



Risk Management of Projects Investment Analysis: A Literature Review

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(Date of received: 20/03/2021, Date of accepted: 24/05/2021)

ABSTRACT

These literature review makes an attempt to study the role of risk management when implementing investment projects. Risk management is an important component of project management. In investment decisions, management must deal with uncertainty in the future either positive uncertainty or negative uncertainty. Risk management is what needs to be considered in investment decisions. The article describes the various types of investment and project risks, methods of risk analysis of investment projects, performance indicators of investment projects, as well as the analysis of risk factors and uncertainties in the course of investment projects' development. Methods for risk assessment of an investment project help to assess the feasibility of the project, initial time period after which it will generate revenue, as well as the probabilistic size of future profits.

Keywords:

Risk, Risk Assessment, Risk Management, Investment Project.



1. Introduction

The definition of risk according to SNI ISO 31000 is effect of uncertainty on objectives. In the uncertainty all the possibilities can occur. The results that will occur are predictable but the likelihood of occurrence is still a question. In the definition of risk there are a number of possible known outcomes, or the likelihood of an event occurring among all the events that might occur. Thus, the risk of an investment can be interpreted as the probability that the expected rate of return is not achieved, or the probability that the return received deviates from the expected. The greater the deviation, the greater the risk. Investment risk means that the return in the future cannot be known, but can only be expected. If the element of risk is included in the assessment of investment proposals, it is possible for investment projects to have different levels of risk so that it will be able to change the overall risk map of the company so that this will be able to change the required rate of return requested by investors. So, if a company will accept a certain investment project that contains a large risk, investors will demand a larger return as compensation, namely in the form of the required rate of return or a larger discount rate. In reality, most investment projects carry risks. How do we measure, quantify and interpret the risks inherent in an investment project? It is important to quantify risk into several standard measures so that it can be communicated with other interested parties.

2. Research Methodology

Another common approach to the project life cycle is associated with the definition of six functions, namely substantiation, planning, implementation, monitoring, evaluation, and completion (Gasparian et al., 2018) [1]. The substantiation phase involves the selection of the most effective project given the shortage of resources, costs and the need for alternative choices of certain needs and ignoring others to achieve set goals. At this phase it is also important denoting the norm of indicators deviation that shows the project effectiveness. The planning stage is carried out during the whole period of the project implementation. It consists of the following components: preliminary planning, as well as formal and detailed planning. Great attention is paid to the development of a preliminary plan, because it constitutes the basis of project planning. Formal and detailed planning can be started only in case the preliminary plan is adopted. In the course of the project implementation the previously approved plan undergoes certain modifications due to the occurrence of various contingencies. The implementation (realization) of the project occurs after adoption of the plan and involves the implementation of defined actions. Controlling is one of the important stages of the project life cycle to evaluate the obtained actual results and compare them with the previously approved plan. The detected deviations are compared to predetermined norms. This allows minimizing the project risk. The next stage (evaluation) is closely linked to controlling, as it is the feedback element. At that, there are some differences between controlling and evaluation. So, controlling displays the project monitoring, while evaluation means drawing interim results. The final stage of the project reflects the result of the work done. Despite the fact that there are quite many approaches to life cycle, it is important to note that the initial stage is always associated with the identification of the best available option of the project implementation, there are most effective, less risky, and profitable alternative. The initial stage of this approach includes gathering information, setting goals and objectives, risk identification, setting deadlines and amount of finance. The second stage (development) involves creating a team, establishing



contacts, defining learning objectives, preparing project content, developing timing and budget schedule, subcontracting, and the like. The next stage is directly associated with the project launch. The final stage consists in the summarizing and analysis of the obtained results. The risks reviewed are client's responsibility, contractor's responsibility, shared responsibility, and undecided responsibility as well as from the project. The following is a research framework in this paper.

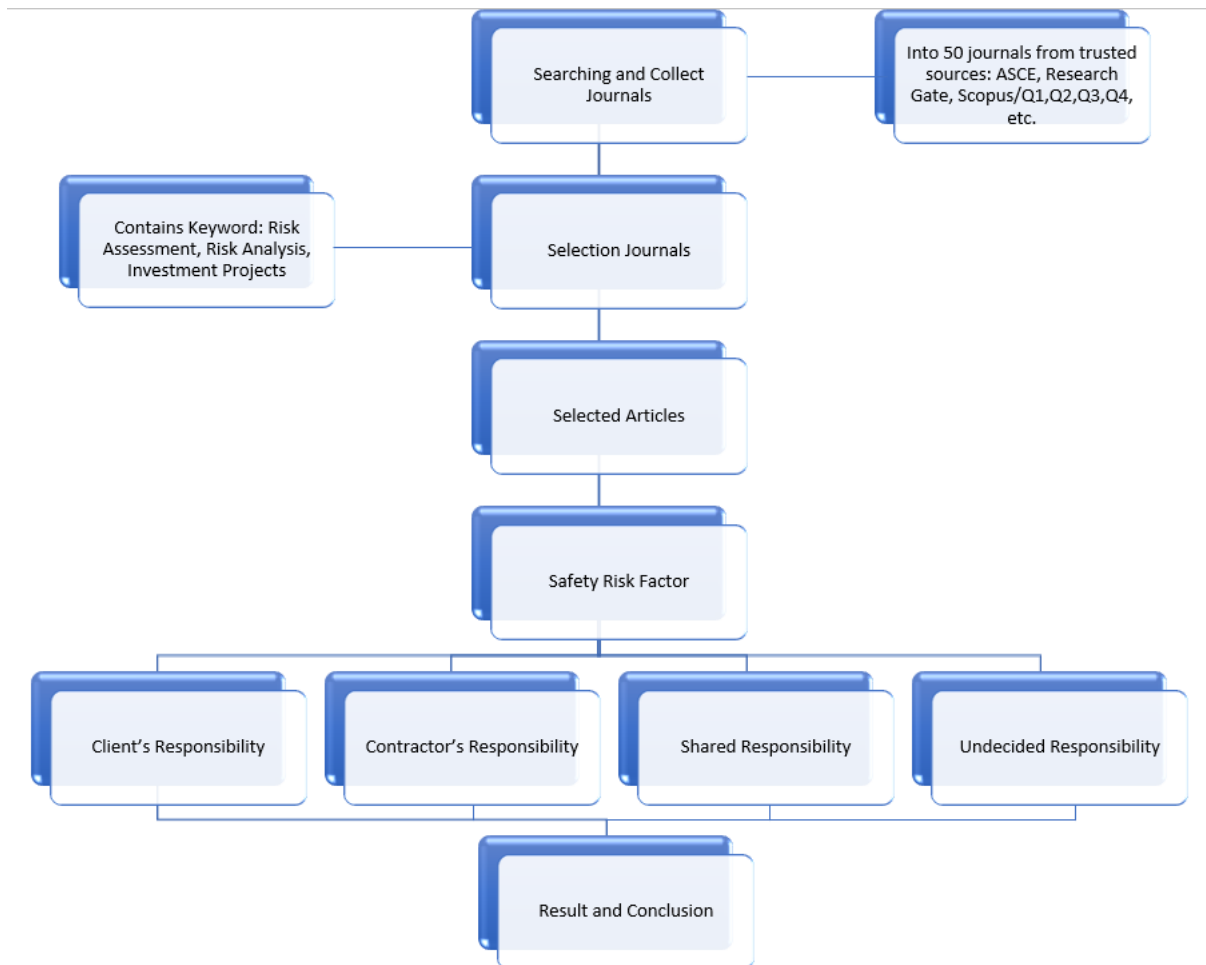


Figure 1. Research Framework.

3. Result and Discussion

In the risk management theory, several ways of influencing risk are identified. These are risk reduction, risk retention, and risk absorption. Risk reduction involves the minimization of possible damage that may occur during the implementation of the investment project, or reducing the probability of occurrence of adverse events. Risk retention, in turn, covers the self-insurance (creation of reserve funds) and obtaining financial resources (loans and borrowings). Risk absorption tools include the transition of responsibility for the risk to third parties provided the same level of risk. These tools include financial guarantee, surety commitment, and insurance against risks (Gasparian et al., 2018) [1].



At a stage, where funds have not yet been invested, certain measures of project risk assessment are applied. At the same time, contractual, legal, insurance and other tools can also be used. At the phase of direct financing, the main role is played by measures such as ensuring the timely completion of the project, the exact implementation of the contract terms for construction and installation works and supply of fixed assets, insurance, etc. During the production phase, assets insurance is carried out, and timely payments of loan obligations and hedging against commercial risks are provided, etc. The final phase of the investment project cannot be imagined without the use of emergency reserve funds, prevention of ecological damage caused by company activities, as well as payment of obligations to third parties by the project participants.

The growth of the company's investment potential is closely associated with the evaluation of the attendant risks of the process, various influencing factors, and the expected results. Therefore, the analysis of a number of qualitative and quantitative criteria of the projects and risks, as well as the potential profit-making opportunities in the investment decision making is required. Risk is exposure to the consequences of uncertainty. As a result, subjective analytical methods that rely on historical information and the experiences of individuals and companies have been used to assess the impact of construction risk and uncertainty. Therefore, Risk assessment is a technique that aims to identify and estimate risks impacted upon by a project. On the investment implementation of that project, much risks can trigger project failed. Those risks can come both from internal and external. Internal failure which often occurred in a project is a cost overrun and delays, meanwhile for external risks the project funding based on unit selling also refers to failure factor in apartment project. The growing number of developers makes land of property business become a tight competition. Funding is the main factor of consideration. Therefore, funding project must be run properly both in internal and external factor.

3.1. Client's Responsibility

The risks that occur will be different when viewed from each stakeholder. Over all the biggest risk is land acquisition (Septiani et al., 2016) [2]. There are two elements inherent in every investment, namely the return and risk. A decision that has a high return is definitely inversely related to a high risk (high return high risk) (Fadilah, 2019) [3]. Sensitivity analysis aims to see feasibility investment if there is a change in the investment variable. The variables that are analyzed for sensitivity are changes in interest rates, changes in investment costs, and changes in selling or rental prices. From the sensitivity analysis it can be concluded that the alternatives to the system selling have a vulnerable safer on its merits, when there is a change in the investment variable (Wahyudhi & Utomo, 2014) [4]. In a project feasibility study to find out the risks that may occur, there are many things that need to be studied including technical aspects, market aspects, financial aspects, legal aspects and aspects social and economic (Ir. Putu Darma Warsika [5]).

3.2. Contractor's Responsibility

Higher project success is linked with higher frequency in the evaluation of strategic, financial, technical, commercial, and environmental and human resources aspects. When a project is successful, environmental and human resources aspects are analyzed. The analysis also allows us to conclude that social and organizational issues, for this sample of firms, are not directly related with project's success (Moutinho & Lopes, 2015) [6]. Construction project planning is an essential



element in the management and execution of construction projects which involves the definition of work tasks and their interactions, as well as the assessment of required resources and expected activity durations (Jayasudha & Vidivelli, 2015) [7]. In making investment decisions, risk assessment, and management is one of the main tasks. Risk management is an integral part of project management and investment solutions' assessment (Shevchenko et al., 2019) [8]. There are four fundamental constraints needed to be considered when managing the construction projects, which are scope, cost, time, and quality. In order to manage the projects successfully, it is necessary to consider whether the project is within those four constraints (Issn, 2010) [9]. Time, cost, quality and risk as four critical objectives of construction project management, are not independent but intricately related (Rezaian, 2011) [10]. To minimize the impact of risks, an effective risk management approach must be incorporated into every project which also includes the effectiveness and measurement of its performance (Rahman & Adnan, 2020) [11].

The basic of risk management process are risk identification, evaluation, mitigation, and monitoring. Six factors identified for analysis were: risk management processes, techniques and tools; care with uncertainties; personal risk evaluation; specific risk assessment; personal knowledge and; simulation of timeframes and costs (Rozenes, 2013) [12]. Researching the financial aspect is one of the most important requirements before do the investment projects (Armaeni, N. K., Widanan, I. W., & Sriastuti, 2017) [13]. Popular risk management performance measurement methods for large construction projects are: Balance Score Card, Earn Value Management System, Key Performance Index, and Risk Management Index (Rahman & Adnan, 2020) [11]. The problem of risk requires proactive managers to analyze the effect of decisions reached, identify risk inherent and manage the risk challenges therein through risk analysis methods such sensitivity analysis, expected value approach, payback period among others (Adebawojo & Alao, 2012) [14]. The object risks can be identified and evaluated by using the Pareto analysis, Saaty's matrix or decision tree (Rehacek & Bazsova, 2018) [15]. The output of a risk assessment task is a risk rating score related to a specific risk path source-event, or project scenario; however, one of the major steps in project risk management is to identify and assess the potential risks (Rezaian, 2011) [10]. To minimize the effects of the risk, it recommends that regulatory bodies must take proactive measures that could minimize policy summersault and that managements must also be sincere and convinced in their investment decisions in order to minimize their investment portfolio risk (Adebawojo & Alao, 2012) [14]. The qualitative risk analysis is an integral part of a risk management process in investment projects. In business practice the analysis should be combined with the quantitative approach. Only this combination can ensure that risks, which occur in an investment project are viewed comprehensively (Korombel & Tworek, 2009) [16]. The medium investment projects revealed that the orientation of the risk is a key factor in the success of the implementation of investment projects and maximizing the value of the oil and gas business (Domnikov et al., 2017) [17]. The strategic projects were analyzed in companies across various business sectors thus the obtained results represent a benchmark of risk factors' significance according to the project team members and managers (Jovanović et al., 2016) [18].

The significance of this study is that understanding risk involved in construction projects at such an early stage (commencement) of the project will help construction practitioners to manage it in such a way that it has minimum negative effect on project targets and maximum positive results (Sharma & Gupta, 2019) [19].



3.3. Shared Responsibility

The project risk management includes several related actions, such as the risk planning, the identification and analysis of risk events, the development of strategies for risk handling and monitoring, all oriented towards the project success (Jovanović et al., 2016) [18]. The risk of project cycle may incur highest project costs and have a key impact on financial viability of the project (Kolodiziev et al., 2017) [20].

There are three levels of main risk categories (Gindu et al., 2016) [21]:

1. Macroeconomic risks (global, political and economic instability, legislative changes, climate change and natural disasters);
2. Business risks (development, manufacture, marketing, finance and growth risks);
3. Project risks (project team, budget, technical aspects, technology transfer, financial risks, environment risk, and project schedule).

Some of approaches to include consideration and measurement of risk in investment projects are (Sri Wardiningsih, 2012) [22]:

1. The mean-standard deviation approximation
2. The certainty equivalent approximation
3. The risk-adjusted discount rate approximation

Key risks in a project are: The combination of risks and human reactions, Pace and management actions, Individuals within the parties, Inter-personal relationships between the project parties, Contracts between the project parties, Culture within the project parties, Changes to the project parties (Williams, 2017) [23].

For example, the investment for the construction of the toll road studied involves several levels of risk and uncertainty. There are 4 main risks identified, namely financing risk, construction risk, equipment risk, and force majeure risk, so risk analysis and mitigation need to be carried out (Sandhyavitri & Zulfiqar, 2019) [24]. By doing risk management is expected to target the right project cost, timely, and appropriate quality in the construction of the building infrastructure (Nurlela & Suprpto, 2010) [25].

Construction companies are particularly vulnerable to financial risk due to the nature of the industry, extreme competition, relatively low entry barrier, high uncertainty and risk involved, and capricious fluctuations in construction volume (Antonio J, 2011) [26]. Construction projects are facing a number of risks which have negative effects on project objects such as time, cost and quality. Two types of risk management techniques were considered: preventive techniques which can be used before the start of a project to manage risks that are anticipated during the project execution; and remedial techniques that are used during the execution phase once a risk has already occurred (Iqbal et al., 2015) [27].

3.4. Undecided Responsibility

The more innovative the outcome, the more risk management process will be concentrated in the planning phase. The present work develops classifying techniques based on the phases of the risk management process, the phases of the life cycle of a project, and the corporate maturity towards risk (Cagliano et al., 2015) [28]. The factors in the financial part and the non-financial one such as the construction aspect, the system one and the market one was all drawn and analyzed through the Influence Diagram and the Decision Tree (Kim et al., 2005) [29].



Three different methods of the risk analysis as well as highlighting their disadvantages, advantages and primary areas of application (selection or pre-estimation) (Dziadosz & Rejment, 2015a) [30]. Two risk management scenarios, namely the option to build a pilot project which is then followed by the development of the whole project; and options to defer project investment while studying emerging risks. The conclusion is that a scenario to build a pilot project followed by the overall project development provides the maximum investment value or the least risk (Narasiang et al., 2015) [31].

In the analysis of investment projects, due to the fact that financial institutions are dependent on borrowed capital, it was observed that the credit institution analysts use instruments of accounting to check how much the institution used capital to third parties in relation to its own capital available for lending (Junkes et al., 2015) [32]. The evaluators of the credit institution use multiple indicators for risk assessment which assume a central role in terms of decision-making and contribute for the approval or the rejection of the submitted projects; namely, the proven ability to pay, the financial records of project promoters, several financial restrictions, level of equity, level of financial indebtedness, evidence of the existence of a consumer market, the proven experience of the partners/owners in the business, environmental aspects, etc. The risk assessment process has been implemented for the potential risks that the construction industry confronts. These risks need mitigation measures by executing risk treatment policy to register, monitor and review the uncertain events (Aloko, 2018) [33]. The risk management in the construction industry requires a complementary, interdisciplinary, flexible approach allowing to capture the changing character of risk factors (qualitative, quantitative) as well as it requires a precise description and explanation of the mechanisms involved in the organization of construction production. Therefore, in developing of a risk assessment model in the construction projects it should be emphasized on the compilation even available and already recognized tools so to use a hybrid approach (Dziadosz & Rejment, 2015b) [34]. On the investment implementation of that project, much risk can trigger project failed. Those risks can come both from internal and external. Therefore, funding project must be run properly both in internal and external factor (Tanzil et al., 2018) [35]. The list of selected articles that were reviewed and analyzed from the aspect of risk assessment in the investment projects is as shown in Table 1.



Table 1. Risk Management of Projects Investment Analysis: A Literature Review.

No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
1	(GINDU et al., 2016)			√	√	Three levels of main risk categories: 1-Macroeconomic risks (global, political and economic instability, legislative changes, climate change and natural disasters) 2-Business risks (development, manufacture, marketing, finance and growth risks) 3-Project risks (project team, budget, technical aspects, technology transfer, financial risks, environment risk, project schedule)
2	(Gasparian et al., 2018)		√			When implementing investment projects, the probability of occurrence of risk situations should identify. These are risk reduction, risk retention, and risk absorption. These tools include financial guarantee, surety commitment, and insurance against risks.
3	(Jovanović et al., 2016)			√		The project risk management includes several related actions, such as the risk planning, the identification and analysis of risk events, the development of strategies for risk handling and monitoring, all oriented towards the project success.
4	(Rozenes, 2013)		√			Six factors identified for analysis were: risk management processes, techniques and tools; care with uncertainties; personal risk evaluation; specific risk assessment; personal knowledge and; simulation of timeframes and costs.
5	(Rahman & Adnan, 2020)		√			Popular risk management performance measurement methods for large construction projects are: Balance Score Card, Earn Value Management System, Key Performance Index, and Risk Management Index. The basic of risk management process are risk identification, evaluation, mitigation, and monitoring.
6	(Cagliano et al., 2015)				√	The more innovative the outcome, the more risk management process will be concentrated in the planning phase. The present work develops classifying techniques based on the phases of the risk management process, the phases of the life cycle of a project, and the corporate maturity towards risk.
7	(Sri Wardiningsih, 2012)			√		Some of approaches to include consideration and measurement of risk in investment projects are : 1-The mean-standard deviation approximation. 2-The certainty equivalent approximation. 3-The risk-adjusted discount rate approximation.



No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
8	(Kim et al., 2005)			√	√	The factors in the financial part and the non-financial one such as the construction aspect, the system one and the market one was all drawn and analyzed through the Influence Diagram and the Decision Tree.
9	(Armaeni, N. K., Widanan, I. W., & Sriastuti, 2017)		√			Researching the financial aspect is one of the most important requirements before do the investment projects.
10	(Junkes et al., 2015)			√	√	In the analysis of investment projects, due to the fact that financial institutions are dependent on borrowed capital, it was observed that the credit institution analysts use instruments of accounting to check how much the institution used capital to third parties in relation to its own capital available for lending.
11	(Adebawojo & Alao, 2012)		√			The problem of risk requires proactive managers to analyze the effect of decisions reached, identify risk inherent and manage the risk challenges therein through risk analysis methods such sensitivity analysis, expected value approach, payback period among others.
12	(Rehacek & Bazsova, 2018)		√			The object risks can be identified and evaluated by using the Pareto analysis, Saaty's matrix or decision tree.
13	(Rezaian, 2011)		√			The output of a risk assessment task is a risk rating score related to a specific risk path source-event, or project scenario; however, one of the major steps in project risk management is to identify and assess the potential risks.
14	(Williams, 2017)			√	√	Key risks in a project are: The combination of risks and human reactions, Pace and management actions, Individuals within the parties, Interpersonal relationships between the project parties, Contracts between the project parties, Culture within the project parties, Changes to the project parties.
15	(Kolodiziev et al., 2017)			√		The risk of project cycle may incur highest project costs and have a key impact on financial viability of the project.
16	(Sandhyavitri & Zulfiqar, 2019)			√		The investment for the construction of the toll road studied involves several levels of risk and uncertainty. There are 4 main risks identified, namely financing risk, construction risk, equipment risk, and force majeure risk, so risk analysis and mitigation need to be carried out.
17	(Narasiang et al., 2015)				√	Two risk management scenarios, namely the option to build a pilot project which is then



No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
						followed by the development of the whole project; and options to defer project investment while studying emerging risks. The conclusion is that a scenario to build a pilot project followed by the overall project development provides the maximum investment value or the least risk
18	(Septiani et al., 2016)	√				The risks that occur will be different when viewed from each stakeholder. Over all the biggest risk is land acquisition.
19	(Adebawojo & Alao, 2012)		√			To minimized the effects of the risk, it recommends that regulatory bodies must take proactive measures that could minimize policy summersault and that managements must also be sincere and convinced in their investment decisions in order to minimize their investment portfolio risk.
20	(Korombel & Tworek, 2009)		√			The qualitative risk analysis is an integral part of a risk management process in investment projects. In business practice the analysis should be combined with the quantitative approach. Only this combination can ensure that risks, which occur in an investment project are viewed comprehensively.
21	(Domnikov et al., 2017)		√			The medium investment projects revealed that the orientation of the risk is a key factor in the success of the implementation of investment projects and maximizing the value of the oil and gas business.
22	(Jovanović et al., 2016)		√			The strategic projects were analyzed in companies across various business sectors thus the obtained results represent a benchmark of risk factors' significance according to the project team members and managers.
23	(Fadilah, 2019)	√				There are two elements inherent in every investment, namely the return and risk. A decision that has a high return is definitely inversely related to a high risk (high return high risk).
24	(Junkes et al., 2015)			√	√	The evaluators of the credit institution use multiple indicators for risk assessment which assume a central role in terms of decision-making and contribute for the approval or the rejection of the submitted projects; namely, the proven ability to pay, the financial records of project promoters, several financial restrictions, level of equity, level of financial indebtedness, evidence of the existence of a consumer market,



No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
						the proven experience of the partners/owners in the business, environmental aspects, etc.
25	(Nurlela & Suprpto, 2010)			√		By doing risk management is expected to target the right project cost, timely, and appropriate quality in the construction of the building infrastructure
26	(Wahyudhi & Utomo, 2014)	√				Sensitivity analysis aims to see feasibility investment if there is a change in the investment variable. The variables that are analyzed for sensitivity are changes in interest rates, changes in investment costs, and changes in selling or rental prices. From the sensitivity analysis it can be concluded that the alternatives to the system selling has a vulnerable safer on its merits, when there is a change in the investment variable.
27	(Ir. Putu Darma Warsika, M.M Sipil et al., 2016)	√				In a project feasibility study to find out the risks that may occur, there are many things that need to be studied including technical aspects, market aspects, financial aspects, legal aspects and aspects social and economic.
28	(Issn, 2010)		√			There are four fundamental constraints needed to be considered when managing the construction projects, which are scope, cost, time, and quality. In order to manage the projects successfully, it is necessary to consider whether the project is within those four constraints.
29	(Antonio J, 2011)			√		Construction companies are particularly vulnerable to financial risk due to the nature of the industry, extreme competition, relatively low entry barrier, high uncertainty and risk involved, and capricious fluctuations in construction volume.
30	(Moutinho & Lopes, 2015)		√			Higher project success is linked with higher frequency in the evaluation of strategic, financial, technical, commercial, and environmental and human resources aspects. When a project is successful, environmental and human resources aspects are analyzed. The analysis also allows us to conclude that social and organizational issues, for this sample of firms, are not directly related with project's success.
31	(Aloko, 2018)				√	The risk assessment process has been implemented for the potential risks that the construction industry confronts. These risks need mitigation measures by executing risk treatment policy to register, monitor and review the uncertain events.



No	Paper Identity	Safety Risk Factor				Result
		Client's Responsibility	Contractor's Responsibility	Shared Responsibility	Undecided Responsibility	
32	(Dziadosz & Rejment, 2015a)				√	Three different methods of the risk analysis as well as highlighting their disadvantages, advantages and primary areas of application (selection or pre-estimation).
33	(Iqbal et al., 2015)			√		Construction projects are facing a number of risks which have negative effects on project objects such as time, cost and quality. Two types of risk management techniques were considered: preventive techniques which can be used before the start of a project to manage risks that are anticipated during the project execution; and remedial techniques that are used during the execution phase once a risk has already occurred.
34	(Shevchenko et al., 2019)		√			In making investment decisions, risk assessment, and management is one of the main tasks. Risk management is an integral part of project management and investment solutions' assessment.
35	(Dziadosz & Rejment, 2015b)				√	The risk management in the construction industry requires a complementary, interdisciplinary, flexible approach allowing to capture the changing character of risk factors (qualitative, quantitative) as well as it requires a precise description and explanation of the mechanisms involved in the organization of construction production. Therefore, in developing of a risk assessment model in the construction projects it should be emphasized on the compilation even available and already recognized tools so to use a hybrid approach.
36	(Jayasudha & Vidivelli, 2015)		√			Construction project planning is an essential element in the management and execution of construction projects which involves the definition of work tasks and their interactions, as well as the assessment of required resources and expected activity durations.
37	(Tanzil et al., 2018)				√	On the investment implementation of that project, much risk can trigger project failed. Those risks can come both from internal and external. Therefore, funding project must be run properly both in internal and external factor.
38	(Rezaian, 2011)		√			Time, cost, quality and risk as four critical objectives of construction project management, are not independent but intricately related.
39	(Rahman & Adnan, 2020)		√			To minimize the impact of risks, an effective risk management approach must be incorporated into every project which also includes the



No	Paper Identity	Safety Risk Factor				Result
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						effectiveness and measurement of its performance.
40	(Sharma & Gupta, 2019)		√			The significance of this study is that understanding risk involved in construction projects at such an early stage (commencement) of the project will help construction practitioners to manage it in such a way that it has minimum negative effect on project targets and maximum positive results.

Based on the review of the articles above, it is found that the most likely risk in investment projects is a contractor's responsibility.

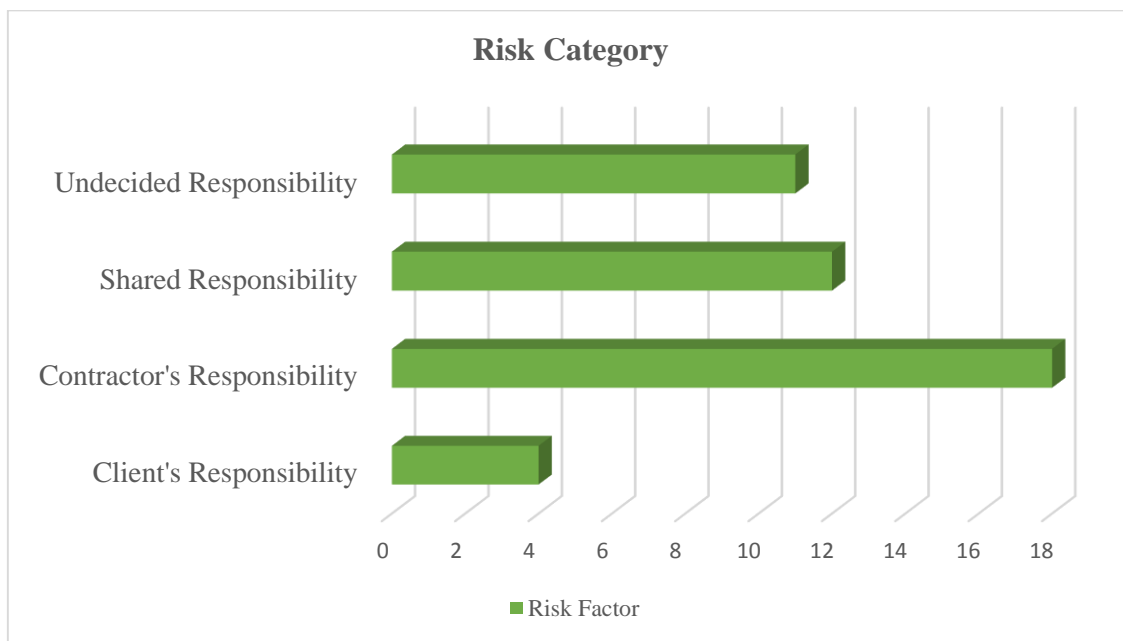


Figure 2. Bar chart Analysis of Research Articles Based on Risk Category in Investment Projects.

Table 1. The Recapitulation of Selected Journals Analyzed.

Risk Category	Research Journal
Client's Responsibility	18, 23, 26, 27
Contractor's Responsibility	2, 4, 5, 9, 11, 12, 13, 19, 20, 21, 22, 28, 30, 34, 36, 38, 39, 40
Shared Responsibility	1, 3, 7, 8, 10, 14, 15, 16, 24, 25, 29, 33
Undecided Responsibility	1, 6, 8, 10, 14, 17, 24, 31, 32, 35, 37

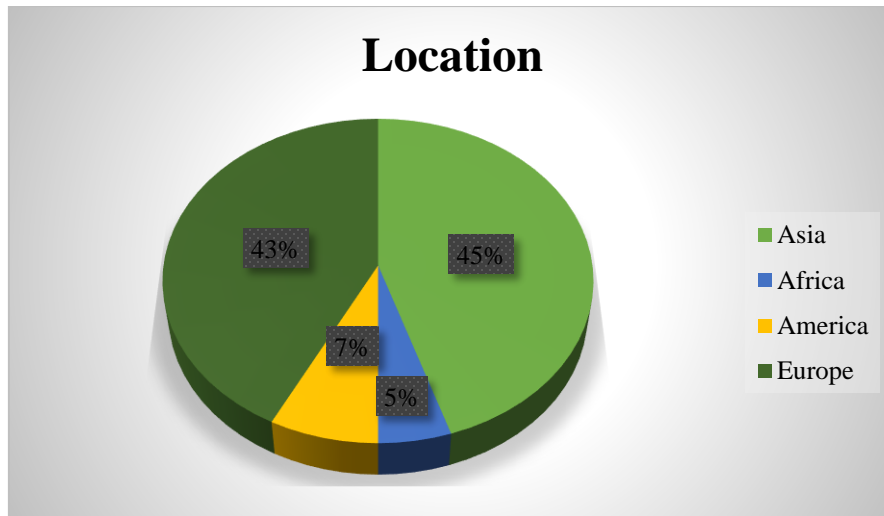


Figure 3. Bar chart Analysis of Research Articles Based on Location for Investment Projects.

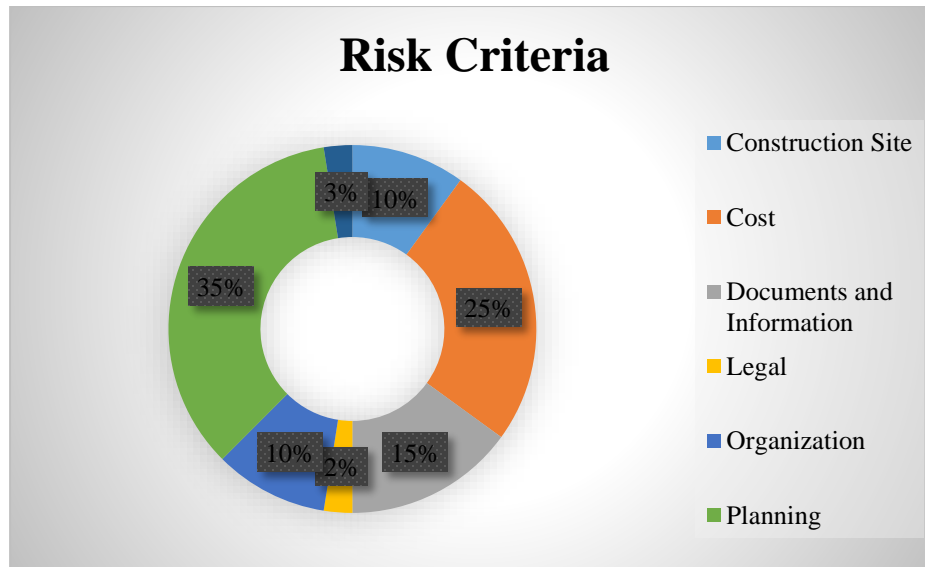


Figure 4. Bar Chart Analysis of Research Articles Based on Risk Criteria in Investment Projects

4. Conclusion

Construction projects are initiated in complex and dynamic environments resulting in circumstances of high uncertainty and risk, which are compounded by demanding time constraints. Risk management is thus in direct relation to the successful project completion. Project management literature describes a detailed and widely accepted risk management process, which is constructed basically from four iterative phases: risk identification, risk estimation, risk response planning and execution, often managing the risk management process is included. Two types of risk management techniques were considered: preventive techniques which can be used before the start of a project to manage risks that are anticipated during the project execution; and remedial techniques that are used during the execution phase once a risk has already occurred. The study revealed that financial issues for projects, accidents on site and defective design are the most



significant risks affecting most of construction projects. As further reported, the contractor is responsible for management of most risks occurring at sites during the implementation phase, such as issues related to subcontractors, labor, machinery, availability of materials and quality, while the client is responsible for the risks such as financial issues, issues related to design documents, changes in codes and regulations, and scope of work.

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