Advance Researches in Civil Engineering
ISSN: 2645-7229, Vol.2, No.3, pages: 24-40

Identification of Safety Risk in Construction Project: A Systematic Literature Review

Indriani Eka Widiastuti [1], Humiras Hardi Purba [2], Aleksander Purba [3]*

[1] Civil Engineering Department, Mercu Buana University, Jakarta, Indonesia.*

(indrianieka.05@gmail.com)

[2] Industrial Engineering Department, Mercu Buana University, Jakarta, Indonesia.

[3] Civil Engineering Department, University of Lampung, Lampung, Indonesia.

(Date of received: 12/07/2020, Date of accepted: 25/08/2020)

ABSTRACT

In the world, accidents that occur in construction projects are ta fairly high part. Several factors cause this accident. One of those is a lack of information about occupational health and safety risk. In the construction project, it is necessary to know about safety risks to minimize the number of accidents, besides that, it is necessary to know the parties responsible for safety risk if there's an accident in the working area. The paper of this literature review is to present risks that cause a safety risk for the past ten years. The result of this paper is safety risk factors as seen from risk responsibility; Client's responsibility, Contractor's responsibility, Shared responsibility, and Undecided Responsibility. This research used a systematic literature review. Based on 26 journals review about safety risk, the most responsibility in construction projects about those risks is the Contractor's Responsibility (57%).

Keywords:

Safety Risk, Construction Management, Risk Management, Construction Project.

Advance Researches in Civil Engineering
ISSN: 2645-7229, Vol.2, No.3, pages: 24-40

1. Introduction

Risk is defined as exposure to loss/gain or the probability of occurrence of loss/gain multiplied by its respective magnitude. The uncertainty varies rather widely. Nowadays, risk can be assessed using various types of information events that are said to be certain if the probability of their occurrence is 100% or uncertain if the probability of occurrence is 0% between these extremes [1]. Construction safety risk has been defined using multiple factors, namely frequency, severity, and exposure. Over the years, researchers have developed several different methods to quantify and analyze safety risks. The research also varies in terms of the methodology used to obtain the risk data for assessment (i.e., qualitative or quantitative) and the scales of measurement [2]. However, the ability to analyze or simulate construction activities related to safety risk is limited. At present, there is no methodology that possible researchers and practitioners to measure how safety risk varies during the duration of the activity and evaluate how the production variables affect the safety risk of the operation in a construction project [3]. In general, an accident at construction sites could be qualified as defects of the health and safety management system, which occur due to several aspects, including technical, technological, organizational, and types of factors [4-5]. The evaluation of risks and the decision about the choice of a preventive or of a non-preventive attitude lead to two different opposite situations: a good safety performance or the lack of safety during the construction work. Because analysis of the risks considered the risks and the planned preventive measures [6].

2. Research Methodology

This paper is based on a literature review from obtained online including various related articles from trusted sources and those related to “risk management’, “safety risk”, “construction project”. So, we get 26 journals which are then selected and reviewed to provide comprehensive information.

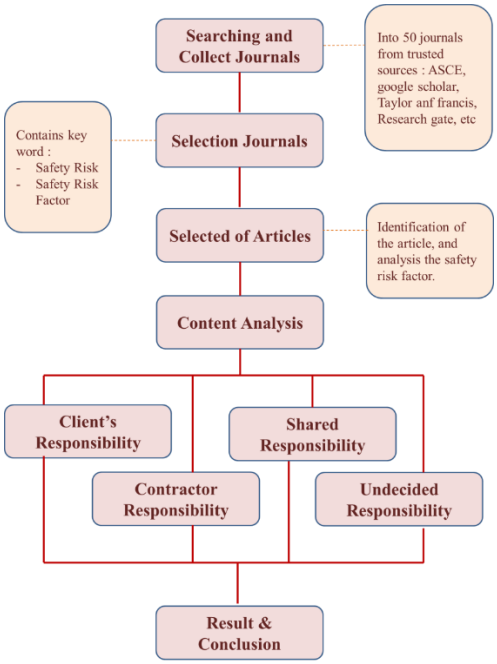

Figure 1. Research Framework.

3. Result and Discussion

In various construction projects, some ignore safety issues when carrying out construction projects, perhaps due to lack of information to project participants for the use of PPE (Personal Protective Equipment) so that not a few people have accidents at work and even cause death. Therefore it is necessary to examine the problem of accidents that occur in construction projects in the world to analyze the risk of opportunities that occur so that in carrying out construction projects, project participants can take action to anticipate the occurrence of safety risks so they can also know the parties who are responsible for accidents in the event of an accident. To reduce the safety risk on-site, one of the general contractors arranged for material recycling to be performed by a specialty subcontractor. This waste management company sent all the material from the site comingled to their facility where the material could be sorted in a controlled environment. With this arrangement, the LEED credit could be earned with minimal excess cost and a vastly reduced safety impact [7]. The importance of construction managers in the management of safety. The primary findings were Subordinate's risk-taking behavior is highly related to previous accident involvement. Subordinates that break rules, take short cuts, ignore safety regulations, and carry out activities that are forbidden are more likely to be involved in accidents than those who are not involved in these activities. The study has identified three construction manager safety behaviors that are related to subordinates' self-reported levels of safety [8]. This creates an understanding of operations, the key to safety variables, and the potential exchange between productivity and safety. Second, increase understanding of aspects of operations that can reduce exposure or the level of task demand factors. This guide increases safety measures against changes in work that reduce exposure and/or reduce the level of task demands. Third, it provides tools to evaluate and compare potential accidents from alternative production designs as paving illustrated case. This method provides a way to capture and measure the presence and level of task demands factors and the task demands score reflects the overall level of "safety difficulty" for certain operating parameters. Scores shouldn't be accurate task demands [3].

The security is affected by the technical conditions, and the environmental conditions, and other factors, and to face a variety of uncertainties, which includes in the whole process of the construction project, as the planning and design, the building construction, the operation, and maintenance. It is of an important significance to strengthen the security risk control and management of the construction project by using scientific methods to identify and measure security risks. Safety influencing factors analysis are third-party damage, design defects, environmental deterioration, operational errors, etc [9].

OSHA first determined some human risk factor categories for their fatality investigations: (1) Misjudgement of hazardous situations; (2) No ppe used; (3) No appropriate protective clothing; (4) Malfunction of procedure for securing operation or warning of hazardous situation; (5) Distracting actions by others; (6) Equipment in use not appropriate for operation or process; (7) Equipment in use not appropriate for operation or process; (8) Malfunction of neuro-muscular system; (9) Malfunction of perception system with respect to task environment; (10) Safety devices removed or inoperative; (11) Operational position not appropriate for task; (12) Procedure for handling materials not appropriate for task; (13) Defective equipment knowingly used; (14) Malfunction of lock-out or tag-out procedure; (15) Insuffcient or lack of housekeeping program; (16) Insuffcient or lack of exposure or biological monitoring; (17) Insuffcient or lack of engineering controls; (18)

Insuffcient or lack of written work practices program; (19) Insuffcient or lack of respiratory protection; (20) Insuffcient or lack of protection work clothing and equipment; and other. And also determined environmental categories for their fatality investigation: (1) Pinch point action; (2) Catch point/puncture action; (3) Shear point action; (4) Squeeze point action; (5) flying object action; (6) Overhead moving and/or falling object action; (7) Gas/vapor/mist/fume/smoke/dust condition; (8) Materials handling equipment/method; (9) Chemical action/reaction exposure; (10) flammable liquid/solid exposure; (11) Temperature above or below tolerance level; (12) Radiation condition; (13) Working layout condition; (14) Overpressure or underpressure condition; (15) Sound level; (16) Weather/earthquake [10].

The safety risk level of a site layout should consider the safety status of unoccupied locations and facilities located at the construction site. The safety risk level of temporary facilities is related to the interaction flows and surrounding hazardous facilities. However, for unoccupied locations, the safety/environmental concern related to those hazardous facilities located in the surrounding area is the only risk factor considered when assessing the safety risk level. To improve site safety, facilities with high interaction flows between them should be placed near each other because, along the transportation path, the collisions and conflicts caused by the frequent transport resources increase the likelihood of accidents. If dangerous and heavy equipment exists nearby, the facilities should be assigned to locations far away from them, as hazard decreases with distance [11].

Most of the accidents in the construction projects happen due to lack of proper education and training about safety measures and also because of negligence and ignorance on the part of either the participant construction or management or both. It is a well-known fact that the construction project employs more labor than any other industry. And also one of the least organized and as a result, there is scope for the exploitation of labor such in India. Safety is all the more important because of a lack of social security to the family left behind. Thus, it becomes necessary to consider certain safety measures to prevent accidents [12].

Finally, because safety risk perception is a subjective measure rather than an absolute measure, the current study assumed that higher levels of the perceived safety risk are desirable (e.g., Tixier et al. 2014). However, the current research findings present an important problem that must be tackled in future research. More specifically, the findings suggested that the workers in the distracted condition perceived higher levels of a safety risk than undistracted workers when hazard recognition levels were less than 59%. However, this finding is surprising because the results suggest that the perceived safety risk was unrelated to the underlying safety hazards present in the case images, and may be related to the distraction itself. Future research must investigate the effect of this increase in safety risk perception even when the underlying hazards may remain unrecognized on workplace behavior and safety outcomes [13].

Both the country china and India both countries are economically raised their per capita income by industrializing the resources. Nepal s influences from their economic growth and planning its infrastructures like road network, railways, housing, irrigations, hydropower development by optimum uses of own construction materials and manpower. During the development of construction infrastructures, in facts, laws, management system of occupational health safety risk management throughout the project life cycle is an important subject. Many facility managers are required to deal directly with small firms engaged in the maintenance, modification, and cleaning of physical infrastructure. Progressively, the performance of small firms reflects on the manager

of the facility, and so an understanding of their operation is required. All firms to provide a safe working environment for their workers and subcontractors [14]. Many existing and well-executed studies have focused on risk identification methods mainly at the preconstruction stage (design and planning). No practical approaches exist to date on how the data of unsafe conditions can be used by practitioners to improve safety during the construction of a project. In this paper, such a methodology is presented, which can enable participants in the construction process to promptly identify and restore safety deficiencies [15].

However, there is a safety risk assessment in the construction process of the existing building renovation project. The main reason is that the renovation project is different from the new construction project. In short, the new construction project is from "blank" to "building entity", and the renovation project is from "building entity" to "partial demolition" to "building entity". Many factors affecting the safety risk in the construction project of the renovation project, and there are many complexities and uncertainties. For example, the rationality of reconstruction project design, the rationality of construction sequence of demolition, reinforcement, and transformation, the construction conditions such as the narrow construction site, and the limited use of large machinery, the impact of construction conditions such as narrow construction sites and limited use of large machinery [16]. Future work is suggested to improve the understanding of construction employers' and business owners' abilities to prepare case study reports that are useful for evaluative research on health/safety interventions. Completeness and consistency of employer documentation in case-study reports are crucial to interpreting how the equipment implementation affected risk-factor/hazard mitigation, work quality, productivity, and employee acceptance. Future work should also consider the feasibility and added value of applying other risk-factor assessment methods, both semiquantitative (e.g., musculoskeletal risk surveys) and quantitative (e.g., wearable biomechanical sensors). Musculoskeletal symptom surveys of employees completed before and during the case-study period could provide additional data beneficial to demonstrating reductions in risk factors and improvements in health/safety [17].

Risk factors apply to various aspects of construction sites, including the technology, circumambient environment, work activities, and management quality, which can cause accidents. A risk can be the result of multiple risk factors, and a single risk factor may lead to multiple risks. In this study, risk factors are categorized into the following five types: (1) project characteristics, (2) geology, (3) construction technology, (4) construction environment, and (5) construction work activities. Types 1 and 3 are associated with technical risks, whereas Types 2, 4, and 5 are associated with geological and environmental risks [18].

Congruently, the key concept behind the safety risk assessment method is that safety risks can be mapped for any tasks at any time by identifying and modeling the task's compositional hazardous attributes. Specifically, accidents are hypothesized to be the outcome of interactions among the physical conditions of the job site, construction objects, processes, and environmental factors. The objective to test this hypothesis by uncovering the fundamental attributes of a construction workplace that characterize safety risk and measuring their relative magnitude [19].

When judging the likelihood of risk, participants considered a large number of attributes, such as different construction methods, the complexity of construction processes, the extent of use of machinery and the nature of machinery used, labor intensity, the number of different trades involved, the location of installation (e.g., external or internal), and level of familiarity with a

specific system. However, when judging the consequence of risk, the main attributes considered are accident type (e.g., slip, trip, fall, struck by), the weight of the building component involved, and the potential height that someone could fall. The four professional groups also showed less between-group similarity in ranking the likelihood of accidental injury associated with the different facade systems than they did in ranking the consequence of accidental injury should it occur [20]. The list of selected articles that were reviewed and analyzed from the aspect of risk identification in the construction project is as shown in Table 1.

Table 1. Summary Literature Review of Safety Risk in Construction Project

No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
1	(Almeida Santos et al., 2011) [6]	√				According to this paper, it is important to invest in the prevention of accidents if costs and risks should be decreased.
2	(Jitwasinkul & Hadikusumo, 2011) [21]			√		According to this paper, the influences of organizational factors on the safe work behavior of the construction industry have never been determined. Empirical findings from a case study show that contributing determinants can be expected to be influential at different levels.
3	(Mitropoulos & Namboodiri, 2011) [3]		√			The method provides a way to capture and quantify the presence and level of task demands factors, and the task demand score reflects the overall level of difficulty to calculate the accident.
4	(Fortunato et al., 2012) [7]		√			Which was one of the credits that increased the safety risk for workers because of "dumpster diving" when recycling materials.
5	(Badri et al., 2012) [22]			√		Lack of reliable and complete evaluation from the start of the project will result in bad decisions which can ultimately threaten the organization's existence which is related to factors that have a major impact on health and safety workers and residents nearby.

6	(Ostfeld et al., 2013) [9]		√		√	Through risk identification, evaluation, and analysis of urban underground cable facilities, monitoring, and management of reinforced safety risks, to find effective preventive measures to avoid, transfer and control risks, and the potential loss of urban cable accident minimization we must develop an emergency plan, and ensure that security incidents can be timely recovery and avoid extended power outages.
No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
7	(Dejus & Antuchevičiene, 2013) [4]		√			A case study for selection of the optimal occupational safety solution for fall-off and elevator shaft fall hazards is presented. The best solution from six possible ones is selected considering some of important criteria.
8	(Martin & Lewis, 2014) [8]		√			Construction managers can involve subordinates in risk assessment, in particular the identification of hazards and possible mitigation strategies, and a system should be in the place that allows all employees to proactively contribute ideas for improvement.
9	(Chi et al., 2015) [10]		√			The study presented in this paper reviewed information on 9,358 accidents that occurred in the U.S. construction industry between 2002 and 2011, first identifying key risk factors associated with each accident type by analyzing the observation frequency of each environmental or human risk factor.
10	(Esmaeili et al., 2015) [19]		√			The flexibility of identifying safety risks at an attribute level makes it possible to quantify safety risks for an individual worker, a crew, an activity, a trade, or a construction site at any time. and also to compare alternative practices and eliminate hazards in the early stages of a project.
11	(Dharmapalan et al., 2015) [2]	√				According to this paper, it used to quantify the construction safety risk associated with the construction of design elements used for multistory buildings and develop a tool for industry to use to evaluate the safety risk of designs.

12	(Iqbal et al., 2015) [1]	√	√	√	√	This paper describes how the way respondents perceive different risks particular to the construction project in Pakistan.

No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
13	(P. Zhang et al., 2015) [20]	√	√			The research contributes to the overall body of knowledge by showing that WHS risk is subjective in nature and individual risk perception is the result of the interplay between factors, including technical factors, psychological factors, and wider social and industrial factors.
14	(Choe & Leite, 2017) [23]		√			In addition, the proposed safety risk quantification models can play a role of a general safety reference for reliable safety risk assessment in construction, which allows data-driven decision making in construction safety management by identifying critical hazard types and sources of injury in the early stages of a project.
15	(Wang et al., 2016) [24]		√		√	In this study, through the statistical ranking analysis, 14 factors are identified as the critical ones. Among them, there are nine related to the external environment, while five depend on workers' internal characteristics.
16	(Nguyen et al., 2016) [25]		√			This study concluded that the data was gathered from this review could serve as input to a simulation model of incident causation for risks of falls. The probabilities of falls from height and near-miss in this operation were estimated at 0.07 and 2.62% per worker or crew per hour exposed to the risk of falls, respectively. The low likelihoods of falls and near-misses indicated that the installation process was safe in the case example.

17	(Dharma et al., 2017) [5]		√			According to this paper out of 275 types of risk identified Occupational Safety and Health on the construction project of Petitenget resorts stage of the work structure as many as 199 types risk (72%), and environmental factors work (environment) as much as 17 risks (38%). and out of 45 types of risk which are classified as categories heavy equipment and dominant vehicles (main risk), heavy equipment overturned due to landslides, Seling Tower, etc.
No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
18	(Ning et al., 2018) [11]				√	The facility layout for a construction site has a crucial impact on the safety risk level. The site environment varies for different facility distributions and assignments, as the existence of hazardous facilities in the surrounding area is the main driver of potential accidents.
19	(Bansal, 2018) [12]	√	√	√	√	This system will enable bankers to make quick decisions for lend finance, which could lead to the closure of the project at a faster pace. Third-party risk rating would certainly raise critical points, which are not normally raised during the finalization of the project.
20	(Namian et al., 2018) [13]		√			Overall, the findings suggested that distractions can adversely affect the hazard recognition performance of workers and may impede their ability to quantify the associated safety risk rationally. Therefore, employers must actively consider interventions to reduce workplace distractions whenever possible to improve workplace safety.
21	(Koirala, 2018) [14]		√			Regarding the arrangements of required training at all levels. Special attention needs to be given to key workers such as scaffolders and crane operators whose mistakes can be especially dangerous to other workers; safe methods or systems of work for the hazardous operation.

22	(Tsoukalis & Chassiakos, 2019) [15]				√	Risks are associated mainly with the absence or incorrect placement of warning signs, fencing, and safety barriers, which could create work accidents and injuries/fatalities.
23	(S. Zhang et al., 2019) [20]		√			Real-time safety risk identification on such projects is an important issue that necessitates accurate risk evaluation, control, and decision-making. Many potential and uncertain safety risk factors must be identified during these types of projects.
No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
24	(Li et al., 2020) [16]		√			According to this paper the index system of construction safety risk assessment for the renovation project, including five primary indexes: human risk factors, technical risk factors, material and equipment risk factors, management risk factors, environmental risk factors.
25	(Lowe et al., 2020) [17]		√			In this case studies, it was concluded that electrical cable pulling equipment, skid steer attachments for concrete breaking, concrete sawing equipment, and man lifts with higher reductions in risk factors and higher-quality case studies.
26	(Nicholson, 2020) [26]		√			The paper discussed a discussion of innovative technology and how efforts to improve road safety could be made more effective by applying concepts and methods in use in risk management

*Remark √ : discussed

The proposed approach is divided into three phases and each phase is divided into steps. This approach outlines all phases of risk management including: (1) risk identification; (2) risk assessment, and (3) actions. Like any approach to risk management, the model gives appropriate consideration to the phase of identifying risk elements (risk factors, undesirable events, and the impact of undesirable events). The risk assessment phase uses multi-criteria analysis, expert judgment, and the new concept of risk factor concentration. The analysis is made according to the

causal links between elements of identified risks. The action phase is based on risk prioritization, this step can be assigned to the project manager, who will plan the project risk evaluation review [22].

In construction management, safety risk management is important to identify potential hazards, evaluate the risks associated with the hazards, and mitigate them before they occur. As Hallowell and Gambatese (2009) stated, current construction risk management practices focus on risk identification and there is a lack of tools for objective risk assessment. In this section, studies related to risk assessment were reviewed to develop and frame a new risk assessment methodology. Particularly, three aspects of risk assessment were reviewed and compared: primary functions for safety risk assessment, data collection method, and target unit of analysis [23].

Empirical findings from before research from various industrial contexts report that work behavior is triggered by certain organizational factors such as inconsistent messages from management. According to this study, available evidence from previous findings, opinions, and explanations from professional safety experts responsible for developing a safety organization construction management system and promoting safe work behavior at work in Thailand conclude from contributors. These seven factors are the only organizational key factors in The context of organizational construction includes communication, safety culture, empowerment, management commitment, leadership, organizational learning, and reward systems [21].

When analyzing occupational hazards and occupational safety a construction site. First, the health and safety training of construction participants was studied. It was stated that the growing number of accidents at work is caused by insufficiency. Improving health and safety training for all construction participant and suggest using an analysis of the typical solution for occupational safety as an effective method [4].

According to the Labor Occupational Health Program, hazards at work are those that can harm workers, both physically and mentally. Hazard is the potential possessed by the material, the way of workers who can cause harm to the safety and mental health of a person. Hazard is also an energy source that can cause injury to workers, damage to equipment, the environment, and structures [5].

The uniqueness and non-repetition of each construction project makes the site experience play a big role in accident prevention. Professional knowledge and experience can not only provide qualified professional skills to workers, but also a clear understanding of the seriousness and possible loss of taking risks, and their limited ability to handle these serious safety risks. Therefore, workers with rich experience and professional knowledge are more rational and less likely to increase risk tolerance when faced with safety risks [24].

In terms of the standard set of risk responsibility for each category, 8 risks came under the responsibility of a client with more than 50% of responsibility as per data supplied by respondents; while 16 risks came under a contractor's responsibility; 8 risks as a shared responsibility; undecided as none of the category received more than 50% score as represented and provided in Table 2.

Table 2. List of Responsibility of Safety Risk Factor According to Journal [1]

Responsibility of Safety Risk Factor	Type of Risk	
Client's Responsibility	Risk of defective design	Risk of change in code and regulation
	Risk of Funding problem for Project	Risk of changes in the scope of work
	Delays in Obtaining Permit	Improper scope of work defined in the contract
	Delay in Availability of drawings	Payment delays
Contractor's Responsibility	Accident/safety during construction	Poor performances of subcontractor
	Risk of bad quality material/equipment	Poor condition with subcontractor
	Inaccurate execution plan/schedule	Risk of defective material from the supplier
	Risk of Insufficient technology	Shortage of plant and equipment
	Theft/Robbery of material at site	Poor productivity of plant and equipment
	Third-party delays	Shortage/delay of material supply
	Risk of labor, material and equipment availability	Lack of qualified staff
	Risk of labor disputes and strikes	Poor competence and productivity of labor
Shared's Responsibility	Risk of natural disaster	Terrorism/was threats
	Delays due to dispute with contractor	Adverse weather conditions
	Inappropriate risk allocation in contract	Politically Instability
	Risk of exchange rate fluctuation and inflation	Corruption including bribery at site
Undecided Responsibility	Risk of unforeseen site condition	
	Risk of differing site conditions	
	Inaccurate estimation of quantities of work	
	Inadequacy of Insurance	
	Delay due to lack of availability of utilities	

In this accident cost analysis, the values considered are arranged by measurable values (fines, employee salaries, damaged equipment, materials, etc.) and by indirect costs (work interruptions, decreased productivity, time wasted by technical staff and law, corporate image damage, insurance, etc.). Therefore a safety management decision is to combine the assumed level of risk with affordable investment in accident prevention. Using this ratio, the probable cost due to lack of prevention is 4.2% of construction costs [6].

Based on Table. 2, each journal has a factor that shows the most factor causes safety factor: client's responsibility, contractor's responsibility, shared responsibility, undecided responsibility.

The 26 journals selected are previous studies published for the past 10 years, fig. 2 shows how many journals selected to review by year from 2010 -2020. Based on fig. 1, there is 0 journal published in 2010 and also 3 journals published in 2011 is selected to review, then 2 journals in 2012, 2 journals in 2013, 1 journal in 2014, 5 journals in 2015, 2 journals in 2016, 2 journals in 2017, 4 journals in 2018, 2 journals in 2019 and 3 journals published in 2020.

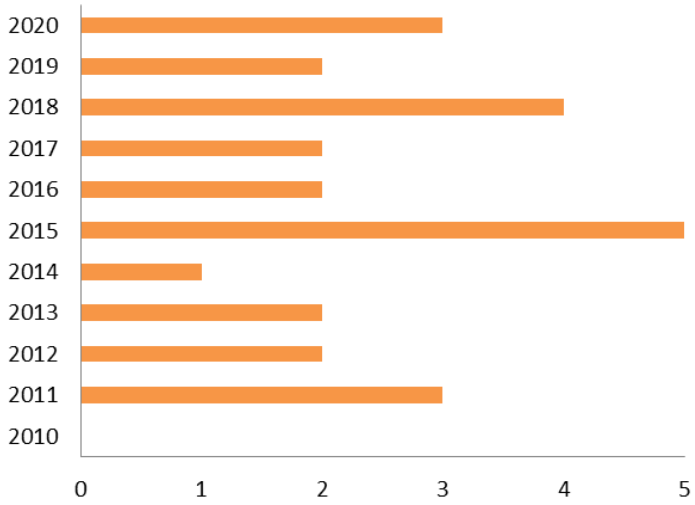

Figure 2. List of Journal's Year Published.

Dharmapalan and Gambatese [2] reported that each of the design elements also quantified the construction safety risk values for each of the four severity categories and for each construction activity. Analyses of the risk factors developed to afford the opportunity to assess differences in risk perception between different project team members. The computed risk factors were further analyzed to compare the risk perception between the three respondent groups (GC superintendents, GC safety managers, and trade contractor personnel) and to compare design alternatives in terms of risk factors [2]. In Table 2, it provides information from 26 selected and reviewed journals, which are safety risk factors (table 2) the causing factors for accidents. The percentages are obtained from the calculated values in table 1 and divide by the total value of the 26 journals reviewed. The results of the literature review of this paper, there is more than one risk factor that most leads to the responsibility of safety risk is the Contractor's Responsibility (57%), the 2nd rank is the Undecided Responsibility (17%), the 3rd Rank is the Client's Responsibility (14%), and the last risk factor is Shared Responsibility (12%) as shown in Figure 3.

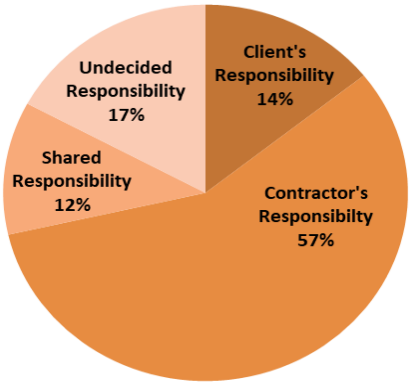

Figure 3. Percentage Responsibility Factors Causes Safety

As a result, 36 factors influencing risk of falls were determined. These 36 factors were classified into four different levels as follows:

• Level 1: External factors include the factors related to political or external issues. Four factors in this category consist of (1) political impact; (2) regulatory influence; (3) market condition;and (4) social impact.

• Level 2: Policy factors include the factors related to contracting strategy, ownership and control, and construction company culture. Seven factors in this category consist of (1) contracting strategy; (2) ownerships and control; (3) company culture; (4) organizational structure; (5) safety and health (S&H) management; (6) labor relations; and (7) company profitability.

• Level 3: Organizational factors include the factors related to site organization and local management. Twelve factors in this category consist of (1) recruitment and selection; (2) training; (3) procedures; (4) planning; (5) incident management andfeedback; (6) management/supervision; (7) communications; (8) safety culture; (9) equipment purchasing; (10) inspection and maintenance; (11) payment conditions; and (12) design process.

• Level 4: Direct factors include the factors related to site operatives and technicians. In this category, the 13 factors consist of (1) competence; (2) motivation/morale; (3) teamwork; (4) situational awareness/risk perception; (5) fatigue/alertness; (6) health; (7) communications; (8) information/advice; (9) compliance; (10) suitable human resources; (11) working condition; (12) operational equipment; and (13) safety equipment/PPE. These 13 factors are similar to the findings from Hu et al. (2011) discussed previously [25].

4. Conclusions

The result of this paper literature review, The most risk factor leading to responsibility of safety is Contractor's Responsibility (57%), 2nd rank is Undecided Responsibility (17%), 3rd Rank is Client's Responsibility (14%), and last risk factor is Shared Responsibility (12%). Percentage obtained from calculate value in table 1 and divide with total value from 26 journals reviewed. From this literature review, construction workers can find out the dangers that occur in construction projects so that they indirectly know and understand the importance of safety induction before starting construction projects such as road infrastructure, high-rise buildings, bridge construction, airports, and irrigation buildings to minimize accidents the highest that causes death. And for

construction officials, they know how responsible they are for safety risks that occur in construction projects.

5. References

[1]-Iqbal, S., Choudhry, R. M., Holschemacher, K., Ali, A., & Tamošaitienė, J., 2015, **Risk management in construction projects**, Technological and Economic Development of Economy, 21(1), 65–78. https://doi.org/10.3846/20294913.2014.994582

[2]- Dharmapalan, V., Gambatese, J. A., Fradella, J., & Moghaddam Vahed, A., 2015, **Quantification and assessment of safety risk in the design of multistory buildings**, Journal of Construction Engineering and Management, 141(4), 1–9. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000952

[3]-Mitropoulos, P., & Namboodiri, M., 2011, **New method for measuring the safety risk of construction activities: Task demand assessment**, Journal of Construction Engineering and Management, 137(1), 30–38. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000246

[4]-Dejus, T., & Antuchevičiene, J., 2013, **Assessment of health and safety solutions at a construction site**, Journal of Civil Engineering and Management, 19(5), 728–737. https://doi.org/10.3846/13923730.2013.812578

[5]-Dharma, A. A. B., Putera, I. G. A. A., & Parami, A. A. D., 2017, **Manajemen Risiko Keselamatan Dan Kesehatan Kerja (K3) Petitenget Risk Management of Occupational Health and Safety (K3) in the Development Projects of Jambuluwuk Hotel & Resort Manajemen K3**. Spektran, 5(1), 47–55. https://doi.org/doi:10.1201/9781420009675.ch1

[6]-Almeida Santos, F. M., Costa, A. R., & Soeiro, A., 2011, **Economic analysis of safety risks in construction**, WIT Transactions on the Built Environment, 117, 51–57. https://doi.org/10.2495/SAFE110051

[7]-Fortunato, B. R., Hallowell, M. R., Behm, M., & Dewlaney, K., 2012, **Identification of safety risks for high-performance sustainable construction projects**, Journal of Construction Engineering and Management, 138(4), 499–508. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000446

[8]-Martin, H., & Lewis, T. M., 2014, **Pinpointing safety leadership factors for safe construction sites in Trinidad and Tobago**, Journal of Construction Engineering and Management, 140(2). https://doi.org/10.1061/(ASCE)CO.1943-7862.0000795

[9]-Ostfeld, A., Salomons, E., Skolicki, Z., Wadda, M. M., Houck, M. H., Arciszewski, T., Perelman, L., Ostfeld, A., St, S., Water, D. H. I., Alle, A., Ph, D., Asce, M. H. H. F., Asce, T. A. M., Kroll, D., King, K., Gueli, R., Grayman, W., Murray, R., and Savic, D., Environmental, W., , Salomons, E., 2013, Icptt 2012 © asce 2013 1574. Journal of Water Resources Planning and Management, 136(5), 1–10. https://doi.org/10.1061/(ASCE)0733-9496(2006)132:4(209)

[10]-Chi, S., Han, S., Kim, D. Y., & Shin, Y., 2015, **Accident risk identification and its impact analyses for strategic construction safety management**. Journal of Civil Engineering and Management, 21(4), 524–538. https://doi.org/10.3846/13923730.2014.890662

[11]- Ning, X., Qi, J., & Wu, C., 2018, **A quantitative safety risk assessment model for construction site layout planning.**, Safety Science, 104, 246–259. https://doi.org/10.1016/j.ssci.2018.01.016

[12]-Bansal, E. G., 2018, **Application of safety and risk management**. July, 2555–2560.
[13]- Namian, M., Albert, A., & Feng, J., 2018, **Effect of Distraction on Hazard Recognition and Safety Risk Perception**, Journal of Construction Engineering and Management, 144(4), 1–11. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001459
[14]-Koirala, M. P., 2018, **Risk Factors in Construction Infrastructures Projects and Safety Engineering Practiced in Nepal**, September. https://doi.org/10.17577/IJERTV7IS090066
[15]-Tsoukalis, F. C., & Chassiakos, A. P., 2019, **Building Information Modeling (BIM) for Safety Risk Identification in Construction Projects**. 812–817. https://doi.org/10.3311/ccc2019-111
[16]- Li, W., Li, Q., Liu, Y., Li, H., & Pei, X., 2020, **Applied sciences Construction Safety Risk Assessment for Existing Building Renovation Project Based on Entropy-Unascertained Measure Theory**.
[17]- Lowe, B. D., Albers, J., Hayden, M., Lampl, M., Naber, S., & Wurzelbacher, S., 2020, **Review of Construction Employer Case Studies of Safety and Health Equipment Interventions**, Journal of Construction Engineering and Management, 146(4). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001782
[18]-Zhang, S., Shang, C., Wang, C., Song, R., & Wang, X., 2019, **Real-Time Safety Risk Identification Model during Metro Construction Adjacent to Buildings**. Journal of Construction Engineering and Management, 145(6). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001657
[19]-Esmaeili, B., Hallowell, M. R., & Rajagopalan, B., 2015, **Attribute-Based Safety Risk Assessment. I: Analysis at the Fundamental Level**. Journal of Construction Engineering and Management, 141(8). https://doi.org/10.1061/(ASCE)CO.1943-7862.0000980
[20]-Zhang, P., Lingard, H., Blismas, N., Wakefield, R., & Kleiner, B., 2015, **Work-Health and safety-risk perceptions of construction-industry stakeholders using photograph-based q methodology**, Journal of Construction Engineering and Management, 141(5), 1–14. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000954
[21]- Jitwasinkul, B., & Hadikusumo, B. H. W., 2011, **Identification of important organizational factors influencing safety work behaviors in construction projects**. Journal of Civil Engineering and Management, 17(4), 520–528. https://doi.org/10.3846/13923730.2011.604538
[22]-Badri, A., Nadeau, S., & Gbodossou, A., 2012, **Proposal of a risk-factor-based analytical approach for integrating occupational health and safety into project risk evaluation**, Accident Analysis and Prevention, 48, 223–234. https://doi.org/10.1016/j.aap.2011.05.009
[23]- Choe, S., & Leite, F., 2017, **Assessing Safety Risk among Different Construction Trades: Quantitative Approach**, Journal of Construction Engineering and Management, 143(5). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001237
[24]-Wang, J., Zou, P. X. W., & Li, P. P., 2016, **Critical factors and paths influencing construction workers' safety risk tolerances**, Accident Analysis and Prevention, 93, 267–279. https://doi.org/10.1016/j.aap.2015.11.027
[25]-Nguyen, L. D., Tran, D. Q., & Chandrawinata, M. P., 2016, **Predicting safety risk of working at heights using Bayesian networks,** Journal of Construction Engineering and Management, 142(9), 1–11. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001154

[26]- Nicholson, A., 2020, **Road Safety: Risk Management Perspective**, ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering, 6(1), 1–10. https://doi.org/10.1061/AJRUA6.0001027