribute to the body of knowledge and practice both in defining workforce diversity factors and in assessing the relationship between diversity factors and project productivity performance (PPP) in the context of the construction industry. Furthermore, this study can serve as a cornerstone for the industry to handle its workforce diversity properly and achieve the benefits of increased productivity, by proposing viable strategies to harness diversity to increase productivity in the construction industry.

This study investigated the relationships between workforce diversity and productivity in the construction industry. Therefore, the following objectives were identified: (i) to identify and assess critical factors affecting workforce diversity, (ii) to assess the impact of workforce diversity on project productivity, and (iii) to propose feasible recommendations to enhance diversity in the construction industry. The main goal of the study was to identify the potential benefits that a more diverse workforce can bring to productivity in the context of the construction industry, as well as to discover solutions to help better integrate diversity into the labor force in construction firms. The benefits and reasons for the solutions were analyzed and reviewed. As workforce diversity concerning project productivity is underexplored in Singapore's construction industry, this paper aimed to draw conclusions on and propose feasible solutions to this matter.

To accomplish each objective, the study proposed the following methods as shown in Figure 1: (i) a comprehensive literature review was conducted to identify the crucial factors affecting workforce diversity in Section 2, (ii) pilot interview and survey questionnaire development were performed for data collection, and structural equation modeling (SEM) method was proposed for the data analysis to assess the impact of workforce diversity on project productivity as described in Section 3, and (iii) post-interview with the analysis results was performed to discuss the results and propose the feasible strategies to improve the workforce diversity and project productivity accordingly as described in Section 5 and 6.

2 | LITERATURE REVIEW

2.1 | Productivity improvement initiatives in Singapore

The workforce in the construction industry is still developing, as the issue lies with labor availability and training (Arditi & Mochtar, 2000). The study conducted by Singapore Contractors Association Ltd (SCAL) (2016) stated that firms had identified the need for human resources with relevant skills and a lack of effort to manage the workforce as reasons for issues in human resource utilization in the productivity of the construction industry. In this context, initiatives to boost productivity come in the form of a construction productivity roadmap. The main objectives pushed included points such as regulating the demand and supply of construction, introduce more construction technology, uphold standards when hiring labor, and further develop the skills of workers (Building and Construction Authority [BCA], 2015a). The other aim of the roadmap was to enable the

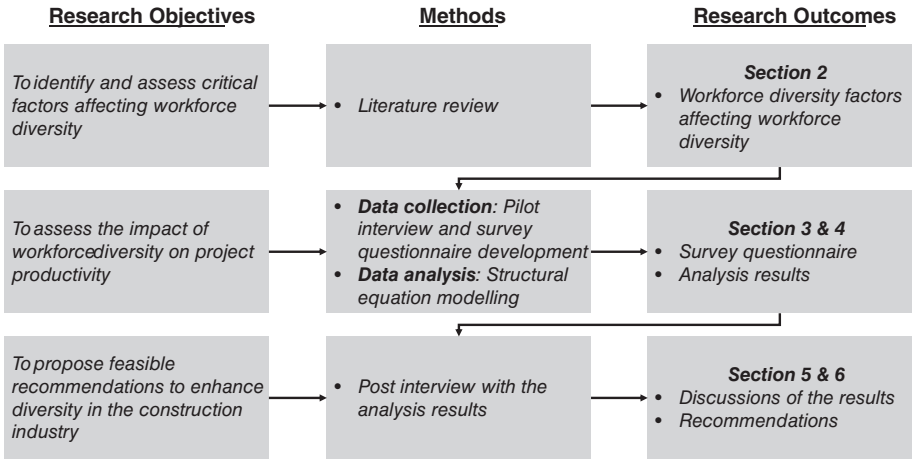

FIGURE 1 Connections among research objectives, methods, and research outcomes

industry to meet the national target of a 2–3% average annual growth by 2020. The areas of focus were a higher-quality workforce, higher capital investment, and a better-integrated construction value chain. In 2015, an additional S$450 million was provided to help firms invest in "impactful productive technologies" and improve the quality of their workforce from 2015 to 2018 (BCA, 2015b). Building and Construction Authority (BCA) is continuously pushing for the implementation and advancement of construction technology, believing it to be the solution to increasing productivity (BCA, 2015a). Moreover, BCA developed a research and development plan for construction productivity, where the construction industry aimed to work on and improve technologies adopted (BCA, 2016). These technologies will occur in several research and development clusters with a future goal and target in sight. Therefore, technology is seen as the solution to boost Singapore's construction productivity, and there is less emphasis on reasons for the lagging productivity of the construction sector in comparison to other sectors in Singapore.

2.2 | Workforce diversity in Singapore

A diverse workforce reflects the country's community. With regard to labor diversity in the workforce, categories are often placed on groups of people for ease of categorization when clustering and segmenting them for differentiation's sake. The following four types are commonly used when addressing Singapore's workforce diversity (Selvaraj, 2015). Firstly, "ethnicity" diversity typically refers to race, but it goes beyond that to include other aspects such as religion and spoken language. The ethnic breakdown of Singapore is estimated to be 74% Chinese, 13% Malay, 9% Indian, and 3% others, while religious groups equate to 43.2% Buddhists and Taoists, 18.8% Christians, 18.5% no religion, 14% Islam, 5% Hindus, and 0.6% others (MTI, 2018). "Skills and education" diversity refers to the qualifications of the workforce required to enter the job market, as different skill sets are certified to enroll in different jobs. The education level and skills also vary across different industries. An increase in skilled labor with a rise in the percentage of higher education graduates in Singapore from 2007 to 2017 symbolizes the country becoming more educated, with the literacy rate also rising every year; for instance, 2017 recorded a 97.2% literacy rate compared to 97% in 2016 (Department of Statistics Singapore [SingStat], 2020). By encouraging more diversified education backgrounds among locals, the diversity of skills will only stand to increase in the future workforce.

Diversity in age would similarly reflect the "Age and experience" distribution in the workforce. Variances in workers' age would generally indicate their level of working experience (Chung et al., 2015). Thus, the experience is a component of diversity under the age category. An increase in the 60 and above age group in the working population reflects the data in 2017, where the median age of Singapore's population stood at 40.5 years (SingStat, 2017). An increasing median age potentially means an aging population and, in turn, a shrinking labor force. However, in response to its aging society, Singapore's retirement age is also increasing. Ministry of Manpower (MOM) announced that the proportion of workers aged 60 and above active in the labor force had increased by 6.5% over 9 years from 2006. Otherwise, gender diversity in Singapore's workforce has been steadily equal over the past few years, with the labor force gender ratio closely reflecting the gender ratio of the population. Although close to having an equal proportion of males and females in Singapore's population, the percentage of females in the labor force was reported at 44.97% in 2017 (SingStat, 2017).

Diversity initiatives typically mean the programs, policies, and strategies enrolled to promote diversity within companies. In Singapore, because the workforce is inherently diverse due to its multi-racial community, MOM has crafted a toolkit for organizations to help them better manage their workforce diversity (National Integration Working Group [NIWG], 2014). MOM promotes the idea that a diverse workforce, along with proper guidance, can help drive better business performance and higher employee engagement. The MOM toolkit provides detailed strategies and reasons why firms should look toward adopting a more inclusive workforce. As workforces in Singapore consist of various workers from different age groups, gender, nationalities, and ethnicities who work together, the toolkit aims to help organizations and managers understand the importance of workforce diversity and to maximize its potential.

2.3 | Impact of workforce diversity on project productivity performance

There are several reasons why MOM is promoting a more diverse workforce. Firstly, organizations that create a more inclusive environment for their diverse workers can enhance their company's reputation in the job-seeking market to attract more workers. Secondly, employees from different backgrounds, who feel more integrated into the workforce, will be more engaged and motivated (Pollitt, 2005; MOM, 2011). Lastly, higher employee engagement across all types of workers may lead to a reduced turnover rate (Dernovsek, 2008; MOM, 2011); a 2008 study by Gallup Management Group revealed that engaged employees had a 51% lower turnover on average (Dernovsek, 2008). Therefore, a more diverse workforce allows for more cross-cultural interactions and a more socially inclusive space reflective of Singapore's multiracial society, where employees stand to benefit from having good relationships among themselves and with the firm.

Concerning the impact that more workforce diversity has on PPP, each of the following diversities, "Ethnicity," "Skills and education," "Age," and "Gender," are elaborated, based on past research and studies conducted. Firstly, the exact impact and results of ethnic diversity on firm performance is somewhat unclear due to conflicting theories and reasoning. On the one hand, ethnic-cultural diversity has been theorized to negatively affect firm performance as it may hinder the exchange of information and knowledge among workers due to linguistic and cultural barriers as well as weaken social ties and trust; people tend to doubt and be warier of people of different ethnicity, and they prefer to interact with others belonging to the same enclave as themselves (Glaeser & Vigdor, 2001). However, ethnic diversity can benefit how well a firm performs as it can help facilitate communications and decisions, and stimulate the brainstorming of new ideas (Hong & Page, 2004). It can also provide useful insights into the global market and demands to increase a company's competitiveness (Parrotta, Pozzoli, & Pytlikova, 2014), therefore reflecting inconclusive results on the opposite end of the spectrum.

Diversity in "Skills and education" can trigger a knowledge exchange among workers within a project group or the firm, which can positively affect firm performance (Tsang, Rumberger, & Levin, 1991). In contrast, diversity in "Age" can help stimulate firm productivity because the interactions between workers of different age groups (young or old workers), as well as the less and more experienced, can complement each other for fresh perspectives (Prieto, Phipps, & Osiri, 2009). On the one hand, younger workers would possess knowledge of new technologies currently in use, while older workers have a clearer understanding of the moving process and technical skills (Lazear, 2001). Besides, firms with mentorship programs also stand to gain more from having more diverse ages within the firm (Mor Barak, 2000).

Lastly, "Gender" diversity has been theorized to have potential benefits, such as where mixed-gender groups complete tasks quicker and make improved decisions (Ali, Kulik, & Metz, 2011; Sabatier, 2015), thus potentially enhancing group performance. The general theory states that men and women partake in different societal roles, where men are typically more logical, independent, and competitive, whereas women are known to be empathetic, dependent, and compromising (Jost & Kay, 2005). Therefore, men are expected to disagree more often and show stronger task behaviors (Myaskovsky, Unikel, & Dew, 2005), which can push the group to be more task-oriented. Women, on the other hand, are perceived as more agreeable and supportive, and this can facilitate more teamwork and interaction. Therefore, when both genders are present in the workforce, their behaviors can be complementary to support project tasks (Jost & Kay, 2005; Pucheta-Martínez, Olcina-Sempere, & López-Zamora, 2020).

In addition, a 2010 Singapore study on inclusive and harmonious workforces showed that 87% of companies surveyed agreed that workforce harmony was essential to business outcomes, and also demonstrated that a better-managed team with more diverse workers could outperform homogeneous teams with more creative solutions alongside more effective problem-solving methods, thus driving workers to be more efficient and productive (NIWG, 2014). However, when diverse groups are not well managed, communication will be scattered, and trust becomes weak, compromising the team dynamics—showing how people management is essential to the impact of a diverse workforce on project productivity (Srikanth, Harvey, & Peterson, 2016).

2.4 | Identification of workforce diversity factors affecting project productivity performance (PPP)

A comprehensive literature review was carried out to identify a set of workforce diversity factors that affect PPP. For the first diversity type, "Ethnicity," diversity factors with negative impact were identified as language barriers and lack of trust. Communication among different ethnic groups, especially from different countries, often results in a language barrier that has the potential to negatively affect productivity due to progress being slower from more rounds of clarification among workers. Also, because of the poor communication among different ethnic groups, technical details and management instructions stand to be misinterpreted; this can lead to different ethnic groups not trusting each other, which will affect the coordination required for productivity (Makulsawatudom, Emsley, & Sinthawanarong, 2004). On the other hand, as for the diversity factors with a positive impact, PPP would depend on how much motivation and job commitment the workers possess as increased morale can influence commitment to the project and boost workforce motivation and, in turn, improve productivity (Thomas & Sudhakumar, 2013). In addition, a group of people with diverse ethnicity could boost productivity by contributing different effective work styles to the project, therefore allowing for a more significant inflow of ideas, which would increase productivity (Parrotta et al., 2014).

For "Skill and education" type of diversity, the negative diversity factors were identified as a lack of training provided, shortage of skilled labor, inspection delays, and incomplete technical specifications. A plethora of unskilled workers have come to the construction industry in developed countries from developing countries

(Abdul-Rahman, Wang, Wood, & Low, 2012; Kaming, Olomolaiye, Holt, & Harris, 1997; Khadria, 2006). Due to unskilled and unqualified workers, inspection delays and incomplete technical specifications occur and eventually decrease productivity. However, contractors usually invest less in labor training as they are dissuaded by the short-term costs incurred, which result in potential long-term benefits not being reaped, rendering construction firms with little option but to hire less-skilled, less-qualified, and less-trained workers to save costs, which can severely affect construction productivity (Lim & Alum, 1995). Also, an unskilled supervisor in the workforce can lead to an incompetent leader, resulting in unproductive activities, such as delayed inspections, more mediocre quality work produced, and increased idle time of resources (Dai, Goodrum, & Maloney, 2007). Therefore, without a skilled and trained supervisor and workforce, incomplete, unclear, or outdated technical specifications will also likely occur due to inadequate site management, resulting in multiple requests for clarification meetings, leading to more interruptions to the work progress (Jarkas & Bitar, 2012).

Otherwise, in the "Skill and education" diversity type, transfer of skills and knowledge, effective project planning and execution, qualified supervisors, and efficient decision-making were identified as the positive diversity factors in "Skill and education." The transfer of knowledge and skills would help generate knowledge spillover among a firm's employees, as long as workers' knowledge sets do not overlap and are relevant to one another, which positively affects firm performance (Parrotta et al., 2014). With more relevant skills and training for construction projects, qualified supervisors can make quicker and more effective decisions to prevent wastage of time and, thus, increase productivity on site (Jarkas & Radosavljevic, 2013; Kazaz, Manisali, & Ulubeyli, 2008). With more highly qualified and trained workers, there can be more effective project planning and execution occurring on-site for construction projects, hence resulting in a positive boost to project productivity through a more skilled and educated workforce.

"Age and experience" usually encompasses work experience as a factor concerning productivity. With a negative impact of "Age and experience," shortage of experienced labor, high rate of labor turnover, and unrealistic deadlines for project completion were identified as diversity factors. Since the labor-intensive construction industry strongly relies on and demands excellent skills and experience of the workforce, a lack of experienced labor can severely affect project deadlines, cost, and quality of works done (Alinaitwe, Mwakali, & Hansson, 2007). Unlike older workers who stay in the construction industry in which they accumulated their experience, a younger labor force results in a higher turnover rate in search of new jobs in different sectors (Thomas, 2015). Such a volatile workforce with more youthful workers may result in lower productivity (Bandhanpreet, Mohindru, & Pankaj, 2013).

Conversely, for the "Age and experience" diversity factors with a positive impact, wages have to be attractive to recruit incoming workers as the construction sector has to compete with other industries for its workforce, such as the engineering market, banking, and finance (Thomas, 2015). Therefore, using wages to attract and retain a workforce of different ages can result in higher productivity due to the incentive gained. With the proper positioning of experienced supervisors, productivity would increase as supervisors have to be assigned to positions and places where they can properly utilize and transfer knowledge gained from experience and translate that into productivity on the job (Lim & Alum, 1995; Thomas, 2015). As the construction industry is becoming mechanized with the introduction of new equipment and technology, it is paramount to recruit and train the younger generation of skilled local workers who are adept at using technology in comparison to their older but more experienced counterparts (Lim & Alum, 1995).

Regarding gender diversity, the diversity factors negatively affecting productivity mainly include the physicality and health of workers. The physical aspect of construction consists of the time and workload of the construction site (Soham & Rajiv, 2013). As men are more accustomed to hard manual labor, a more physical job is usually undertaken by men for increased productivity. Taking the health of workers into consideration as a factor affecting productivity, for maternity leave, women in Singapore are entitled to 16 weeks of paid leave. In the context of Singapore's construction industry, workers' health may affect productivity as cross-training and handing over as well as hiring temporary replacements all consume time and resources, which can impact project productivity. However, with a more diverse distribution of gender in the workforce, productivity may stand to gain from the contrasting behavior and work pattern of men and women as they have different sets of social behaviors that could be complementary (Jost & Kay, 2005; Pucheta-Martínez et al., 2020).

3 | METHODS AND DATA COLLECTION

3.1 | Survey design

Before conducting a wide-ranging survey, a pilot interview was conducted with three industry experts to validate the identified factors from the literature review as well as to certify the applicability and understandability of the questionnaire. This interview helped to eliminate insignificant and repetitive diversity factors identified concerning their impact on the productivity of construction projects. During the interview, the questions were posed to the respondents to list additional factors that may not have been identified through the literature review. Targeted respondents of this pilot interview were industrial experts who were chosen due to their relevance and involvement in the construction industry, who have worked closely with various associates of different diversities. Therefore, their ability to provide valuable insights and views were taken into consideration to develop the final survey questionnaire. Finally, as shown in Table 1, a total of 21 diversity factors categorized into four principal diversity types were included in a survey questionnaire.

The survey questionnaire was designed based on workforce diversity factors. The questionnaire consists of three main sections, as shown in Appendix S1. The first two sections aimed to solicit

TABLE 1 Diversity factors affecting labor productivity

Diversity type	No.	Diversity factors	Definition	Makulsawatudom et al., 2004; Jarkas & Radosavljevic, 2013	Kazaz et al., 2008; Jarkas, Radosavljevic, & Wuyi, 2014	Thomas & Sudhakumar, 2013	Parrotta et al., 2014	Jarkas & Radosavljevic, 2013	El-Gohary & Aziz, 2013	Jarkas & Bitar, 2012	Jarkas, 2015	Lim & Alum, 1995	Thomas, 2015	Bandhanpreet et al., 2013	Dai et al., 2007	Enshassi, Mohamed, Mustafa, & Mayer, 2007	Makulsawatudom et al., 2004	Mojahed & Aghazadeh, 2008	Soham & Rajiv, 2013	Jost & Kay, 2005
Ethnicity	1	Language barrier	Communication between different ethnic groups, especially from different countries, often result in a language barrier, which has the potential to negatively affect productivity due to progress being slower from more rounds of clarification between workers	●																
	2	Lack of trust between groups	Because of lousy communication, technical details and management instructions stand to be misinterpreted which can lead to the different ethnic groups not trusting each other which will affect the coordination required for productivity	●																
	3	Motivation and job commitment	The project productivity would also depend on how much motivation and job commitment the workers possess. As increased morale can influence the commitment to the project and boost the motivation of the workforce and in turn increase productivity			●														
	4	Contribution of different work ethic	A group of people with diverse ethnicity can boost productivity by contributing different effective work styles in the project, therefore allowing for more inflow of ideas				●													
Skill and education	5	Lack of training provided	Due to unskilled and poorly trained workers, productivity decreases as faulty works will eventually result in more cost spent on maintenance and corrections					●	●											
	6	Shortage of skilled labor	Unskilled labor in the workplace would lead to unproductive activities such as poorer quality work done and increased idle time of resources.							●	●	●								
	7	Inspection delays	One of the reasons for inspection delay is the lack of skill and education, and therefore it was included in the workforce diversity factor as a mediator affecting project productivity accordingly					●							●	●	●			
	8	Incomplete technical specifications	Incomplete technical specifications are usually caused by the lack of skill and education. Thus, it can be included in the workforce diversity factor as a mediator affecting project productivity					●		●							●			
	9	Transfer of skills and knowledge	The transfer of knowledge and skill would help generate knowledge spillover among the employees within a firm, as long as the sets of workers knowledge do not overlap and are relevant to one another, which positively affects firm performance				●													
	10	Effective project planning and execution	Through a more skilled and educated workforce, there can be more effective project planning and execution occurring on-site for the construction projects, resulting in a positive boost to labor productivity		●															
	11	Qualified supervisors	With more relevant skill and training for construction projects, the qualified supervisors can make quicker		●		●													

TABLE 1 (Continued)

Diversity type	No.	Diversity factors	Definition	Makulsawatudom et al., 2004; Jarkas & Radosavljevic, 2013	Kazaz et al., 2008; Jarkas, Radosavljevic, & Wuyi, 2014	Thomas & Sudhakumar, 2013	Parrotta et al., 2014	Jarkas & Radosavljevic, 2013	El-Gohary & Aziz, 2013	Jarkas & Bitar, 2012	Jarkas, 2015	Lim & Alum, 1995	Thomas, 2015	Bandhanpreet et al., 2013	Dai et al., 2007	Enshassi, Mohamed, Mustafa, & Mayer, 2007	Makulsawatudom et al., 2004	Mojahed & Aghazadeh, 2008	Soham & Rajiv, 2013	Jost & Kay, 2005
			and more effective decisions to prevent wastage of time and thus, increase productivity on site																	
	12	Efficient decision-making	With more highly qualified and trained workers more efficient decision-making can be occurred on site for the construction projects, resulting in a positive boost to labor productivity		●															
Age and experience	13	Shortage of experienced labor	Where since the labor-intensive construction industry strongly relies on and demands good skills and experience of the workforce. Therefore, a lack of experienced labor can severely affect the project deadlines, cost, and quality of works done											●				●		
	14	High rate of labor turnover	Unlike older workers who stay in the construction industry in which they accumulate experience in, a younger labor force projects a higher turnover rate in search of new jobs in different sectors. Such a volatile workforce with more youthful workers may result in a lower productivity										●					●		
	15	Unrealistic deadlines for project completion	If there is a lack of diverse labor with little experienced project managers, there may also be negative impacts on productivity, such as milestones and deadlines that are unrealistic. If the deadline is not possible to meet, it would place production pressure on the workers and cause a negative impact on the project productivity															●		
	16	Amount of pay and wages	The amount of wages has to also be attractive in order the recruit the incoming workers as the construction sector has to compete for workforce with other more attractive industries such as the engineering market or banking and finance. Therefore, by using wages to attract and retain the workforce of different ages, it can result in higher productivity due to the incentive gained									●	●							
	17	Positioning of experienced consultants	The proper positioning of experienced supervisors can positively affect productivity as they have to be assigned to positions and places where they can properly utilize and transfer knowledge gained from experience and translate that into productivity on the job									●	●							
	18	More dependence on equipment and technology	As the construction industry is becoming more mechanized with the introduction of more new equipment and technology, it is paramount to recruit and train a younger generation of skilled local workers who are adept at the usage of technology in comparison to the older but more experience counterparts									●								
Gender	19	Physical fatigue	Where the physical aspect of construction includes the time and workload of the construction site which men are more accustomed to hard manual labor, therefore, a																●	

(Continues)

TABLE 1 (Continued)

Diversity type	No.	Diversity factors	Definition	Makulsawatudom et al., 2004; Jarkas & Radosavljevic, 2013	Kazaz et al., 2008; Jarkas, Radosavljevic, & Wuyi, 2014	Thomas & Sudhakumar, 2013	Parrotta et al., 2014	Jarkas & Radosavljevic, 2013	El-Gohary & Aziz, 2013	Jarkas & Bitar, 2012	Jarkas, 2015	Lim & Alum, 1995	Thomas, 2015	Bandhanpreet et al., 2013	Dai et al., 2007	Enshassi, Mohamed, Mustafa, & Mayer, 2007	Makulsawatudom et al., 2004	Mojahed & Aghazadeh, 2008	Soham & Rajiv, 2013	Jost & Kay, 2005
			more physical job is usually undertaken by men for increased productivity																	
	20	Health of workers	Especially in the context of maternity leave where women in Singapore are entitled to 16 weeks of paid leave may affect the productivity in the workplace as cross-training and handing over as well as hiring temporary /replacement all consume time and resources which can impact the productivity of projects															•		
	21	Complementary social behaviors	With a more diverse distribution of genders in the workplace, productivity may stand to gain from the contrasting behavior and work pattern of men and women as they have different sets of social behaviors, which can be complementary																	•

information regarding the respondent's organization and their personal work experience in different construction project categories to validate the survey, targeting respondents using their qualifications. The last part of the questionnaire required the respondents to indicate their perception of the significance and PPP of all the diversity factors on projects based on their experience. The significance referred to how they perceived the level of impact that the respective diversity factor had on the project, which was measured using a five-point Likert scale: 1 = not significant, 2 = a little significant, 3 = uncertain and neutral, 4 = moderately significant, and 5 = very significant. The PPP referred to how respondents perceived the diversity factor to affect the project's level of productivity, which was also measured using a five-point Likert scale: 1 = very bad, 2 = bad, 3 = neutral, 4 = good, and 5 = very good.

3.2 | Data collection

The target population of the study belonged to firms involved in the construction industry, such as developers, contractors, architects, or quantity surveyors who had experience in construction projects. They were selected in the belief that they could provide accurate and constructive responses on the workforce diversity factors and their significance and impact on PPP. Firms of the targeted respondents were sourced through BCA's Directory of Registered Contractors and Licensed Builders, which includes global companies working in Singapore, such as the list of architectural consultancy firms and registered contractors. Simple random sampling was conducted to select 140 companies from the BCA's directory, and the questionnaires were distributed via e-mail. Among the selected companies, 28 survey responses were collected. In addition, the other 36 questionnaires were printed and distributed to relevant personnel in the industry, and 30 responses were received from them. All in all, the questionnaire achieved a 33% response rate, with a total of 58 complete sets of surveys.

Four types of organizations participated in the survey. The respondents that completed the survey included 26 contractors, 3 developers, 23 consultants, and 6 architects. Table 2 summarizes the respondents' respective job positions in the firms as well as their relevant years of experience in the construction industry. As seen in Table 2, the majority of the respondents had at least 5 years of experience in the construction industry, with the next highest group having at least 3 years of experience. Only one respondent had less than a year of experience, while five respondents had more than 10 years of experience in the industry.

The data collected also reflected the various project characteristics of the projects managed and participated in by the respondents, as shown in Table 3. There were a total of 154 projects: 87 building (56.5%), 42 infrastructure (27.3%), 11 heavy industrial (7.1%), and 14 light industrial (9.1%) projects. A large percentage of the projects involved new construction projects (71.4%), while the remaining 28.6% of projects were addition and alteration projects. Similarly, the majority (38.3%) of the projects cost between S$10 million and S$100 million.

TABLE 2 Survey respondents' job positions and years of experience

Respondent characteristics		Number	Percentage (%)
Job position	Project manager	15	25.9
	Architects	8	13.8
	Quantity surveyors	12	20.7
	Consultant	9	15.5
	Contractor	14	24.1
Total		58	100
Years of experience	Less than 1 year	1	1.7
	1–2 years	8	13.8
	3–4 years	20	34.5
	5–10 years	24	41.4
	More than 10 years	5	8.6
Total		58	100

TABLE 3 Project characteristics undertaken by survey respondents

Project characteristic		Number	Percentage (%)
Project type	Building	87	56.5
	Infrastructure	42	27.3
	Heavy industrial	11	7.1
	Light industrial	14	9.1
Total		154	100
Project nature	New construction	110	71.4
	Addition and alteration	44	28.6
Total		154	100
Project cost	Less than 1 million SGD	32	20.8
	1–10 million SGD	42	27.3
	10–100 million SGD	59	38.3
	100 million–1 billion SGD	21	13.6
Total		154	100

3.3 | Data analysis methods

3.3.1 | Partial least squares structural equation modeling

The Shapiro–Wilk test (Shapiro & Wilk, 1965) was firstly used to test for the normality of the dataset collected from the questionnaires. According to the result of the Shapiro–Wilk test, the method to be used for analysis was determined between parametric and nonparametric methods. In this study, diversity factors identified from the literature review were assessed by industry experts through survey questionnaires. The survey asked respondents to indicate their general perception of the significance of each diversity factor and its impact on productivity performance based on their project experiences using a five-point Likert scale. A structural equation model, partial least squares structural equation modeling (PLS-SEM), was subsequently applied. The PLS-SEM aimed to test the proposed hypothesis, which, in this study, represented the relationship between diversity factors and perceived PPP. Based on the data collected through survey questionnaires, a hypothesized model of diversity factor significance and its perceived productivity performance was established, assuming there was a positive relationship between the two.

In order to analyze a structural equation model with latent variables using the PLS method, the model was divided into a structural model, a measurement model, and a weight relation that represented latent variables as linear combinations of measurement variables (Fornell & Cha, 1994). The structural model represented the causal relationship between latent variables, including error variables that were not explained through the model by following the basic matrix equation:

$$\boldsymbol{\eta} = \boldsymbol{B}\boldsymbol{\eta} + \boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\zeta}, \quad (1)$$

where each $\boldsymbol{\eta}$, $\boldsymbol{\xi}$, and $\boldsymbol{\zeta}$ represent the matrixes for endogenous latent variables, exogenous latent variables, and error variable; $\boldsymbol{B}$ and $\boldsymbol{\Gamma}$ are the matrixes of path coefficients between latent variables. On the other hand, the measurement model represented the causal

relationship between the latent variable and the measured variable, including the measurement error occurring during the measurement process by following the basic matrix equation:

$$\boldsymbol{y} = \boldsymbol{\Lambda_y}\,\boldsymbol{\eta} + \boldsymbol{\varepsilon}, \tag{2}$$

$$\boldsymbol{x} = \boldsymbol{\Lambda_x}\,\boldsymbol{\xi} + \boldsymbol{\delta}, \tag{3}$$

where $\boldsymbol{y}$ and $\boldsymbol{x}$ are the matrixes of measurement variables $\boldsymbol{\eta}$ and $\boldsymbol{\xi}$, $\boldsymbol{\Lambda_y}$ and $\boldsymbol{\Lambda_x}$ are coefficient matrixes of the measurement model, and $\boldsymbol{\varepsilon}$ and $\boldsymbol{\delta}$ are the matrixes of error. The weighting relationship in the PLS estimation process required calculating the predictive value of the latent variables, $\hat{\boldsymbol{\eta}}$ and $\hat{\boldsymbol{\xi}}$ using a linear combination of the measured variables, defined in the following equations:

$$\hat{\boldsymbol{\eta}} = \boldsymbol{w_\eta}\,\boldsymbol{y}, \tag{4}$$

$$\hat{\boldsymbol{\xi}} = \boldsymbol{w_\xi}\,\boldsymbol{x}, \tag{5}$$

where $\boldsymbol{w_\eta}$ and $\boldsymbol{w_\xi}$ are the matrixes of weights needed to compute the predictive value of a latent variable.

The PLS method was chosen for analyzing the structural equation model due to its propriety for non-distributional form presumed in the measured variables (Aibinu & Al-Lawati, 2010), which is applicable to the dataset of this study as determined by the Shapiro–Wilk test. Furthermore, PLS-SEM works well and has high statistical power with a smaller sample size (Fornell & Bookstein, 1982; Hair, Hollingsworth, Randolph, & Chong, 2017; Lim, Ling, Ibbs, Raphael, & Ofori, 2012; Raymond & Bergeron, 2008). PLS is a method of repeating a regression analysis to find the optimized parameter combination that minimizes the prediction error by using the parameters whose values are known or fixed by specific conditions. The iterative process can be primarily divided into the external approximation process that calculates the value of the latent variable using the measured variables and internal approximation process that calculates the value of the latent variable using the relationship between the latent variables (Fornell & Cha, 1994).

In the internal approximation, the value of the latent variable is estimated based on its initial weight, which is commonly initialized as one, and its normalized measurement variables, which represent the attribute of the latent variable. After standardizing the estimated latent variable values, the weight is calculated using one of the weight selection methods (Fornell & Cha, 1994) defined according to the causal relationship of latent variables. There are three main methods for weight selection: (i) the path-weighting scheme, in which weights are differentiated by distinguishing the roles of causes and effects among potential variables, (ii) the factor-weighting scheme that uses the correlation coefficients of two variables as weights without distinguishing roles between potential variables, and (iii) the centroid-weighting scheme that uses the sign of the correlation coefficient between the latent variable to be found and the latent variable affecting the variable as a weight. The path-weighting method is most common and generally utilized among the above methods, which was applied in this study. Based on the obtained weights, the weighted sum of the latent variables is re-estimated in the model, and the values of the latent variables are renormalized for the next step.

In the external approximation, the regression coefficients are estimated by simple or multiple regression analysis using normalized latent and measurement variables, and the estimated latent variables are re-estimated using the weighted sum of the regression coefficients of measured variables using Equations (4) and (5). The internal and external approximations are repeated using the estimated latent variables. This iterative process is repeated until the difference between the value of each weight in the external approximation becomes less than 10^{-3} (Chin, 1998). After estimating the latent variables using the final weight obtained through the iterative process, all the path coefficients of both the measurement and structural models are estimated by simple or multiple regression analysis using the estimated values.

After the development of the structural equation model, evaluation of the model needs to be performed to ensure confidence that the measures represent the construct of interest, hence adequately using them to examine the structural relationship. The model evaluation included the assessment of model measures with regard to four aspects: (i) internal consistency reliability, (ii) indicator reliability, (iii) convergent validity, and (iv) discriminant validity. The evaluation was processed by applying four kinds of validity following certain criteria with the statistical indicators that were generated in the SmartPLS software: composite reliability, indicator loadings, and average variance extracted (AVE). For internal consistency reliability to be regarded as satisfactory, composite reliability values should be higher than 0.70 (Hair, Ringle, & Sarstedt, 2011). Indicator reliability requires values of indicator loadings to be at least higher than 0.40, and, for the convergent validity assessment, AVE values should be higher than 0.50 (Hair et al., 2011). Lastly, discriminant validity was assessed by two measures: cross-loadings, where an indicator's loading should be higher than all of its cross-loadings; and the Fornell–Larcker criterion, where the AVE of each latent construct should be higher than the construct's highest squared correlation with any other construct (Hair et al., 2011).

After ensuring the evaluation of the model, the significance of path coefficients was generated by bootstrapping, which is a statistical method for the inference of a population using sample data (Hair et al., 2011). The critical *t*-value for a two-tailed test is 2.58 at a significance level of 1% (Hair et al., 2011). A *t*-value of below 2.58 accepts the null hypothesis, concluding in this case that workforce diversity does not have a significant impact on PPP. The various indicator loadings of each management diversity factor define how impactful they are, with higher loadings deemed as having greater effectiveness within the category.

3.3.2 | Post-interviews

In order to fine-tune the recommendations, a follow-up interview was conducted with the selected specialists listed in Table 4. The post-interviews were performed with the three professionals in both face-to-face and untact manners. The professionals' information is

TABLE 4 Profile of pilot and post-interviewees

Respondents	Company type	Years of experience in the industry	Job position
A	Developer firm	12	Project director
B	Construction company	9.5	Project manager
C	Construction company	4	Project executive

TABLE 5 Normality test results

	Significance			Productivity performance		
Diversity factors	Statistic	DoF	Significance	Statistic	DoF	Significance
F1	0.790	10	0.011	0.844	10	0.049
F2	0.830	10	0.033	0.814	10	0.022
F12	0.704	10	0.001	0.744	10	0.003
F13	0.783	10	0.009	0.654	10	0.000
F3	0.811	10	0.020	0.746	10	0.003
F4	0.828	10	0.031	0.690	10	0.001
F5	0.661	10	0.000	0.776	10	0.007
F6	0.835	10	0.039	0.696	10	0.001
F14	0.797	10	0.013	0.746	10	0.003
F15	0.729	10	0.002	0.766	10	0.006
F16	0.830	10	0.033	0.842	10	0.046
F17	0.820	10	0.025	0.781	10	0.009
F7	0.785	10	0.010	0.671	10	0.000
F8	0.812	10	0.020	0.792	10	0.012
F9	0.778	10	0.008	0.825	10	0.029
F18	0.725	10	0.002	0.805	10	0.017
F19	0.826	10	0.030	0.842	10	0.046
F20	0.776	10	0.007	0.530	10	0.000
F10	0.830	10	0.034	0.744	10	0.003
F11	0.844	10	0.049	0.823	10	0.028
F21	0.812	10	0.020	0.694	10	0.001

described in Table 4, which include one project director from a development firm as well as two project managers and a project executive from construction companies. Their feedbacks were carefully considered when analyzing the results and devising the strategies. More details on the outcomes from the post-interviews are provided in Sections 5 and 6.

4 | DATA ANALYSIS RESULTS

4.1 | Normality test

In order to determine the suitable test methods for the data, the Shapiro–Wilk test was conducted. A significance level (α) of 0.05 was used to assess the hypothesis. If the *p* value falls below 0.05, the null hypothesis will thus be rejected, concluding that the dataset does not fit a normal distribution. The null hypothesis and alternative hypothesis are established below:

H_0. The data are normally distributed.

H_1. The data are not normally distributed.

Table 5 shows the results of the Shapiro–Wilk test for the data for the perceived significance and productivity performance of the 21 diversity factors. The *p* values of all the diversity indexes reflected a value lower than 0.05, thus rejecting the null hypothesis and concluding that the dataset does not fit a normal distribution. As the dataset is not of a normal distribution, a nonparametric statistical test, the PLS-SEM, was then adopted for analysis in this research.

4.2 | Deriving the relationship between workforce diversity and project productivity via PLS-SEM

The study mainly aimed to investigate which workforce diversity factor was significantly correlated with construction PPP. In order to derive the relationship, the SEM technique PLS-SEM was applied. This section presents the results of the modeling and an in-depth

TABLE 6 Measurement models

Diversity type	Code	Loading	*t*-value	AVE	CR
Ethnicity	E1	0.713	24.219	0.561	0.864
	E2	0.759	32.929		
	E3	0.776	44.556		
	E4	0.822	47.182		
Skill and education	SE5	0.746	28.207	0.514	0.892
	SE6	0.685	22.441		
	SE7	0.647	23.257		
	SE8	0.443	10.671		
	SE9	0.695	28.713		
	SE10	0.721	33.884		
	SE11	0.816	44.025		
	SE12	0.899	92.952		
Age and experience	AE13	0.807	42.139	0.583	0.847
	AE14	0.697	24.014		
	AE15	0.635	20.369		
	AE16	0.550	13.493		
	AE17	0.695	22.554		
	AE18	0.755	37.118		
Gender	G19	0.849	39.121	0.665	0.854
	G20	0.921	145.241		
	G21	0.654	18.636		

Note: E = ethnic, SE = skills and education, AE = age and experience, G = gender.

discussion on which diversity factors are most effective and which diversity aspects need to be enhanced. The hypothesis for the model development was proposed as follows:

H0. *Workforce diversity does not have a significant impact on PPP.*

H1. *Workforce diversity has a significant impact on PPP.*

The significance of the path coefficient was generated using bootstrapping. If the *t*-value is below 2.58, the null hypothesis is accepted, concluding that workforce diversity does not have a significant impact on PPP. Conversely, the null hypothesis is rejected if the *t*-value falls higher than 2.58. With the proposed hypothesis, a structural equation model was developed via SmartPLS software. Then, the developed model was evaluated through measurement model analysis, and the model was analyzed and discussed to suggest recommendations to improve workforce diversity and construction PPP.

4.2.1 | Measurement model analysis

The evaluation of the model reliability involved separate assessments of the measures from the measurement model (Hair et al., 2011), as presented in Table 6. If the indicator loadings for each diversity factor are higher than 0.4, and if *t*-values are higher than 2.58, this indicates satisfactory indicator reliability. The composite reliability (CR) (Equation [6]) values shown in Table 6 are all higher than 0.7, implying satisfactory internal consistency reliability (Nunnally, Bernstein, & Berge, 1967). On the other hand, for the validity of the model, several measures needed to be evaluated, such as AVE, cross-loading, and the Fornell–Larcker criterion (Hair et al., 2011). Firstly, all the values of AVE (Equation [7]) presented in Table 6 are all more than 0.5, thus indicating a sufficient degree of convergent validity (Bagozzi & Yi, 1988; Fornell & Larcker, 1981):

$$\text{Composite Reliability (CR)} = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum (1-\lambda_i^2)}, \quad (6)$$

$$\text{Average Variance Extracted (AVE)} = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum (1-\lambda_i^2)}, \quad (7)$$

where λ is the factor loading of the i-th measurement variable.

Also, two measures, cross-loading, and the Fornell–Larcker criterion (Fornell & Larcker, 1981), needed to be assessed for discriminant validity to determine which factors are distinct and uncorrelated. Table 7 shows that each factor's loading (bolded in the table) is higher than all of the other cross-loadings for each category: ethnicity (E), skills and education (SE), age and experience (AE), and gender (G); for example, the loading of E1, 0.713, is the highest value compared to other categories such as SE, AE, and G. Table 8 presents each

TABLE 7 Cross-loadings for discriminant validity

Factor category / Factor	E	SE	AE	G
E1	0.713	0.557	0.508	0.267
E2	0.759	0.605	0.588	0.652
E3	0.776	0.617	0.614	0.416
E4	0.822	0.616	0.600	0.381
SE5	0.600	0.746	0.565	0.323
SE6	0.453	0.685	0.553	0.260
SE7	0.606	0.647	0.604	0.681
SE8	0.506	0.742	0.382	0.566
SE9	0.504	0.695	0.604	0.294
SE10	0.613	0.721	0.604	0.532
SE11	0.613	0.816	0.565	0.562
SE12	0.520	0.899	0.561	0.596
AE13	0.530	0.558	0.807	0.497
AE14	0.604	0.534	0.697	0.328
AE15	0.439	0.524	0.735	0.242
AE16	0.509	0.571	0.650	0.637
AE17	0.547	0.557	0.695	0.445
AE18	0.541	0.509	0.755	0.593
G19	0.338	0.455	0.512	0.849
G20	0.552	0.577	0.470	0.921
G21	0.493	0.443	0.385	0.754

Note: E = Ethnic, SE = Skills and education, AE = Age and experience, G = Gender.

TABLE 8 Fornell–Larcker criterion

Category	AE	E	G	SE
AE	0.723			
E	0.585	0.747		
G	0.661	0.567	0.841	
SE	0.695	0.649	0.662	0.744

Note: E = Ethnic, SE = Skills and education, AE = Age and experience, G = Gender.

construct's AVE, bolded figures in the table higher than the squared correlation with any other construct, which satisfies the Fornell–Larcker criterion; for example, for the AVE value for AE to AE, 0.723 is the highest value compared to other categories such as E, G, and SE. Both the above measurements indicate that the factors rightfully relate more strongly to their diversity category than to another category, which satisfied discriminant validity.

4.2.2 | Structural equation model analysis

The structural model showed a *t*-value higher than 2.58 between two diversity categories and their perceived productivity performance to substantiate the null hypothesis, as presented in Figure 2. The effects of each diversity factor in relation to productivity performance are deduced from the factor loadings generated by the bootstrapping, with higher loadings having a more substantial impact. Diversity factors were grouped into four categories, with a total of 21 factors measured and tested for their correlation to perceived productivity performance. This was achieved by computing the significance and productivity performance indicated by all respondents. A path analysis between the four diversity categories and productivity performance of the factors was implemented. The outer model showed the loadings and *t*-values for the respective diversity factors, while the inner model showed the path coefficient and *t*-values. The *t*-values, 12.697 for "Skill and education" and 10.947 for "Age and experience" with "Productivity performance" (as shown in Figure 2), are both higher than 2.58, indicating its statistical significance at the 0.01 level (Hair et al., 2011). Therefore, the null hypothesis proposed is rejected, concluding that the two categories of workforce diversity have a significant impact on PPP in the construction industry.

"Skills and education" was the top set of diversity factors with a path coefficient of 0.552. "Age and experience" had the second-highest path coefficient of 0.359, and "Ethnicity" was the third with a path coefficient of 0.046. Lastly, "Gender" ranked fourth with a path coefficient of 0.031. "Skills and education" had the highest path coefficient among the four diversity categories, which implies a stronger influence on perceived productivity performance than the rest, followed by "Age and experience" also having a strong influence. As for the other two diversity categories, "Ethnicity" and "Gender," they have a small path coefficient of less than 0.100. A discussion on the various diversity factors in the two significant categories ("Skill and education" and "Age and experience") and their corresponding effect are discussed in the following section.

5 | DISCUSSION OF THE RESULTS

The structural model presents the impacts of the diversity factors on PPP as perceived by the respondents. Two out of the four diversity categories, namely "Skill and education" and "Age and experience," were shown to have significant effects on the productivity of construction projects, while the other two categories, "Ethnicity" and "Gender," had statistically insignificant and small correlations to PPP due to the t-values being less than 2.58. Table 9 summarizes the rankings of the diversity factors belonging to the two significant categories. The categories' assorted diversity factors are discussed based on the descending order of their loadings as follows.

5.1 | Skill and education

5.1.1 | SE12: Efficient decision-making

Efficient decision-making received the highest loading in this category. Decisions are usually made by an executive who should know how to

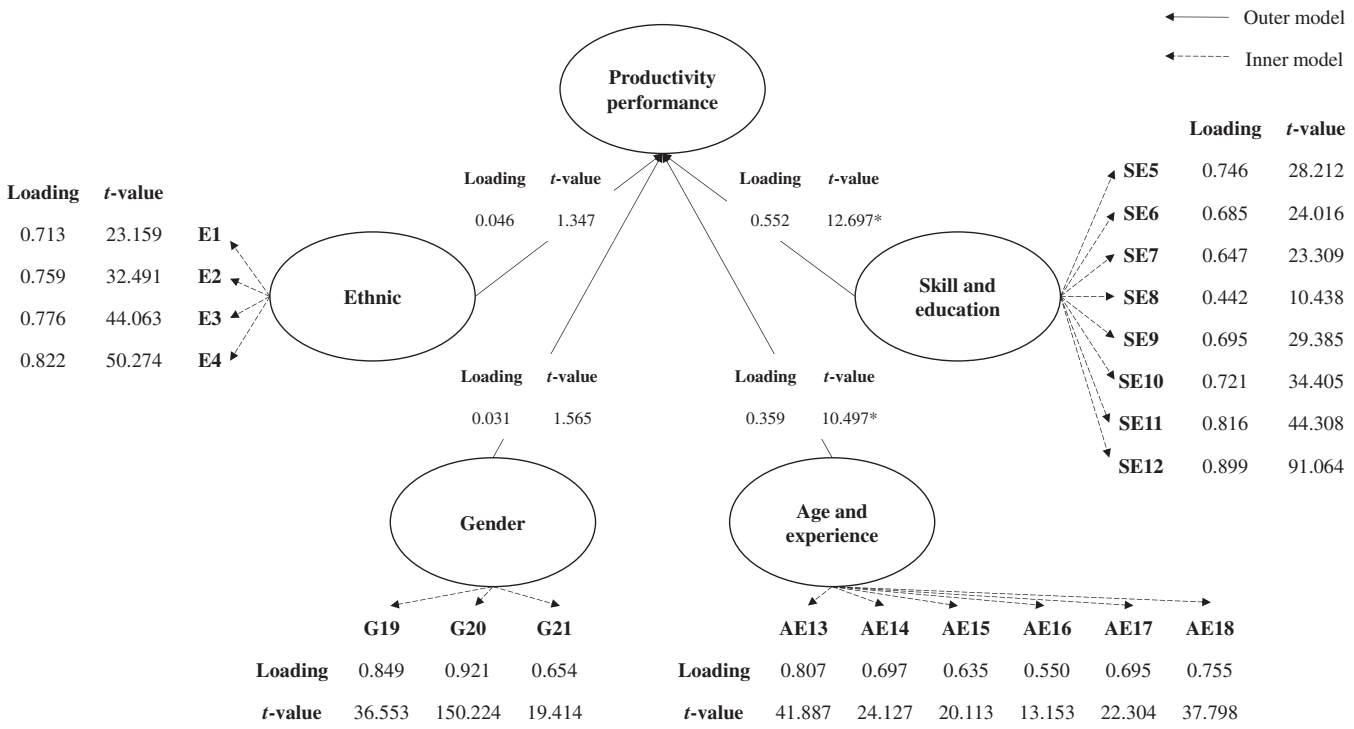

FIGURE 2 Best-fitted structural equation model

TABLE 9 Summary of the effectiveness of diversity factors by category

Code	Diversity factors	Loading	Rank
Skill and education (SE)			
SE12	Efficient decision-making	0.899	1
SE11	Qualified supervisors	0.816	2
SE5	Lack of training provided	0.746	3
SE10	Effective project planning and execution	0.721	4
SE9	Transfer of skills and knowledge	0.695	5
SE6	Shortage of skilled labor	0.685	6
SE7	Inspection delays	0.647	7
SE8	Incomplete technical specifications	0.442	8
Age and experience (AE)			
AE13	Shortage of experienced labor	0.807	1
AE18	More dependence on equipment and technology	0.755	2
AE14	High rate of labor turnover	0.697	3
AE17	Positioning of experienced consultants	0.695	4
AE15	Unrealistic deadlines for project completion	0.635	5
AE16	Amount of pay and wages	0.550	6

make wise and logical decisions based on principles and how to weigh the pros and cons. This can be attributed to the vital role that efficient decision-making plays throughout the entire project life cycle, where the post-interviewees have emphasized how meetings are often delayed due to a conclusion not being made. The most time-consuming step in the whole process is not merely making the decision but putting it into effect (Thorngate, 1980). Thus, effectively making a decision and swiftly translating it into action are highly essential steps in the whole decision-making process. Therefore, a determination is valid only when the initial steps are taken to ensure that the process is streamlined, and the respective superiors are on the same page for them to quickly give approval. The decision-maker (which in the context of the construction industry is a project manager) must also consider the worker capabilities that the decision will affect (Thorngate, 1980). Therefore, a single decision can have a long-term impact on the construction project and has the potential to affect productivity levels.

5.1.2 | SE11: Qualified supervisors

Having a qualified leader strongly relates to the quality of the decisions being made. A more qualified supervisor has the capability to make more effective decisions. A qualified supervisor, in turn, would also step into more leadership roles with the opportunity to lead various groups of project teams. The constant push for higher levels of productivity requires more effective and ethical leadership (Mason, 2000). Competent supervisors with the necessary leadership skills are crucial in the organizational hierarchy as processes and decisions have to be run by them before being executed (Lee, 2007; Russell & Petrie, 1994). In general, supervision is about establishing relationships in the workforce to work with and guide people in new directions (Mason, 2000). In addition, the post-interviewees affirmed the positive impact of qualified supervisors as they are needed for quality control of the project and a stringent reporting structure of project task teams. More qualified supervisors can influence the people that work under them as they heed the instructions given by the supervisor so that they can finish their goal on target (Hui, Chiu, Yu, Cheng, & Tse, 2007)—ultimately improving project productivity. However, the post-interviewees also mentioned that smaller projects require less manpower; therefore, with more qualified supervisors managing the staff, the effect of the supervisor's good management skills is more noticeable among the small workforce in contrast to among a larger workforce where the impact is not so perceptive (Disselkamp, 2013).

5.1.3 | SE5: Lack of training provided

A lack of training can negatively impact workforce safety and the health of the construction workforce. Thus, workers need to receive adequate health and safety training. Also, poorly trained employees will lead to more mediocre performance in the workforce, where they hinder the productivity of the project progress and disrupt the workflow of their team, which can lead to more delays and pressure to meet tighter deadlines (Elnaga & Imran, 2013; Latham & Kinne, 1974). Also, with the constant introduction of new technology, the levels of competition in the industry increase as workers are expected to be more productive and have a higher output. Hence, the workforce must be well trained to equip them with the necessary tools through education and skills for them to work safely and productively. Therefore, companies need to retain well-trained employees by investing in their well-being and enrolling them in training and education with a long-term view.

5.1.4 | SE10: Effective project planning and execution

The planning aspect is especially crucial because of a need to evolve and change (Dvir, Raz, & Shenhar, 2003); in the construction industry, as newer construction technology emerges, it becomes even more important for companies to plan in order to keep their workforce current. Proper planning and execution are paramount for the construction industry due to the handling and management of resources. More precise directions for the usage of resources, such as people, money, time, or raw materials, can drive higher effectiveness and productivity (Mason, 2000). Therefore, in order to ensure the project flows smoothly, without facing a shortage of resources and causing delays, companies have to ensure that planning occurs before project execution so that the product can be delivered on time and schedule.

5.1.5 | SE9: Transfer of skills and knowledge

The transfer of learned skills and knowledge is crucial to develop competencies in the respective fields. This is especially essential in a project-based environment where workers need to have positive interactions and efficiency in order to meet milestones, as skill transfer helps create a more dynamic learning and working environment where interactions enable workers to learn more from each other (Parrotta et al., 2014). By engaging in the transfer of skills and knowledge, workers can improve their capabilities. Therefore, a communicative project environment promotes active and sustainable collaboration in the workforce, which is optimum for transferring skills and knowledge for self- and group improvement and improves the project productivity accordingly. However, a post-interviewee mentioned with a different perspective that construction projects are temporary-based where teams assembled only interact as long as the duration of the project, and, therefore, the transfer of skills and knowledge have lower significance in the construction industry in comparison to the manufacturing industry, which is more continuous based on factory and products.

5.1.6 | SE6: Shortage of skilled labor

Many industries, including the construction industry, are currently dealing with a skills mismatch amid higher competition for job-seekers (Ejohwomu, Proverbs, & Olomolaiye, 2005). The issue is finding qualified workers at the current fast pace of a developing economy. Companies that fail to attract skilled workers lag in terms of productivity and progress and lose out among the competition (Richardson, 2009). This failure may result in unfortunate consequences, such as overworked staff where they have to work extra hours to make up for the lack of workers or workers with lower skills, thus doubling their workload. A shortage of skilled labor also leads to more untrained staff who may not execute jobs properly, leading to more defects or idling during the construction period—ultimately resulting in an imminent decrease in productivity levels for the whole firm. Therefore, organizations need to ensure that the labor they hire has enough skills to make up for the shortage of workers or make the hiring incentives more attractive in order to attract newcomers as well as retain their current labor force.

5.1.7 | SE7: Inspection delays

Typically in the construction industry, supervisors or architects are responsible for inspections of the construction site, and inspection

delays can potentially have a severe impact on contract completion. The inspection delays are usually caused by incompetent project managers, who fail to complete prioritizations for job inspections and achieve insufficient cooperation, and irresponsible inspectors (Makulsawatudom et al., 2004). Accordingly, it is crucial for project managers or supervisors to stringently go through the works required, such as quality assurance and safety inspection (Jarkas & Bitar, 2012). Coordination between inspectors and their project team is crucial to ensure that inspections do not interfere with the contractor's work and delay progress. Delays in inspections that induce an obstruction in works can eventually lead to unwanted costs where the respective parties have to be adequately compensated.

5.1.8 | SE8: Incomplete technical specifications

Incomplete technical specifications cause repeated demands for clarification, and therefore successive delays and disturbances to work progress. These unclear specifications have the potential to severely delay a project by causing rework and more variation orders, which involve time-consuming meetings and negotiations with involved parties, such as engineers, project managers, and architects, to rush to solve the issues. Accordingly, rectifications or substantial revisions may be required, which can lead to rework on sites caused by a lack of precise specifications at the beginning of the project (Jarkas & Bitar, 2012); therefore, low productivity occurs. Defining a project in its entirety at the beginning is impossible; however, it is vital to have critical specifications and details rather than going with an open-ended project. As such, the project should be approached by first defining the partial scope and completing it before going forward with the rest of the project. Any initial underestimation or lack of detail is likely to contribute in a significant manner to project cost overruns or perceived project failure. Thus, having workers with the appropriate technical expertise and project capability is essential to counter the negative impact of this diversity factor. Specifying important technical details during project development and contractual discussions and then renegotiating down the road would be more beneficial to productivity (Yeo, 2002).

5.2 | Age and experience

5.2.1 | AE13: Shortage of experienced labor

The shortage of experienced labor had the highest loading in the "Age and experience" diversity category. As modern times and companies create more promises of new infrastructure and construction projects, there is a challenge for construction firms struggling to maintain their project teams to ensure there is enough qualified staff involved in the projects (Hafez, Aziz, Morgan, Abdullah, & Ahmed, 2014; Törner & Pousette, 2009). The construction industry in Singapore is often not a popular choice among fresh graduates and is also not a typical industry promoted in university courses. The main reasons for its unpopularity and the principal motives for leaving are better prospects in other industries, poor job conditions, and dissatisfaction with the profession and industry (Ling & Leow, 2008). Also, other reasons include the lack of rewards and personal development, exhaustion resulting from the lifestyle required by profession, and conflict between workers' requirements and those of other roles (Teixeira & Gomes, 2000). The responsibility thus falls on construction firms to ensure that their recruitment terms are attractive enough to hire not just young workers but also older and experienced workers who are looking for something new in an existing industry. Besides, safety concerns go along with the hiring of less qualified workers to keep up with growing project demands. The shortage of experienced labor is a severe problem, particularly in the construction industry (which is highly accident-prone and volatile, with many risks and hazards).

5.2.2 | AE18: More dependence on equipment and technology

Technological advancements have always played a critical role in driving advancement in the construction industry. Companies that are keen to be competitive are quick to adopt new technologies. New technology helps to improve construction productivity by reducing the manual steps taken, such as inspections and technical specifications (Goodrum, Zhai, & Yasin, 2009; Loosemore, 2014). New tools also help to build more creatively designed buildings and to monitor safety on the construction site by giving feedback and data analysis of past incidents. Through such technology, workers can become more interconnected, boosting their communication and access to information, which, in turn, can help them to be more efficient in whatever processes they are involved in (Rivard, 2000). Therefore, applying new technologies and tools could support and make the younger and more inexperienced workers more productive and safer, particularly in comparison to traditional building methods where teams are fragmented, and the construction sites prove to be more dangerous and riskier. Thus, by fully embracing technology, PPP in the construction industry is bound to increase, as seen through visible results from existing tools.

5.2.3 | AE14: High rate of labor turnover

A high rate of labor turnover usually results in the cost of hiring new labor to replace the lost workers. The cost of hiring new labor also includes the cost to train them to be as efficient as the previous worker; this is indispensable in order to ensure that no productivity is lost. The theory is, if the outflow of employees is high, the company stands to incur higher costs from losing existing workers, and productivity levels are bound to decrease (Alinaitwe et al., 2007). Therefore, companies should look to retention as a key to prevent this issue, which results in a loss of experience, know-how, and capabilities. The prevention of labor turnover can be achieved by ensuring that the needs and well-being of current employees are taken care of so that

they have little desire to leave the company, as reiterated by Lim and Alum (1995). In addition, cross-training is also recommended to ensure that workers can cover up any losses when a team member leaves or is absent.

5.2.4 | AE17: Positioning of experienced consultants

Identifying the right place in the project team and company for a suitable consultant is the first and most important decision to put a project team together. With the appropriate consultant positioned adequately in a role that allows them to exercise their knowledge and experience, the project team will have the ability to pursue the level of efficiency and productivity they are targeting (Törner & Pousette, 2009). A well-positioned consultant can make a difference in the decisions made, the relationships, and the organizational hierarchy in the team. The post-interviewees also stated that both the proper positioning of experienced consultants and their supply of knowledge facilitate the progress of a project. Thus, by correctly positioning experienced consultants, project labors can be impacted in a positive manner, which creates an opportunity for productivity improvements.

5.2.5 | AE15: Unrealistic deadlines for project completion

When a project has a deadline that is almost impossible to meet, it can result in several repercussions, such as a threat to the worker's safety and health, productivity pressure, and decreased morale among workers (Raymond & Bergeron, 2008). Overworked workers also become less productive in time due to symptoms such as exhaustion and fatigue. Longer work hours do not necessarily correlate to more output; the output of workers pushed beyond their capacity may also be compromised in terms of quality, leading to issues such as defective work. Worst-case scenarios could include fatalities due to constant overexposure leading to a weak and dangerous work ethic where workers cut corners to meet deadlines and, as a result, the work environment and productivity suffer. When the project team becomes too deadline-oriented—where everyone is under pressure to meet the demands placed on them by their superiors—spontaneity, innovation, and creation also decrease (Bunce & West, 1994); that is, workers may not consider alternatives as they do not want to be sidelined, thus creating a tension-filled work environment that is not suitable for productivity.

5.2.6 | AE16: Amount of pay and wages

The power of how salary influences workers should not be underestimated as it is the deciding factor for many in the workforce nowadays; people use salary and wages as a deciding factor in whether to apply for the job or not (Němečková, 2017; Barber, 2018; Garver, Goffnett, Divine, Williams, & Davis, 2019). As companies cannot function without a strong and capable workforce, they have to make themselves attractive for workers to want to join them. Thus, the higher the salary, the stronger the draw to entice workers to consider the job offer. A higher salary is also often associated with a reward, where current workers are expected to work harder and produce a more prodigious output if they want a promotion or a bonus with a higher salary (Kipnis & Schmidt, 1988)—this shows how wages can act as a form of motivation to drive the workforce to have a higher productivity output. The motivation, in turn, also acts as a retention tool for existing workers who are rewarded for their loyalty and efforts dedicated to the company. Therefore, wages can be a useful tool to drive up the diversity of "Age and experience" in construction firms, and eventually improve productivity in the firm as well as the industry as a whole.

6 | CONCLUSIONS AND RECOMMENDATIONS

The Singapore Government is continuously striving for and pushing productivity growth in the construction sector to achieve sustained economic growth. However, the efforts rolled out in the government's productivity roadmap mainly focus on the use of automation and technology to boost productivity levels in the construction industry, leaving less room to consider alternative resources and their potential impact on productivity. Due to the global trend of increasing workforce diversity in construction projects, to improve the industry performance through untapped potential, it is crucial to understand factors affecting workforce diversity and their impact on productivity. However, there is limited research investigating the relationship between workforce diversity and productivity in the context of construction projects. Therefore, the results of this study contribute to the core body of knowledge and practice both in defining workforce diversity factors and in assessing the relationship between diversity factors and PPP. In addition, the study proposes viable strategies to harness diversity to increase productivity in the construction industry, which serves as a starting point for the industry to properly handle its workforce diversity and enjoy the benefits of increased productivity. In turn, the productivity gains will re-promote workforce diversity and create a virtuous cycle in the construction industry. Moreover, the cycle can further contribute to the establishment of a sustainable working environment in the current trend that workforce diversity is increasing across different countries.

This study aimed to analyze the relationship between labor diversity and productivity of construction projects. Diversity in the workplace brings about various benefits, and this study examined diversity for its potential impact on PPP to understand precisely which type of diversity has the most significant impact on the construction sector in the Singaporean context. A literature review was conducted to gain a thorough understanding of the types of diversity present in the labor force as well as methods to measure the levels of diversity. Through

the comprehensive literature review, diversity factors that could potentially affect construction productivity were identified. Based on this review, questionnaires were developed to obtain responses from local industry workers in order to understand the level of diversity in their workplaces and the perceived impacts of the various identified diversity factors on project performance. A total of 58 responses were collated, covering contractors, consultants, developers, and architects. Also, post-interviews with industry experts were conducted to acquire more extensive information on Singapore's construction industry. Based on the survey and interview results, the following research objectives were achieved.

In order to assess the impact of workplace diversity on PPP, a structural equation model of the relationship between workforce diversity factors and their respective categories and perceived PPP was created using the SmartPLS software. The significance of the diversity factors and their perceived productivity performance was analyzed using the partial least squares method and bootstrapping in the software to generate the relevant t-values and loadings to infer the correlation levels. Two diversity types out of the four, namely "Skill and education" and "Age and experience," were identified as being the most statistically significant, rejecting the proposed null hypothesis, which determined that these two diversity types in the workforce would have a significant impact on construction productivity.

To propose feasible recommendations to enhance workforce diversity and productivity in the construction industry, analysis results from the structural equation model and post-interviews helped to fine-tune which areas of diversity efforts should be focused on. Factors with a higher impact on PPP within their diversity categories were prioritized to create strategies to help productivity growth. The results highlighted that diversity aspects such as efficient decision-making and countering the shortage of skilled labor had the highest impact in their respective categories of "Skill and education" and "Age and experience." Therefore, the bulk of efforts should be concentrated on these factors to implement the suggested strategies in the workplace. Regarding the analysis results, the following recommendations are made.

The "Skill and education" category should be prioritized through more training programs to target the educational well-being of workers. Establishing a well-trained workforce to execute tasks efficiently can help to facilitate better workflow to raise productivity. The shortage of skilled labor was also identified to be a prime concern in the post-interviewees. Therefore, it is recommended that companies either retain existing skilled and experienced staff or make incentives to work in the construction industry more attractive to avoid losing out to other sectors. These activities should be strategized in order to avoid unnecessary downtime and significant loss of productivity. Following the identification of a lack of training, the effectiveness of efficient decision-making was highlighted by the SEM as well as the post-interviewees. Therefore, companies need to recognize competent supervisors as well as establish protocols and clear organizational charts to set out appropriate and frequent meetings. This will support better discussion and decision-making sessions through clear communication channels for better and faster decisions to be made, ultimately raising productivity.

As the construction industry is project-based and includes regular interactions between different project teams, it is necessary to facilitate meetings and communications between workers to ensure the exchange and transfer of skills and knowledge between workers of different job positions and trades. The transfer of knowledge and skills between workers of varying diversity groups can also help the workers themselves to benefit from more experience gained, and companies stand in cross-training the workers. Also, the government's plan to introduce more technology into construction projects should be integrated with the utilization of an increase in diversity. Workers of different age groups and different levels of skill and education should be made aware of the new technologies present as well as have a basic knowledge of construction technology in order for a more integrated workforce.

In addition, construction firms need to address and fully implement the findings from the suggested structural equation model and strategies. This can be done by creating more tailored workshops focused on training workers of different backgrounds, providing more platforms and coworking spaces to boost opportunities for workers to self-instigate cross-training and exchange knowledge and experience. The hiring of more experienced supervisors can significantly increase the impact of the benefits of a stable leader influencing the project group, and making better, more effective decisions will help to align workers to the same goal and create a more task-oriented team. In general, by diversifying management-level staff, the workplace productivity rate is expected to increase. Therefore, it is recommended that organizations have a constant gauge on the diversity index of their workforce as well as have hiring and management policies in place to ensure a diversified labor force to drive construction productivity as a first step to improving the organization's productivity level. The various factors under the "Skill and education" and "Age and experience" are recommended to be monitored or enforced to allow construction firms to mitigate any potential negative impacts of a lack of diversity and benefit from the positive impacts to improve productivity.

This study would help local organizations within the construction industry understand the untapped potential of workforce diversity and its impact on PPP. With the construction sector in Singapore lagging behind other areas amid the government's push for economic growth, it is paramount for the construction industry to source alternative ways to boost productivity levels. The BCA relies heavily on physical and tangible methods to push productivity growth, such as investing in construction technology. Despite this reliable and proven method, the government and construction organizations should also expand their scope and explore other means of productivity growth. Thus, their efforts prompt the relevance of this study, which has touched on and analyzed the diversity aspect of the labor force—a vital resource of the construction industry. Through this research, a significant correlation between diversity factors and PPP has been established, which can help steer the focus and awareness into directing more efforts toward implementing and enhancing the diversity factors to push for productivity growth within the industry. Thus,

instead of limiting the scope of productivity improvement methods to standard and more typical strategies, organizations should evaluate the people that make up the sustainable workplace and make an effort to harness the impact of diversity and translate it into productivity growth.

Despite achieving its objectives and the findings from this study are still valuable and contribute to the body of knowledge, this study acknowledges some limitations during the process of the study. Although the number of respondents was still valid to perform the statistical analyses, a larger sample size would have helped to assure a more reliable and accurate investigation. As the responses across the three different project types were not equally proportional, and the respondents were from the firms working in Singapore, caution needs to be given when the results are interpreted and generalized. In addition, the proposed method, SEM itself, cannot assess the direct causality between workforce diversity and PPP. However, it can quantify the effect between the two variables by demonstrating discriminant validity among the measures, and enable us to achieve the valuable findings. Nevertheless, the findings are still valuable as they help uncover the impact of labor diversity on productivity, and the results contribute to addressing the meaningful relationship. Furthermore, the proposed strategies help global companies working in diverse countries to deal with not only their workforce diversity issues but also improve their productivity.

All in all, this research has provided a stepping stone for the introduction of the correlation between labor diversity and PPP in the construction industry. Further studies exploring more diversity strategies to enhance productivity growth should be considered in order to establish a workforce diversity system and policies not just in the construction industry but across other sectors for productivity improvement. As the research encompasses the evaluation of each organization's level of workplace diversity, this index can be further standardized and promoted to organizations. In particular, organizations need to keep track of their diversity levels in order to identify what their company may be lacking and develop strategies to counter issues or tap into existing diversification not previously realized. Therefore, future studies can further expand on and explore more comprehensively diversity's potential role in the workplace and other benefits that this can bring.

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ORCID

Bon-Gang Hwang https://orcid.org/0000-0002-9034-2033

REFERENCES

Abdul-Rahman, H., Wang, C., Wood, L. C., & Low, S. F. (2012). Negative impact induced by foreign workers: Evidence in Malaysian construction sector. *Habitat International*, *36*(4), 433–443.

Aibinu, A. A., & Al-Lawati, A. M. (2010). Using PLS-SEM technique to model construction organizations' willingness to participate in e-bidding. *Automation in Construction*, *19*(6), 714–724.

Ali, M., Kulik, C. T., & Metz, I. (2011). The gender diversity–performance relationship in services and manufacturing organizations. *The International Journal of Human Resource Management*, *22*(7), 1464–1485.

Alinaitwe, H. M., Mwakali, J. A., & Hansson, B. (2007). Factors affecting the productivity of building craftsmen-studies of Uganda. *Journal of Civil Engineering and Management*, *13*(3), 169–176.

Arditi, D., & Mochtar, K. (2000). Trends in productivity improvement in the US construction industry. *Construction Management and Economics*, *18* (1), 15–27.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, *16*(1), 74–94.

Bandhanpreet, K., Mohindru, P., & Pankaj, M. (2013). Antecedents of turnover intentions: A literature review. *Global Journal of Management and Business Studies*, *3*(10), 1219–1230.

Barber, E. (2018). Job Satisfaction-To determine whether Irish graduates' favour intrinsic factors over extrinsic factors when choosing a place of employment? (Doctoral dissertation, Dublin, National College of Ireland).

Building and Construction Authority (BCA) (2015a). The Second Construction Productivity Roadmap. Retrieved March 10, 2020 from https://tinyurl.com/y7pwtu9s

Building and Construction Authority (BCA) (2015b). Media Release – About 7,000 firms to benefit from S$450 million boosts for construction productivity. Retrieved from December 13, 2019, https://tinyurl.com/ybhtcqyw

Building and Construction Authority (BCA) (2016). Construction Productivity R&D Roadmap. Retrieved November from 10, 2019, https://tinyurl.com/yahurlxn

Bunce, D., & West, M. (1994). Changing work environments: Innovative coping responses to occupational stress. *Work and Stress*, *8*(4), 319–331.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research*, *295*(2), 295–336.

Chung, J., Park, J., Cho, M., Park, Y., Kim, D., Yang, D., & Yang, Y. (2015). A study on the relationships between age, work experience, cognition, and work ability in older employees working in heavy industry. *Journal of Physical Therapy Science*, *27*(1), 155–157.

Dai, J., Goodrum, P. M., & Maloney, W. F. (2007). Analysis of craft workers' and foremen's perceptions of the factors affecting construction labour productivity. *Construction Management and Economics*, *25*(11), 1139–1152.

Department of Statistics Singapore (SingStat). (2017). Population Trends 2017. Retrieved December 13, 2019 from https://www.singstat.gov.sg/-/media/files/publications/population/population2017.pdf

Department of Statistics Singapore (SingStat). (2020). Education, Language Spoken and Literacy. Retrieved March 10, 2020 from https://tinyurl.com/ybrjf9gv

Dernovsek, D. (2008). Engaged employees. *Credit Union Magazine*, *74* (5), 42.

Disselkamp, L. (Ed.). (2013). *Workforce asset management book of knowledge*. Hoboken, NJ: John Wiley & Sons.

Dvir, D., Raz, T., & Shenhar, A. (2003). An empirical analysis of the relationship between project planning and project success. *International Journal of Project Management*, *21*, 89–95.

Ejohwomu, O. A., Proverbs, D. G., & Olomolaiye, P. (2005). A conceptual demand led model founded on theories of labour market mismatch for

the construction and building services industry. Paper presented at: Proceedings of the 21st ARCOM Annual Conference.

El-Gohary, K. M., & Aziz, R. F. (2013). Factors influencing construction labor productivity in Egypt. *Journal of Management in Engineering*, *30*(1), 1–9.

Elnaga, A., & Imran, A. (2013). The effect of training on employee performance. *European Journal of Business and Management*, *5*(4), 137–147.

Enshassi, A., Mohamed, S., Mustafa, Z. A., & Mayer, P. E. (2007). Factors affecting labour productivity in building projects in the Gaza strip. *Journal of Civil Engineering and Management*, *13*(4), 245–254.

Fornell, C., & Bookstein, F. L. (1982). Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research*, *19*(4), 440–452.

Fornell, C., & Cha, J. (1994). Partial least squares. In R. P. Bagozzi (Ed.), *Advanced methods of marketing* (pp. 52–78). England: Blackwell Business.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.

Garver, M. S., Goffnett, S. P., Divine, R. L., Williams, Z., & Davis, C. (2019). Analysis of the job preferences of undergraduate supply chain students. *Operations and Supply Chain Management: An International*, *12*(1), 31–41.

Gladwin, T. N., Krause, T. S., & Kennelly, J. J. (1995). Beyond eco-efficiency: Towards socially sustainable business. *Sustainable Development*, *3*(1), 35–43.

Glaeser, E. L., & Vigdor, J. L. (2001). Racial segregation in the 2000 census: Promising news. Washington: Brookings Institution, Center on Urban and Metropolitan Policy.

Goodrum, P. M., Zhai, D., & Yasin, M. F. (2009). Relationship between changes in material technology and construction productivity. *Journal of Construction Engineering and Management*, *135*(4), 278–287.

Hafez, S. M., Aziz, R. F., Morgan, E. S., Abdullah, M. M., & Ahmed, E. K. (2014). Critical factors affecting construction labor productivity in Egypt. *American Journal of Civil Engineering*, *2*(2), 35–40.

Hair, J. F., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. (2017). An updated and expanded assessment of PLS-SEM in information systems research. *Industrial Management & Data Systems*, *117*(3), 442–458.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, *19*(2), 139–152.

Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proceedings of the National Academy of Sciences*, *101*(46), 16385–16389.

Hui, C. H., Chiu, W. C., Yu, P. L., Cheng, K., & Tse, H. H. (2007). The effects of service climate and the effective leadership behaviour of supervisors on frontline employee service quality: A multi-level analysis. *Journal of Occupational and Organizational Psychology*, *80*(1), 151–172.

Jarkas, A. M. (2015). Factors influencing labour productivity in Bahrain's construction industry. *International Journal of Construction Management*, *15*(1), 94–108.

Jarkas, A. M., & Bitar, C. G. (2012). Factors affecting construction labor productivity in Kuwait. *Journal of Construction Engineering and Management*, *138*(7), 811–820.

Jarkas, A. M., & Radosavljevic, M. (2013). Motivational factors impacting the productivity of construction master craftsmen in Kuwait. *Journal of Management in Engineering*, *29*(4), 446–454.

Jarkas, A. M., Radosavljevic, M., & Wuyi, L. (2014). Prominent demotivational factors influencing the productivity of construction project managers in Qatar. *International Journal of Productivity and Performance Management*, *63*, 1070–1090.

Jost, J. T., & Kay, A. C. (2005). Exposure to benevolent sexism and complementary gender stereotypes: Consequences for specific and diffuse forms of system justification. *Journal of Personality and Social Psychology*, *88*(3), 498–509.

Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management and Economics*, *15*(1), 83–94.

Kazaz, A., Manisali, E., & Ulubeyli, S. (2008). Effect of basic motivational factors on construction workforce productivity in Turkey. *Journal of Civil Engineering and Management*, *14*(2), 95–106.

Khadria, B. (2006). India: Skilled migration to developed countries, labour migration to the Gulf. *Migración y Desarrollo*, *7*, 4–37.

Kipnis, D., & Schmidt, S. M. (1988). Upward-influence styles: Relationship with performance evaluations, salary, and stress. *Administrative Science Quarterly*, *33*, 528–542.

Latham, G. P., & Kinne, S. B. (1974). Improving job performance through training in goal setting. *Journal of Applied Psychology*, *59*(2), 187–191.

Lazear, E. P. (2001). Educational production. *The Quarterly Journal of Economics*, *116*(3), 777–803.

Lee, A. M. (2007). Developing effective supervisors: Concepts of research supervision. *South African Journal of Higher Education*, *21*(4), 680–693.

Lim, B. T., Ling, F. Y., Ibbs, C. W., Raphael, B., & Ofori, G. (2012). Mathematical models for predicting organizational flexibility of construction firms in Singapore. *Journal of Construction Engineering and Management*, *138*(3), 361–375.

Lim, E. C., & Alum, J. (1995). Construction productivity: Issues encountered by contractors in Singapore. *International Journal of Project Management*, *13*, 51–58. https://doi.org/10.1016/0263-7863(95)95704-H

Ling, F. Y. Y., & Leow, L. (2008). Enabling knowledge flow: Retaining graduate women in the Singapore construction industry. *Journal of Construction in Developing Countries*, *13*(2), 65–81.

Loosemore, M. (2014). Improving construction productivity: A subcontractor's perspective. *Engineering Construction and Architectural Management*, *21*(3), 245–260.

Makulsawatudom, A., Emsley, M., & Sinthawanarong, K. (2004). Critical factors influencing construction productivity in Thailand. *The Journal of KMITNB*, *14*(3), 1–6.

Mason, G. (2000). Production supervisors in Britain, Germany and the United States: Back from the dead again? *Work, Employment and Society*, *14*(4), 625–645.

Ministry of Manpower (MOM). (2011). Managing Workforce Diversity – A toolkit for organisation. Retrieved March 10, 2020 from https://tinyurl.com/y532xe4l

Ministry of Trade and Industry Republic of Singapore (MTI). (2018). Economic Survey of Singapore 2017.

Ministry of Trade and Industry Republic of Singapore (MTI). (2019). Economic Survey of Singapore 2018.

Mojahed, S., & Aghazadeh, F. (2008). Major factors influencing productivity of water and wastewater treatment plant construction: Evidence from the deep South USA. *International Journal of Project Management*, *26*(2), 195–202.

Mor Barak, M. E. (2000). The inclusive workplace: An ecosystems approach to diversity management. *Social Work*, *45*(4), 339–353.

Mundi. (2018). Japan Demographics Profile 2018. Retrieved December 13, 2019 from https://tinyurl.com/y3glf3qh

Myaskovsky, L., Unikel, E., & Dew, M. A. (2005). Effects of gender diversity on performance and interpersonal behavior in small work groups. *Sex Roles*, *52*(9–10), 645–657.

National Integration Working Group (NIWG). (2014). Managing Workplace Diversity: A Toolkit for Organisation, Retrieved December 13, 2019 from https://tinyurl.com/y532xe4l

National Population and Talent Division. (2013). A sustainable population for a dynamic Singapore: Population white paper. Retrieved March 10, 2020 from https://tinyurl.com/y93jfqj5

Němečková, I. (2017). The role of benefits in employee motivation and retention in the financial sector of The Czech Republic. *Economic Research-Ekonomska istraživanja*, *30*(1), 694–704.

Nunnally, J. C., Bernstein, I. H., & Berge, J. M. T. (1967). *Psychometric theory*. New York: McGraw-Hill.

Parrotta, P., Pozzoli, D., & Pytlikova, M. (2014). Labor diversity and firm productivity. *European Economic Review*, *66*, 144–179.

Plummer, R. (2006). The evolution of sustainable development strategies in Canada: An assessment of three federal natural resource management agencies. *Sustainable Development*, *14*(1), 16–32.

Pollitt, D. (2005). Diversity is about more than observing the letter of the law. *Human Resource Management International Digest*, *13* (4), 37.

Prieto, L. C., Phipps, S. T., & Osiri, J. K. (2009). Linking workplace diversity to organizational performance: A conceptual framework. *Journal of Diversity Management (JDM)*, *4*(4), 13–22.

Pucheta-Martínez, M. C., Olcina-Sempere, G., & López-Zamora, B. (2020). Female directorship on boards and corporate sustainability policies: Their effect on sustainable development. *Sustainable Development*, *28* (1), 56–72.

Raymond, L., & Bergeron, F. (2008). Project management information systems: An empirical study of their impact on project managers and project success. *International Journal of Project Management*, *26*(2), 213–220.

Richardson, S. (2009). What is a skill shortage? *Australian Bulletin of Labour*, *35*(1), 326.

Rivard, H. (2000). A survey on the impact of information technology in the Canadian architecture, engineering and construction industry. *ITcon*, *5*, 37–56.

Russell, R. K., & Petrie, T. (1994). Issues in training effective supervisors. *Applied and Preventive Psychology*, *3*(1), 27–42.

Sabatier, M. (2015). A women's boom in the boardroom: Effects on performance? *Applied Economics*, *47*(26), 2717–2727.

Saxena, A. (2014). Workforce diversity: A key to improve productivity. *Procedia Economics and Finance*, *11*, 76–85.

Scholtens, B., & Zhou, Y. (2008). Stakeholder relations and financial performance. *Sustainable Development*, *16*(3), 213–232.

Selvaraj, P. C. (2015). The effects of work force diversity on employee performance in Singapore organisations. *International Journal of Business Administration*, *6*(2), 17.

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika*, *52*(3–4), 591–611. https://doi.org/10.1093/biomet/52.3-4.591

Shifnas, M. F., & Sutha, J. (2016). Impact of effective workforce diversity management on employees performance in construction sector. Paper presented at: Proceedings of 5th Annual International Research Conference at the Faculty of Management and Commerce, pp. 237–248. http://ir.lib.seu.ac.lk/handle/123456789/1930.

Singapore Contractors Association Ltd (SCAL). (2016). Construction productivity in Singapore: Effective measurement to facilitate improvement. A study by: The Singapore Contractors Association Ltd Singapore Chinese Chamber of Commerce and Industry.

Soham, M., & Rajiv, B. (2013). Critical factors affecting labour productivity in construction projects: Case study of South Gujarat region of India. *International Journal of Engineering and Advanced Technology*, *2*(4), 583–591.

Srikanth, K., Harvey, S., & Peterson, R. (2016). A dynamic perspective on diverse teams: Moving from the dual-process model to a dynamic coordination-based model of diverse team performance. *Academy of Management Annals*, *10*(1), 453–493.

Teixeira, M., & Gomes, W. (2000). Autonomous career change among professionals: An empirical phenomenological study. *Journal of Phenomenological Psychology*, *31*(1), 79–96.

Thomas, A. V., & Sudhakumar, J. (2013). Labour productivity variability among labour force–a case study. *The International Journal of Engineering and Science*, *2*(5), 57–65.

Thomas, J. (2015). Study on causes and effects of employee turnover in construction industry. *International Journal of Science and Research*, *4* (5), 3041–3044.

Thorngate, W. (1980). Efficient decision heuristics. *Behavioral Science*, *25* (3), 219–225.

Törner, M., & Pousette, A. (2009). Safety in construction–a comprehensive description of the characteristics of high safety standards in construction work, from the combined perspective of supervisors and experienced workers. *Journal of Safety Research*, *40*(6), 399–409.

Tsang, M. C., Rumberger, R. W., & Levin, H. M. (1991). The impact of surplus schooling on worker productivity. *Industrial Relations: A Journal of Economy and Society*, *30*(2), 209–228.

Yeo, K. T. (2002). Critical failure factors in information system projects. *International Journal of Project Management*, *20*(3), 241–246.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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