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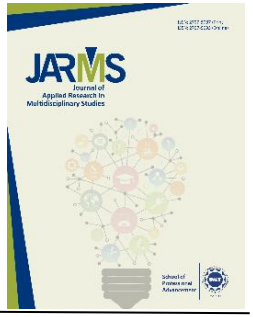

Title: **Impacts of Safety Management Practices on Project Success in Punjab: Safety Policy as Moderator and Safety Performance as Mediator**

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Impacts of Safety Management Practices on Project Success in Punjab: Safety Policy as Moderator and Safety Performance as Mediator

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Abstract

Even though safety management is considered to be a critical factor in the construction industry due to the high rate of accidents and injuries, the lack of safety management practices (SMPs) had always been a serious issue in the construction sector of Pakistan. In addition, other factors like safety policy and safety performance also influence the project's success. The current study brought clarity to the assessment of the relationship of SMPs on project success by addressing moderation and mediation of safety training, safety meeting, safety communication, and safety inspection. A quantitative research strategy was employed to obtain the data from 231 safety and engineering professionals belonging to the construction industry in Punjab, Pakistan. The collected data was examined by structural equational modeling (SEM) through the partial least squares method by using Smart PLS. The results indicated that four SMPs, namely safety training, safety meeting, safety communication, and safety inspection reflect safety performance. The study concluded that SMPs have a positive and significant influence on project success. When these four SMPs are mediated with safety performance, it shows partial mediation between safety performance and project success. Meanwhile, when these four SMPs are moderated with a safety policy, results indicate a moderate to strong relationship between different variables with safety inspection showing insignificant values. The results may be utilized by the safety and engineering professionals working in the construction sector to improve their safety and project performance significantly Moreover, it is a contribution to the advancement of safety performance and improvement in Pakistan.

***Keywords*:** project safety management, project success, project safety performance, safety policy

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Introduction

The construction sector is recognized as the most threatening industry due to its high injury and mortality rate. Studies conducted earlier have shown that it is one of the most unsafe industries. There is a higher rate of accidents in construction projects in spite of the provision of occupational health safety at construction site (Wu et al., 2016). Safety refers to the extent to which general conditions favor the project completion without serious accidents or casualties (Farooqui et al., 2007). It is vital for the successful completion of the construction projects (Bubshait & Almohawis, 1994; Chan et al., 2004). Safety management is the method that impacts the safety rules and procedures implemented on work site as well as its approach to deal with the projects of construction sector. It is a dynamic procedure that allows for little or big modifications made to various project tasks in order for people to work properly without experiencing unforeseen setbacks to a construction project (Cheng et al., 2015; Choudhry et al., 2008). Despite the fact that the implementation of safety measures on work sites increases the effectiveness of project safety due to which many safety problems are resolved. Still, it has also been observed that many construction projects do not follow safety measures on their sites. As previously stated, a dedication of managers to safety management increases motivation and enhances safety knowledge (Tappura, Nenonen, & Kivistö-Rahnasto, 2017). Human performance has major contribution to safety management; their handling of construction activities in a safe manner ensures the project's success. Even small mistakes can be the leading factors in accidents that occur in industrial sector, further ignorance to safety practices can be the main root cause of different safety problems in those places that are prone to high risk (Bottani et al., 2009).

The costs incurred due to these tragic accidents at construction sites are enormous that are borne by all the stakeholders involved within that project or outside of the project; families of the victims, employers, and government as well as society as a whole. For instance, in the United Kingdom, it is estimated that injuries as well as cases related to sickness of the workers due to construction projects cost the society more than £1.1 billion. This is a very huge amount in a year that results due to poor HSE on these sites. As per the reports on National Incidents Statics 2002 from the Department of Labor, the costs of non-fatalities and fatalities of construction-related injuries were projected to be $11.5 million (Waehrer et al., 2007). This elicits the need of Safety Management Practices (SMPs); a collection of

work-related practices that aid in the prevention and reduction of workplace accidents (Cheng et al., 2015). As per the Hong Kong government safety practices Code 2002 which was drafted by their labor department on Health and Safety, there are different safety practices for managing sites. These safety practices include inspection of safety at site, training of the workers, investigation of the accidents, supervision of committees on safety, and safety auditing. They examined the connection between six SMPs and safety behaviors and used the samples of workers from eight main manufacturing divisions in southern India in the accident risk process. It was concluded that one of the key SMPs was safety training that they considered important and that had impact over knowledge related to safety, motivation for safety workers, and willingness to participate in different safety tasks (Vinodkumar & Bhasi, 2010).

Construction is one of the rapidly expanding industry that plays a vital role in the economic development of the country (Farooq et al., 2018). The main driver in the continuation and expansion of this industry is the delivery of successful projects. Studies have shown that organizations have core focus directed towards project success. Construction activities include interaction among a many stakeholders, that makes this industry way more complex and poses many challenges that other industries simply don't (Demirkesen & Ozorhon, 2017). Three traditional success metrics for construction projects that are usually acknowledged by the industry are costs, schedule, and quality performance. Basically, there are mainly two different criteria for project success, one is internal criteria that is dependent on factors like cost, schedule, and scope and other is based on external factors like stakeholders' satisfaction and project outcome (Agarwal & Rathod, 2006). The construction industry also established the usage of a safety metric, led by the Institute of Construction Industry (CII) of Austin, TX, that correlates to the performance of the project. Industry professionals have acknowledged that safety performance is the major success criteria for some projects, irrespective of the results of the other performance indicators (Hughes et al., 2004). In order to assure the criticality of the safety management practices assessment, Sanders et al. (2007) provided a checklist and defined 10 subjective and objective success criteria by considering the following factors: timeframe and cost; quality and safety issues; client satisfaction and employee satisfaction; cash-flow management; profitability; environmental impact; learning and development (da Silva & Warnakulasooriya, 2017).

Furthermore, various studies have been conducted on managing safety, such as safety check lists, safety manuals, safety audit, safety records, and the performance of a project in the construction sector (Cheng et al., 2015; Cheng et al., 2012; Fang et al., 2020; Awwad et al., 2016). The results were in accordance with the assumption that SMPs have a beneficial impact on performance of the project. Nevertheless, this does not imply that there would be a major improvement in performance of the projects once SMPs have been applied. That is due to the fact that other factors may have an impact on performance of the project. SMPs can also impact other performance related factors mentioned above and lead to a more comprehensive conceptual framework. For instance, training the workers on safety and safe work practices are derived from the policy on safety, while standard safety organizations are responsible for accident analysis, safety promotion, and organizing the meeting on safety (Cheng et al., 2015). Currently, underway research is used to investigate the aforementioned relationships which would help to develop a comprehensive model for studies on managing safety properly. Based on findings of literature review and recommendations of the previous study, the current research focused on the SMPs impacts on project success with safety policy serving as a moderator between safety performance and SMPs and safety performance serving as a mediator between SMPs and project success. The importance of safety in ensuring project success cannot be underestimated (Cheng et al., 2015).

SMPs not only improve working circumstances, but also positively change the behavior of workers in following safety that leads to a sufficient decrease in accidents on workplaces (Vinodkumar & Bhasi, 2010). The study tried to fill the contextual gap by focusing on construction industry of Pakistan, where safety regulation is not commonly applied. In underdeveloped countries, such as Pakistan, the regulatory authority is typically weak in terms of properly enforcing the regulations and occupational risks are either not recognized at all or are thought to be less harmful than they really are. Although, the construction sector employs 6.29% of the overall labor force, injuries, and fatalities which affect 20 to 25% of Pakistan's total labor force. Institutional standards are deficient in the field of safety law and regulations development, administration and monitoring. On work sites, safety control systems are not applied. There is limited literature and data available on on injury and fatality rates in context of Pakistani construction projects that has negative impact on safety

consciousness (Choudhry et al., 2008). Informal reviews have revealed that poor safety performance has not only resulted in a greater accident rate but also in delays, cost overruns, and poor productivity. Health and safety terms are commonly included in contract agreements in the Pakistani construction sector; however, they are seldom strictly implemented due to worker carelessness and ignorance of their rights, resulting in poor safety outcomes. Furthermore, no trustworthy source of published data on construction-related injuries and fatalities exists upon which any regulation or action could be developed by the authorities (Ahmed & Saleem, 2007). The negative consequences of workplace accidents necessitate the repositioning of responsibilities that are assigned to management for implementing safety practices. Although, accidents that occur due to the dynamic environments are hard to prevent, the existing safety managing system can be regulated and improved to protect workers against workplace hazards that occur due to the negligence of workers by an implementation of effective safety managing system(Cheng et al., 2012).

Thus, the main objective of the current study is to investigate the impact of SMPs on project success, by studying the moderating role of safety policy in between SMPs and safety performance, and the mediating role of safety performance in between SMPs and project success. As per given objectives, following questions were formulated and answered:

1. What are the impacts of Safety Management Practices (SMPs) on project success?
2. How safety policy as a moderator impacts the relationship between SMPs and safety performance?
3. How safety performance as a mediator impacts the relationship between SMPs and project success?

The current research focused on the impact of various SMPs on safety performance and how they influence the success of construction projects by reducing the onsite incidents. It also established that safety policy plays a significant role for any organization to implement safety on their projects and in businesses. By understanding how SPMs influence safety participation and safety compliance and reduce accidents by increasing safety awareness and its relationship with project success.

Literature Review

Safety Training

Safety risks may result into fatalities and injuries for workers. In order to improve safety results, there are many methods and processes for occupational Health &Safety (H&S) training in the construction area including traditional methods and computer based technologies, for instance virtual reality, simulation (Gao et al., 2019). Construction work requires intensive labor due to nature of work. But due to lack of safety trainings, number of accidents on construction sites are significantly increasing, leading to an increase in injury rates which results in less productivity of labour and negative image of a company as well. In 2015, almost 15% of the accidents occurred only in construction sector in New Zealand, causing a huge loss to the economy of the country round about $108 million (Boyle & Maine, 2016).

For any construction project, H&S training is very essential for the workers. A proper training helps the workers to identify the hazards and how to react to those hazards in an appropriate way or to report them timely. There are different strategies that can be used for safety trainings such as lectures, handouts, tool box talks, and audio-video demonstration. Some studies showed that these traditional tools are not much effective and highlighted the role of proactivity and experience of construction workers that is possible with effective trainings (Gao et al., 2019).As traditional tools were less effective, therefore research was conducted to find new computer aided training programs that are more efficient and easily accessible.

The effective implementation of Computer aided training program is needed for the successful training of health and safety. However, it is important to gauge effectiveness of new technologies, such as computer simulation. It is a general phenomenon that when any tool is used without first determining its requirement and implication, it turns out to be a mere waste of time and resources. (Chi et al., 2013; Benitti, 2012). These tools can be used by an experienced workers with proper trainings. On the contrary, various training methods are given and designed as per the requirements, such as EDDIE, SMART, and A-B-C-D model. It was confirmed by latest studies (da Silva & Amaral, 2019) that various trainings have positive impact on performance. The findings of another study indicated that safety training plays a crucial role in enhancing safety

performance, with the mediation of safety knowledge and safety culture (Ofori et al., 2023).

Literature also depicted moderate relation between specialized SMPs and safety performance. A study conducted by Kaspers et al. (2017) revealed that accidents' investigations, subcontracted labor, safety awards, and safety trainings influenced the safety performance positively. Therefore, safety training is one of the most important SMPs that influences high safety performance across the organizations. The organizations provide safety trainings through structured training programs and ongoing development initiatives which are basic components used as key performance indicators. Studies have emphasized the importance of safety training in predicting safety performance results since it is a reliable method of forecasting accidents. Resultantly, it alters the workers' behavioral outcomes of safety. One argument for the importance of safety training is that diverse safety-related training programs shape cognitive skills and behaviors. Furthermore, enhancements in safety-related outputs in organizations are a result of thorough occupational health and safety programs for new hires, coaching and mentoring, and career development programs, orientation for new employees, and refinements in work health and safety systems that are planned through proper system (Barbaranelli et al., 2015).Furthermore, companies with active safety training programs have been reported with low accidents and injury rates. Based on the above literature review, following hypothesis were developed.

H1: Safety Management Practices (SMPs) have positive influence on project success.

H1a: Safety training has a positive influence on success of project.

Safety Meetings

Safety meetings enable organizations to review different perspectives on critical safety problems and safety participants must infer safety management techniques for making safety plans, controlling and executing safety. Periodic health and safety meetings are held to communicate safety information to project participants (Cheng et al., 2015).

Meetings are held on a regular basis during the construction process in order to meet the expectations predefined by the stakeholders. These sessions include all relevant participants and objectives of the meetings are already defined clearly. The significance of face-to-face interaction for the

successful project execution and its team cannot be underestimated. To work through any impending project challenges, a platform for all parties to communicate their project concerns or thoughts is required. “When communication occurs in between stakeholders, they want to change the intellectual context of the individuals they are speaking to”. The goal of project meetings is to anticipate future difficulties and find solutions before they have a negative influence on the project (Validi et al., 2018).

A study conducted by Gorse and Emmitt (2007) found that this practice was common in the construction sector since there is no time for emotional talks in the project. This study was conducted by using Bales Interaction Process Analysis model. This model categorized the communication process into three parts during the meetings. The first part is Positive Social Emotional Communication, second is Task Based Communication, and third is Negative Social Emotional Communication. The task based items in these sub categories are further used to develop information of the project updates, status, delivery, and future planning. Control of the project progresses, changes, safety issues is also defined in these meetings by using these communication tasks (Gorse & Emmitt, 2007). These meetings are followed by positive and negative emotions that guide participants throughout project and social duties. Some members are at ease with the group and meetings and some individuals may be restricted, coerced, or harassed. Overall, being a member of a group can be a worthwhile experience if all members positively contribute. Some participants, on the other hand, can create a hostile environment and a stressful group situation or one that breeds boredom. It can irritate and dissatisfy people, for instance some people are biased as a result of their prior experiences, unwilling to participate in or communicate with a group. There are several clear characteristics of group discussions that influence knowledge exchange inside the meetings (Gorse & Emmitt, 2009).

A study conducted by Ansari et al. (2022) focused on investigating the effects of project assessment, safety management trainings, and risk assessment on migrant labor. However, negative attributes can be overcome by comprehensive safety management trainings, meetings, and programs. Literature shows its positive impact on the safety awareness. Previous researches concluded that safety trainings enhance the adherence to safety protocols and promote active participation in daily meetings which helps to maintain a safe working environment. Safety meetings allow organizations

to review diverse perspectives on critical safety risks. Therefore, safety participants should develop consensus on safety management solutions for making plans, executing and controlling them. Throughout the meetings, safety participants are expected to discuss the progress of previous actions, review current safety progress and evaluations, check the recent reports of various unsafe activities, analyze accident reasons and prepared precautionary measures, and discuss the safety walks and various observations that concern with the project safety (Kaspers et al., 2017).

H1b: Safety meetings have positive influence on project success.

Safety Inspection

The safety inspection is an important element to ensure safety management. It depicts the seriousness of top management and involves the inquiry of the labors' unsafe behaviors and working situation, which is used in conjunction with other monitoring methods to reduce unsafety incidents. However, in terms of practicalities, such inspections can be undertaken directly by quality assurance manager for safety, or by an appointed member of the firm's insurance company, or an Occupational Safety and Health Administration inspector (OSHA auditor). Singapore has a governing body named MOM which is responsible for implementing and regulating all safety protocols and proper safety legislation. The main legislation that all the construction firms have to show compliance with, is the Factories Act and regulation 1994. As per this regulation, all the firms having contract value more than $10 million have to implement a safety management system based on Code of Practice 79 (CP79) on construction safety management system (Teo & Ling, 2006). This CP79 has 14 safety management techniques which are given below in Fig. 2.8. This includes occupational safety checks, domestic housekeeping to create a safe working environment, sufficient equipment for personal safety, safe working conditions, preservation of all tools and vehicles, safety check, appropriate monitoring procedure that can control the movement of dangerous items and substances as well as effectiveness for responding to any emergency (Teo & Ling, 2006). After safety training, safety inspection ensures project success. An increasing tendency has also been seen in the construction sector of assessing how many accidental events were identified in the duration of project completion (Feng, 2013). Prior to award project to construction organizations, government bodies also investigate that how many such incidents occurred in the previous projects. In a safety

management system, technical safety intervention entails inspecting unsafe areas, such as surroundings, tools, and equipment in order to ensure a safe start of working (Zaira & Hadikusumo, 2017).

Construction firms are now paying more attention towards the implementation of full time safety inspection. They have increased interval of regular inspection from monthly or fortnightly to weekly or daily base inspection of the hazards and its reporting. The purpose is to reduce number of accidents and avoid negative image in front of clients or regulatory bodies. Construction companies require a formal safety inspection system to oversee these issues; such as Safety practices should be outlined in the contract documents that need to be followed by the team and their minimum compliance level must also be defined. An independent safety inspector should also be hired to make regular safety inspections and report to clients regarding the safety conditions of the projects. If minimum level of safety is not being met by the contractor upon inspection, he should be penalized or removed from the contract list in the next bidding process. Furthermore, whichever process is adopted either penalizing or removing from contract, it should be clearly mentioned in the contract.

A current sanity checklist has been published by OSHA which is a part of their New Business Guidebook series and they are an excellent place to start. The process of addition or mark off parts or articles should be followed that do not pertain to the operations; however, after making up one's mind, each and every element should be thoroughly examined. Afterwards, OSHA regulations must be studied for precise and comprehensive rules that may apply to one's situation (OSHA, 2017). This leads to the hypothesis:

H1c: Safety inspection has positive influence on project success.

Safety Communication

Communication refers to the way through which individuals express their feelings, thoughts, and share information or knowledge. The term 'add safety' refers to a tool that safety persons utilize in order to manage safety issues and spread awareness among workers regarding safety hazards and accidents. This is not just a process by which safety information is shared, however, it is also used to influence the behavior as well as attitude of the employees towards following safety. Studies have shown that any organization and its commitment to provide safety to its workers depends on how well they communicate safety measures and how effectively that

information is disseminated to other team members. Effective communication changes the behavior of workers to follow safety, meanwhile miscommunication between employee and top management takes place due to neglecting constructive communication at project site as well as there may not be any safety culture in the organizations (Shuen & Wahab, 2016). A good communication between employees enhances the effectiveness of the communication. Lack of communication leads the workers to unavoidable accidents furthermore, it is believed that honest upward communication (that is flow of smooth communication from lower level to higher management) is the most crucial element in safety communication that helps in avoiding accidents and injuries. An effective communication between workers and managers has gained more importance by becoming the most influential safety intervention in any organization. Frequent discussions between employees and management regarding safety develops safety culture and increase helps commitment of staff towards following safety at work place and at project sites (Shuen, 2016).

The customer, the project team, the main sponsor, the supplier, and the end user all need to contribute to the project's success. Each partner is responsible for formulating and measuring success. They have distinct jobs and responsibilities that they must complete in order to be successful. Each entity involved in the project follow different preferences regarding the measurement of project success. It is critical to obtain an agreement on project objectives early in the project lifetime. Early strategic planning is crucial to the project's ultimate success. In order to achieve these aforementioned goals, each stakeholder needs to communicate and give his input so that it can be formally or informally be incorporated and requirement should also be provided by these stakeholders for forceful implementation of the project activities (Validi et al., 2018). Naji et al. (2022) investigated the mediating role of safety communication in the relationship between safety culture and employees' safety performance. It suggested that safety communication acts as a mediator between safety culture and employees' safety performance. Safety communication involves the exchange of information, ideas, and feedback related to safety within an organization. It serves as a mechanism for disseminating safety-related knowledge, promoting safety awareness, and influencing employees' safety behaviors. Various forms of communication are utilized to enhance the effectiveness of any inspirational exercises. The volume and effectiveness

of communication is increased during interactive communication, which may result in behavioral diversity. Communicating at regular intervals regarding workplace safety problems between management, team members, and workers is an efficient management practice for improving the workplace safety (Vinodkumar & Bhasi, 2010).

Evidence suggests that safety information provided through conferences and bulletins is considerably more direct and effective in firms that use a cooperative style of management as compared to others that use an authoritarian approach. Resultantly, construction partnering may be an appropriate project arrangement to facilitate the creation and administration at two different levels (higher and lower management) that serve as safety transmitting information hubs for project participants. This would improve project team communication and cooperation, which is required to strengthen the safety management practices of construction firms (Cheng et al., 2012).

However, literature shows disparity in findings on the relationship between safety management and safety performance, attributable to the various ways SMS processes are deployed and safety performance criteria are defined across organizations. The interconnectivity of various safety management systems and safety initiatives is of vital importance here. As continuous interaction and horizontal as well as vertical communication plays an important role in any organization for the success and endurance of safety performance. Moreover, lack of sharing information between various management members creates hindrance in the ability of organisations to align its safety initiatives and horizontal & vertical communication channels. To cater above mentioned problems, a new theoretical model called System Theoretic Accidental Model and Process (STAMP) has been introduced to work on system engineering. According to STAMP theory, undesired events occur not only as a result of individual component failures, however, also due to unrestrained interactions between network components, a lack of feedback mechanisms across hierarchy levels, and communication breakdowns among characters at the same organizational level. To create outstanding work practices, effective communication with co-workers should be encouraged. Employees should be provided with proper safety information and safety awareness should be raised. All personnel should be made aware of the risks associated with their jobs (Kaspers et al., 2017).

H1d: Safety communication has positive influence on project success.

Safety Performance

Managing construction tasks safely ensures the project's success. This is especially true if organizations want to enhance project performance by reducing on-site accidents. The project execution is measured by project performance, due to which managing safety becomes the essential element of project management (Cheng et al., 2012).

While, typical safety approaches leads to mishaps or information related to injuries on sites. Various attitudes associated with safety including compliance and safety participation are considered as components of safety performance. Employees' behavior that increases their personal safety and health is referred to as safety compliance. Safety participation refers to employees' behavior that promotes work safety and health while also supporting an organization's defined objectives and goals (Vinodkumar & Bhasi, 2010).

H2: Safety performance has a mediating role between the relationship of SMPs and project success.

H2a: Safety Performance mediates in between the relationship of safety training and project success.

H2b: Safety Performance mediates in between the relationship of safety meetings and project success.

H2c: Safety Performance mediates in between the relationship of safety inspection and project success.

H2d: Safety Performance mediates in between the relationship of safety communication and project success.

Safety Policy

Safety policies can aid in the promotion of cirumstances that are safe, regarded as the most important part of the socioeconomic element of successful construction. Safety policy and legislation has great impct upon the level of safety in constrcution projects (Teo & Ling, 2005). Policies on safety assist organisations in developing safety process and procedures, as well as in implementing safety programmes and training for workforce (Cheng et al., 2015).

Studies have documented organizational policies on safety, to train the workers in safety, to conduct meetings on safety, personal safety tools, inspecting safety, safety benefits and fines as significant components influencing safety performance (Alkilani et al., 2013).

H&S Policies are written declaration of norms and practices that reflect the dedication of the company to safety and health at work. It illustrates top leaderships dedication to keep working conditions safe as well as environmentally safe surroundings on construction sites (Dorji & Hadikusumo, 2006). The study states that management assistance for safety programs both in emerging and developed countries should be considered an economic need in order to avoid financial risks, because incidents have demonstrated that they are highly costly for the contractor. This adds to the ethical and technical obligation of the leadership to ensure that all employees have a safe and healthy workplace.

The inclusion of a written safety policy was the first SMP that was found to have a substantial impact on the safety. One of the five factors that influence employees' perceptions regarding safety was discovered to be organizational safety policy. Likewise, an insufficient safety policy is seen to increase the number of incidents A safe workplace conditions is recognized as one of the essential components of the social ‘foundation' of sustainable development, “the other three ‘guiding principles' being economic, biophysical, and technological”. Management is assisted by safety policy in developing safety rules and instructions (Teo & Ling, 2006).

The concept on Safety managing system has become popular in recent years but exact definition has not been developed yet. Some studies show that it is basically a set of written safety policies, procedures, rules and strategies on implementing safety. There was another definition that explains that SMS is a set of interrelated or interacting elements that are used to establish safety policy and safety objectives as well as procedures to achieve those objectives. Cheng and Lu (2015) studied 15 SMPs and their impact for increasing the performance of the construction. The result of the study showed that out of these 15 SMPs three practice that were most related to project performance, from this study the importance of written safety policy can show that it has significant importance and impact on project performance.

H3: Safety policy has a moderating role between the relationship of safety management practices and Safety Performance.

H3a: Safety Policy moderates the relationship of safety training and safety performance.

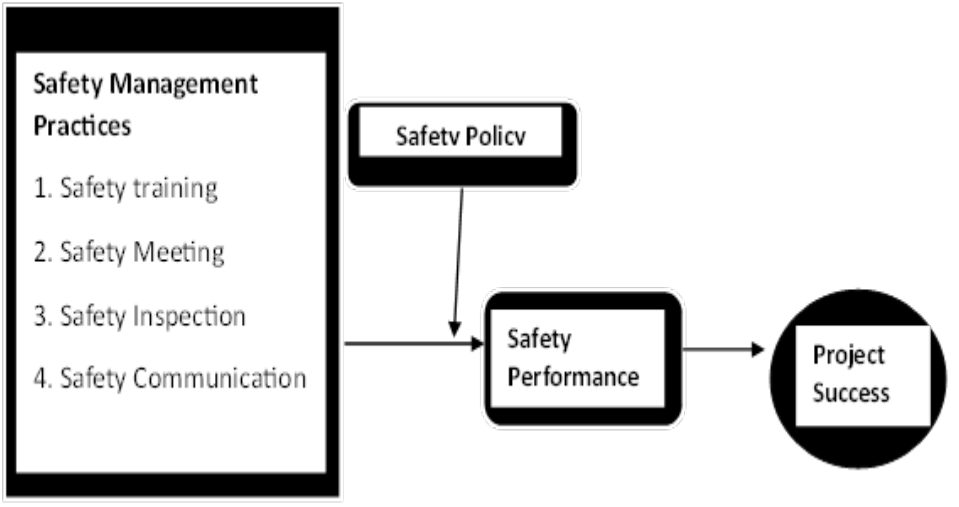
H3b: Safety Policy moderates the relationship of safety meetings and safety performance.

H3c: Safety Policy moderates the relationship of safety inspection and safety performance.

H3d: Safety policy moderates the relationship of safety communication and safety performance.

Figure 1

Conceptual Framework



Methodology

Data Collection Process

The exact population size for this study is unknown because there is no record of safety professionals in Punjab as well as number of engineering professionals working in each organization. For the purpose of sampling, the study follows Hair et al. (2011) who states that for any unknown population, the minimum number respondents must be 5 times the number of questions asked in the survey. There are total 41 items in the questionnaire (excluding the demographic part) so the total sample size for

research is calculated as (41 x 5) = 205 samples. After data screening, 231 responses were received that satisfied the required number of responses and unit of observation are engineering professional like project directors, project managers and safety professional, safety managers were the respondents of this study. Engineering and safety professionals from different companies as specified above were asked for collections of the required data to analyze the link between all the mentioned variables. A convenient sampling technique is used that is non probability technique for gathering the required data. A questionnaire was surveyed by using social media and emails for collection of data. The questionnaire is consisting two parts first part was about the demographics of the respondent and second was about the research topic. The anonymity of the respondents is also taken care by not asking any personal information. Data analysis is done by using Smart PLS structural equational modeling technique (SEM) for testing hypothesis, because this is the latest technique and has the ability to analyses more than one variable at same time including independent, dependent and mediating variables (Hair et al., 2016). Reliability and Validity analysis is used to further analyze the data consistency.

Questionnaire Development

Questions for Safety Training are adapted from Vinodkumar and Bhasi (2011). It consisted of 05 items. Its sample included "my company gives comprehensive training to its employees, this independent variable includes adequate training, high priority to safety training, emergency response training and encouragement to attend training. Its CA is 0.76 and CR is also 0.76. Scale that is adapted for Safety meeting variable is from study of Choudhry et al. (2008). It consisted of 5 items and sample includes "there is sufficient opportunity to discuss and deal with safety issues in meetings" it also includes factors management attending meetings, tool box meeting, progress, subcontractors' participation. Its CA is 0.79 and CR is 0.78. The research Instrument had two parts, first contained the demographic information and second part was a questionnaire. To measure the mediating variable safety performance scale is adapted was from the study of Vinodkumar and Bhasi (2010). It consisted of total 10 items. Sample included "I use all necessary safety equipment to do my job". Other factors are safety manners, correct safety rules, level of safety, practically follow safety, helping coworkers, point out safety issues, efforts, voluntarily and encouragement of safety. Its CA values is 0.83 and CR is 0.82. A scale that

was used to measure the moderating variable safety policy is adapted from the study of Cheng et al. (2012). It consisted of 5 items and sample included "My company has formally developed Health, Safety & Environmental policy". Other factors are policy priority, policy compliance, policy targets and policy identifying responsible management. Its CA value is 0.80 and CR is also 0.80. For dependent variables scale is adapted from the study of Tahir et al. (2019). It consisted of 6 items and sample included "Project clients / end users were satisfied with the project outputs". Other factors are schedule, costs, delays, injuries and fatalities. Its CA values is 0.82 and CR 0.84. Table 1 given below shows the detail of measurement instrument with CA and CR values also stated.

Table 1

Measurement Items

Variable	Type of variable	Source	Items	CA	CR
Project Success	Dependent Variable	(Tahir et al., 2019)	6	0.82	0.84
Safety Training	Independent Variable	(Vinodkumar & Bhasi, 2010)	5	0.76	0.76
Safety Meeting	Independent Variable	(Choudhry et al., 2008)	5	0.79	0.78
Safety Inspection	Independent Variable	(Fang et al., 2020)	5	0.75	0.77
Safety Communication	Independent Variable	(Fang et al., 2020)	5	0.76	0.76
Safety Performance	Mediating Variable	(Vinodkumar & Bhasi, 2010)	10	0.83	0.82
Safety Policy	Moderating Variable	(Cheng et al., 2012)	5	0.80	0.80

Results

Reliability and Validity Analysis

A common threshold for the value of Cronbach's Alpha value and Composite reliability is that its value should be above than 0.7 (Shanmugapriya & Subramanian, 2016), however a value in between 0.6 and 0.7 is also acceptable (Ab Hamid et al., 2017). Indicators reliability is referred to as the fraction of indicator variation that is explained by the latent variable, it is check by outer loadings of the indicators and the value of outer loading should be above than 0.7, if the removal of value in between 0.4 to

0.7 contributes or improves the value of CR and AVE it can be deleted, furthermore indicators values less than 0.4 should be deleted in any case (Ab Hamid et al., 2017). To check the validity of the three are two types, first is Convergent validity and second is Discriminant validity. Convergent validity shows that indictors represent the one same construct not another construct. Average Variance Extracted (AVE) is the criteria used to check the convergent validity its value ranges from 0 to 1 and it should be higher than 0.5 (Hair et al., 2011; Ab Hamid et al., 2017). Results details are shown in Table 2.

Table 2

Reliability and Convergent Validity

Construct	Indicators	Project Success	Cronbach Alpha	rho_A	Composite Reliability	Average Variance Extracted(AVE)
PS	PS_II	0.792	0.815	0.849	0.837	0.566
	PS_III	0.583				
	PS_IV	0.784				
	PS_V	0.826				
SC	SC_II	0.604	0.765	0.777	0.76	0.518
	SC_III	0.706				
	SC_IV	0.832				
SI	SI_I	0.535	0.752	0.805	0.775	0.543
	SI_II	0.838				
	SI_III	0.8				
SM	SM_II	0.701	0.786	0.788	0.787	0.552
	SM_III	0.752				
	SM_IV	0.774				
SP	SP_II	0.697	0.807	0.813	0.804	0.51
	SP_III	0.804				
	SP_IV	0.745				
	SP_V	0.593				
ST	ST_I	0.769	0.756	0.759	0.756	0.508
	ST_II	0.667				
	ST_III	0.699				
S_PER	S_PER_IX	0.705	0.831	0.834	0.827	0.547
	S_PER_VI	0.829				
	S_PER_VII	0.649				
	S_PER_VIII	0.764				

Note. PS= Project Success; SC= Safety Communications= Safety Meeting; SI=Safety Inspection; ST= Safety Training; SP= Safety Policy; S_PER= Safety Performance

Discriminant Validity

Heterotrait-Monotrait (HTMT) ratio of correlation close to 1 depict that there is lack of discriminant validity, its threshold value of 0.85, a value above than threshold also shows that there no lack of discriminant validity (Ab Hamid et al., 2017).

The analysis results given in Table 2 and 3 show that Cronbach's Alpha and CR values are above 0.7 with minimum value of 0.756, outer loading values are above than minimum value of 0.4, while AVE values are more than threshold value 0.5 and lastly HTMT values are also above than 0.85. results also shows that all the values are as per the threshold values, to bring the AVE value into the range, those items which had outer loading less than 0.4 were deleted. AVE shows that all the indicators of the construct are measuring that construct.

Collinearity Analysis

Collinearity is the linear relationship between two predictor variables. Collinearity in PLS is measured through VIF (Variance Inflation Factor), a VIF value More than 10 shows that there is multicollinearity problem in the variables (Shanmugapriya & Subramanian, 2016). Values close to 1 is good that indicates that there is no collinearity, while value ranging from 5 to 10 show that variable are highly correlated and this is not acceptable (Gareth et al., 2013). Meanwhile VIF values less than 5 are within the acceptable range.

Table 4 given below shows the VIF values for this model and these are all within the acceptable range.

Table 3

Discriminant Validity - Heterotrait-Monotrait Ratio Criterion

Construct	Project Success	Safety Communication	Safety Inspection	Safety Meeting	Safety Performance	Safety Policy	Safety Training
Project Success							
Safety Communication	0.45						
Safety Inspection	0.122	0.188					
Safety Meeting	0.385	0.849	0.331				
Safety Performance	0.504	0.623	0.194	0.582			
Safety Policy	0.476	0.522	0.142	0.521	0.665		
Safety Training	0.535	0.704	0.214	0.599	0.63	0.638	

Table 4

Collinearity Statistics

Outer VIF			Inner VIF	
Construct	VIF	Project Success	Project Success	Safety Performance
PS_II	3.556	Safety Communication		4.423
PS_III	1.087	Safety Inspection		1.165
PS_IV	2.965	Safety Meeting		3.846
PS_V	4.742	Safety Performance	1	
SC_II	1.711	Safety Policy		1.772
SC_III	1.605	Safety Training		2.508

Outer VIF			Inner VIF	
Construct	VIF	Project Success	Project Success	Safety Performance
SC_IV	1.436			
SI_I	1.199			
SI_II	2.333			
SI_III	1.311			
SM_II	1.541			
SM_III	1.671			
SM_IV	1.766			
SP_II	1.697			
SP_III	1.684			
SP_IV	1.632			
SP_V	1.716			
ST_I	1.56			
ST_II	1.611			
ST_III	1.432			
S_PER_IX	1.692			
S_PER_VI	1.62			
S_PER_VII	2.043			
S_PER_VIII	1.882			

Structural Model

After establishing the measurement model adequacy bootstrapping procedures has been applied for evaluating the structural model and hypothesis testing. Path coefficients are the measure of direct and indirect effect of set of independent latent variable on dependent latent variable, path coefficients also show the expected change in the value of endogenous construct due to unit change in the predictor construct. In Smart PLS consistent PLS Bootstrapping is used that creates a large number of subsamples like 5000 from the original sample with replacement (Henseler et al., 2009).

R^2 gives the predictive power of the model, it shows that how well exogenous latent variables explain or predict the endogenous latent variable. The value of R^2 should be between 0 to 1, Values of R^2 0.67, 0.33, and 0.19 are taken a substantial, moderate, and weak respectively, if there are several exogenous variables in the model then moderate values of R square are acceptable as endogenous variable relies on more than one variable (Shanmugapriya & Subramanian, 2016).

Values of R^2 for this study are shown in Table 5 below values 0.241 and 0.577 for project success and safety performance are considered as weak and moderate respectively.

Table 5

Model Summary

Latent variables	R^2	R^2 Adjusted
Project Success	0.241	0.238
Safety Performance	0.577	0.567

The values of path coefficients represent the direction and magnitude of the variables and relationship in between variables, the greater the path coefficient values show the stronger relationship in between Independent latent variable and dependent latent variable. To find out the significance of the relationship *p* values and *t* values were used. *p* values less than 0.5 and corresponding *t* value greater than 1.96 shows that all the hypothetical paths in model are significant and supported, values of *p* greater than 0.5 or *t* less than 1.96 means that there was no significant relationship in between Independent and depend Latent variables (Hair et al., 2011).

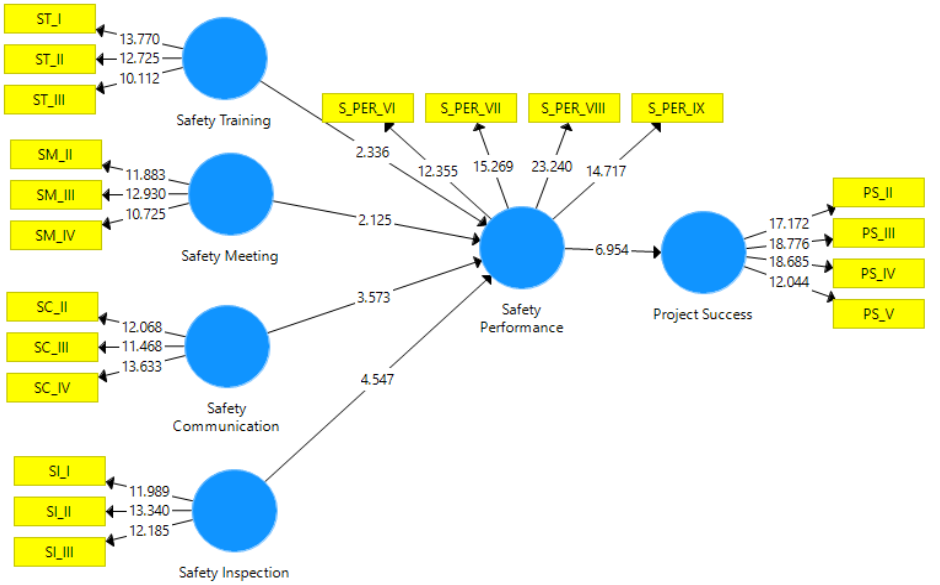
In this research there were 12 hypothesis, 4 hypothesis for direct relationship, 4 mediating relationship and 4 for moderating relationship, Consistent bootstrapping results are shown in below Table 6,7,8 and 9.

Mediation Analysis

Partial least squares- Structural equational modelling technique was used to check the mediation effect of safety performance in between SMPs and Project Success, this method was suggested by Rigdon et al. (2010). In Table 6, Table 7 and Table 8 are the results of bootstrapping for mediation relationship,

Figure 3

Mediational Model



Structural Model - Mediation

The results show that P values are less than 0.5 and T values are higher than 1.96 for all the given relationships this means that all relationships are significant.

Furthermore, the direct effects are significant as well as indirect effects are also significant which mean that mediating variable safety performance

partially mediates the relationship between all four Intendent latent variables, safety training, safety communication, safety meeting, safety inspection and dependent variable project success. Furthermore, hypothesis H1a, H1b, H1c, H1d, H2a, H2b, H2c & H2d significant and supported.

Table 6

Path Coefficient- Direct Effects

	Original Sample (O)	*t* Statistics (|O/STDEV|)	*p* Values	Inference
Safety Communication -> Safety Performance	0.154	3.573	0	Significant
Safety Inspection -> Safety Performance	0.512	4.547	0	Significant
Safety Meeting -> Safety Performance	0.159	2.125	0.034	Significant
Safety Training -> Safety Performance	0.172	2.336	0.02	Significant
Safety Performance -> Project Success	0.554	6.954	0	Significant

Table7

Total Indirect Effects - Mediation

	Original Sample (O)	*t* Statistics (|O/STDEV|)	*p* Values	Inference
Safety Communication -> Project Success	0.085	3.013	0.003	Significant
Safety Inspection -> Project Success	0.284	4.064	0	Significant
Safety Meeting -> Project Success	0.088	1.966	0.049	Significant
Safety Training -> Project Success	0.095	2.113	0.035	Significant

Table 8

Specific Indirect Coefficients - Mediation

	Original Sample (O)	*t* Statistics (|O/STDEV|)	*p* Values	Inference
Safety Inspection -> Safety Performance -> Project Success	0.284	4.064	0	Significant

	Original Sample (O)	*t* Statistics (|O/STDEV|)	*p* Values	Inference
Safety Meeting -> Safety Performance -> Project Success	0.088	1.966	0.049	Significant
Safety Communication -> Safety Performance -> Project Success	0.085	3.013	0.003	Significant
Safety Training -> Safety Performance -> Project Success	0.095	2.113	0.035	Significant

In the given above Table 6, Table 7 & Table 8 are the results of bootstrapping for mediation relationship, the results show that P values are less than 0.5 and T values are higher than 1.96 for all the given relationships this means that all relationships are significant. Furthermore, the direct effects are significant as well as indirect effects are also significant which mean that mediating variable safety performance partially mediates the relationship between all four Intendent latent variables, safety training, safety communication, safety meeting, safety inspection and dependent variable project success. Furthermore, hypothesis H1a, H1b, H1c, H1d, H2a, H2b, H2c & H2d significant and supported.

Moderation Analysis

Partial least squares- Structural equational modelling technique was used to check the mediation effect of safety performance in between SMPs and Project Success, this method was suggested by Rigdon et al. (2010). Table 9 given below show the result of bootstrapping for moderation in between four independent latent variables safety training, safety meeting, safety communication & safety Inspection, one dependent latent variable project success and one moderating variables safety performance.

In this moderation, responses of each independent variables for each item were multiplied with the dependent variable and the results of the path coefficients were calculated in software. Results show that safety policy was moderating the relationship in between 3 independent latent variables safety training, safety meeting and safety communication as the *p* vales for these were less than 0.5 and *t* values were higher than 1.96, from this three hypothesis, H3a, H3b and H3d were significant and supported, while fourth hypothesis H3c was non-significant and not supported as *p* value for this was more than 0.5 and *t* value less than 1.96 this means that safety policy

doesn't moderates the relation in between safety inspection and safety performance.

Figure 4

Structural Model - Moderation

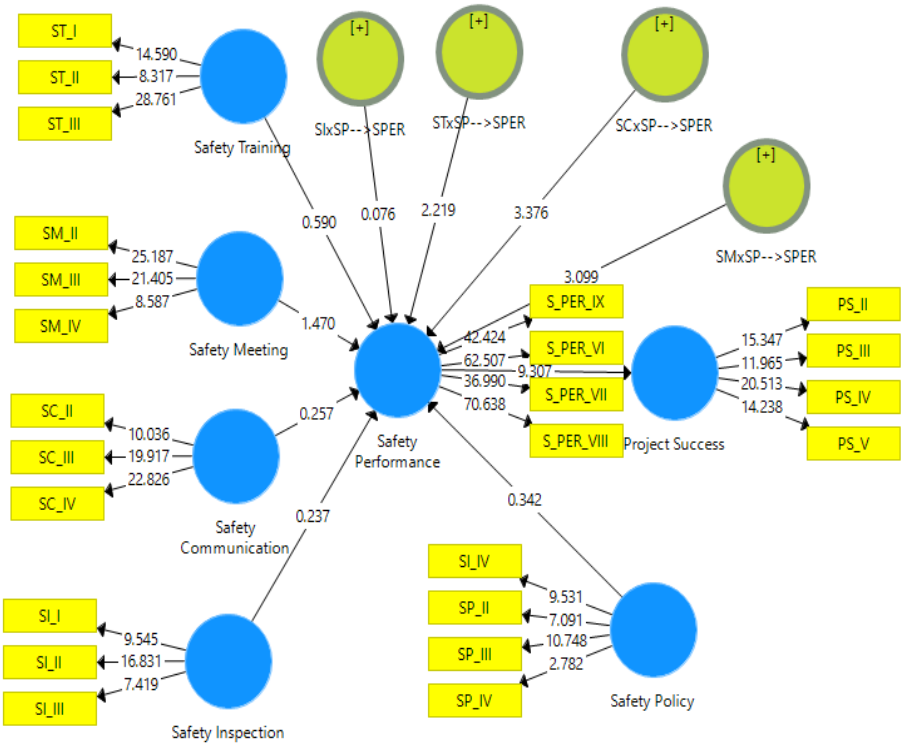


Table 9

Path Coefficinats – Moderation Analysis

	Original Sample (O)	*t* Statistics (|O/STDEV|)	*p* Values	Inference
SCxSP-->SPER -> Safety Performance	0.182	3.376	0.02	Significant
SIxSP-->SPER -> Safety Performance	0.015	0.076	0.942	Insignificant
SMxSP-->SPER -> Safety Performance	1.043	3.099	0.027	Significant
STxSP-->SPER -> Safety Performance	0.827	2.219	0.077	Significant

Discussion

The results from the analysis of outer measurement model and inner structural model support the reliability and validity of the construct. Consistent PLS algorithm and Bootstrapping was used to analyse the hypothesized model and 11 out of 12 hypotheses were significant and supported. Table 5 to Table 9 show the results for direct and indirect effects of the variables. All independent latent variables have significant and positive relationship with safety performance as well as project success. By checking all the path coefficients in structural model, it was found that safety performance has significant contribution towards achieving the project success with (β = 0.554), it was also found that improving the safety performance has positive and significant impact on the project success as its T value was also very high of 6.954 with *p* value of 0.

Results show that Safety performance can only be achieved through Safety compliance and Safety participation (Vinodkumar & Bhasi, 2010). Both are significant in achieving project targets like decrease in number of accidents and to avoid the fatalities at sites; to complete the project without any delays and within allocated budget. Results also show that SMPs like safety training, safety meeting, safety inspection and safety communication has positive and significant impact on the safety performance as well as project success. Indirect and direct effect given in Table 6 to Table 8 also depict that project success was not only influenced by safety performance, but it was significantly and positively influenced by SMPs. As depicted in Table 5 independent latent variables SMPs explain 57.7% mediating latent variable safety performance and safety performance explains 24.1% of the Project Success.

In moderation analysis with safety policy (H3a,H3b,H3d) are significant while H3c is non-significant and therefore it can be rejected while others can be accepted. It can be observed from the Table 8 that safety policy has positively and significantly moderated the relationship in between SMPs and project success. Safety meeting relationship with project success was highly moderated as it has (β = 1.043 & *t* =3.09).

Safety performance links the SMPs with project success and safety policy impacts the link in between SMPs and Safety performance. Those construction firms that want to achieve excellence in safety performance and achieve project targets effectively must pay attention towards SMPs and

align their processes with safety policies. The efficiency of the SMPs and project Performance can be increased by paying attention towards safety meeting, conducting regular meeting, providing training to the employees as well as workers, by conducting regular safety inspection, most of all safety communication should be done openly and reliantly, it can be seen from the moderation results that safety policy significantly impacts the relation in between project success and safety training, safety meeting & safety communication (β= 0.827, 1.043, & 0.182, **)** respectively and T values higher than 1.96.

Furthermore, PLS analysis for mediation shows that safety performance mediates the relationship in between project success and SPMs significantly and positively, as the values given in Table 8show that safety inspection (β=0.284, *t* =4.06), safety meeting (β= 0.08, *t* = 1.96), safety communication (β = 0.085, *t* =3.013) & safety training (β=0.095, *t* =2.13). Studies also show that SMPs has significant impact on safety performance (Cheng et al., 2015).

From these results it can be seen that safety performance (safety compliance and safety participation) can be increased by conducting safety meeting, training the employees, and communicating timely safety issues. Although safety inspection has significant impact on the project success and safety performance but it was not that much effective. Safety performance can be increased through these SMPs and that contributes towards project success significantly by reducing number of injuries and accidents.

Theoretical implications

This research created model in PLS of SMPs, safety performance and Project success, and provided an insight towards implanting four safety managing practice and improving safety performance as well as increasing project success. In construction sector project safety plays a vital role and has a significant impact on the outcome of the project, through this study it was shown that how much safety can contribute towards project success, further more problems related to safety can be resolve through implementing these SMPs. This research contributed theoretically to results of present researches in Asian context.

Practical Implications

In this study project success criteria based on safety is measured that has strong practical implication. It is shown that Safety Management Practices

has 57.7% effect on safety performance and safety performance has 24.1% contribution towards project success. These findings will help safety professionals as well as engineering professionals in implementation of SMPs to enhance the overall outcome of the project. It will also direct practitioners to engage proactively in SMPs at project sites to prevent injuries and fatalities. The result of these studies can help the organizations to reduce their financial, time and personal losses that are caused due to poor safety management at sites. This study shows important factors like SMPs, safety meetings, training of the worker, properly and timely communication of safety related issues as well regular inspection of the project sites have significant positive impact on the safety performance. It not only increases safety compliance and but also ensures more commitment of employees leading to project success significantly. Thus, by implementing these SMPs, organizations can achieve their project goals, satisfy stakeholders and meet the requirement of the project in a better and effective way.

Limitations

There were some limitations in the study as it was conducted in C1 category construction firm only in Punjab, SMPs can be applied to any other project in other province of Pakistan. Furthermore, responses were collected from private sector firms of construction working in industrial and building sector because of Covid-19 pandemic, accessibility to other sections of the industry like road and dams sites was not possible. Online data was collected through google form that was very difficult because respondents either didn't show the serious behaviour towards providing the data.

Conclusion

This research investigated Safety Management Practices and its significant impact on safety performance and project success using structural equational modeling. The results show positive and significant impact of SMPs on the project success, and its proper implementation decrease the fatalities or injury rate to improve the safety compliance. Safety compliance and Safety participation are two important components of Safety Performance and project success can be achieved by following them. These results of this study further indicate the importance of upward communication and trainings. The study will help the construction firm to develop the necessary understanding of SMPs and implement these

practices in order to improve their safety performance by reducing the number of accidents. Safety professional and engineering professional from any sector of the industry should understand the importance of SMPs and develop framework to utilize these SMPs for achieving their required targets timely and effectively.

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