Revealing Risk Factors and Risk Levels in Housing Construction Projects in Sukoharjo Regency, Indonesia

Budi Priyanto[1,2,*], *Ika* Setyaningsih[2], *and Ardian Wahyu* Setyadi[2]

[1] PhD student in the Department of Civil Engineering and Built Environment, Universiti Tun Hussain Onn Malaysia
[2] Department of Civil Engineering, Universitas Muhammadiyah Surakarta, Jl Ahmad Yani Po. Box No. 1 Pabelan, Sukoharjo, Indonesia

Abstract. Business in the housing sector attracts many business actors to invest, because of the large market opportunities and high-profit prospects. However, numerous danger factors that occur because of the house-building process are present after this situation. Project goals are frequently not met by developers who lack the necessary project risk management skills. This study tries to identify risk variables and establish which factors in a housing development project have the highest risk level. An organized survey questionnaire was used for the investigation. Critical risk factors were identified by data analysis using SPSS version 26.0 software and the statistical method of the mean score. According to the viewpoint of the respondents who took part in the survey, the level of risk is established based on the frequency of risk occurrence and the severity of the danger. According to the findings, Sukoharjo Regency housing construction projects were at risk for 31 major reasons. Three risk factors are categorized as high risk, namely errors in estimating costs, not considering unexpected costs, and limited project funds, and 9 risk factors are categorized as moderate risk. Knowing the risk level of each factor will make it easier to manage project risk.

1 Introduction

The property sector is one of the most profitable sectors and indices for polishing a country's economic growth and development. Apart from affecting the welfare of a country, a well-performing property sector can provide an important foundation for all other sectors to fully realize their potential so that the economy can develop and remain competitive [1]. Businesses and communities cannot operate without commercial property services, including the supply of shops, offices, factories, housing, and many other types of property [2].

Property development projects are fraught with risks and uncertainties that pervade every stage of the development process. Risks and uncertainties, if not managed properly, can have a detrimental impact on a development project by affecting the project's time, quality, and cost [2]. Property development is a multi-phase process that involves developing land, followed by residential development (horizontal) or commercial buildings (vertical), ending with the marketing stage of the development through the completion of a sale or site lease. The three phases of the housing industry are interrelated, each stage involving various risks that are allocated between land owners, land developers, and house builders [3].

The construction industry such as real estate projects is very vulnerable to risk, with a complex and dynamic project environment that creates an atmosphere of uncertainty and high risk [4], [5]. The construction industry requires a large amount of investment for project implementation, and resources must be put to good use which can be achieved with proper risk management [6]. Investment decisions for real estate projects should accurately estimate risks in addition to advantages. Benefits and dangers coexist, and the more benefits there are, the greater the risks that come with them. [1]. Therefore, an appropriate risk management process can be vital to minimizing risk, maximizing opportunities, and securing a successful project process [7].

The main challenge facing the management of housing developers is being able to estimate the level of risk that occurs, as well as being able to estimate whether the risk management implemented in avoiding risk will run effectively and on target. Therefore, top management must research the numerous project risks and how to handle them using their training, prior experience, and other resources. Finding out how risky a housing development project is takes multifaceted abilities because doing so necessitates an understanding of economics, engineering, mathematics, and many other fields. [8]. To avoid the risk of developing housing, the parties need to know the critical risk factors in housing construction.

* Corresponding author: [1]bp225@ums.ac.id

2 Residential Development Process

Residential development is a process that creates environmental change by intensifying the use of land to provide shelter for the community. The integrated residential development process connects various phases or stages offering various action plans and construction activities to unlock property values [9]. Residential projects are risky projects and rank average on the middle level, so the project requires a risk management process [10].

The process of residential development is an entrepreneurial activity, and the developers' attention is primarily focused on four key issues: cost, time, quality, and safety. Numerous risk factors and decision-making processes are involved in the process. These elements have a direct impact on the actors and the creative process. Each residential project's performance during the development process may be threatened by project risk and several decision-related elements. Because the capacity to mitigate this risk declines throughout the project's life cycle, early project planning and monitoring becomes crucial. Throughout their development, residential projects will confront a variety of hazards that could tip the balance between the four guiding principles of cost, time, quality, and safety [11].

3 Risk Identification on Housing Development

Risk identification is the first step that is carried out in any risk management activity. The actions that should be taken in this process are to determine the causes of risk, determine the possible consequences of the occurrence of the risk, and, identify the entities that are affected by the risk. The results obtained from risk identification activities are a list of events that could potentially occur in a project and their risk classification [12]. Risk identification is an important process carried out by project managers to ensure the success of their projects. This success is evidenced by the completion time that is according to plan, cost-efficient, achieved the expected quality and maintained project safety. The project location is the first place that can be used to identify project risks. To help identify risks, you can use a list of project constraints, a list of tasks, and the factors that determine the success of the project itself [13].

Identification of risk factors can also be done by studying the literature and followed by investigations with field practitioners. Risk analysis and conclusions from previous research can also be used to help identify potential risks and to test the suitability of lists of identified risks with projects in a specific area, interviews with professionals and project managers are conducted to produce a risk register [14]. Risk identification must be carried out carefully and with an adequate system. Errors in identifying project risks have the potential to cause cost overrun, and time overrun and can cause social, environmental, and casualty damage during project implementation [13].

* Corresponding author: [1]bp225@ums.ac.id

Risk identification in this study was carried out in two stages. First, to list the risk factors for housing development projects that were collected from several similar studies conducted in previous studies. The second conducted interviews with 3 senior housing developer practitioners in Sukoharjo district [15]. The interview was conducted to clarify what risk factors were recorded in the list of risks faced by developers in Sukoharjo and to ask whether other risk factors had not been recorded in the list faced by the developers. From the results of risk identification of housing development in Sukoharjo district, it was found that 31 risk factors could potentially cause failure to achieve the objectives of housing development projects. A list of these potential risks is shown in Table 1.

Table 1. Risk Identification

No	Risk Factors	References
1	Increase in material prices.	[16] [17]
2	Late delivery of materials	[6] [16] [17]
3	Material Theft	[17] [18] [19]
4	Poor quality material	[6] [10] [17]
5	Excess use of material	[17]
6	Equipment not suitable for use	[6] [10]
7	Delay in delivery of equipment	[10] [17]
8	Low equipment productivity	[10][18]
9	Cost estimation error	[17] [20]
10	Unmanaged Cash flow	[17]
11	Illegal fees and unexpected fees	[17] [18]
12	Exchange rate fluctuation	[10] [17] [21]
13	Financial Problem for the Owner	[6] [22]
14	Incomplete Design	[20] [23] [22]
15	Inaccurate work methods	[17] [18]
16	Difficulty implementing technology.	[17][24]
17	Lack of communication	[16][17][24]
18	Lack of project manager experience	[17] [24]
19	Low project schedule control	[10] [17]
20	Lack of supervision	[17] [20]
21	Difficulty accessing the site	[10][17]
22	Poor site conditions	[17] [19] [25]
23	Catastrophes	[10] [20]
24	Difficult land acquisition conditions	[17]
25	Weather conditions (continuous rain)	[18]
26	Demonstration	[17][18]
27	Cultural conditions of the community	[6] [16] [17]
28	Delay in licensing	[6][18] [19]
29	Changes in government policy	[6][17] [21]
30	Health and Safety	[17][24]
31	Equipment failure	[6][17] [20]

4 Questionnaire Design

After identifying the risk factors, a risk analysis will be carried out to determine the level of the highest risks that exist in a housing development project. The data analyzed is data from the respondents' opinions obtained by using a questionnaire. Respondents are practitioners involved in housing development in the districts of Sukoharjo. The survey questionnaire that will be distributed is divided into two parts; the first part contains the respondent's profile while the second part contains the identified risk factors. Respondent data include the respondent's position in the company, the length of time he worked in the housing development project sector, and the respondent's educational qualifications. The second section lists the risk factors associated with 5 probability of occurrence scales (almost certain, likely, possible, unlikely, and rare) and 5 consequence scales (severe, large, moderate, minor, and negligible), according to ISO 31000. Respondents were asked to select one of 5 probability scales and one consequence scale by ticking each risk factor according to their beliefs.

5 Risk Assessment

Research data was obtained from the assessment of housing developer practitioners in Sukoharjo as many as 40 respondents filled out questionnaires. They have different educational backgrounds, positions in companies, and work experience (table 2). But they all work for real estate development companies. Judging from the position of the respondents, they are very appropriate because they are directly involved in project implementation so they understand the project problems. There are 68% of respondents directly in the field, namely, project managers and site managers, and 32% are directors who, although not always in the project, are fully involved in all the policies implemented in the project. Judging from the educational background of the respondents, 62% are graduates of Bachelor's and masters who are considered capable of understanding the questionnaire they fill out. Respondents who have worked for more than 5 years constitute the majority of respondents (92%). Long work experience has made respondents have sufficient experience in dealing with risks that occur in the project and the magnitude of the probability of risk events and their impact on the project.

Table 2. The Background of the Respondents

A.	**Position in the Company**	**Percentage**
	Director	32 %
	Project Manager	40 %
	Site Manager	28 %
B.	**Education Background**	**Percentage**
	High School	10 %
	Diploma	15 %
	Bachelor	53 %
	Master	9 %
C.	**Work Experience**	**Percentage**
	1 – 5 years	8 %
	6 – 10 years	27 %
	11 – 15 years	39 %
	16 – 20 years	23 %
	>20 years	3 %

In this study, risk is assessed based on its possible severity, namely the amount of potential loss that may occur which can be measured by calculating the value of the building lost, the cost of the loss that must be incurred, and the additional time required. Probability is judged from an event that is unlikely to occur to events that always occur. Therefore, in the assessment process, it is very important to make the best estimates so that they can be prioritized correctly [26]. The average index is used to determine the opinion of experts in assessing the probability and impact of each risk factor.

The risk level (R) is the product of the multiplication of two components, the consequence (C) or the amount of loss due to the occurrence of the risk with the probability (L) of the occurrence of the risk. The level of risk can be accessed mathematically as:

$$\text{Risk} = \text{Consequence} \times \text{Probability } (R = C \times L) \qquad (1)$$

The C and L scales are intervals from 1 to 5, the lowest R scale is 1 and the highest is 25.

Table 3 describes the possible processes and descriptions used to combine the level of crisis with the possibility to determine the level of risk. The value of R is used to establish the risk category. Low risk for R = 1 to 4, medium risk for R = 4.01 to 8, high risk for R = 8.01 to 12, and R = 12.01 or more are included in the Very high-risk categories. The number of risk categories specified in the table reflects the need for the study to be carried out. The risk category is also associated with the level of management attention that should be paid to that factor in considering or on the time scale of risk response or treatment.

Table 3. The Level of Risk

Consequences Scale	**Probability Scale**				
	Rare (1)	Unlikely (2)	Possible (3)	Likely (4)	Almost Certain (5)
Severe (5)	Medium (5)	High (10)	Very High (15)	Very High (20)	Very High (25)
Major (4)	Low (4)	Medium (8)	High (12)	Very High (16)	Very High (20)
Moderate (3)	Low (3)	Medium (6)	High (9)	High (12)	Very High (15)
Minor (2)	Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
Negligible (1)	Low (1)	Low (2)	Low (3)	Low (4)	Medium (5)

6 Discussion

Developers in Sukoharjo revealed that 31 risk factors must be considered in housing development projects. Table 4 shows the ranking of risk levels and provides a category for each risk factor. 3 risk factors have a high-risk category, 21 risk factors that are included in the moderate risk category, and 7 low-risk factors. There are no risk factors that fall into the very high-risk category.

Factors that have a high-risk category are cost estimation error (R=9.00), financial Problems to the owner (R=8.07), and illegal fees, fees, and unexpected fees (R=8.06). The cost estimation error factor occurs because the expert team involved in planning does not have sufficient experience. So they are less proficient in estimating project cost requirements, including material requirements, labor, estimated execution time, unexpected costs, and other factors. This usually happens

* Corresponding author: [1]bp225@ums.ac.id

https://doi.org/10.1051/e3sconf/202451705011

to new developers who don't have a team of experienced experts.

The impact of cost estimation errors on housing development projects is the occurrence of cost overruns, unexpected costs, inaccurate spending schedules, and so on. Several factors that cause financial problems to owners include incorrect project cost estimates, non-current credit, inability to manage cash flow, failure to achieve planned sales, or changes in financial policy at the crediting bank. The impact of this risk is fatal because it will cause the project to stop. After all, the owner does not fulfill short-term and long-term obligations. Illegal fees, unexpected costs, and fees occur due to poor social environmental factors of the project, work errors, damage to materials, tools, and home products, and so on. The existence of illegal levies in the licensing process, the implementation process, and bullying by criminals in the community are also the causes of illegal fees. The resulting consequence is cost overruns.

The project management team must focus on these three risk factors and from the start of the project they must anticipate that this does not happen or minimize the impact that occurs. While focusing on high risk, stakeholders also need to pay attention to risk factors in the medium category, especially those with a large R-value. With minimum financing, risk factors in the medium category still need to be anticipated so as not to cause significant risks. Against low-risk factors, stakeholders can ignore it.

Table 4. Ranking and Category of Risk

Ranking	Risk Factors	C	L	R	Category
1	Cost estimation error	2.95	3.05	9.00	High
2	Financial Problem for Owner	2.83	2.85	8.07	High
3	Illegal fees, fees, and unexpected fees	2.78	2.90	8.06	High
4	Lack of communication between parties	3.05	2.38	7.26	Medium
5	Lack of project manager experience	2.85	2.40	6.84	Medium
6	Lack of control over worker execution schedules	2.90	2.30	6.67	Medium
7	Unmanaged Cash flow	2.28	2.83	6.45	Medium
8	Increase in material prices	2.45	2.63	6.44	Medium
9	Material Theft	2.40	2.65	6.36	Medium
10	Poor quality material	2.30	2.65	6.10	Medium
11	Equipment that is no longer suitable for use	2.18	2.65	5.78	Medium
12	Late delivery of materials	2.25	2.43	5.47	Medium
13	Delay in delivery of equipment	2.23	2.45	5.46	Medium
14	Exchange rate fluctuation	2.23	2.38	5.31	Medium
15	Changes in government political policy	2.18	2.40	5.23	Medium
16	Low equipment productivity	2.50	2.05	5.13	Medium
17	Difficult land acquisition conditions	2.13	2.35	5.01	Medium
18	Lack of supervision	2.20	2.23	4.91	Medium
19	Excess use of material	2.28	2.15	4.90	Medium
20	Delay in licensing	2.13	2.25	4.79	Medium
21	Incomplete Design	2.13	2.05	4.37	Medium
22	Demonstration	2.25	1.93	4.34	Medium
23	Poor site conditions	2.25	1.88	4.23	Medium
24	Catastrophes (floods, earthquakes, fire)	2.28	1.85	4.22	Medium
25	Difficulty implementing new technologies	1.95	2.00	3.90	Low
26	Difficulty accessing the site	2.05	1.90	3.90	Low
27	Inaccurate work methods	1.90	1.93	3.67	Low
28	Weather conditions (continuous rain)	2.13	1.70	3.62	Low
29	Equipment failure	1.90	1.55	2.95	Low
30	Cultural conditions of the community	1.78	1.53	2.72	Low
31	Health and Safety	1.80	1.38	2.48	Low

* Corresponding author: [1]bp225@ums.ac.id

7 Conclusion

The three levels of risk categories should become a reference for the housing development management team in Sukoharjo district in managing housing development projects. Priority management is prioritized for the high-risk category, which includes cost estimation errors, and financial problems for owners, as well as illegal fees, charges, and unexpected charges. so that the incident does not occur or at least the impact of the loss is minimal. The second priority in risk management is the medium risk category. Risks with risk categories are the last priority and are even ignored.

References

1. L. Lin and L. Fei, "Real estate investment project risk analysis," *J. Chem. Pharm. Res.*, **6**, no. 5, pp. 1789–1794, 2014.
2. O. C. Nnamani, "Application of risk management techniques in property development projects in Nigeria : a review Risk and Uncertainty," no. 2012, pp. 1–15, 2008.
3. R. J. Buttimer, S. P. Clark, and S. H. Ott, "Land development: Risk, return and risk management," *J. Real Estate Finance. Econ.*, **36**, no. 1, pp. 81–102, 2008, doi: 10.1007/s11146-007-9077-z.
4. S. T. Namitha Sheen, R. Shanmuga Priyan, and S. Sugumar, "A Review on Risk Management in Residential Projects," *Int. J. Eng. Res.*, **6**, no. 11, 2017, doi: 10.17577/ijertv6is110150.
5. B. Priyanto, M. N. Sahid, M. Solikin, and J. Al Faruqi, "Investigation of Critical Risk Factors and Level of Risk for Environmentally damage induced by house projects," *Casp. J. Environ. Sci.*, **20**, no. 2, pp. 413–421, 2022, doi: 10.22124/CJES.2022.5589.
6. A. A. Prakash, D. K. N. Manikanta, and S. M. Prabhu, "Risk assessment of residential buildings in the Indian construction industry by application of fuzzy," *Int. J. Civ. Eng. Technol.*, **8**, no. 4, pp. 884–894, 2017.
7. J. Bonander and H. Ulriksson, "Risk Management in Residential Construction," 2016.
8. K. Mallik, "Factors and Impact of Risk Management Practice on Success of Construction Projects of Housing Developers, Kathmandu, Nepal," *Int. J. Sci. Basic Appl. Res.*, **36**, no. 7, pp. 206–232, 2017.
9. G. Costello and F. Preller, "Property development principles and process - an industry analysis," *Pacific Rim Prop. Res. J.*, **16**, no. 2, pp. 171–189, 2010, doi: 10.1080/14445921.2010.11104300.
10. M. Fergany, M. Badawy, and O. El-nawawy, "Risk assessment Model for Residential Construction Projects Risk assessment Model for Residential Construction Projects," no. September, pp. 328–337, 2019.
11. M. Khandekar, P. N. Futane, and P. S. S. Sabihuddin, "Study of Factors Influencing Residential Real Estate Development Process," **7**, no. 7, pp. 13303–13307, 2017.
12. P. Szymański, "Risk management in construction projects," *Procedia Eng.*, **208**, pp. 174–182, 2017, doi: 10.1016/j.proeng.2017.11.036.
13. E. Cheraghi, M. Khalilzadeh, S. Shojaei, and S. Zohrehvandi, "A Mathematical Model to Select the Risk Response Strategies of the Construction Projects: Case Study of Saba Tower," *Procedia Comput. Sci.*, **121**, pp. 609–616, 2017, doi: 10.1016/j.procs.2017.11.080.
14. W. Wang, Y. Wu, and M. Sloan, "A framework & dynamic model for reform of residential land supply policy in urban China," *Habitat Int.*, **82**, no. January, pp. 28–37, 2018, doi 10.1016/j.habitatint.2018.10.006.
15. M. F. Wajdi, A. A. Setyawan, Syamsudin, and M. Isa, "Manajemen Risiko Bisnis Umkm Di Kota Surakarta," *BENEFIT J. Manaj. dan Bisnis*, **16**, no. 2, pp. 116–126, 2012, [Online]. Available: http://journals.ums.ac.id/index.php/benefit/article/view/1359/915.
16. A. Qazi, J. Quigley, A. Dickson, and K. Kirytopoulos, "Project Complexity and Risk Management (ProCRiM): Towards modeling, project complexity is driven risk paths in construction projects," *Int. J. Proj. Manag.*, **34**, no. 7, pp. 1183–1198, 2016, doi: 10.1016/j.ijproman.2016.05.008.
17. R. R. Rumimper, B. F. Sompie, and M. D. J. Sumajouw, "Analisis Resiko Pada Proyek Konstruksi Perumahan di Kabupaten Minahasa Utara," *J. Ilm. Media Eng.*, **5**, no. 2, pp. 381–389, 2015.
18. B. Partamihardja, "Persepsi Risiko Pengembang Perumahan Di Kabupaten Banyumas," *J. Tek. Sipil dan Perenc.*, **16**, no. 2, pp. 105–116, 2016.
19. R. Mubarak, S. Murtiadi, and H. Sulistiyono, "Analisis resiko developer dalam perumahan di kota Mataram," pp. 19–25, 2015.
20. S. Iqbal, R. M. Choudhry, K. Holschemacher, A. Ali, and J. Tamošaitienė, "Risk management in construction projects," *Technol. Econ. Dev. Econ.*, **21**, no. 1, pp. 65–78, 2015, doi: 10.3846/20294913.2014.994582.
21. H. Bon-Gang, "Risk Assessment and Mitigation

* Corresponding author: [1]bp225@ums.ac.id

Measures for Green Construction Projects," *Perform. Improv. Green Constr. Proj.*, pp. 211–233, 2018, doi: 10.1016/b978-0-12-815483-0.00013-2.

22. M. Shan, B. Gang Hwang, and K. S. N. Wong, "A preliminary investigation of underground residential buildings: Advantages, disadvantages, and critical risks," *Tunn. Undergr. Sp. Technol.*, **70**, no. July, pp. 19–29, 2017, doi: 10.1016/j.tust.2017.07.004.

23. F. Soomro, M. Memon, A. Chandio, S. Sohu, and R. Soomro, "Causes of Time Overrun in Construction of Building Projects in Pakistan," *Eng. Technol. Appl. Sci. Res.*, **9**, no. 1, pp. pp. 3762–3764, 2019, doi: 10.5281/zenodo.2576277.

24. B. G. Hwang, M. Shan, H. Phua, and S. Chi, "An exploratory analysis of risks in green residential building construction projects: The case of Singapore," *Sustain.*, **9**, no. 7, pp. 9–11, 2017, doi: 10.3390/su9071116.

25. M. Isa, M. Farid Wajdi, A. A. Setyawan Pusat Studi Penelitian dan Pengembangan Manajemen dan Bisnis UMS, and J. A. Yani Pabelan Kartasura Surakarta, "Strategi Penguatan Kapasitas Stakeholder Dalam Adaptasi Dan Mitigasi Banjir Di Kota Surakarta," *J. Manaj. dan Bisnis*, **17**, no. 2, pp. 99–110, 2013.

26. New Partners Initiative Technical Assistance, "Developing a Risk Management Plan," 2010.

* Corresponding author: [1]bp225@ums.ac.id