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Fostering a Total Construction Safety Culture to Enhance Safety Performance in Indonesia's New Capital City Establishment

Catra Rahma Pashya[1], Rossy Armyn Machfudiyanto[1*], Akhmad Suraji[2]

[1] Department of Civil and Environmental Engineering, Faculty of Engineering, Universitas Indonesia, Pondok Cina, Depok 16424, Indonesia
[2] Department of Civil Engineering, University of Andalas, Limau Manis, Padang 251263, Indonesia

Corresponding Author Email: rossyarmyn@gmail.com

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ABSTRACT

Establishment of Indonesia New Capital City (Ibu Kota Nusantara) is an initiative by the Government to promote equal economic and infrastructure development throughout the country. Consequently, the report made from safety awareness reveals several unsafe conditions during the construction project, possibly arising from various factors. In general, safety culture of construction industry mirrors the evolution of 'safety culture theory'. The theory emphasizes developing beliefs and taking practical steps to reduce accidents, specifically in the construction sector. Therefore, this research aimed to validate and review the factors influencing total construction safety culture, in order to improve safety performance. Furthermore, these factors were validated using Delphi method and the results showed that 36 factors contributed to the development of total construction safety culture. This outcome helped in improving safety performance in the establishment of Indonesia New Capital City. Specifically, the 36 factors included those related to workers, management, and project complexity that could influence the development of total construction safety culture. This outcome held significant implications for improving safety performance in the establishment of Indonesia New Capital City and could be applicable in similar contexts, which can used by construction company management to create a strategy to minimize an accident.

1. INTRODUCTION

The Indonesian Government has strategically planned and established a New Capital City which is called Ibu Kota Nusantara (IKN) to promote economic and infrastructure development equality throughout the country [1]. Located in East Kalimantan, the establishment of IKN reflects the concern of the government regarding the massive population in Jakarta and its potential long-term adverse effects [1]. Law number 63 of 2022 provides comprehensive details on the organization of this New Capital City, outlining its development stages, goals, and designated development zones.

The building process for this facility uses a lot of resources and emphasizes safety awareness, since the construction industry often faces accidents [2, 3]. According to data from the Indonesian Department of Employment spanning 2017 to 2021, approximately 234,270 work accidents have occurred. In the UK, the construction industry ranks second among other industries in terms of accident frequency (2019-2022) [4], and this is attributed to various factors, including human error, poor design, communication issues, and deficient safety culture [2, 5-10].

The causation of a poor safety culture is also influenced by factors such as inadequate leadership, insufficient work resources, low awareness and behavior, and ineffective company management [10-15]. On a micro level, construction accidents lead to increased costs, delayed schedules, and decreased project productivity [3]. Meanwhile, at the meso and macro levels, the impacts include loss of client trust and satisfaction, reduced profits, penalties from authorities, worker depression, and a decline in the national global competitiveness index [16-18].

The safety report for the coordinator ministry building construction in IKN shows 30 unsafe conditions in September 2023. Out of these values, 26.67% obtained a risk-containing audit score of around 0.2 (dangerous), 26.67% had a score of 0.5 (medium risk), and 53.33% have not been identified yet. Secondary data was obtained from one of the companies included in constructing the building and examples of these unsafe conditions include the lack of safety signs, safety barriers, and obstructions to mobility access. These safety defects pose significant risks and the potential for fatal accidents [19]. The percentage of construction accident risks in building construction is further divided into 13.3% low risk, 37.7% medium risk, 44.4% high risk, and 4.6% extreme risk [20].

Total safety culture theory is a safety-oriented method applicable to all industries, showing the responsibility for occupational safety among all personnel, including workers and all management levels [21]. Furthermore, this theory

rotates around three main factors namely Person, Environment, and Behavior [21]. Although the theory is already implemented in various industries, there is a lack of a sense of safety management to promote occupational safety. As a result, leadership principles have been introduced in total safety culture to maximize the role of the leader in the organization for promoting occupational safety [22].

Total Construction Safety Culture is an evolution of the broader total safety culture, specifically tailored to the construction sector, with a particular focus on the construction phase. This development aims to improve safety throughout the entire project life cycle, emphasizing the application of safety measures during all phases, including conceptual design, detailed engineering design, procurement, construction, and start-up [23]. Every stakeholder included in the construction phase bears the responsibility, authority, and duty to ensure construction safety [24]. The main contractor, as the organization overseeing the construction phase, plays three crucial roles in establishing total construction safety culture [25]. Furthermore, the contractor is directly included in the planning phase to allocate resources and consider technical design. In the control phase, the contractor monitors and enforces safety through the use of personal safety equipment. However, during the operational phase, the contractor focuses on creating a comfortable and safe working environment.

The development of total construction safety culture is aimed at improving project performance, which is assessed through safety performance, including the occurrence of catastrophes. The achievement of safety performance in construction can be measured using leading and lagging indicators [26]. Leading indicators are predictive and preventive, including risk measurement, planning, routine inspection, and audit [27-30]. On the other hand, lagging indicators are historical and based on recordable data on construction safety and accidents, such as accident reporting and accident frequency rate [9, 27-30].

1.1 Gap and related research of total safety culture

Some research showed a relationship between total safety management and total safety culture, where accidents are preventable [31]. The total safety culture method has also been adopted in the aviation sector and traffic management. In aviation, there was a positive impact, shifting the focus from blaming each other in the workplace to caring for each other based on the behavioral factors of total safety culture [32]. In traffic management, total safety culture implies creating consistency in occupational safety and influencing individuals to stick to safety rules [33].

Accident frequently happened at some case in China work environment, and the company should bear the impact of the accident. The company CEO changed the culture along with the system using total safety culture concept. The CEO said that safety should be balanced with a regulation which cover penalty to whom violate the rules [31].

Unfortunately, implication of total safety culture was rarely found in construction industry. This can be happened because construction accidents are often considered disgraceful [8]. Disparity between inadequate safety implementation and safety documents for administration became a phenomenon and obstacle to implement total safety culture, especially in construction [8]. So, how to achieve and develop a total safety culture, by finding the factors related in construction sector, to improve safety performance, especially in Indonesia New Capital City Establishment?

1.2 Research purpose and objective

This research aims to show the factors that help in creating a total construction safety culture. It also aims to understand the implications of these factors for improving safety performance, specifically in this establishment or similar settings. Indonesian safety regulations for construction are also referenced to support the local ecosystem of construction safety in Indonesia. Consequently, the research focuses on the perspective of the contractor as the organization responsible for executing and constructing the project.

2. METHOD

2.1 Research strategy

The research approach included different methods similar to experiments, surveys, document analysis, literature review, historical analysis, and case study discussions [34]. The research functioned as a systematic way to collect and analyze the gathered data [35]. In this research, a review of previous research was used to compile factors that could have impacted the total safety culture in construction.

Table 1. Research strategy

Research Question	Type of Question	Research Strategy
What are the factors that can affect total construction safety culture development in the New Capital City of Indonesia establishment?	What	Literature review, Delphi method

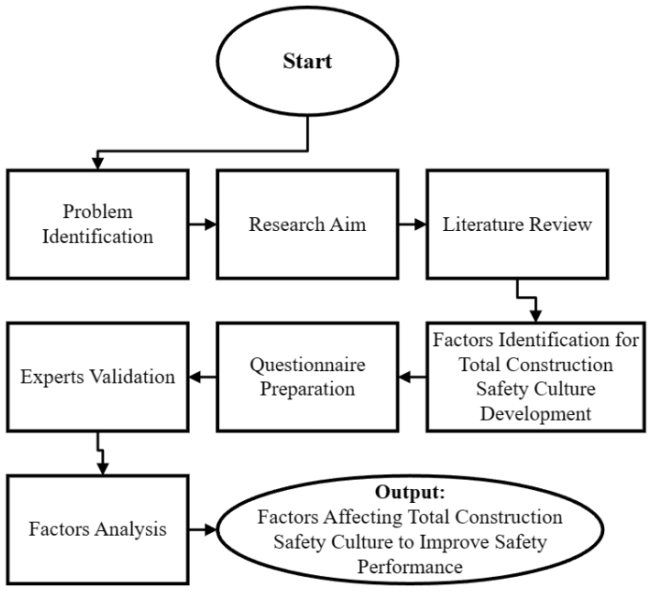

Figure 1. Research design

Overall, Table 1 and Figure 1 explained about the strategy to answer the research question by using Delphi method and for all factors which obtained from literature review process. Then, experts filled up the questionnaire to assess which factors are match for total construction safety culture

development. Experts also requested to give a suggestion to correct the factors if it is required.

2.2 Delphi method

Delphi is a method used to reach consensus on particular objectives and requirements [36]. In this process, experts with relevant knowledge and experience in the research topic were consulted [37]. The Delphi method was organized as a stage of group communication to reach a consensus on specific issues [8].

2.3 Experts criteria

To be considered experts, at least three individuals were required, each having a minimum of 15 years of experience in the field of construction safety and holding a bachelor's degree [38].

3. RESULTS AND DISCUSSION

3.1 Propose of total construction safety culture factors

After conducting a literature review of previous analyses, the factors that might have affected total construction safety culture were compiled and submitted.

3.1.1 Leadership (X.1)

Effective leadership played a crucial role in shaping a comprehensive safety culture in construction and acted as a bridge in the hierarchical structure among project personnel [15]. Positive motivation stemming from a skilled leader could yield beneficial results. This inspired the team to comply with technical and safety regulations, including work methods, design specifications, and the promotion of safety awareness [8]. Great leadership boost psychological effect towards project team, since leader motivate them to belief that accident can be prevented by following the safety rules [39].

3.1.2 Competency (X.2)

Competency included both the skills of the workers and the management. The contractor team was required to show strong competency in line with the relevant company or national standards [23]. A team with extensive experience coupled with skills, including subcontractors and workers, ensured that processes and outcomes met quality standards as well as reduced occupational risks [9, 14, 40, 41].

3.1.3 Commitment (X.3)

All stakeholders in the organization had to show commitment to the project to underscore its sustainability [14]. Effective communication and coordination between contractor team members and workers showed their dedication to completing the job or resolving issues in the working field [6, 14, 41]. Additionally, obedience by all project personnel to operational procedures reflected their commitment to completing the work [42]. These factor covers attitude and behavior of project personnel, where they can follow safety regulations made by government and project company, also influence other personnel to create a safe work environment [21].

3.1.4 Regulation (X.4)

There were two main types of regulations namely national regulations and company regulations. National regulations provided the foundational rules for ensuring project safety, including specific laws and ministerial regulations such as Law Number 2 of 2017 (Construction Services), Public Work and Public Housing Ministerial Regulation Number 10 of 2021 (Construction Safety Management System Guidelines), and Public Work and Public Housing Ministerial Regulation number 1 of 2022 (Budget Estimation of Construction Work Preparation Guidelines) [43-45], alongside national regulations was important to incorporate company-specific regulations. As the executor, the contractor was required to present these regulations as proof to the project client or inspector consultant, showing a commitment to occupational responsibility [5].

3.1.5 Project scope (X.5)

The complexity of the design was one of the project scopes, a more complicated design could have introduced occupational risks based on its complexity [40, 42, 46-48]. The working environment could have influenced the sustainability and safety of the performance of the project, minimizing risks by ensuring smooth mobilization and reducing disruptions outside the project [42]. Larger projects were also considered as a scope, as they brought additional responsibilities for controlling and monitoring the project [41].

3.1.6 Resources (X.6)

Consideration for resource allocation prioritized suitability to ensure a comfortable environment for project personnel [12]. Proactively minimizing accidents was possible by ensuring that resources were sufficient in order to meet the specified requirements [41]. Budget planning for safety resources, including personnel equipment costs, was based on the number of personnel included [23].

3.1.7 Supervision (X.7)

Supervision throughout the entire project minimized accidents [48], but the absence of supervision led to an unsafe and insecure working environment [49]. Conducting supervision, such as auditing, enabled contractors to identify defects, thereby improving technical safety [6, 50].

3.1.8 Training (X.8)

The role of training was crucial, which could contribute to the improvement of the construction safety system [50]. Examples of training programs that could be conducted by the contractor organization included coaching and safety induction [2, 5, 6, 50, 51]. In the advanced stages, the organization could conduct certifications for team personnel to promote competence and skill development among team members [6, 51].

3.2 Explanation of the factors

This section provided an explanation and detailed information about the factors that shaped total construction safety culture.

Table 2. Factors explanation

Factor	Indicators	Description
Leadership (X.1)	Motivation (X1.1)	Project manager and contractor team motivated all of the personnel and described about safety vision to prevent an accident [15, 39]
	Role Model (X1.2)	Project manager became a good role to be emulated by all of the personnel in construction safety implementation [15, 39]
	Responsibility (X1.3)	Project manager had a responsibility to spread and implement construction safety on the working field [2, 15, 23, 40]
	Concern (X1.4)	Project manager was concerned and cared about safety implementation for all of the project personnel [15]
Competency (X.2)	Knowledge (X2.1)	All of the project personnel had knowledge and awareness of construction safety importance [5, 11, 21, 39]
	Skills (X2.2)	All of the project personnel had good skills and could be applied in the working field to prevent accidents [11, 21, 39]
	Sub-Contractor Selection (X2.3)	Sub-Contractor who was selected to participate in this project had specialization on a specific work based on the main contractor's instruction [9, 14, 23, 40, 42]
	Experience (X2.4)	Contractor team had the experience to do this project and implemented the construction safety [9, 21]
Commitment (X.3)	Organization Commitment (X3.1)	Contractor organization committed to finishing the project by following all of the procedures including safety procedures [14, 21, 23, 42]
	Workers Involvement (X3.2)	Workers got included in finishing the project by following all of the procedures and regulations [6, 21]
	Communication (X3.3)	All of the project personnel communicated and coordinated to ensure construction safety and clear any problems on the working field [6, 14, 21, 41]
Regulation (X.4)	Government Regulation (X4.1)	All government rules about construction safety were followed by the contractor organization to prevent an accident such as Law number 2 of 2017 and Public Work and Public Housing Ministerial Regulation number 10 of 2021 [9, 40, 47]
	Organization Regulation (X4.2)	All of the organization rules about construction safety were followed by all of the project personnel such as safety plan and job safety analysis [2, 6, 40, 41, 47, 49, 50]
Project Scope (X.5)	Design (X5.1)	Design complexity was considered by the contractor teams in construction safety implementation [40, 42, 46, 48]
	Work Environment (X5.2)	Project environment supported construction safety implementation without any obstruction and disruption outside the project [21, 42]
	Project Size (X5.3)	Project scale influenced construction safety implementation, control, and monitoring [40]
Resources (X.6)	Materials (X6.1)	Availability of materials was appropriate with specifications and requirements [2, 40, 52]
	Manpower (X.6.2)	Manpower quantity was suitable with the plan requirement to prevent work overload [39, 40]
	Machine and Tools (X6.3)	Availability of heavy machines and tools was based on specification and requirements [21, 40, 52]
	Safety Budget (X6.4)	Appropriate safety budget covered all of the construction safety based on the project plan scheme [2, 23, 39, 42]
Supervision (X.7)	Audits (X7.1)	Auditing the work method and work results were based on engineering design to prevent catastrophe [6, 23, 50]
	Inspection (X7.2)	Inspected and supervised all ongoing works, including all the safety aspects of the project such as personnel safety equipment [6, 41, 48-50]
	Report (X7.3)	Person in charge of the contractor team reported any kind of accident (fatality or near miss) to their leader and team [42, 50]
	Record (X7.4)	Person in charge of the contractor team recorded any incident to be lessons learned for the project personnel [2, 41, 42, 50]
Training (X.8)	Coaching (X8.1)	Project manager and team held a safety coaching clinic program for all personnel [5, 6, 21, 23, 51]
	Safety Induction (X8.2)	Person in charge (safety officer) did safety induction to all project personnel routinely [2, 23, 50, 51]
	Certification (X8.3)	Contactor organization gave a certification program to increase competency and skills to all project personnel [6, 23, 46, 51]
Leading (Y.1)	Organization Activity (Y1.1)	Contractor organization activity held frequently to prevent an accident as weekly project review [30, 32, 33]
	Hazard Identification (Y1.2)	Created hazard and risk identification which could potentially happen on the project to prevent accidents [30, 32, 33, 44]
	Safety Planning (Y1.3)	Created safety plan or other similar context as a leap to prevent an accident [30, 32, 33, 44]
Lagging (Y.2)	Accident Reporting (Y2.1)	Reported any accident (near miss, fatality, etc.) as evidence and lesson learned [31-33, 44]
	Accident Calculation (Y2.2)	Calculated any kind of accident to see how often accidents might happen (accident frequency rate) [31-33, 44]
	Accident Ranking (Y2.3)	Gave rank for all the accidents to have historical data and lessons learned [31-33, 43]

Table 3. Experts personal description

Categories	Expert 1	Expert 2	Expert 3
Name	IZ	AS	HV
Gender	Male	Male	Male
Age	63	72	61
Occupational Position	Member of Safety Committee in Public Work and Public Housing Ministry of Indonesia	Academics	Head of IKN Acceleration Development Program
Work Experience	> 15 Years	> 15 Years	> 15 Years
Last Education	Master	Doctor	Doctor

Table 4. Experts recommendations

Factor	Indicators	Description
Competency (X.2)	Skills (X2.2)	All of the project personnel had good skills and specifically placed on their specialization to be more efficient and minimize any accident or rework [11, 21, 40]
	Sub-Contractor Selection (X2.3)	Sub-Contractor who was selected to participate in this project had a specialization on a specific work based on the main contractor's instruction and supervision to maintain the work quality [9, 14, 23, 40, 41]
	Experience (X2.4)	Contractor team had the experience to do this project and implemented the construction safety and contractor competency could be seen by the project that they already handled [9, 40]
Commitment (X.3)	Communication (X3.3)	All of the project personnel communicated and coordinated equally without any hierarchical context to implement construction safety and to clear any problem on the working field for achieving the project goals [6, 14, 21, 40]
Resources (X.6)	Materials (X6.1)	Availability of materials was appropriate with specifications and requirements, also the contractor had to check the materials after purchasing through the specification documents [2, 39, 52]
Training (X.8)	Coaching (X8.1)	Project manager and team held a safety coaching clinic program for all personnel routinely for all phases until the project finished [5, 6, 21, 23, 51]

Table 2 contained all of the factors which obtained from literature review process. There are 10 factors with various indicators that occur the explanation and description for each factor. After that, these factors are validated by the experts. Based on the expert criteria, all of the experts are appropriate to validate the factors, and Table 3 displayed the recap of the expert description. Then, there are few suggestions and recommendations form the experts to add some description and explanation for several factors to be more comprehensive, and it can be seen in Table 4.

3.3 Expert judgement

Three experts were assigned to validate all the factors, and they were deemed suitable based on the criteria. Most of these experts were practitioners with experience in the construction safety sector.

Following the experts' validation of all factors, recommendations were given to make the descriptions of these factors more specific.

Experts agreed that all factors were suitable for developing a total construction safety culture to improve safety performance in the establishment of the New Capital City of Indonesia. They also suggested that this approach could be applied to similar contexts. Table 4 provided a few recommendations from the experts to make Competency (X.2), Commitment (X.3), Resources (X.6), and Training (X.8) more specific. The majority of these recommendations included adding more detailed descriptions of the factors.

4. CONCLUSIONS

In conclusion, this research showed the initial steps toward developing a more specific total safety culture in the construction industry. Furthermore, the case study focused on the development of New Capital City in Indonesia, named Ibu Kota Nusantara (IKN), which was selected due to its expansive construction scope and substantial resource needs. Despite no reported accidents in this establishment, secondary data showed conditions that might have caused safety risks.

The research question focused on understanding how the concept of a total construction safety culture enhanced safety performance. Various influencing factors were identified through a literature review of previous explorations. Experts validated these factors using Delphi method with predefined criteria in a qualitative approach. These factors consisted of leadership, competency, commitment, regulation, project scope, resources, supervision, and training. Furthermore, they contributed to improving safety performance through both leading and lagging indicators. Effective leadership directed all personnel to be more secure and efficient in achieving project goals. Competency among team members and workers was essential to meet organizational requirements.

Commitment was crucial for everyone participating in the project to work safely and diligently, in line with government and company regulations. The complexity of the project scope influenced the vulnerability of the working field. However, with adequately assigned resources, the project became more manageable. Finally, supervision and training programs were conducted to enhance project security, promote personnel awareness, and foster a positive work culture. The primary aim of this development was to improve project performance, particularly safety performance.

In future research, it would be essential to develop a total construction safety culture strategy to improve safety performance. Company management can create a strategy based on these factors such as, scheduled training for increasing workers involvement towards safety, documenting evidence of workers violations for raising workers involvement or behavior, and using technology to facilitate project personnel to control and monitors safety around project area. Additionally, determining the implications of implementing safety culture should be carried out after the

measure has been put into practice.

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