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The Study of Six Sigma Practices in Construction Project Management Performance

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Abstract

The construction industry is known for its high risk and complexity, making Six Sigma an ideal methodology for improving project performance management and efficiency. Malaysian construction projects were hampered by the lack of knowledge and understanding about Six Sigma among construction practitioners limited its implementation in Malaysia construction projects. Therefore, the objectives are to identify the main Six Sigma practice in improving project performance towards the construction industry, to study main the effectiveness level of Six Sigma practice in improving project performance construction industry and to examine the relationship between practice with effectiveness level of Six Sigma practice in improving project performance towards construction industry. The study used a quantitative approach to accomplish all its objectives, with the G7 construction companies in Gombak district serving as the respondent. The purpose of this research is to examine the viewpoints of 113 Gombak district Grade 7 contractors' companies. The survey was distributed to participants via email, WhatsApp, and in-person meetings using a Google Form link. Out of the total number of respondents, 93 (or 82.3%) have provided feedback through the survey. All objectives' data was evaluated using descriptive statistics, frequency, and crosstabs in SPSS software. The findings of this study, the main practices and main corresponding effectiveness level is Six Sigma practices improve project outcomes and reduce defects and importance of Six Sigma in ensuring its efficiency accordingly was determined as the greatest frequency. Furthermore, the strongest relationship with main practice with its main efficiency level is Knowledge of Six Sigma practices – Ongoing development with Importance of Six Sigma in ensuring its efficiency – Reduce construction carbon impact. This study could help G7 contractor's companies through research information and framework development as a guideline to adopt Six Sigma practices to improve project performance towards construction industry.

1. Introduction

The construction industry in Malaysia was widely recognized as a key driver of the country's economic growth. Six Sigma is an innovative methodology that has been introduced to the construction industry to enhance process performance and improve overall quality. Six Sigma in construction aims to improve process quality and reduce project defects (Sobek II, 2006). The construction industry is high-risk and complex, making Six Sigma ideal for improving performance and efficiency (Hess & Benjamin, 2015).

1.1 Research Background

Bill Smith, an engineer employed by Motorola in 1986, initially introduced Six Sigma. The application of the Six Sigma concept in the construction sector is relatively recent in comparison to its use in the manufacturing and other sectors. According to a recent study (Desai, Arun & Dhawale, 2017), the construction industry could benefit from implementing quality management strategies and quality improvement programs. The primary goal of project management in the construction industry is to ensure that projects are completed on time, within budget, and according to established standards. Measurement of performance, diagnosis of issues, and implementation of specific solutions all benefit greatly from the use of statistical tools and methods. The goal of Six Sigma in the construction industry is to improve the quality of construction processes and reduce the number of defects or errors in a project (Sobek II, 2006). The construction industry is known for its high risk and complexity, making Six Sigma an ideal methodology for improving performance and efficiency. By implementing Six Sigma, construction companies can identify and eliminate waste, improve communication between teams, and increase customer satisfaction (Wang *et al.*, 2016). Overall, Six Sigma can lead to improved project outcomes, reduced costs, and increased profitability for construction companies. Despite the benefits of Six Sigma, its implementation in Malaysia's construction sector has been slow due to several obstacles. separately. Below is an example which the authors may find useful.

1.2 Problem Statements

According to Linderman *et al.* (2003), the construction industry only needs to apply Six Sigma's principles where process improvements will see reductions in costs and increases in quality, in contrast to the manufacturing industry, where Six Sigma techniques require thoroughness and full adherence to its technicalities in all processes of production. In addition, there have been instances where Six Sigma was not successful in enhancing quality and decreasing defects in the building sector. Six Sigma in Malaysian construction companies may be too focused on statistical analysis and ignore human factors. Next, Six Sigma requires time, training, and software. Some say Six Sigma can stifle innovation and creativity in a company. Six Sigma may not work for all projects or industries, and its success depends on the organization. Yusof *et al.* (2017) found that resistance to change and lack of organizational support prevented Malaysian construction firms from implementing Six Sigma. Many Malaysian construction companies lack financial and human resources. The lack of qualified Six Sigma professionals and dedicated training programs hinder Six Sigma adoption. Abdul-Rashid *et al.* (2016) found that resource constraints prevented Malaysian construction companies from implementing Six Sigma. According to Tchidi (2010), Zhen (2011), and Li (2012), Six Sigma goals require data-driven project improvement to achieve management effects. Antony & Banuelas (2004), Goh & Love (2004), Pakdil & Leonard (2010), Yusof, Awang & Iranmanesh (2017), Ahmad & Mohamed (2018), and Smith & Jones (2019) demonstrate Six Sigma implementation issues in construction project management. Thus, this study examines Six Sigma in the construction industry, focusing on project performance practices that enable it. This research examines, analyses, and interviews industry experts to identify Six Sigma practices that improve project performance in the construction industry, study their effectiveness, and examine the relationship between practice and effectiveness.

1.3 Research Questions

This research has three main questions:
(a) What is the main Six Sigma practice in improving project performance towards the construction industry?
(b) What is the main effectiveness level of Six Sigma in improving project performance towards the construction industry?
(c) How to extend the relationship between the main practice and the main effectiveness level of Six Sigma practice in the construction industry?

1.4 Research Objectives

This research has three main objectives:
(a) To identify the main Six Sigma practice in improving project performance in the construction 3 industry.

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(b) To study the main effectiveness level of Six Sigma practice in improving project performance construction industry.
(c) To examine the relationship between main practice with main effectiveness level of Six Sigma practice in improving project performance towards the construction industry.

1.5 Research Hypothesis

Based on the research's objective, an initial hypothesis can be developed. The following are the research hypotheses:

H0: There is no significant relationship between the main practice and the main effectiveness level of Six Sigma in improving project performance towards the construction industry.

H1: There is a significant relationship between the main practice and the main effectiveness level of Six Sigma in improving project performance in the construction industry.

1.6 Scope of the Study

Although this study does not belong to any genre, it is consistent with those that place an emphasis on accuracy, solving problems, and making the most of limited resources. The construction industry, as well as the company's bottom line, stand to gain from adopting Six Sigma methods. Due to the inherent complexity of construction projects, effective Six Sigma integration is required to improve project performance (Ruiz, 2023). Gombak district is the location of the study area. Selangor's share of the construction industry in 2023 was notably high, accounting for over a third of the total value of work completed (RM8.1 billion) in the first quarter (Jabatan Perangkaan Malaysia, 2023). The focus of this study is on the project performance of the G7 selected construction firms in the Gombak area. The findings of this study will shed light on how Six Sigma's level of effectiveness in the building industry correlates with specific practices. The ISO 9000 Quality Management System certification is required for all Grade G7 contractors by the Construction Industrial Development Board (CIDB). Ratings downgrades will have an impact on the company's ability to conduct business (Marhani *et al.*, 2013). Construction companies are increasingly pursuing ISO certification as a means of preventing problems like those caused by poor quality materials and workmanship, as well as the delays, accidents, and environmental impacts that often accompany them (Khan, Liew & Ghazali, 2014). Those who would respond would be the project managers. There are 113 respondents of 160 G7 construction firms in the Gombak area that are registered with CIDB (CIDB, 2023).

Studying Six Sigma knowledge, technique, and practices has several benefits. They help people gather and assess data for educated decisions. Second, Six Sigma's methodical approach to process improvement and problem-solving helps find and fix inefficiencies. Customers love quality management. Six Sigma standardizes and increases process control and productivity. Project management matters. Finally, Six Sigma certification boosts employment. Six Sigma training helps organizations and people (Kumar, 2023). The scope study's second aim emphasizes Six Sigma indicators and their benefits. They help companies track process performance, prioritize improvements, and resolve concerns. Organizations may make educated decisions and promote continual development using objective data. Indicators improve stakeholder communication, transparency, and accountability. They help organizations develop, perform better, and succeed. Understanding and using Six Sigma indicators accelerates development and benefits enterprises (Antony, 2014).

1.7 Significance of the Study

The research is needed to find out how to improve project performance in Malaysia's construction industry so that Six Sigma can be used. This study is important for the following people and organizations. This research could be beneficial to top managers in construction companies to continuously improve the performance of their company and be able to maintain the good name of their company if they implement Six Sigma because of its many benefits. Moreover, this research could help contractors that most projects 4 are very cost effective, achieving a median benefit/cost ratio of 2.66 for the Six Sigma program for the contractor (Rodin, 2012). The study demonstrates that organizational capabilities in implementing Six Sigma have an impact on project success (Hudnurkar, Ambekar & Bhattacharya, 2019). This research could help workers always be aware of what needs to be done to keep a project running smoothly. If a construction worker can understand and use Six Sigma, then they will be a good worker. Finally, this research may benefit the student and educator in learn something new and better understand how innovative Six Sigma can help the Malaysian construction industry.

2. Literature Review

2.1 The Six Sigma Practice in Improving Project Performance.

(a) Sigma practices promote sustainable construction.
Future research should focus on developing a framework that considers the social and cultural aspects of the construction industry, as it is possible that Six Sigma does not fully account for the human element of a process. Abdelhamid and Everett's (2010) research also shows that implementing Six Sigma practices into the construction industry can boost project performance by decreasing defects and rework while simultaneously enhancing teamwork, communication, and client satisfaction. Sustainable development in the construction industry and the growth of an eco-friendly construction sector (Oladapo, Oyedolapo & Goulding, 2014), the study also suggests that Six Sigma can help construction companies in continuous improvement, process optimization, data driven decision making, risk reduction and cost savings.

(b) Six Sigma practices improve project outcomes and reduce defects.

Six Sigma's ability to boost project performance and cut down on defects has made it a popular choice in Malaysia's booming construction sector. Zakuan *et al.* (2014) conducted research on the effectiveness of Six Sigma in the Malaysian construction industry and found that management support, training, project selection, and teamwork were critical success factors. In addition, Six Sigma initiatives were evaluated based on key performance indicators like defects per million opportunities (DPMO), cycle time, and cost of quality. The research also found that construction projects could benefit from the implementation of Six Sigma practices due to their potential to enhance quality control, boost teamwork, and satisfy clients. However, it is crucial for businesses in Malaysia's construction sector to take into account the sector's distinctive challenges and characteristics when launching Six Sigma projects. Industry fragmentation, extensive project customization, and the need for efficient supply chain management all contribute to these difficulties (Zakuan *et al.*, 2014).

(c) Six Sigma practices lower operational expenses.

Everyone contributes more to a project's success when they are using their strengths. The job is done in a more safe, effective, and cautious way. The project's management group must naturally come up with the most effective plan for putting everything together. Data collection is only one area where Six Sigma might help; the methodology could also offer novel planning ideas that would help contractors better schedule work (Hussain *et al.*, 2019). As a result of this enhanced efficiency, productivity and the quality of work performed will increase. When monitoring the ideal distribution of a workforce, it may also become clear where personnel are no longer needed. Some processes may have been repeated, or the work may have grown simpler and faster over time. The savings may be used towards anything the business deems necessary, whether it the purchase of new tools or the introduction of flexible scheduling options for employees. The contractor might utilize the profit to provide lower prices for better work (Sokovic *et al.*, 2006).

(d) Six Sigma practices reduce injuries.

Sokovic *et al.* (2006) noted that accidents are upsetting for workers since they require absences from work and, in some cases, lengthy periods of rehabilitation. The employee also has the difficult responsibility of arguing for worker's compensation benefits. As a result of witnessing their teammate's injuries, the other members of the group may become less enthusiastic about engaging in the hazardous 5 aspects of their career. The contractor is also affected since they must find a suitable replacement for the injured worker and make sure they can integrate them into the existing team. The initial completion date must be met regardless of who sustained an injury. Companies in the construction sector might benefit from using Six Sigma for more than just improving safety. Since adopting Six Sigma, the organization and the team may collaborate to improve processes to the maximum extent possible, protecting construction workers from unnecessary harm. As with any Six Sigma initiatives, the analysis of collected data will be bolstered by insightful comments from the people doing the risky tasks. Given the inherent risks inherent in the industry, it is hard to completely eradicate them. But the company might utilise Six Sigma to make the office as safe as possible for its employees (Sokovic *et al.*, 2006).

(e) Process of Six Sigma practices

Lopes, Oliveira & Carvalho (2020) found that defects per million opportunities (DPMO), cycle time, and cost of quality are used as key performance indicators in Six Sigma project management. The DMAIC (Define, Measure, Analyze, Improve, and Control) framework is used throughout the methodology. The Six Sigma methodology relies on a straightforward road map to boost performance: define, measure, analyze, improve, and control. As

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such, it serves as the Six Sigma process's de facto primary standard roadmap for problem solving and product enhancement. The primary objective of a DMAIC roadmap project is to identify and permanently address the causes of the most serious issues affecting the results of the process that the business values. The steps of the Six Sigma DMAIC roadmap are shown in Fig. 1 (Kumar & Sharma, 2012).

Fig. 1 *Six Sigma's DMAIC roadmap*

(f) Knowledge of Six Sigma practices

Processes that are not under control are common targets for Six Sigma-based process improvements. Unpredictable processes may still meet some statistical requirements. The goal of process improvement is to get things back to where they are statistically under control. Once the process has been optimised, the Six Sigma measurement, statistical analysis, and other tools are used to ensure that it remains under control. Any process that aims for continuous improvement must include such controls and ensure that the people who work directly with the process daily understand how to use them (Sokovic *et al.*, 2006).

(g) Technique of Six Sigma practices in construction

Even within an area, the specific jobs that make up construction might differ significantly. The contractor is paid more money when the scope of the project is broader. Demolition of a basement wall can be as inexpensive as USD10,000, whereas building a multibillion-dollar sports stadium can cost tens of millions. Hsiang, Ching & Cou (2011) found that construction firms might benefit from implementing Six Sigma to increase output and cut down on mistakes. Contractors provide employment for a sizable portion of the construction workforce. Independent contractors are project managers that can effectively organise a team and keep everyone on the same page. Additionally, contractors are accountable for sourcing and transporting all necessary supplies to the construction site. They must also communicate with customers and do tasks within predetermined time frames, which may change as the project develops. The contractor is ultimately liable for any mistakes that arise, even months after the project has been completed (Hsiang & Ming, 2011). However, while introducing Six Sigma initiatives, it's crucial to take into account the specific difficulties and traits of each sector. A good example of a sector where supply chain 6 management is essential is the construction industry. Selecting the right projects and working together effectively are also crucial.

(h) Six Sigma Certification Levels

Six Sigma certification verifies a person's comprehension and practical application of the approach. Many businesses have internal certification processes. Most Six Sigma certificants take a classroom or online course. Most Six Sigma organisations provide certification (Sokovic *et al.*, 2006). Improving project results is a top priority for each Six Sigma belt's role. They take the reins and are held to account for achieving results and enhancing procedures. They can assess data and make smart choices because of their familiarity with various methods and software. They pinpoint inefficiencies and put in place corrective measures by concentrating on process improvement. They can effectively communicate and coordinate across departments and projects because of their collaborative nature and project management skills. They also help with change management by lowering barriers to adoption and bolstering initiatives already under way. Projects led by Six Sigma belts ultimately see increased productivity, quality, and customer satisfaction (Sokovic *et al.*, 2006).

2.2 Effectiveness Level of Six Sigma in Improving Project Performance

According to Tehrani (2010), Six Sigma has been shown to be a useful method for boosting construction projects' output. The research looked effectiveness level in improving project performance at how the Six

Sigma methodology may be used in the real world to boost productivity in the construction industry through measurement of its' indicator, importance, and advantages.

(a) Indicator to measure Effectiveness level of Six Sigma
Defects Per Million Opportunities (DPMO) can quantify Six Sigma's success (Vincent, Pocius & Huang, 2021). DPMO calculates process faults per million opportunities. It aids in Six Sigma process assessment and improvement. Six Sigma efficacy increases with a lower DPMO score. It measures quality, customer happiness, and cost (Lamine, 2019). Quality Indicators (QI) performance was estimated using Westgard calculator (Westgard, 2020) using data from October 2017 to September 2019. Six Sigma calculated both. Zero faults meant Six Sigma greater than 6. If Six Sigma exceeded 4, this investigation's QI performance was good. If the Six Sigma score was less than 3, immediate action should be taken to enhance QI (Lamine, 2019).

(b) The importance of Six Sigma in ensuring its efficiency

Six Sigma is essential in building because it emphasises quality, efficiency, and defect reduction. Six Sigma may help construction projects achieve or exceed specifications, making customers happy and reducing rework. The expenses associated with material waste, inefficient labour, and project delays are reduced as a result. Process optimisation helps construction projects finish on time. Six Sigma also identifies and mitigates hazards. It encourages building creativity and flexibility by promoting ongoing improvement. Overall, Six Sigma improves construction quality, prices, timelines, risks, and continual improvements. The construction sector may gain a great deal from adopting Six Sigma as a quality initiative, performance indicator, and management approach. According to the research of Yilmaz & Firat (2012), the construction sector has benefited from Six Sigma's implementation by cutting costs and waste while also boosting safety and productivity. Hussain *et al.* (2019) found a number of favourable associations between lean construction practices and Six Sigma ratings and construction sector advantages. Six Sigma's ability to reduce mistakes has been shown to have a positive effect on prices, quality, and customer loyalty (Mumtaz, 2019). It also has the potential to boost company morale, job prospects, and earnings. According to research done by Kala, Singh & Singh (2018), the construction industry's carbon footprint decreased when Six Sigma was implemented. This was due to a drop in waste production. The research also revealed that by eliminating non-value-added tasks, Six Sigma helped cut down on the use of resources including power, water, and raw materials. Six Sigma's ability to cut down on inefficiencies and maximise the use of available resources can assist reduce construction's detrimental effect on the natural world. Six Sigma is being used by more and more businesses to boost the quality of their operations and offerings (Pulakanam & Voges, 2010). Overall, Six Sigma is a powerful instrument that may boost the success and profitability of construction businesses which leads to successful projects.

(c) Advantages of Six Sigma that increase its efficiency.

Six Sigma boosts efficiency in construction by reducing faults and rework saves time and materials. Optimising operations and recognising bottlenecks improves project scheduling by completing projects faster. Six Sigma decreases faults, rework, and waste, boosting construction company profitability. Improved quality control ensures projects meet or exceed standards. Six Sigma promotes data-driven decision-making and proactive risk assessment, which smoothes project execution. Finally, it encourages problem-solving, creativity, and best practices. Six Sigma in construction improves schedule, quality, cost, risk mitigation, and continuous improvement. The construction sector may gain a great deal from adopting Six Sigma as a quality initiative, performance indicator, and management approach. According to Yilmaz & Firat (2012), Six Sigma has been effectively adopted in the construction sector, where it has contributed to the reduction of waste and expenses while also enhancing safety and boosting productivity. Multiple advantages in the building sector have been associated with the use of lean construction methods and high Six Sigma ratings (Hussain *et al.*, 2019). Six Sigma's ability to reduce mistakes has been shown to have a positive effect on prices, quality, and customer loyalty (Mumtaz, 2019). Better company culture, more opportunities for employment, and a bigger paycheck are all potential outcomes. In conclusion, Six Sigma is a powerful method that may help construction businesses succeed.

2.3 The Relationship between practice with effectiveness level of Six Sigma in improving Project Performance Towards Construction Industry

Six Sigma is widely used as a means of enhancing process quality (Tehrani, 2010). Using this method (Tehrani, 2010), construction firms may achieve six sigma levels of quality. Several studies have found that Six Sigma may enhance the success of construction projects (Han *et al.*, 2008). Strategic choices to improve quality can benefit from quality control practices that increase process consistency (Tehrani, 2010). As a result, the effectiveness of Six Sigma techniques is essential for maximising the results of building projects. The construction sector may benefit from Six Sigma's emphasis on eliminating flaws and minimising variance. Six Sigma is unique amongst improvement strategies in that it allows for the tracking of defect rate, performance, and quality on construction projects. The findings of this study will aid a construction firm in its pursuit of Six Sigma excellence. To increase customer satisfaction and profits, this strategy consistently decreases errors and varies from specifications (Pheng & Hui, 2004). Previous research has demonstrated that there has been no research into how Six Sigma practices and the level of Six Sigma's effectiveness relate to one another when evaluating the efficiency of construction projects. To round out the findings of this study, it would be desirable to conduct an analysis of the explanation of the relationship between Six Sigma practices and the effectiveness level of Six Sigma in the performance evaluation of construction project management.

3. Research Methodology

3.1 Research Design

(a) Procedure of Research

The research procedure for this study is in Appendix A. This research has 5 stages. All phases usually represent the research process.

(b) Research Methodology

This study achieves every objective with quantitative methods. Quantitative research numbers its findings. Quantitative research uses structured questions and surveys to achieve study objectives.

(c) Respondent

This research uses Krejcie & Morgan (1970) Table to determine sample size. This study includes Grade 7 contractor's companies and around 160 Gombak district respondents (CIDB, 2023). This means the sample size is roughly 113 (Appendix B)

(d) Research Instrument

The questionnaire was used to assess contractors' acceptance with the main practices of Six Sigma practices in construction project management performance, the main effectiveness level, and the relationship between the main practices and the main effectiveness level. Questions are asked on Likert five-point scales from never to always (Section B), not effectiveness to extremely effective (Section C). There are three sections: A, B, C, and D. Section A covers respondent's background. Section B addresses Six Sigma practices in improving construction project management performance. The effectiveness level of Six Sigma in improving construction project management performance are in Section C in questionnaire form.

3.2 Pilot Study

Ten G7 contractors from Gombak participated in this pilot study. According to Bullen (2021), a pilot study should have at least 10 participants to collect useful data. The pilot study is crucial to ensure respondents understand all researcher questions.

(a) Reliability analysis

In reliability analysis, the reliability scale was calculated using Cronbach's Alpha. Cronbach's alpha can be anywhere from 0.0 to 1.0. If the value is close to 1, then the spread of test scores can be trusted. Conversely, if the value is zero, then there is no significant variation (Connelly, 2011). After reliability analysis, Table 1 shows that the questionnaire is reliable, and the items have high internal consistency with a Cronbach's Alpha of 0.884.

Table 1 *Reliability test*

Number of Questions	Number of Respondents	Alpha Cronbach's Value
172	8	0.884

3.3 Data Collection

A business email was sent to the construction company's contractors, who in turn forwarded it to their staff via email, WhatsApp, Telegram, and the old-fashioned face-to-face method. The targeted respondent is G7 contractors in Gombak district. It is because Gombak district has multiple G7 contractors. G7 contractors is a larger company that has more complicated operations thus it may be better for them to answer the questionnaire. The person that is suitable to answer the questionnaire is the project manager. Wessel, Godecke & Burcher (2004) confirmed that any corporation may use Six Sigma, but smaller firms may struggle to adopt Six Sigma owing to limited resources and lack of knowledge.

3.4 Data Analysis

Data was analyzed using SPSS Software, frequency analysis explained data basics in this study. A mean-based descriptive analysis and crosstab relationship analysis were utilized. Sections A (Respondent's background), B (Six Sigma practices in improving construction project performance), and C (Six Sigma effectiveness level in improving construction project performance) were analyzed using frequency. This research utilized the different Likert Scale in Sections B and C. These sections evaluated Grade 7 contractors' agreement using the 5-point Likert Scale. From the 5-point Likert scale, the researcher calculated the mean and outcomes. Objective 3—measure the strength of the relationship between the main practices and main effectiveness level to strengthen Six Sigma practices in construction project performance—was analyzed using cross-tabulation (Crosstab). This study employed ordinal data to identify the main practices with Six Sigma practices in construction project management and the main effectiveness level to empower them, making crosstab analysis appropriate.

4. Results and Discussion

The information here is geared towards fulfilling the study's first and second objectives. Respondents received 118 surveys. All 93 surveys returned with responses in the 113 were used for data analysis of which response rate is 82.3%. However, a response rate of 50% or greater is considered outstanding (Reinisch, Daniel & Li, 2016).

(a) Section A: Respondent's Background

The section includes typical respondent sample characteristics and response behavior. In addition, **Table 2** showed Section A data analysis summary. Male replies outnumber female responders 75.3% to 70. The age between 30–49 has the largest number, 76.3% or 71 responders. Malay is the most common race among responders, accounting for 82.8% of the total and 77 out of 93. Bachelor's Degree credentials are highest, with 78.5% and 73 replies. Next, 54.8% of 51 respondents have more than 5 years of experience in the industry. The highest number is 26.9%, or 25 replies, for project managers.

Table 2 *Summary of data analysis in Section A*

No.	Background of Respondents	Frequencies	Percentage (%)
1	Gender		
	Female	23	24.7
	Male	70	75.3
2	Age		
	Between 18 to 29 years old	17	18.3
	Between 30 to 49 years old	71	76.3
	Between 50 to 59 years old	5	5.4
3	Race		
	Chinese	13	14.0
	Indian	3	3.2
	Malay	77	82.8
4	Highest Qualifications		
	Diploma	7	7.5
	Bachelor's Degree	73	78.5
	Masters/ Ph.D.	8	8.6
	Others	5	5.4

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5	Years of service in the construction industry		
	Less than 5 years	25	26.9
	More than 5 years	51	54.8
	More than 10 years	17	18.3
6	Position		
	Architect	12	12.9
	Construction Manager	15	16.1
	Engineer	12	12.9
	Project Manager	25	26.9
	Quantity Surveyor	11	11.8
	Others	18	19.4

(b) Section B: Six Sigma practices in improving project performance in the construction industry (Objective 1)

Table 3 provides the basis for classifying and interpreting the mean average score into three tiers. Low mean values are indicated by scores between 1.00 and 2.33, moderate mean values by scores between 2.34 and 3.66, and high mean values by scores between 3.67 and 5.00.

Table 3 *Assessment level based on mean score for Objective 1 (Ibrahim, 2013)*

Mean Score Range	Level	Mean Score Level
1.00-2.33	Low	(Not Agree/ Very poor/ Never)
2.34-3.67	Moderate	(Agree/ Helpful/ Satisfied/ Sometimes)
3.68-5.00	High	(Strongly Agree/ Fully Satisfied/ Always)

Table 4 provides the basis for classifying and interpreting the mean average score into five tiers. Insignificant mean values are indicated by scores between 1.00-1.50, minor mean values by scores between 1.50 and 2.50, moderate mean values by scores between 2.50 to 3.50, major mean values by scores between 3.50 to 4.50 and sever mean values by scores between 4.50 and 5.00.

Table 4 *Assessment level based on mean score for Objective 2 (Zikmund, 2003)*

Mean Score Range	Rating	Mean
1.00-1.50	Insignificant	(Extremely ineffective)
1.50-2.50	Minor	(Inefficient)
2.50-3.50	Moderate	(Moderately in effective)
3.50-4.50	Major	(Very ineffective)
4.50-5.00	Sever	(Extremely effective)

Table 5 shows that most respondents agreed (refer Table 4) that Six Sigma Practices Improve Project Outcomes and Reduce Defect is one of the main practices with its effectiveness level in construction project. The mean agreement level was 4.1936. The next three practices, with mean values of 4.1441, 4.0301, and 4.0153, respectively, are Six Sigma Practices Promote Sustainable Construction, Six Sigma Certification Levels and Knowledge of Six Sigma Practices. The difficulties stem from Technique of Six Sigma practices in Construction, according to several respondents (high agreement level; mean value: 3.8968). Data analysis of the returned surveys revealed that respondents reached a high agreement level regarding the Process of Six Sigma Practices (3.8333) as one of the issues. Respondents agreed (at the moderate agreement level) that Six Sigma Practices Reduce Injuries (3.6624), and Six Sigma Practices Lower Operational Expenses (3.6172) are the main practices with Six Sigma practices in improving construction project management performance.

Table 5 *Mean analysis of Six Sigma Practices in improving construction project performance*

No.	Six Sigma Practices in Improving Project Performance in the Construction Industry.	Mean	Agreement Level	Ranking
Six Sigma Practices Promote Sustainable Construction.		4.1441	High	**2**
1.	Enhance teamwork.	4.3333	High	1

2.	Decrease defects.	4.2366	High	2
3.	Boost project performance.	4.1613	High	3
4.	Decrease rework.	4.0000	High	4
5.	Social aspects.	3.9892	High	5
Six Sigma Practices Improve Project Outcomes and Reduce Defects.		4.1936	High	**1**
1.	Reduce overall costs.	4.3441	High	1
2.	Management support.	4.2581	High	2
3.	Key performance indicators.	4.2258	High	3
4.	Boost teamwork.	4.0968	High	4
5.	Enhance quality control.	4.0430	High	5
Six Sigma Practices Lower Operational Expenses.		3.6172	Medium	**8**
1.	Effective schedule work.	3.7742	High	1
2.	Total Quality Management (TQM).	3.7634	High	2
3.	Utilise the profit.	3.5484	Medium	3
4.	Cautiously elements.	3.5054	Medium	4
5.	Effective project management.	3.4946	Medium	5
Six Sigma Practices Reduce Injuries.		3.6624	Medium	**7**
1.	Smart construction work.	3.9032	High	1
2.	Hire office safer.	3.7957	High	2
3.	Commentary from risk-taker.	3.7097	High	3
4.	Effective OSH.	3.6559	High	4
5.	Maximum extent possible in process.	3.2473	High	5
Process of Six Sigma Practices.		3.8333	High	**6**
1.	Product-improvement plan.	4.0215	High	1
2.	Business-value process.	3.9892	High	2
3.	Performance with a roadmap.	3.8280	High	3
4.	Problem-solving plan.	3.4946	High	4
Knowledge of Six Sigma practices.		4.0153	High	**4**
1.	Ongoing development.	4.2151	High	1
2.	Uncontrolled process are improved.	4.0870	High	2
3.	Process enhancement.	4.0860	High	3
4.	Remains under control.	3.9355	High	4
5.	Statistical standards.	3.7527	High	5
Technique of Six Sigma practices in construction.		3.8968	High	**5**
1.	Increase output.	4.1613	High	1
2.	Cut down on mistakes.	4.0968	High	2
3.	Consider each sector's challenges.	3.9677	High	3
4.	Working together effectively.	3.6344	High	4
5.	Select the right projects.	3.6237	High	5
Six Sigma Certification Levels.		4.0301	High	**3**
1.	Improving project results.	4.1290	High	1
2.	Corrective measure.	4.0968	High	2
3.	Choose wisely due to knowledge.	4.0538	High	3
4.	Pinpoint inefficiencies.	3.9462	High	4
5.	Lowering barriers.	3.9247	High	5

The most effective way to enable Six Sigma practices in improving construction project performance is with Six Sigma Practices Improve Project Outcomes and Reduce Defect with mean 4.1936. Therefore, to facilitate Six Sigma practices within the framework of construction project, it may be excellent and relate as research done by Kala, Singh & Singh (2018), the construction industry's carbon footprint decreased when Six Sigma was implemented. Additionally, they discovered that Six Sigma practices is the most effective strategy to help cut down on inefficiencies and maximise the use of available resources (Pulakanam & Voges, 2010). The value flow is also emphasized by the lowest mean of 3.6172. The reason is because most poll takers believe that improving Six Sigma practices should not revolve around value transfer. Therefore, we have achieved our second objective, which was to identify the main practices that may be improved within the framework in improving the construction industry.

(c) Section C: Effectiveness Level of Six Sigma in improving project performance in the construction industry (Objective 2).

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Based on Table 6, with a mean score of 4.3419 and a degree of agreement of high, the importance of Six Sigma in ensuring its efficiency comes in first. With a mean score of 4.2236 and an agreement level of high, Indicator to measure Effectiveness Level of Six Sigma ranks second. The third-ranked item, Advantages of Six Sigma that increases its efficiency, comes next with a mean score of 4.1509 and an agreement level. The researcher used all the rankings for the crosstabulations.

Table 6 *Mean analysis of effectiveness level in improving construction project performance*

No.	Effectiveness Level of Six Sigma Practice in Improving Project Performance in the Construction Industry	Mean	Agreement Level	Ranking
The Importance of Six Sigma in ensuring its efficiency		4.3419	High	**1**
1.	Decrease generation of waste.	4.3656	High	1
2.	Reduce raw materials usage.	4.3656	High	1
3.	Reduce construction carbon impact.	4.3548	High	3
4.	Reduce power usage.	4.3333	High	4
5.	Employment opportunities.	4.2903	High	5
Indicator to measure Effectiveness Level of Six Sigma		4.2236	High	**2**
1.	Score for immediate action.	4.2688	High	1
2.	Apply zero faults.	4.2688	High	1
3.	Lower DPMO score.	4.2151	High	3
4.	Aids in Six Sigma process assesment.	4.1935	High	4
5.	Implement Quality Indicators (QI).	4.1720	High	5
Advantages of Six Sigma that increase its efficiency		4.1509	High	**3**
1.	Powerful project tool.	4.2366	High	1
2.	Reduce rework.	4.1739	High	2
3.	Continuous improvement.	4.1290	High	3
4.	Enhance safety.	4.1075	High	4
5.	Performance indicator	4.1075	High	4

The highest ranking that respondent chose is the importance of Six Sigma in ensuring its efficiency. The finding relates to Yilmaz & Firat (2012), the construction company may benefit from Six Sigma's implementation by cutting costs and waste while also boosting safety and productivity. Advantages of Six Sigma that increases its efficiency, the lowest mean is 4.1509 because Six Sigma's ability to cut down on inefficiencies and maximise the use of available resources can assist reduce construction's detrimental effect on the natural world.

(d) Section D: Strength of Relationship Between the main practice with main effectiveness level of Six Sigma in improving project performance towards construction industry (Objective 3).

In Table 7, the estimated significance for variables must < 0.05 and value must < 0.5 indicates a strong or weak association between them. Variables affect approximate significance. This study has two hypotheses: H0 and H1. H0: There is no significant relationship between practices and the effectiveness level of Six Sigma in improving project performance in the construction industry. H1: There is a significant relationship between practices and the effectiveness level of Six Sigma in improving project performance in the construction industry. The researcher picked all of 8 main practices and each three subs of it and all main effectiveness level and each of it has three subs to create this relationship. The number of variables in a prediction model relies on several aspects. Even though cross-tabulations are often used in statistical analysis, a better comprehension of the supplied data is necessary for several stakeholders (Mohn, 2010).

Table 7 *Crosstab analysis (Deeptanshu, 2022)*

Appr. Significant	Value	Explanation
< 0.05	< 0.5	There is a relationship between the variables and the relationship is strong. (H_1 is accepted)
> 0.05	> 0.5	There is no association between the variables and the relationship is weak. (H_0 is accepted)

Table 8 shows Relationship Between the Main Six Sigma Practices with Main Effectiveness Level of Six Sigma in Improving. The relationship between practices and effectiveness level is shown in Table 8, along with its value and its relevance. For each practice and its effectiveness level, the ranking is determined by strong values. The strongest H1 is Knowledge of Six Sigma practices – Ongoing development with Importance of Six Sigma in ensuring its efficiency – Reduce construction carbon impact with strength value is 0.0810. According to Sokovic *et al.* (2006), every procedure that has the objective of achieving continuous improvement and development must include such knowledge that the individuals who deal directly with the procedure daily to make sure they aware of how to operate them. The strongest H0 is Six Sigma practices improve project outcomes and reduce defects – Management support with Indicator to measure effectiveness level of Six Sigma – Lower DPMO score with 0.0020 value. As stated by Al-Mashari, Irani, and Zairi (2009), the effectiveness of Six Sigma efforts in the construction sector relies heavily on management support, training, selecting the right projects, and cooperation. Also, by reducing the number of defects, Six Sigma can help construction projects go more quickly and at a lower cost.

Table 8 *Relationship analysis for main practices with main effectiveness level*

Main practices	Main effectiveness level	Appr. Significant (Relationship)	Value (Strength)	Hypothesis	Ranking
1. Six Sigma practices improve project outcomes and reduce defects. - Reduce overall costs.	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.3490 (No)	0.0980 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.1370 (No)	0.1550 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.7390 (No)	0.0350 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.6190 (No)	0.0520 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.4460 (No)	0.0800 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.9480 (No)	0.0070 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.9520 (No)	0.0060 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.8620 (No)	0.0180 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.9040 (No)	0.0130 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.4440 (No)	0.0800 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.2270 (No)	0.0126 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0990 (No)	0.1730 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0090 (Yes)	0.2690 (Strong)	H1	1
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0890 (No)	0.1770 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.1880 (No)	0.1380 (Strong)	H0	-
1. Six Sigma practices improve project outcomes and reduce defects. - Management support.	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.3140 (No)	0.1050 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.2020 (No)	0.1330 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.5210 (No)	0.0670 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.6250 (No)	0.0510 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.2780 (No)	0.1140 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.8340 (No)	0.0220 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.4680 (No)	0.0760 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.9830 (No)	0.0020 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.1740 (No)	0.1420 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.7810 (No)	0.0290 (Strong)	H0	-

	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.8540 (No)	0.0190 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.2410 (No)	0.1240 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.1690 (No)	0.1440 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.1050 (No)	0.1690 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.9590 (No)	0.0050 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.1700 (No)	0.1430 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0990 (No)	0.1720 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.5530 (No)	0.0620 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.6170 (No)	0.0530 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.1470 (No)	0.1520 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.9240 (No)	0.0100 (Strong)	H0	-
1. Six Sigma practices improve project outcomes and reduce defects. - Key Performance indicator (KPI).	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.9620 (No)	0.0050 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.5340 (No)	0.0650 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.7960 (No)	0.0270 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.7160 (No)	0.0380 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.4800 (No)	0.0740 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.3820 (No)	0.0920 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0450 (Yes)	0.2080 (Strong)	H1	2
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0470 (Yes)	0.2070 (Strong)	H1	1
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.2480 (No)	0.1210 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0480 (Yes)	0.2060 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.3430 (No)	0.0990 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.6920 (No)	0.0420 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.4820 (No)	0.0740 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.1210 (No)	0.1620 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.3370 (No)	0.1010 (Strong)	H0	-
2. Six Sigma practices promote sustainable construction - Enhance teamwork	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.7580 (No)	0.0320 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.5590 (No)	0.0610 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0000 (No)	0.4610 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.4890 (No)	0.0730 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.8180 (No)	0.0240 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.9620 (No)	0.0050 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0010 (Yes)	0.4990 (Strong)	H1	2
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.3870 (No)	0.0910 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.7780 (No)	0.0300 (Strong)	H0	-
2. Six Sigma practices promote sustainable construction	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0250 (Yes)	0.2330 (Strong)	H1	2
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.5020 (No)	0.0700 (Strong)	H0	-

- Decrease defects	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.0520 (No)	0.2020 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.4290 (No)	0.0830 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.0190 (Yes)	0.2430 (Strong)	H1	3
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.9910 (No)	0.0010 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.3390 (No)	0.1000 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.3400 (No)	0.1000 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.6130 (No)	0.0530 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.9770 (No)	0.0030 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.5960 (No)	0.0560 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.2110 (No)	0.1320 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0001 (Yes)	0.5720 (Weak)	H1	3
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0760 (No)	0.1850 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0880 (No)	0.1780 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0140 (Yes)	0.2530 (Strong)	H1	4
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.6100 (No)	0.0540 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.0710 (No)	0.1880 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.3350 (No)	0.1010 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.1740 (No)	0.1420 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.3910 (No)	0.0900 (Strong)	H0	-
2. Six Sigma practices promote sustainable construction - Boost project performance	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.1140 (No)	0.1650 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.3470 (No)	0.0990 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.3260 (No)	0.1030 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.9580 (No)	0.0060 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.3160 (No)	0.1050 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0660 (No)	0.1930 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0150 (Yes)	0.2510 (Strong)	H1	3
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0170 (Yes)	0.2470 (Strong)	H1	2
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0190 (Yes)	0.2430 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.4840 (No)	0.0730 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.2560 (No)	0.1190 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.4390 (No)	0.0810 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.5860 (No)	0.0570 (Strong)	H0	-
3. Six Sigma Certification Levels - Improving project results	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.9330 (No)	0.0090 (Strong	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0100 (Yes)	0.2670 (Strong)	H1	1
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0790 (No)	0.1830 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.2610 (No)	0.1180 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0090 (Yes)	0.2700 (Strong)	H1	2

	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.2490 (No)	0.1210 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Powerful project tools	0.1140 (No)	0.1650 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Reduce rework	0.2060 (No)	0.1330 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Continuous improvement	0.0850 (No)	0.1800 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Performance indicator	0.1200 (No)	0.1620 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Enhance safety	0.1460 (No)	0.1520 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0160 (Yes)	0.2500 (Strong)	H1	8
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0500 (Yes)	0.1980 (Strong)	H1	2
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.2620 (No)	0.1170 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0710 (Yes)	0.1880 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.3220 (No)	0.1040 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0001 (Yes)	0.3580 (Strong)	H1	6
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0050 (Yes)	0.2870 (Strong)	H1	3
3. Six Sigma Certification Levels - Corrective measures	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0040 (Yes)	0.3000 (Strong)	H1	4
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0000 (Yes)	0.3600 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0030 (Yes)	0.3040 (Strong)	H1	5
	Advantages of Six Sigma that increases its efficiency - Powerful project tools	0.1290 (No)	0.1580 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Reduce rework	0.0001 (Yes)	0.3840 (Strong)	H1	8
	Advantages of Six Sigma that increases its efficiency - Continuous improvement	0.1150 (No)	0.1640 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Performance indicator	0.0730 (No)	0.1870 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Enhance safety	0.0060 (Yes)	0.2810 (Strong)	H1	2
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.1760 (No)	0.1420 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0490 (Yes)	0.2040 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.2800 (No)	0.1130 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0370 (Yes)	0.2170 (Strong)	H1	3
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.4140 (No)	0.0860 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0010 (Yes)	0.3260 (Strong)	H1	9
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0460 (Yes)	0.2070 (Strong)	H1	2
3. Six Sigma Certification Levels - Choose wisely due to knowledge	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0270 (Yes)	0.2290 (Strong)	H1	4
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0040 (Yes)	0.3000 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0140 (Yes)	0.2540 (Strong)	H1	6
	Advantages of Six Sigma that increases its efficiency - Powerful project tools	0.0890 (No)	0.1770 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Reduce rework	0.0020 (Yes)	0.3120 (Strong)	H1	8
	Advantages of Six Sigma that increases its efficiency - Continuous improvement	0.1290 (No)	0.1580 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Performance indicator	0.0270 (Yes)	0.2300 (Strong)	H1	5
	Advantages of Six Sigma that increases its efficiency - Enhance safety	0.0720 (No)	0.1870 (Strong)	H0	-
4. Knowledge of Six Sigma Practices	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.3610 (No)	0.0960 (Strong)	H0	-

- Ongoing development	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0480 (Yes)	0.2050 (Strong)	H1	3
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact.	0.0360 (Yes)	0.0810 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0020 (Yes)	0.3130 (Strong)	H1	5
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.0740 (No)	0.1860 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0000 (Yes)	0.4700 (Strong)	H1	11
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0000 (Yes)	0.3850 (Strong)	H1	8
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0010 (Yes)	0.3460 (Strong)	H1	6
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0000 (Yes)	0.3550 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0000 (Yes)	0.4470 (Strong)	H1	10
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.0100 (Yes)	0.0810 (Strong)	H1	1
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0580 (No)	0.1980 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0000 (Yes)	0.4320 (Strong)	H1	9
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0070 (Yes)	0.2760 (Strong)	H1	4
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0780 (No)	0.1840 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency. - Decrease generation of waste.	0.9930 (No)	0.0010 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.4460 (No)	0.0800 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.1670 (No)	0.1450 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0470 (Yes)	0.2080 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.6530 (No)	0.0470 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0030 (Yes)	0.3030 (Strong)	H1	3
4. Knowledge of Six Sigma Practices - Uncontrolled processes are improved	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0070 (Yes)	0.2810 (Strong)	H1	2
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0010 (Yes)	0.3360 (Strong)	H1	4
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0000 (Yes)	0.4470 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0000 (Yes)	0.3550 (Strong)	H1	5
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.2990 (No)	0.1100 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.1210 (No)	0.1640 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0000 (Yes)	0.3720 (Strong)	H1	6
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.2470 (No)	0.1220 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0680 (No)	0.1910 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.6850 (No)	0.0430 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0650 (No)	0.1920 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.0040 (Yes)	0.2960 (Strong)	H1	6
4. Knowledge of Six Sigma Practices - Process enhancement restores statistical control	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0130 (Yes)	0.2570 (Strong)	H1	4
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.4150 (No)	0.0860 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0030 (Yes)	0.3040 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0530 (No)	0.2010 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0150 (Yes)	0.1640 (Strong)	H1	1

	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0220 (Yes)	0.2380 (Strong)	H1	3
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0130 (Yes)	0.2570 (Strong)	H1	4
	Advantages of Six Sigma that increases its efficiency - Powerful project tools	0.0390 (Yes)	0.2150 (Strong)	H1	2
	Advantages of Six Sigma that increases its efficiency - Reduce rework	0.5030 (No)	0.0710 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Continuous improvement	0.0030 (Yes)	0.3040 (Strong)	H1	7
	Advantages of Six Sigma that increases its efficiency - Performance indicator	0.0780 (No)	0.1840 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Enhance safety	0.4020 (No)	0.0880 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.2200 (No)	0.1280 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.1440 (No)	0.1530 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact.	0.0370 (Yes)	0.2170 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0510 (No)	0.2030 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.2650 (No)	0.1170 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0040 (Yes)	0.2940 (Strong)	H1	3
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0090 (Yes)	0.2710 (Strong)	H1	2
5. Technique of Six Sigma Practices in Construction - Increase output	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0000 (Yes)	0.3650 (Strong)	H1	6
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0000 (Yes)	0.3860 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0040 (Yes)	0.2940 (Strong)	H1	3
	Advantages of Six Sigma that increases its efficiency - Powerful project tools	0.2030 (No)	0.1330 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Reduce rework	0.0660 (No)	0.1920 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Continuous improvement	0.0020 (Yes)	0.3150 (Strong)	H1	5
	Advantages of Six Sigma that increases its efficiency - Performance indicator	0.3440 (No)	0.0990 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency - Enhance safety	0.2700 (No)	0.1150 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.1050 (No)	0.1690 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0050 (Yes)	0.2900 (Strong)	H1	4
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.2020 (No)	0.1340 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0710 (No)	0.1880 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.2370 (No)	0.1240 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.8200 (No)	0.0240 (Strong)	H0	-
5. Technique of Six Sigma Practices in Construction - Cut down on mistakes	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0070 (Yes)	0.2810 (Strong)	H1	2
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.7930 (No)	0.0280 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.4140 (No)	0.0860 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.4990 (No)	0.0710 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.0480 (Yes)	0.2060 (Strong)	H1	1
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.1180 (No)	0.1640 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0050 (Yes)	0.2900 (Strong)	H1	4
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0060 (Yes)	0.2850 (Strong)	H1	3
	Advantages of Six Sigma that increases its efficiency.	0.0000	0.3560	H0	-

	- Enhance safety	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0850 (No)	0.1790 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.1470 (No)	0.1510 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.0380 (Yes)	0.2150 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0150 (Yes)	0.2510 (Strong)	H1	2
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.1020 (No)	0.1700 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0000 (Yes)	0.3800 (Strong)	H1	9
5. Technique of Six Sigma Practices in Construction - Consider each other sector's challenges	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0010 (Yes)	0.3490 (Strong)	H1	8
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0150 (Yes)	0.2510 (Strong)	H1	2
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0010 (Yes)	0.3300 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0040 (Yes)	0.2990 (Strong)	H1	6
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.1490 (No)	0.1510 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0110 (Yes)	0.2640 (Strong)	H1	4
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.2760 (No)	0.1140 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0000 (Yes)	0.4580 (Strong)	H1	11
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0000 (Yes)	0.3970 (Strong)	H1	10
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.3910 (No)	0.0900 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0450 (Yes)	0.2090 (Strong)	H1	2
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact.	0.0190 (Yes)	0.2440 (Strong)	H1	5
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0770 (No)	0.1850 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.6650 (No)	0.0450 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0350 (Yes)	0.2180 (Strong)	H1	3
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.1930 (No)	0.1360 (Strong)	H0	-
6. Process of Six Sigma Practices - Product-improvement plan	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0480 (Yes)	0.1900 (Strong)	H1	1
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0260 (Yes)	0.2310 (Strong)	H1	4
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0950 (No)	0.1740 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.2260 (No)	0.1270 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.5810 (No)	0.0580 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.3360 (No)	0.1010 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.6050 (No)	0.0540 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.1680 (No)	0.1440 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.4960 (No)	0.0710 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.2020 (No)	0.1330 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.1040 (No)	0.1700 (Strong)	H0	-
6. Process of Six Sigma Practices - Business-value process	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0480 (Yes)	0.2060 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.3390 (No)	0.1000 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0010 (Yes)	0.3410 (Strong)	H1	6
	Indicator to measure Effectiveness level of Six Sigma	0.0020	0.3130	H1	5

	- Apply zero faults.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0030 (Yes)	0.3020 (Strong)	H1	4
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0000 (Yes)	0.2760 (Strong)	H1	3
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0070 (Yes)	0.2760 (Strong)	H1	3
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.6010 (No)	0.0550 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.2230 (No)	0.1280 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0370 (Yes)	0.2170 (Strong)	H1	2
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.7720 (No)	0.0310 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.7660 (No)	0.0310 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0040 (Yes)	0.1790 (Strong)	H1	1
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0000 (Yes)	0.4120 (Strong)	H1	12
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.0000 (Yes)	0.3680 (Strong)	H1	7
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0000 (Yes)	0.3820 (Strong)	H1	9
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.0120 (Yes)	0.2590 (Strong)	H1	2
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0000 (Yes)	0.3970 (Strong)	H1	11
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0040 (Yes)	0.2980 (Strong)	H1	5
6. Process of Six Sigma Practices - Performance with a roadmap	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0000 (Yes)	0.3740 (Strong)	H1	8
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0110 (Yes)	0.2640 (Strong)	H1	3
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0010 (Yes)	0.3400 (Strong)	H1	6
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.6500 (No)	0.1920 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0000 (Yes)	0.3900 (Strong)	H1	10
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0860 (No)	0.1790 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0560 (No)	0.1990 (Strong)	H0	-
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0100 (Yes)	0.2190 (Strong)	H1	4
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0350 (Yes)	0.2190 (Strong)	H1	4
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0150 (Yes)	0.2520 (Strong)	H1	6
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact.	0.0470 (Yes)	0.2070 (Strong)	H1	2
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0540 (No)	0.2000 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.2480 (No)	0.1210 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0000 (Yes)	0.3610 (Strong)	H1	11
7. Six Sigma reduce injuries - Smart construction work	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0110 (Yes)	0.2640 (Strong)	H1	7
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0460 (Yes)	0.2070 (Strong)	H1	2
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.1030 (No)	0.1700 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0100 (Yes)	0.2670 (Strong)	H1	9
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.0270 (Yes)	0.2290 (Strong)	H1	5
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0100 (Yes)	0.2660 (Strong)	H1	8
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0130 (Yes)	0.1010 (Strong)	H1	1
	Advantages of Six Sigma that increases its efficiency.	0.0020	0.3150	H1	10

	- Performance indicator	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0000	0.3850	H1	12
	- Enhance safety	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0150	0.2530	H1	2
	- Decrease generation of waste.	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0060	0.2840	H1	4
	- Reduce raw materials.	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0010	0.3320	H1	10
	- Reduce construction carbon impact	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0010	0.3290	H1	9
	- Reduce power usage.	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0060	0.2830	H1	3
	- Employment opportunities.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0030	0.3030	H1	6
	- Score for immediate action.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0040	0.2920	H1	5
	- Apply zero faults.	(Yes)	(Strong)		
7. Six Sigma reduce injuries	Indicator to measure Effectiveness level of Six Sigma	0.0010	0.3400	H1	11
- Hire safety officer	- Lower DPMO score.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0060	0.2810	H1	3
	- Aids in Six Sigma process improvement.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0020	0.3140	H1	7
	- Implement Quality Indicators (QI).	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.1110	0.1660	H0	-
	- Powerful project tools	(No)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0000	0.3670	H1	13
	- Reduce rework	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0420	0.2110	H1	1
	- Continuous improvement	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0000	0.3580	H1	12
	- Performance indicator	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0020	0.3170	H1	8
	- Enhance safety	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0510	0.2030	H0	-
	- Decrease generation of waste.	(No)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0030	0.3060	H1	4
	- Reduce raw materials.	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0010	0.3280	H1	6
	- Reduce construction carbon impact	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0000	0.3850	H1	11
	- Reduce power usage.	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0050	0.2900	H1	3
	- Employment opportunities.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0000	0.4310	H1	14
	- Score for immediate action.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0000	0.4120	H1	13
7. Six Sigma reduce injuries	- Apply zero faults.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0010	0.3330	H1	8
- Commentary from risk-takers	- Lower DPMO score.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0000	0.4050	H1	12
	- Aids in Six Sigma process improvement.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0010	0.3280	H1	6
	- Implement Quality Indicators (QI).	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0340	0.2200	H1	1
	- Powerful project tools	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0000	0.3710	H1	10
	- Reduce rework	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0180	0.2440	H1	2
	- Continuous improvement	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0000	0.3620	H1	9
	- Performance indicator	(Yes)	(Strong)		
	Advantages of Six Sigma that increases its efficiency.	0.0020	0.3140	H1	5
	- Enhance safety	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.3360	0.1010	H0	-
	- Decrease generation of waste.	(No)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0300	0.2250	H1	1
8. Six Sigma Practices Lower Operational Expenses	- Reduce raw materials.	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.0000	0.4530	H1	12
	- Reduce construction carbon impact.	(Yes)	(Strong)		
- Effective schedule work	The importance of Six Sigma in ensuring its efficiency	0.0240	0.2330	H1	2
	- Reduce power usage.	(Yes)	(Strong)		
	The importance of Six Sigma in ensuring its efficiency	0.4410	0.0810	H0	-
	- Employment opportunities.	(No)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma	0.0000	0.4530	H1	12

	- Score for immediate action.	(Yes)	(Strong)		
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0010 (Yes)	0.3480 (Strong)	H1	10
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0010 (Yes)	0.3400 (Strong)	H1	9
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0090 (Yes)	0.2680 (Strong)	H1	5
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0000 (Yes)	0.3590 (Strong)	H1	11
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.0140 (Yes)	0.2550 (Strong)	H1	3
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0050 (Yes)	0.2930 (Strong)	H1	6
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0010 (Yes)	0.3350 (Strong)	H1	8
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0010 (Yes)	0.3300 (Strong)	H1	7
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0110 (Yes)	0.2640 (Strong)	H1	4
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.6080 (No)	0.0540 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0080 (Yes)	0.2740 (Strong)	H1	5
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.0540 (No)	0.2010 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0020 (Yes)	0.3210 (Strong)	H1	11
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.0840 (No)	0.1800 (Strong)	H0	-
	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0000 (Yes)	0.4110 (Strong)	H1	12
8. Six Sigma Practices Lower Operational Expenses - Total Quality Management (TQM)	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0040 (Yes)	0.2970 (Strong)	H1	9
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0080 (Yes)	0.2730 (Strong)	H1	4
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0060 (Yes)	0.2830 (Strong)	H1	6
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0060 (Yes)	0.2850 (Strong)	H1	7
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.0190 (Yes)	0.2440 (Strong)	H1	2
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0270 (Yes)	0.2310 (Strong)	H1	1
	Advantages of Six Sigma that increases its efficiency. - Continuous improvement	0.0150 (Yes)	0.2510 (Strong)	H1	3
	Advantages of Six Sigma that increases its efficiency. - Performance indicator	0.0040 (Yes)	0.2940 (Strong)	H1	8
	Advantages of Six Sigma that increases its efficiency. - Enhance safety	0.0030 (Yes)	0.3020 (Strong)	H1	10
	The importance of Six Sigma in ensuring its efficiency - Decrease generation of waste.	0.0780 (No)	0.1830 (Strong)	H0	-
	The importance of Six Sigma in ensuring its efficiency - Reduce raw materials.	0.0000 (Yes)	0.3600 (Strong)	H1	9
	The importance of Six Sigma in ensuring its efficiency - Reduce construction carbon impact	0.0240 (Yes)	0.2330 (Strong)	H1	3
	The importance of Six Sigma in ensuring its efficiency - Reduce power usage.	0.0010 (Yes)	0.3350 (Strong)	H1	5
	The importance of Six Sigma in ensuring its efficiency - Employment opportunities.	0.0320 (Yes)	0.2230 (Strong)	H1	2
8. Six Sigma Practices Lower Operational Expenses - Utilize the profit	Indicator to measure Effectiveness level of Six Sigma - Score for immediate action.	0.0000 (Yes)	0.4600 (Strong)	H1	14
	Indicator to measure Effectiveness level of Six Sigma - Apply zero faults.	0.0010 (Yes)	0.3390 (Strong)	H1	6
	Indicator to measure Effectiveness level of Six Sigma - Lower DPMO score.	0.0020 (Yes)	0.3110 (Strong)	H1	4
	Indicator to measure Effectiveness level of Six Sigma - Aids in Six Sigma process improvement.	0.0010 (Yes)	0.3520 (Strong)	H1	8
	Indicator to measure Effectiveness level of Six Sigma - Implement Quality Indicators (QI).	0.0000 (Yes)	0.3910 (Strong)	H1	11
	Advantages of Six Sigma that increases its efficiency. - Powerful project tools	0.0000 (Yes)	0.3620 (Strong)	H1	10
	Advantages of Six Sigma that increases its efficiency. - Reduce rework	0.0010 (Yes)	0.3420 (Strong)	H1	7
	Advantages of Six Sigma that increases its efficiency.	0.0350	0.2190	H1	1

- Continuous improvement	(Yes)	(Strong)		
Advantages of Six Sigma that increases its efficiency.	0.0000	0.4450	H1	13
- Performance indicator	(Yes)	(Strong)		
Advantages of Six Sigma that increases its efficiency.	0.0000	0.4270	H1	12
- Enhance safety	(Yes)	(Strong)		

The researchers achieved objective three, which was to assess the strength of the relationship between the main practices and main effectiveness level in improving project performance, as no study has done so. In addition, Fig. 2 demonstrates the main practices with main effectiveness level of Six Sigma to improving project performance in construction industry. Researchers can infer that not all practices have a correlation with the main effectiveness level.

Fig. 2 *Relationship analysis for main practices with main effectiveness level*

5. Conclusion

All the study objectives have been met, according to the results, by making use of the data analysis conducted on the returned questionnaires. For the research to be considered a success, it is essential that the objectives to be met. Research by Hussain *et al.* (2019), Jusoh & Kasim (2017), Chakraborty & Leyer (2013) and Sokovic .. (2006) indicates that Grade 7 contractor's companies agreed that Six Sigma practices lower operational expenses is the main practices and the importance of Six Sigma in ensuring its efficiency is the main effectiveness level in

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improving construction project performance. According to the researcher, Six Sigma Practices Lower Operational Expenses (The importance of Six Sigma in ensuring its efficiency) has the strongest relationship (H1), while Six Sigma Practices Improve Project Outcomes and Reduce Defects (Management support) has the weakest relationship (H0). The results of this study (Fig. 3) suggest that the people or organizations charged with fixing the issues should use the suggestions made to them. If this is how the construction companies is run, it may be a lot more successful and can improve project performance in construction.

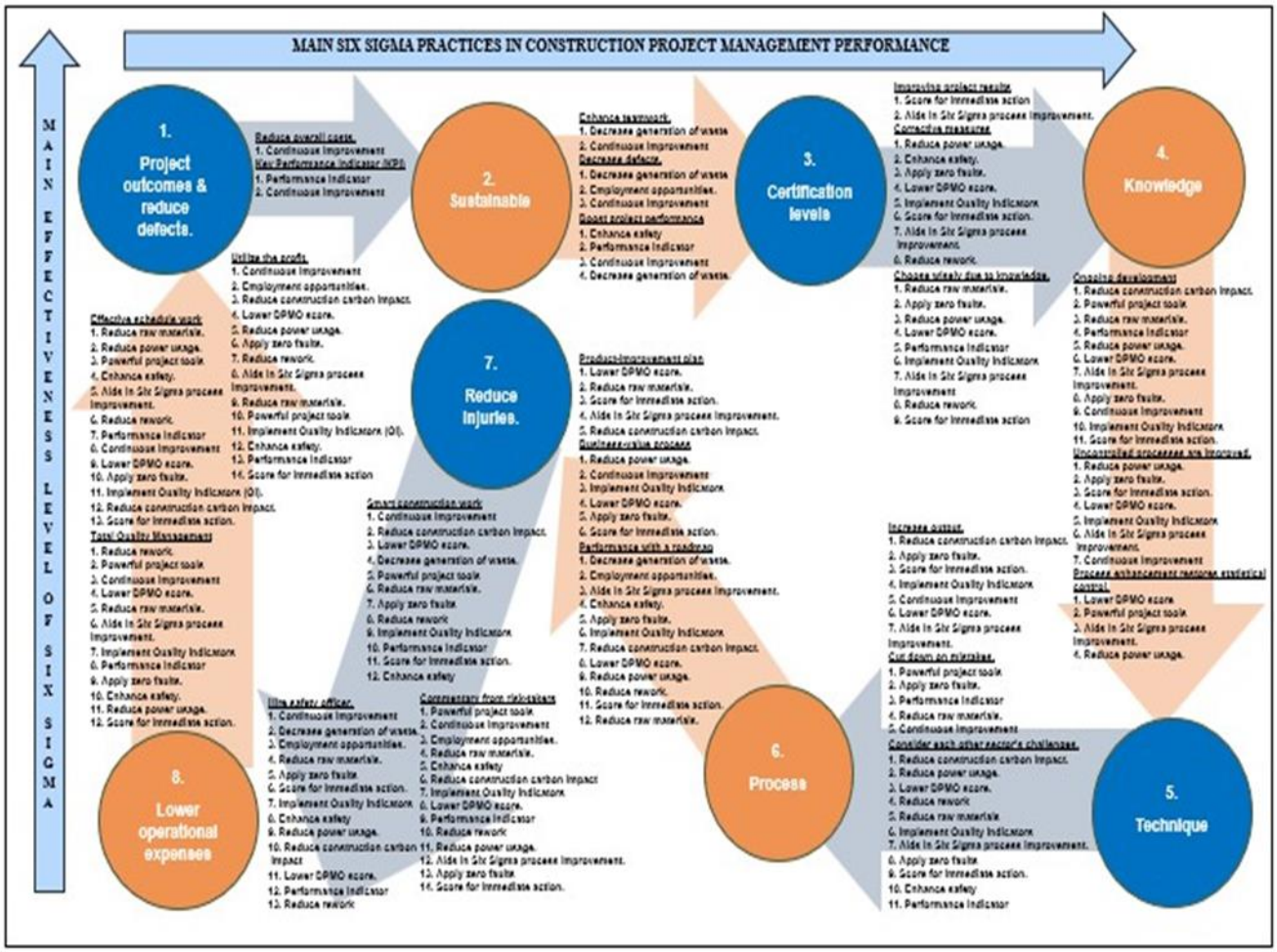

Fig 3. *Relationship framework for main practices with main effectiveness of Six Sigma to improving project performance in the construction industry*

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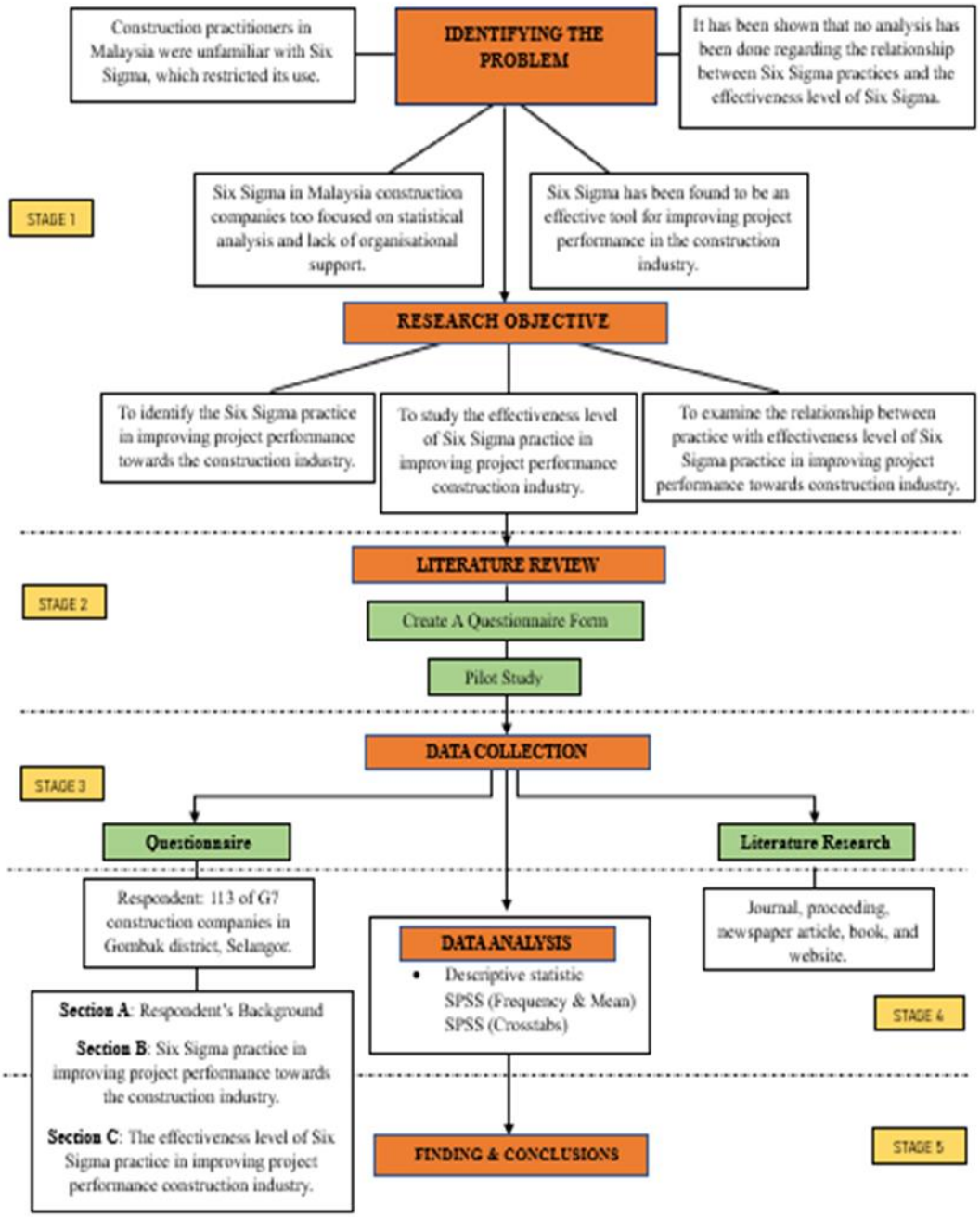
Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Fatimah Johari, Rozlin Zainal;* ***data collection:*** *Nur Fatimah Johari;* ***analysis and interpretation of results:*** *Nur Fatimah Johari;* ***draft manuscript preparation:*** *Nur Fatimah Johari, Rozlin Zainal, Narimah Kasim, Sharifah Meryam Shareh Musa. All authors reviewed the results and approved the final version of the manuscript.*

Appendix A: Research flow chart



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Appendix B: Table population (N) and sample (S) Krejcie and Morgan

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

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