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Identifying factors and mitigation measures of safety practices for sustainable building construction

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Abstract: Sustainability is a balanced approach that puts equal focus on the environment, economy and society. Research suggests that safety issues is an integral dimension of social sustainability and considered as the major concern in the construction industry. Despite the rapid advancement of technology, implementation and establishment of safety programs, it is revealed that the rate of the fatalities and injuries in this industry is extremely high. However, in this sector achieving a safe working environment is an ongoing challenge. Therefore, this study aims at identifying and assessing the potential factors of safety practices in sustainable construction. A review of the current state-of-the-practices in the area of construction safety would be indispensable for establishing the critical factors and mitigation measures to share innovative research findings and gain access to future research trends. From the literature analysis thirty-seven (37) factors and twenty (20) mitigation measures were identified and presented a database of the findings of construction safety. The findings of this study can serve as motivation for researchers and practitioners to work on the next generation of studies and the development of future effective measures, thus ensuring a safe construction environment.

1. Introduction

To balance the exponential growth in the world population, construction industries have displayed extensive development in the last few years. A need for additional shelters, infrastructures, workspaces and facility has been continued to extend the construction markets which have become a significant sector of every single economy. The global Architecture, Engineering and Construction (AEC) markets are forecasted to grow at a rate of 5.50% from 2016 to 2021 and predicted to be worth of US\$12.7 trillion in 2022 [1]. However, construction works have been connected with large number of works associated fatalities and injuries which regarded as one of the most unsafe industries at present [2]. The situation is not any better in USA, China, Australia and Middle Eastern countries where incidents related to construction work has exceeded in quantity those generating from other industries (agriculture, ship breaking and fish) [3]. Construction sector engages almost 7% of the world's work force but is accountable for 30–40% of total death occurrences [4]. This huge injury rate may be attributed to the characteristic of construction works which greatly depends on the usage of heavy machineries and necessitate work under an unfavourable condition [5].



As risks associated with construction are high and employer-hazard relations are unavoidable, safety systems should be developed to avoid accidents and injuries. Unlike developed nations which have invested substantial efforts to devise advanced safety standards targeting at zero injury policy, instead construction safety in developing countries is still at infancy [6]. Table 1 demonstrates the status of construction safety in some countries and can be suggested that construction safety is one of the persistent global problems. It is thought that construction industries are far from the vision of “zero accident/injuries”. Poor safety performances in those countries can be attributed to uncooperative client, improper law enforcement and insufficient work procedure [7].

Sustainability concept has gained noteworthy attention over the last few years within construction industries. Sustainability in building construction is often assessed by the level of the “Leadership in Energy and Environmental Designs (LEED)” accreditation given to buildings. The LEED rating systems are certification program established by the United States Green Building Council (USGBC) to encourage sustainable goals in built environment [8]. This LEED certification process has become an internationally recognized benchmark for the design, construction and operation of high performance sustainable buildings. The growth of the LEED market has increased because of the long-term value of sustainable buildings that creates from a reduction in maintenance cost and improved quality of life for tenants. Though this rapid growth is exciting, the all stakeholders in the construction industry must evaluate the potential impacts of sustainable building components on construction cost, quality, schedule and safety in order to optimize project success.

As sustainable developments are expected to produce social, ecological and financial benefit; lifecycle safety is found to be an essential feature of social sustainability [9]. However, only limited studies have explored the impacts of sustainable constructions on worker health and safety. A recent study by Hinze *et al.* [10] investigate the LEED rating systems put minimal attention on social sustainability, particularly worker safety and health compared with economic and environmental considerations. Rajendran *et al.* [11] observed that LEED-certified project incurs greater injury rate (48%) than conventional construction project. Unfortunately, the safety risk associated with precise LEED design components have yet to be acknowledged and documented. Assumed the probable increase in adoption of LEED standards, such knowledge shall be important to protect the welfare and health of construction workforce.

Table 1. The status of construction safety practices in some developed nations

Countries	Description
United States	A total of 774 workers died in 2010 in the construction industry, accounting for 16.5% of all industries. The fatality rate 9.8% ranked the fourth highest among all industries [52]
United Kingdom	The fatal injury rate over four times of all industries and the largest number of worker fatalities [53]
China	The number of fatalities was 2538 in the construction industry in 2007 [13]
Singapore	There were 24 fatalities in the construction sector in 2006, accounting for 39% of all industries fatalities [54]
Australia	A total of 30 fatalities were recorded in 2012, which was the fourth highest fatality rate of all the industries [55]
Korea	The construction industry occupied the highest percentage of fatalities among all industries [46]

Many papers with various subjects on construction safety topic have been published, many of the past reviews were concentrated on particular aspect of construction safety, rather than systematic and comprehensive. For instance, Hu *et al.* [12] reviewed the risk factors of falls on construction projects. In another study, Pinto *et al.* [2] emphasized traditional management procedures associated with occupational safety and health related areas. An investigation on relationships between digital design practice and construction safety is observed by Zhou *et al.* [13]. Moreover, Zhou *et al.* [14] conducted a research in the field of innovative technology application for construction safety management.

In contrast to some past reviews, contributions of this study mostly in systematic review on current and past research topics on sustainable construction safety. The objectives set for this study is to identify factors toward a safe work environment in sustainable building construction and formulating potential mitigation measures to improve the safety practices. This research supports thorough examination and suggests potential chances for practitioners and researchers to fill up the gaps between practice and research in construction safety field. It is strongly believed that such systematic review will encourage further studies in the field of sustainable construction safety.

2. Literature review

2.1 Sustainable construction

The construction industry aims to satisfy the requirement for shelter, infrastructure and working environments without negotiating the abilities of future generation to meet their particular requirements at appropriate time. Sustainable construction helps to improve the qualities of living by sticking to sustainable standard for attaining sustainable building. A widely quoted definition says sustainable construction has been categorized as the making of healthy and resource-efficient building planned from the ecological principles [15]. The “UK Government’s Strategy and European Policy” for sustainable construction addresses CO₂ reduction, along with the climate change resilience, biodiversity, water, materials and waste management [16]. The strategy for sustainable construction considers accurate design as identical with sustainability [17]. Furthermore, it is gradually becoming a main focus for building practitioners with the aim of growing economic efficiency, restoring and protecting ecological systems as well as improving human well-being [18].

2.2 Sustainable building defined

Sustainable development in building construction and design are then defined as an active process to improve and defend “the healthiness of the environment or associated health and welfare of building’s residents, construction employer, the public or future generation” using effective methods and resources [19]. According to Berardi [11], sustainable building is one type of building that preserve and maximise serviceability and functionality. It is planned to improve aesthetic quality and whole-lifecycle cost. When any building is planned to achieve the purpose for its use with least environmental impact, it shall contribute to achieving sustainable building [21]. Kibert [22] defines sustainable buildings provide a healthy or good atmosphere for habitants, based on the consideration for resource efficiency and ecological environment. Balaban and Oliveira [23] mention to sustainable building as the combination of sustainability principle in building design, construction as well as management to progressively and gradually decrease environmental footprints of building industry. They conclude that the perception of sustainable buildings is a new method to offering solution to the health and environmental problems.

According to Ding [24] another term “green buildings” is often used and aim at reducing environmental impacts and maximising resources too. Though, there are some argue that the green building is dissimilar from sustainable building. Green buildings stand on the environmental pillar of sustainability or economic pillar while sustainability rest strongly on all these three pillars (environmental, social and economic) of the triple bottom line [20, 25].

From various definitions as described above, sustainable building is defined as a building designed or built with the wellbeing and health of inhabitants and using materials in construction that are environmentally amiable. It is like a building designed by characteristics that aid reducing negative impacts on the environment and higher effective usage of natural resources for example water, energy and building material during building’s lifecycle and encourage culture and heritage. Such explanation offers a very detailed and simple description of sustainable buildings.

2.3 Safety risk in sustainable construction

Construction workforce health and safety plays a main role in attaining sustainable socio-economic development of the employers in the industry. The sustainable health and safety concepts, which consider economic and social welfare of the construction employers, is a novel method to boost the

health and safety performances of construction labors. Many construction labor's life had been reduced by repetitive physical hazard posed by exposure to lead, asbestos, silica and other environmental and chemical hazards. The sustainable health and safety concept aid to sustain construction worker's health and safety.

Design feature and construction practice linked with the adoption of LEED rating system generate numerous benefits to construction stakeholders, such as reducing operating cost and enhancing the health and well-being of building occupants [8]. However, several studies have reported a negative potential impact of sustainable construction features on worker health and safety. Rajendran *et al.* [11] found statistically suggestive evidence that sustainable buildings encounter higher recordable incident rates than traditional counterparts. Further research involved formal analysis of safety risk associated with the implementation of LEED requirements and found that sustainable design elements and construction strategies tend to expose construction workers to unfamiliar tasks and hazardous work environments due to the incorporation of new materials, technologies and innovative strategies [26-28]. Such materials, technologies and strategies may add another layer of complexity to construction processes as workers are unfamiliar with required methods and procedures. This condition may increase safety risk and hazard exposure to field personnel during construction and maintenance operations when compared with traditional building design alternatives.

In a recent study, researchers performed an analysis of the impact of LEED rating systems credit on occupational health and safety (OHS) across the U.S. construction industry. The study findings indicated that LEED requirements are associated with increases in base-level safety risk across the construction industry [29]. Specifically, sustainable strategies used to reduce urban heat effects and recycling methods implemented to manage construction waste on construction jobsites were classified as having unacceptable safety risks to field personnel. Recycling building materials were found to present potential safety hazards to construction workers as this task involves diverting waste and demolition debris from disposal in landfills. In this regard, recyclable materials were found to expose workers to health problems and safety issues due to the presence of sharp and heavy objects among disposed materials or harmful substances associated with construction waste diversion [27, 30]. Accordingly, determining effective safety measures that are capable of proactively eliminating hazards seems to be of paramount significance to create truly sustainable development in the built environment.

3. Methodology

Even though literature analysis generally plays significant contribution of a study at most of the cases, it may also be one type of stand-alone job. Literature review studies are not simply a statement on references. A recent research trend shows an increasing use of systematic review in current literature. This review is more logical and consistent technical procedure to assess a research field, therefore, demonstrating the transparency and objectivity of procedure to reader [31]. This research adopts the methodical review as a procedural approach to explore the existing construction safety related literature to discover useful findings.

The identification of the factors of safety practices started with a thorough examination from peer-reviewed papers that publish on construction health and safety. A research by Zhou *et al.* [32] projected the top ten journals who regularly report construction related engineering issues and safety management. The peer-reviewed journal as acknowledged by Zhou *et al.* [32] includes: Journal of Safety Research (JSR), Safety Science (SS), International Journal of Construction Management (IJCM), Accident Analysis and Prevention (AAP), Journal of Construction Engineering and Managements (JCEM), Reliability Engineering and Systems Safety (RESS), Journal of Management in Engineering (JME), Engineering Construction and Architectural Management (ECAM), Construction Management and Economics (CME) and International Journal of Project Management (IJPM). Such peer-review journals were carefully chosen to guide literature review for this study.

Electronic data search via keywords (sustainable construction, sustainable building, safety, accident) was conducted on these journals. The full search scheme "Title/Abstract/Keyword" of peer-reviewed manuscripts within those journal archives that could possibly provide the understanding of topics like read, selected and identified. Additional, relevant names from bibliographic/ references found in those

peer-reviewed manuscripts that could contribute to understanding of topic were also chosen. In addition, electronic books relating to sustainable construction, sustainable building, safety management and construction management were searched from Directory of Open Access Book (DOAB) and Google Books. Manuscripts from conference proceeding that have main titles or themes as sustainable construction and sustainable building together with health and safety were also considered. Boolean connector for example AND NOT, AND, OR were also utilised to relate the research keyword to make search string for example “sustainable construction AND safety” and “sustainable building AND safety”. The purpose was based on the idea like if any manuscript bears powerful links to sustainable construction and sustainable building of existing built assets then its safety features will be taken in that book or paper or report.

4. Factors affecting construction safety practices

The construction industries are one of the dangerous industries which have resulted in highest quantity of occupational fatalities and injuries in the last years [33]. Though construction works share same high-risk all over the world. Durdyev *et al.* [34] exposed that fatality rate in developing countries are found three times higher than first world countries. A research by Karakhan and Gambatese [29] stated that developing countries face the most cases of fatalities and accidents.

Many studies have been conducted at assessing present safety practices as well as investigating the reason behind poor safety performances. The main reasons for high fatality or injury rates informed in maximum literature are extensive subcontracting, nonappearance of safety trainings, deficiency of awareness, inadequacy of safety regulation and legislation and uncooperative top managements. Because subcontractors have deficiency of safety commitments due to resource limitation, extensive subcontracting may be a main cause for poor safety performances [35]. Furthermore, the lack of satisfactory safety trainings for workers and top management are also posed as a main cause for poor safety climates in China, Pakistan and Saudi Arabia. Other factors are deficiency of awareness, lack of private protective equipment, safety officers and first aid [36-37]. Inadequacy of policies and regulations is stated as the major reason for poor safety environments [38]. In a different study by Chaturvedi *et al.* [39] attributed some bad safety records of India on improper enforcement of laws and regulations and corruption that are originated by bureaucratic control where fatalities are not filed or if in case filed, they are negotiated by cash payment.

Previous studies were conducted to examine the reasons of the discrepancy in accident rate between developing and developed countries, for example South Africa versus Singapore and China versus Australia [40-41]. Both studies findings reveal that key factors have lack of management commitments, absence of supervision and differences in training or competence level at construction worksite. In another study, Durdyev *et al.* [34] investigated the difference in safety performances due to weak regulatory system in some developing countries.

Al Haadir and Panuwatwanich [42] indicated the critical success factors influencing safety program implementation in Saudi Arabia, including management support, clear and reasonable objectives, personal attitudes, teamwork, effective enforcement, safety training and suitable supervision. The results of an empirical data analysis revealed that behavioural and cultural elements are influencing in the construction safety practices [43]. Based on the review of related literature, several studies from various perspectives have reported some factors of construction safety practices. However, the identification of factors causing poor safety practices in sustainable construction is of strategic importance for the construction stakeholders. Table 2 presents an extensive list of factors affecting construction safety practices amongst others as recognized in previous articles on this subject. The factors of safety practices are represented by “F”.

Table 2. Factors impacting construction safety practices

Factors	References in Literature
F1 Absence of adequate safety training	[36], [40-41], [56-58]
F2 Absence of safety officers on site	[11], [34], [45]
F3 Excessive overtime work	[35], [57], [59-60], [63]
F4 Extensive subcontracting	[26], [29], [45]
F5 Hazardous materials	[41], [61]
F6 Improper handling of materials	[60-61]
F7 Inadequate fire and electrical prevention procedures	[26], [29], [34], [41]
F8 Ineffective laws and lack of enforcement	[10], [35], [38], [47], [57], [63]
F9 Insufficient promotion of safety awareness	[2], [35], [59-60], [62-63]
F10 Lack of certified skilled labour	[34], [36]
F11 Lack of emergency plan and procedures	[11], [35-36], [57], [63]
F12 Lack of frequent worksite inspection or investigation	[5], [10], [35], [60], [62-63]
F13 Lack of management commitment to safety budget allocation	[35], [40], [47], [57], [63]
F14 Lack of management commitment to safety programs	[2], [5], [63]
F15 Lack of monitoring the compliance of safety measures	[35-36], [62]
F16 Lack of protection in material storage	[60-61]
F17 Lack of protection in material transportation	[60-61]
F18 Lack of safe construction site environment	[57], [63]
F19 Lack of safety warning sign	[64]
F20 Lack of strict operational procedures	[26], [40-41]
F21 Lack of technical guidance	[62]
F22 Lack of worker compensation insurance	[5], [34]
F23 Lack of workers' self-protection and awareness	[37-38], [41]
F24 Low level of formal education	[2],[5],[10], [35-36], [59-60], [62-63]
F25 Poor accident record keeping and reporting system	[10], [36]
F26 Poor precautions on working from height	[5]
F27 Poor safety awareness among top management	[5], [34], [39], [62]
F28 Poor safety awareness of project managers	[5], [34], [39], [62]
F29 Poor selection and control of subcontractors	[5], [10], [57]
F30 Poor weather conditions	[34], [62]
F31 Presence of unprotected or unsecured scaffolding	[26], [34], [62]
F32 Reluctance to input resources for safety	[34], [41], [57], [60]
F33 Uncooperative clients and inadequate work procedures	[40]
F34 Use of unidentified faulty equipment	[2], [35], [57], [60], [63]
F35 Using inappropriate personal protective equipment	[35]
F36 Workers' physical fatigue	[36], [60], [63]
F37 Working with reckless scheduling	[2], [57], [59-60]

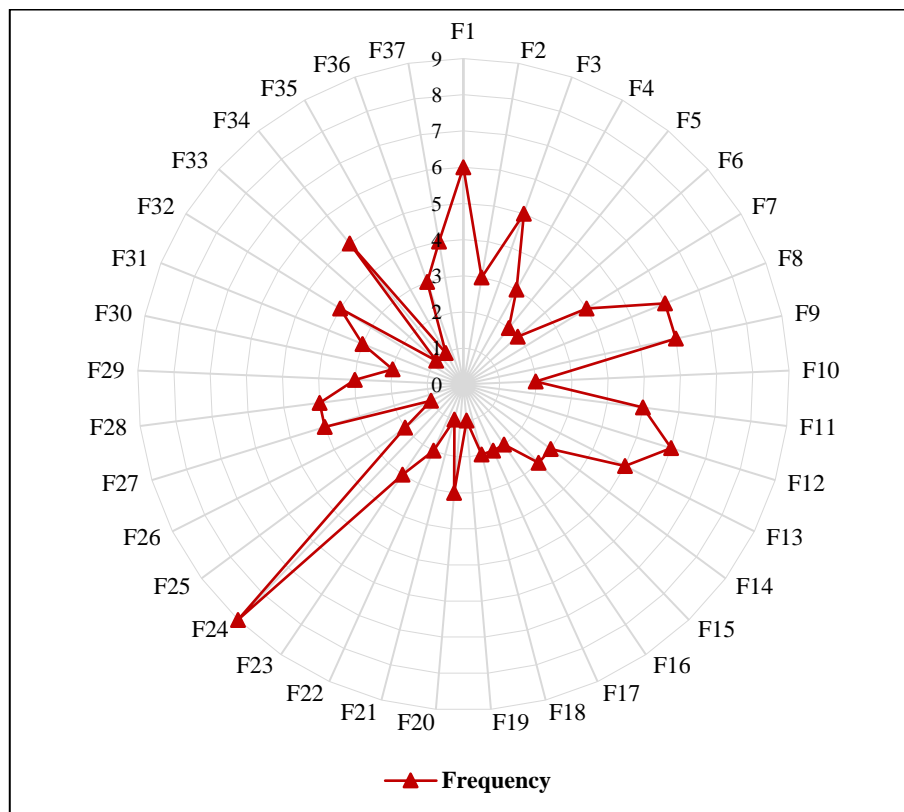


Figure 1. Frequency of factors in literature

From Table 2, factor F24 (low level of formal education) was spotted nine times and four (4) similar factors (F1, F8, F9 and F12) were also spotted six times from different studies. A strong correlation between educational preparation and accident frequency rate was well established that more experienced and highly educated workers tend to have better safety performance [2,10,35,59]. Regarding formal education (F24), Han *et al.* [59] and Feng [63] show same opinion that lack of education and training are affecting worker safety awareness; conversely adequate knowledge and skills prevent accidents. Figure 1 illustrates the distribution of factors within construction safety practice. The factors were very scattered in the construction safety research domain

Lack of law enforcement (F8), safety awareness (F9) and frequent worksite inspection (F12) were also highlighted in different studies [38,57,63]. Inadequate supervision of construction operatives could lead to accidents on site [47]. Thus, safety programs are also an effective way to determine potential safety factors thereby protect workers from workplace hazards.

5. Construction safety risk mitigation measures

A thorough literature exploration was performed to recognize any research which has examined the safety risk of sustainable building on construction worker's health and safety. The search uncovered very few studies reviewing the negative influences of sustainable construction and design on the health and safety of construction labors. Its effect on construction safety is still incomplete and unpublished. However, the addition of health and safety in sustainability concept is familiar with occupational health and safety community. Occupational health and safety issues are a section of social dimensions in sustainability agenda [44].

The American Society of Civil Engineers (ASCE) issued updated Policy Statements in 2001 which state that safety must be addressed for every project in a project particular basis. Several researchers stated that selection of subcontractor and specifications of safety requirement at contract documents were found two important strategies to improve safety performance [5,11]. Karakhan and Gambatese [29] also highlighted the importance of integrated safety concept during the planning and design phase,

involvement of top management in safety program and posting adequate safety signage in construction site. Several research have been done on identifying the best practice to progress safety practice, for example Hinze *et al.* [10] studied the important strategies including top management commitment, zero tolerance policy, safety training or workshop, subcontractor's prequalification on safety and regular meeting of safety performance. Different strategies such as informal site safety inspection, drug and alcohol testing, engage experienced project manager and budget allocation for safety reward and recognition were recommended for achieving excellence in construction safety performance [38, 45-47].

Throughout the systematic exploration and analysis of the gained literature, some mitigation measures were initially marked and tabulated. By successive careful study of these, multiple happening (repeating) mitigation measures were left out resulting in an eventual comprehensive list comprising twenty (20) mitigation measures. A detailed result from the review are presented in Table 3. Construction safety researches done in the last few decades have assisted to advance the safety performances of employers. Providing injury free atmospheres and supporting the effort in construction industries will need the efforts of the team in any project. This study findings will be uniting the health and safety initiatives of all the main parties in any project. The mitigation measures for effective safety practices are represented by "M".

Table 3. Identified mitigation measures to reduce safety risk

Mitigation Measures	References in Literature
M1 Arranging brief and regular updates on safety precaution	[5], [60], [62-63]
M2 Ensuring engagement of qualified safety supervisor	[11], [34], [45]
M3 Ensuring labour safety insurance	[5], [34]
M4 Ensuring safety procedures are followed by all workers	[26], [40-41]
M5 Ensuring the supply of appropriate tools	[38], [41]
M6 Ensuring the use of personal protective equipment	[35], [38], [41]
M7 Implementation of safety concept during design process	[10]
M8 Including prior safety performance as a criterion for selecting subcontractor	[5], [11]
M9 Including safety budget in project cost	[35], [57], [63]
M10 Increase safety awareness of firm's upper management	[5], [34], [39], [62]
M11 Increase workers' self-protection and awareness	[37-38], [41]
M12 Involvement of top management in safety program	[5], [34], [39], [62]
M13 Maintaining regular safety meeting onsite	[5], [34], [39], [62]
M14 Provide incentives for contractors to adopt safety	[10]
M15 Providing accurate and detailed safety information	[10], [36]
M16 Providing well-understood warning and safety signs	[64]
M17 Regular safety inspection by project manager or safety officer	[5], [60], [62-63]
M18 Rigorous enforcement of safety regulations or code of practice	[10], [57], [63-64]
M19 Safety requirement as a part of contract with subcontractor	[5], [11]
M20 Specific safety training or workshop for workers	[56-58]

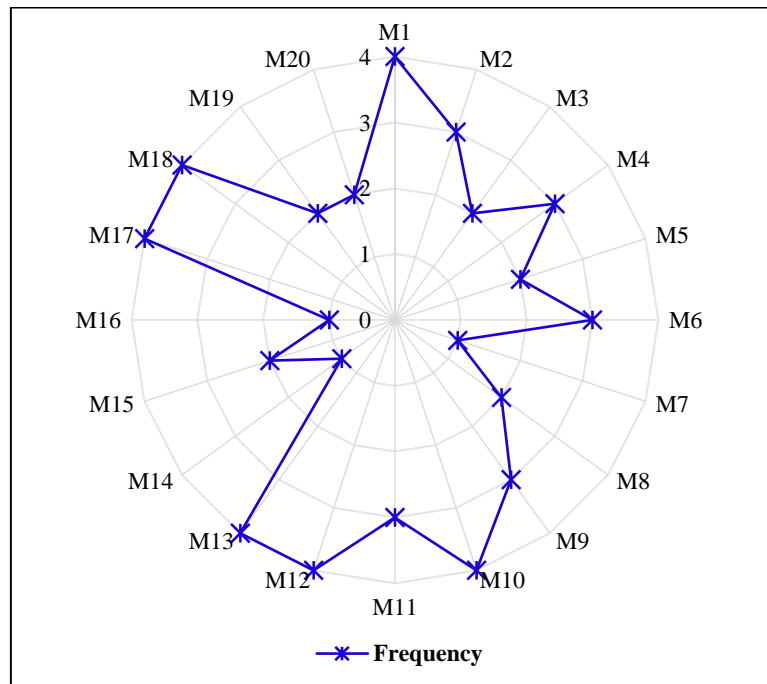


Figure 2. Frequency of mitigation measures in literature

Table 3 indicates that M1 (arranging brief and regular updates on safety precaution), M10 (increase safety awareness of firm's upper management), M12 (involvement of top management in safety program), M13 (maintaining regular safety meeting onsite), M17 (regular safety inspection by project manager or safety officer) and M18 (rigorous enforcement of safety regulations or code of practice) were spotted in four studies. The most effective safety program measures are upper management support and commitment, regular safety inspection and regular safety meeting [5,57,64]. Hinze *et al.* [10] share the view that increase safety awareness and rigorous enforcement of safety regulations are needed to prevent or minimise fatalities or accident on construction projects. Wu *et al.* [62] reinforced this view by mentioning that management support can ensure enough resources for safety management and proper actions are conducted to improve safety performance. With reference to Figure 2, the distribution of mitigation measures for safety practices became increasingly diversified in the safety research field.

6. Implications for further research

Considering the significance of effective safety practice, it is thus important to systematically consolidate and extract from existing literature the different bits of reported factors and mitigations. Through a thorough review, a comprehensive list of thirty-seven (37) factors together with twenty (20) mitigation measures has been developed. These findings give a strong preliminary foundation for more empirical study to the development of unified and coherent guidance for a safe implementation in Bangladesh and Malaysia.

Bangladesh has become the fastest growing economy in the world and construction industry represents average gross domestic product (GDP) of 9 percent with the value of 12 billion USD [48]. However, construction safety now became a main anxiety due to immense losses caused by workplace injuries. From preliminary data 190 fatalities were recorded in 2013, which was the second highest number of fatalities of all industries. This corresponds to a fatality rate of 7.35 fatalities per 100,000 workers, which accounts for 16 percent of fatalities for all industries. In addition, for the last six years, the construction industry accounted an average 135 deaths per year in the country [49]. The government of Peoples Republic of Bangladesh prohibited the use of unsafe and illegal operations during construction which were the driving factors of such high deaths. A same kind of situation existed in Malaysian construction industries with an average annual incidence of 9.2 fatal job-related injuries per 100,000 workers [50], which is little bit higher than Bangladesh. Department of Occupational Safety

and Health (DOSH) exposed that almost 1,116 work-related injuries happened in the period from 2011 to 2016 and that 37.85% to 51.50% of injuries resulting in temporary/permanent disability and death happened in construction sites [51].

Therefore, further research works are expected to be addressed to compare or investigate the perceptions of main safety risk features in Bangladesh and Malaysian construction industry. A statistical analysis will be carried out using a software package named Statistical Package for Social Sciences (SPSS). Comparison of mean values of perception of safety practice on construction sites in these two countries would be conducted to check whether there was difference in the perception. The mean value of different factors from the questionnaire to be calculated to attain the rank of factors on construction sites so that the common type factors could be compared between Bangladesh and Malaysia. Finally, the relationships between factors of safety risk and the potential mitigation measures will be identified using correlation tests. This in-depth comparison may reinforce future improvements and learning from each other in safety risk management for both nations.

7. Conclusion and recommendation

Sustainable developments are some comprehensive task directing majorly at the attainment of intergenerational equity on three major aspects like social, ecological and economic. Social sustainability in construction course is a life-enhancing procedure to achieve social equalities amongst all construction stakeholders in terms of economic welfare, health, education and human rights. For any project to be considered sustainable, these three pillars of sustainability should be equally achieved, where worker safety and health is an integral dimension of social sustainability.

This manuscript aims to identify the factors affecting safety performances on sustainable building projects along with mitigation measures. There found numerous literature reviews on sustainable building safety in the past, but majority of those studies have focused on specific aspect of construction safety and adopted either quantitative or qualitative to identify factors and strategies. Such limitations made it complex to simplify the obtained data in other countries and region.

Therefore, a systematic approach was conducted in this manuscript to classify factors affecting safety practices on sustainable building projects. This manuscript reviewed and analysed peer-reviewed journal to get all the factors affecting safety performances of a construction project. Methodology, result, discussion and finding from peer-reviewed manuscripts were investigated carefully to achieve the objectives. After performing analytical procedure of the articles, thirty-seven (37) factors of safety risk and twenty (20) mitigation measures were identified. The extraction from literature analysis shows that most common factors are low level of formal education (F24), absence of adequate safety training (F1), ineffective laws and lack of enforcement (F8), insufficient promotion of safety awareness (F9) and lack of frequent worksite inspection or investigation (F12). Regarding the mitigation measures, the mostly discussed measures are arrangements of brief and regular updates on safety precaution(M1), increase safety awareness of firm's upper management (M10), involvement of top management in safety program(M12), maintaining regular safety meeting onsite(M13), regular safety inspection by project manager or safety officer (M17) and rigorous enforcement of safety regulations or code of practice(M18)

Though the findings of this manuscript are based on the literature reviews and rational with previous research, there remains some limitations imposed upon the findings of our research due to structural and circumstantial conditions encompassing this research. Several numbers of publications were published on construction safety, however, very few papers have published on sustainable construction safety in Bangladesh and Malaysia. In near future, a study may be carried out to bring a comparison of the perceptions of safety risk factor in Bangladesh and Malaysian construction industries using statistical tools. In addition, interrelationships will be measured between factors and mitigation strategies to reduce safety risk in sustainable construction projects.

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