Risk Identification and Assessment in Sustainable Housing Project: A Case of Housing Sector in Pakistan

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ABSTRACT

Purpose: The study aims to identify the risk factors that are associated with the housing projects in Pakistan based on their relative importance. Moreover, this study intends to highlight the extreme, high and low risks that are involved in housing projects.

Design/Methodology/Approach: The study adopts the quantitative research method and conducted a survey through a five-point Likert scale questionnaire. The study has collected 168 responses from the project managers, contractors, designers and consultants of housing projects in Pakistan. In order to examine the relative importance of the risk, the study has applied the Relative Importance Index (RII) method to analyse the risks.

Findings: The results of the study depict that there are five extreme risks, ten high risks and 13 low risks which may contribute harm the sustainability of the housing projects. Moreover, all the critical risk factors have high probability of occurrence and extreme impact on the sustainability of the housing projects in Pakistan.

Implications/Originality/Value: The practitioners are recommended to develop such projects that should not damage the ecology of the region in which they are located. Also, the land should be determined on the basis of sociological and environmental consideration and not on land value alone.

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Introduction

In the housing industry risk plays a significant role hence it is known of being borne to risks. Due to risk quality problems, safety, cost overruns and schedule delays may be caused also it can exert negative impacts on achieving project objectives. Alternately, throughout the lifecycle of a project a formal and orderly process is required which is termed as risk management (Zhang et al., 2019).
It systematically identify, analyse and respond to risk. Since the uncertainty is linked to several aspects that contribute to the objective of sustainable housing construction, a sustainable risk assessment has been devised to gather more information regarding it. The main aim of sustainable housing project is to reduce environmental pollution, reducing the consumption of resources and energy (Taghizadeh-Hesary & Yoshino, 2020).

Though still conserving the planet's most essential resources for upcoming generation, the process of achieving our everyday needs is sustainability. Achieving sustainability is one of the goals of the housing sector of Pakistan. Owing to this goal the concept of sustainable housing construction has been taken place (Siraj & Fayek, 2019). It is related to design, construction and operations of green building projects. Sustainable housing projects are the new branch of the construction industry. Thus, new technology and methodologies must be used in projects. in order to achieve these goals (Chan & Adabre, 2019).

On the society, environment, economic and social aspect the housing industry has massive impacts. Since the public's knowledge of ecological concerns has grown, sustainability has become a hot topic and waste being one of the major issue (Adabre et al., 2021). Through two-third of waste emerging from construction Pakistan have now develop into one of the main producers of unwanted and excess material as the housing industry is growing in the country (Serrano-Jiménez et al., 2021).

Recently throughout the world sustainable housing projects are being encouraged. Especially with the regulatory incentives by the government individual have started to think about sustainable housing projects. Pakistan over the past years has experienced a boom in housing industry (Saidu & Yeom, 2020). Due to environment activist on a small scale the urge to shift to sustainability housing is being encouraged. Also this transition toward conservation will eventually become a must, therefore it is being enforced by government (Heffernan & De Wilde, 2020). These risks majorly include incapacity to complete the project under economical price restrictions, as well as ineffective ecological project management. In Pakistan the housing industry faces most significant risk majorly due to inflation, sudden changes in prices and delay (Abdullah & Alshibani, 2021). Therefore, for projects success it is important to stress on the inevitability of managing risk factors as an essential criteria (Triana et al., 2021).

Also, there are certain risks which are related to Inflation is an example of both conventional and sustainable project. Another concern is a lack of green resources and the longevity of materials, both of which are solely associated with sustainable initiatives. More importantly, risk such as design changes and poor construction quality are more critical for sustainable projects (Salim & Dabous, 2022). It has become necessary now to identify hazards unique to green building projects in Pakistan as there is a significant growth in urban projects in the nation, and to enforce energy efficiency in buildings project has been introduced (Zeina, 2022).

Because this field of study has not previously been investigated or implemented in Pakistan, the risk assessment associated with these specific initiatives has become a critical research subject. Furthermore, due to anticipated growth in the field of sustainable housing construction it is imperative to study the risk related to it (Oluleye et al., 2021). As with the advancement in sustainable construction there is requirement of information however, marginal info is available concerning risks in ecological housing projects in the Pakistan. Hence the aim of this study is to identify risks in sustainable housing projects along with assessing the identified risk based on the risk severity (Aris et al., 2019). Pakistan has obvious sustainable house projects crisis. A number of policy directions for the future can be extracted from this study (Patel, 2020). However, not many studies in the past literature have studied thus the study would be helpful for practitioners to comprehend what risks should be considered priory for management and assessment (Karji et al.,
Also, certain professionals are required who can deal with the phenomena of sustainable housing and support and guide it in the future, thus research leading to an understanding of the processes will help create such professionals. It is vital that academic institutions give great importance to housing related community projects (De Wilde, 2019). But the studies related to sustainable housing projects are very limited (Francis et al., 2019). Hence both practitioners and academicians from the study’s findings would be able to comprehend what risk are associated with sustainable housing in emerging economy and how they can be prevented in effective way (Burroughs & Růžička, 2019).

**Literature review**

**Risk identification**

The success of building housing projects is influenced by a number of factors. These dangers were discovered after a thorough assessment of the literature. Some dangers are exclusive to sustainable housing initiatives, while others apply to both sustainable and regular housing. Management, technical, green team (stakeholders), green materials and technology, regulatory and economic risks are categorized into five categories (Siraj & Fayek, 2019).

**Management risks**

Management risks are the ones that might arise while supervising the construction of housing project. Restricted timetables are a danger because owners may impose schedules that are unrealistic and impossible to meet (Santos et al., 2019). This danger may be greater in sustainable housing projects, as green housing takes longer than regular building. Because dealing with sustainable aspects is more difficult, sustainable initiatives need thorough consideration of their practicality (Badi & Murtagh, 2019). When clients have financial difficulties, it puts the contractor at danger. Having a academic knowledge of green construction, their lack of implementation pose s a significant danger. Finally, because sustainable house building necessitates a high performance standard and excellent construction quality, the low quality of sustainable housing construction is a concern (Mavi & Standing, 2018).

<table>
<thead>
<tr>
<th>Table 2.1: Management Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unreasonably tight schedule for sustainable construction</td>
</tr>
<tr>
<td>Improper sustainable project feasibility and planning</td>
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<tr>
<td>Shortage of clients’ funding</td>
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<tr>
<td>Inaccuracy in project budgeting due to unfamiliarity in green projects</td>
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<tr>
<td>Poor project manager skills related to sustainable construction</td>
</tr>
<tr>
<td>Additional costs due to green material and equipment</td>
</tr>
<tr>
<td>Poor quality of sustainable construction work</td>
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</table>

**Technical Risks**

During the development of a housing project, technical hazards may arise, including design revisions, deficient or erroneous ecological plan material, delays due to numerous consultations with green specialists, and so on.. Due to a lack of green materials research, there is a danger of incorrect or inadequate green standards (Opoku et al., 2019). Another danger that may result from a contractor’s lack of expertise is a bad choice of housing construction procedures. The third technical risk is low labour and equipment productivity in the construction of sustainable houses (El-Sayegh et al., 2021).
Table 2.2: Technical Risks

- Design changes
- Insufficient or incorrect sustainable design information
- Improper or incomplete green specifications
- Poor scope definition of sustainable housing project
- Failure to meet green code or certification
- Delay caused by frequent meetings with green specialist
- Poor selection of construction techniques in sustainable housing project
- Poor productivity of labor and equipment in sustainable housing project

Green team (stakeholders) Risks
Stakeholders, sometimes known as the green team, are the third group. Only risks that influence sustainable house building are covered in this category; conventional housing construction projects are not affected. This category includes risks such as client reluctance to new green ideas and consultants' and contractors' lack of experience (Guan et al., 2020). One of the difficult issues project managers confront is workers' aversion to changing their old habits (Ahmad et al., 2019).

Table 2.3: Green Team (Stakeholders) Risks

- Resistance from the client to adopt new green ideas
- Limited experience of the consultant about sustainable housing project
- Limited experience of the contractor about sustainable housing project
- Limited availability and reliability of green subcontractors
- Limited availability and reliability of green suppliers
- Shortage in labor skilled in sustainable housing project

Green Materials and Technology Risks
Green materials and technology are the fourth category. This category includes the risks associated with material shortages, handling, and quality. Advanced green materials are commonly used in green housing construction to increase sustainable performance; nevertheless, these materials have not been well explored, posing the possibility of poor performance (Li et al., 2019). Furthermore, improper handling and storage would degrade the quality of the green materials, increasing the danger. Finally, the absence of papers for novel sustainable technology poses a danger since the contractor might be unaware of the material's specs and hence might be unaware of what should be done to achieve the best outcomes (Adabre & Chan, 2020).

Table 2.4: Green Material and Technology Risks

- Poor performance of green materials
- Shortage of green materials
- Long lead time for green materials
- Inappropriate handling and storage of green materials
- Lack of documents and information for new green technologies

Regulatory and Economic Risks
Regulatory and economic risks are final category. These include any government-enforced laws or regulations, as well as any potential economic downturn. The project start date is delayed due to delays in government clearances for green housing construction. Furthermore, variations in ecological housing rules and guidelines are occurring at a rapid rate therefore it is impractical to
expect the project to be compliant and consistent with the new norms, causing the project to be delayed (Taghizadeh-Hesary & Yoshino, 2020). Inflation is defined as an increase in the price level of goods and a decline in the buying power of currencies, both of which can result in cost overruns. Inflation is a danger in all types of housing building projects; thus it would pose a significant risk in sustainable house development as well (Adabre et al., 2022).

Table 2.5: Regulatory and Economic Risks

<table>
<thead>
<tr>
<th>Risk Factor</th>
</tr>
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<tbody>
<tr>
<td>Delay in government approvals for green housing project</td>
</tr>
<tr>
<td>Changes in sustainable construction codes and regulations</td>
</tr>
<tr>
<td>Inflation of green materials’ prices</td>
</tr>
<tr>
<td>Currency volatility worsened by the import of green materials</td>
</tr>
</tbody>
</table>

Methodology
Sample and population
Based on the criteria-based non-probability purposive sampling technique, 150 project managers, contractors, consultants and designers have been approached for data collection that have prior experience with the housing projects and are currently involved in some green housing projects in Pakistan. Email has been sent individually with an attached URL of Google Form for data collection. However, only 68 responses have been collected that are valid for analysis and therein, the response rate was 45.33 percent.

Data Collection
A five-point Likert scale questionnaire has been adapted from El-Sayegh et al. (2021) comprising 30 risk factors in the construction industry of UAE while these 30 statements have been revised and restructured for green housing projects in Pakistan. The questionnaire was categorized into three sections. 1st section comprised of demographic information of the respondents; 2nd section comprised of the 30 risk-related statements with the rating-scale based on probability of occurrence for each risk factor. The rating scale for 2nd section denoted 1 as very low probability of occurrence and 5 as very high probability of occurrence. The 3rd section has the same 30 risk-related statements based on their impact denoting 1 as very low impact and 5 as very high impact.

Data analysis

Relative Importance Index (RII) has been calculated using MS Excel 2016 as used in numerous past studies related to risk anticipations in different sectors (Amarkhil et al., 2021; Genc, 2021; Gündüz et al., 2013; Kassem et al., 2020). The estimation formula for RII is as follows.

\[ RII = \frac{\sum W}{A*N} \]

In the above RII equation, W represents weighting given to each factor by the respondent (i.e. 1, 2, 3, 4, and 5); A represents highest weight in the scale i.e. 5; and N represents the total number of respondents i.e. 68.

Results and Findings

Demographic profile of the respondents
The following table 4.1 shows the demographic profile of 68 respondents.

Table 4.1: Demographic Profile (n = 68)

<table>
<thead>
<tr>
<th>Years of Experience</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10</td>
<td>23</td>
<td>33.8</td>
</tr>
<tr>
<td>10 to 20</td>
<td>25</td>
<td>36.8</td>
</tr>
<tr>
<td>More than 20</td>
<td>20</td>
<td>29.4</td>
</tr>
</tbody>
</table>
Overall risk significance against probability of their occurrence during housing projects in Pakistan
Among the thirty identified risks related to housing projects in Pakistan, the top five risks have
been highlighted in the following table 4.1 for their probability of occurrence and probability of
impact; based on their RII ranking.

Table 4.2: Estimation of Overall Risk Significance

<table>
<thead>
<tr>
<th>Risks</th>
<th>Probability</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unreasonably tight schedule for sustainable construction</td>
<td>0.151</td>
<td>0.183</td>
</tr>
<tr>
<td>Improper sustainable project feasibility and planning</td>
<td>0.162</td>
<td>0.177</td>
</tr>
<tr>
<td>Shortage of clients’ funding</td>
<td>0.168</td>
<td>0.179</td>
</tr>
<tr>
<td>Inaccuracy in project budgeting due to unfamiliarity in green projects</td>
<td>0.166</td>
<td>0.174</td>
</tr>
<tr>
<td>Poor project manager skills related to sustainable construction</td>
<td>0.154</td>
<td>0.172</td>
</tr>
<tr>
<td>Additional costs due to green material and equipment</td>
<td>0.150</td>
<td>0.171</td>
</tr>
<tr>
<td>Poor quality of sustainable construction work</td>
<td>0.139</td>
<td>0.168</td>
</tr>
<tr>
<td>Design changes</td>
<td>0.139</td>
<td>0.163</td>
</tr>
<tr>
<td>Insufficient or incorrect sustainable design information</td>
<td>0.144</td>
<td>0.162</td>
</tr>
<tr>
<td>Improper or incomplete green specifications</td>
<td>0.146</td>
<td>0.173</td>
</tr>
<tr>
<td>Poor scope definition of sustainable housing project</td>
<td>0.146</td>
<td>0.175</td>
</tr>
<tr>
<td>Failure to meet green code or certification</td>
<td>0.155</td>
<td>0.169</td>
</tr>
<tr>
<td>Delay caused by frequent meetings with green specialist</td>
<td>0.149</td>
<td>0.168</td>
</tr>
<tr>
<td>Poor selection of construction techniques in sustainable housing project</td>
<td>0.151</td>
<td>0.176</td>
</tr>
<tr>
<td>Poor productivity of labor and equipment in sustainable housing project</td>
<td>0.135</td>
<td>0.176</td>
</tr>
<tr>
<td>Resistance from the client to adopt new green ideas</td>
<td>0.122</td>
<td>0.179</td>
</tr>
<tr>
<td>Limited experience of the consultant about sustainable housing project</td>
<td>0.142</td>
<td>0.179</td>
</tr>
<tr>
<td>Limited experience of the contractor about sustainable housing project</td>
<td>0.132</td>
<td>0.163</td>
</tr>
<tr>
<td>Limited availability and reliability of green subcontractors</td>
<td>0.119</td>
<td>0.168</td>
</tr>
<tr>
<td>Limited availability and reliability of green suppliers</td>
<td>0.119</td>
<td>0.161</td>
</tr>
<tr>
<td>Shortage in labor skilled in sustainable housing project</td>
<td>0.129</td>
<td>0.163</td>
</tr>
<tr>
<td>Poor performance of green materials</td>
<td>0.101</td>
<td>0.172</td>
</tr>
<tr>
<td>Shortage of green materials</td>
<td>0.098</td>
<td>0.162</td>
</tr>
<tr>
<td>Long lead time for green materials</td>
<td>0.138</td>
<td>0.163</td>
</tr>
<tr>
<td>Inappropriate handling and storage of green materials</td>
<td>0.111</td>
<td>0.166</td>
</tr>
<tr>
<td>Lack of documents and information for new green technologies</td>
<td>0.138</td>
<td>0.164</td>
</tr>
<tr>
<td>Delay in government approvals for green housing project</td>
<td>0.142</td>
<td>0.154</td>
</tr>
<tr>
<td>Changes in sustainable construction codes and regulations</td>
<td>0.133</td>
<td>0.155</td>
</tr>
<tr>
<td>Inflation of green materials’ prices</td>
<td>0.112</td>
<td>0.161</td>
</tr>
<tr>
<td>Currency volatility worsened by the import of green materials</td>
<td>0.119</td>
<td>0.172</td>
</tr>
</tbody>
</table>
In the above table; thirty prequalified and segmented risks have been assessed to estimate their probability of occurrence and impact on the housing projects of Pakistan. The results have been discussed in the following section while the above ranking has been based on the RII rating of each risk.

**Risk Assessment Based on their Probability of Occurrence**

Shortage of clients’ fund has been ranked most critical risk among all 30 based on its RII (16.8%). This might be due to the fact that there is usually economical as well as political turbulences in Pakistan, hence investors refrain from devoting their funds in huge amounts, because they often fear losing their money in these uncertain situations (Li, 2019). Often times there are other issues with banks, contractors, investors which can hinder the process of easy funds transfer. Communication gaps also might be the cause behind it (Ghufran et al., 2021).

Furthermore, project budgeting has been identified as 2nd critical risk in housing projects of Pakistan due to unfamiliarity with green projects (RII = 0.166). Although unexpected weather or events beyond people's control might have an influence on budgets, most project overruns are the consequence of poor analysis or planning before construction even begins (Chan & Aghimien, 2022). In addition to improved planning, technology may assist to decrease frequent problems or aspects that lead to cost overruns, allowing to uproot efficiency and revenues (Amirtash et al., 2021).

Moreover, improper planning and feasibility skills and capacity has been identified as 3rd critical risk due to its 16.2 percent probability of occurrence (RII = 0.162). There are many reasons responsible for this critical risk in Pakistan. A feasibility study must be included in the pre-contract process that should be prepared with great care (Al Saadi & Rahman, 2019). In every expansion, a valuer or quantity surveyor must be employed by the clients to conduct a market and financial feasibility analysis. There is a critical necessity for a feasibility study so that the owner may analyse the development's potential ROI and viability to move forward with the planned project (Al-Kilidar & Hasib, 2021).

Additionally, 4th critical risk has been identified as the failure to meet green requirement, code of conduct and certification by the housing projects based on its 15.5 percent probability of occurrence in the housing projects of Pakistan (RII = 0.155). The biggest factor contributing to this risk is the lack of awareness, green knowledge, green consciousness and simply lack of care (Khan et al., 2021). In Pakistan, government and officials do not really care about ecological harms they are doing to the planet and their carbon footprint. Contractors, project managers and clients, all the stakeholders should be held responsible and the government of Pakistan should also bring such laws to counter this critical risk factor and promote sustainable building (Azeem et al., 2020).

However, 5th critical risk in the housing projects of Pakistan has been identified as poor skills of the project manager towards sustainable/green project practices (RII = 0.154). Here, in Pakistan, due to lack of proper training and counselling of project managers, they do not have enough knowledge and skills required to make their construction projects sustainable and eco-friendly (Hussain et al., 2019). Also, it is observed that project managers do not put conscious efforts and usually don’t take the initiative to increase their knowledge in this regard (Fitriani & Ajayi, 2022). This is indeed a major drawback and therefore this critical risk stands at 5th position in this study, in terms of their probability of occurrence.

**Risk Assessment Based on their Anticipated Impact**

The unreasonably tight schedule of the project processes has been identified as the most impactful risk on the housing project performance in Pakistan (RII = 0.183). Due to lack of pre-planning managers often face this risk during construction projects in Pakistan. One of the most common errors that a firm may make is attempting to complete a whole project in one go (Buniya et al.,
It can be easily countered through breaking down the project in manageable and easy subprocesses. Also, setting priorities and pre-scheduling and planning of the project will help dealing with this risk that can have a significant impact on the housing project performance in Pakistan (Yiu et al., 2019).

Additionally, the clients’ resistance to adopt new green ideas and practices has been anticipated as the 2nd impactful risk factor on housing projects in Pakistan (RII = 0.179). Lack of knowledge and awareness are a major factor contributing negatively in this regard (Shankar & Kumari, 2019). In addition, clients often feel that a sustainable way of living is typically more expensive. Also the lack of enforcement by the government and concerned authorities are seemingly contributing towards the resistance to adopt new green ideas and practices (El-Sayegh et al., 2021).

Furthermore, shortage of the clients’ fund found as the 3rd impactful risk factor on housing projects in Pakistan (RII = 0.179). Shortage of financial resources often causes delays in the construction project and it may easily be the most significant source of additional costs and loss of financial return or other advantages from the project (Eyiah et al., 2019). As a result, shortage of funds may actually be costly for both the owner and the contractor, in the long run. This can be countered through early success in the construction process and having an efficient portfolio to gain ultimate trusts of your investors (Peters et al., 2019).

Likewise, contractors’ limited experience and exposure with green/sustainable housing projects found as the 4th impactful risk factor with a RII of 0.179. Since Pakistan is a developing nation, there are not many options available for the contractors to improve their experience and exposure with green/sustainable housing projects (Bodaghi, 2020). Few of the construction companies who are currently employing sustainable methods in construction, are often high profile and maximum security. Therefore, there are very less chances for common contractors to increase their exposure and experience sustainable building methods first hand (Young, 2020).

Lastly, project feasibility and planning has been identified as the 5th most impactful risk factor in housing projects of Pakistan (RII = 0.177). A feasibility study must be conducted at the start to assess the practicality of the project to determine whether or not you can proceed with the project. Similarly, pre-planning is a must, which is often neglected due to lack of knowledge, awareness, and experience of the project managers and contractors (Hatmoko et al., 2019).

**Conclusion and Recommendations**

Through the data analysis of the current study, it can be concluded that the shortage of clients’ fund is the most critical risk, according to the respondents. Shortage of the funds and timely availability of the finances, not only hinder the process of construction but also proves to be costly in the long run. The delays in payments and non-availability of materials are the main results of this critical risk. Project budgeting was found to be the 2nd critical risk in housing projects of Pakistan due to unfamiliarity with green projects. Third most critical risk was improper planning and feasibility skills and capacity. Next most critical risk according to the respondents of the study is the failure to meet green requirement, code of conduct and certification by the housing projects in Pakistan. Furthermore, the next five critical risks are based on their anticipated impact in the construction sector of Pakistan. The shortage of the clients’ fund was found to be the third most impactful risk. The second last risk was concluded to be contractors’ limited experience and exposure with green/sustainable housing projects. Lastly, the fifth and final critical risk based on its anticipated impact in the housing industry of Pakistan is identified as project feasibility and planning.

**Recommendations**

The practitioners should recognise and evaluate the possible risks in green housing projects as Risk identification and evaluation are critical components of risk management in construction. Because
of this component, effective risk response, development, and switch is also imperative. The academicians are implicated to identify more risk by analysing previous empirical studies. Since Pakistan has contrasting risk factors as compared to other nations, the academicians should conduct studies so that differences of risk can be highlighted as risk are exclusive in other economies. The academicians and researchers are further implicated to properly implement the project management methods with a specific emphasis on green construction programs so that major management risk can be addressed. While dealing with specific clients the contractors should take extra care as they may have funding problems.

Other important risks are technical. This category contains risk that are solely because of shortage of design experience in sustainable building projects. Thus, individuals who have experience in sustainable housing projects should select appropriate designers. Also during the project execution, they should be able to create a sound design with little alterations. The practitioners are recommended to develop such projects that should not damage the ecology of the region in which they are located. Also the land should be determined on the basis of sociological and environmental consideration and not on land value alone. In order to asses and prevent risk it is necessary that all future developments a minimum density of person per hectar should be enacted. Against the corruption of land the civil society groups should support indigenous movement against the occupation of their land by developers so that the courts of law could pursue this issue seriously.

The risks are also associated with designs and these are technical risks. In order to asses them and to reduce cost and improve design it is implicated to practitioners to create a design department which produces standardized design for homes and apartments which can guide developers and individual families. The study has certain limitations. However, the study has only investigated the two factors that are related to risk such as identification and assessment. Therefore, the future researchers are implicated to consider other factors of risk such as management, prevention, tolerance and after effects of risk as this would help the future practitioners and academicians to understand the housing projects risk efficiently. While the futures studies should consider other risk related to housing projects such as environmental risk so that the housing projects can flourish well in the future. Also the future researchers are implicated to look into management strategies so that risk related to housing projects can be prevented and maintained efficiently.

References


spearman’s rank and relative importance index integrated approach. Canadian Journal of Civil Engineering, 48(11), 1498-1507.


Li, J. (2019). Research on Risk Control Measures of Construction Project under the Model of PPP.


Young, D. (2020). *Sustainable construction in the real estate value chain through land conversion planning and development activities: a study in the greater Durban area* Faculty of Engineering