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Prioritization Assessment of Housing Development Risk Factors: A Fuzzy Hierarchical Process-Based Approach

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Abstract**—**The construction industry and housing subsector are fraught with risks that have the potential of negatively impacting on the achievement of project objectives. The success or otherwise of most construction projects depends to large extent on how well these risks have been managed. The recent paradigm shift by the subsector to use of formal risk management approach in contrast to hitherto developed rules of thumb means that risks must not only be identified but also properly assessed and responded to in a systematic manner. The study focused on identifying risks associated with housing development projects and prioritisation assessment of the identified risks in order to provide basis for informed decision. The study used a three-step identification framework: review of literature for similar projects, expert consultation and questionnaire based survey to identify potential risk factors. Delphi survey method was employed in carrying out the relative prioritization assessment of the risks factors using computer-based Analytical Hierarchical Process (AHP) software. The results show that 19 out of the 50 risks significantly impact on housing development projects. The study concludes that although significant numbers of risk factors have been identified as having relevance and impacting to housing construction projects, economic risk group and, in particular, 'changes in demand for houses' is prioritised by most developers as posing a threat to the achievement of their housing development objectives. Unless these risks are carefully managed, their effects will continue to impede success in these projects. The study recommends the adoption and use of the combination of multi-technique identification framework and AHP prioritization assessment methodology as a suitable model for the assessment of risks in housing development projects.

Keywords**—**Risk identification, risk assessment, analytical hierarchical process, multi-criteria decision.

I. Introduction

THE complex nature of mass housing construction projects, usually involving multiple stakeholders, inputs and processes all aimed at creating valued products, results in huge risks and uncertainty to the project's success, which in turn contributes to poor performance with attendant cost and time delays. The study by [28] has shown that there is strong correlation between the construction industry's performance and its capability in managing project risks. The industry is characterized with high risk which has not always been dealt with adequately.

To cope with this challenge and other recent industry challenges such as internal competitions; rapid technological changes; need for more prudency by clients and overriding need for improved performance in the industry [34], the promoters of mass housing projects have developed series of rules of thumb that relies on intuition to manage risk [1], [24]. However, with increasing complexity and uncertainty, these rules of thumb have failed to effectively respond to the challenge and hence, the need to deploy more robust, logical and systematic approach to risk management.

Management of risks has become more critical nowadays and forms an important and integral aspect of project management required for the realization of project objectives. The approach to risk management within the industry has been in two ways: the use of intuition and past experience as the only way (informal approach) and the deployment of robust systematic procedure in managing the risk complexities (the formal approach). Previous studies [9], [18], [8] have found low usage of formal (systematic) risk management (RM) techniques and greater reliance on informal approach among stakeholders in the construction industry. The informal approach has not only been criticized for lacking rational, straightforward approach that can combine all the facets of risk systematically into a prioritized manageable scheme, but according to [34], it also makes products price models unrealistic in a competitive business environment. Although there is great disparity among scholars [12], [13] on concept and scope RM within the project purview but the level of convergence on the key stages, processes and procedures required achieving success in managing risks is high. Scholars are in concordance that systematic RM requires planning, assessment and response. RM within the formal realm entails RM planning to conceptualize and select the framework of operation, resources requirements, the input-output expectations and similar other factors. The RM planning is followed by risk assessment (RA) which most scholars consider as the most essential stage and forms the basis for risk response and mitigation. RA involves two essential processes: risk identification and risk analysis.

Over the last few decades, the systematic RM approach has attracted so much attention and exponential growth in a number of system approaches, methods, models and techniques developed both from academia and practitioners [23], [22], [26], [36], [2] to guide project promoters to the achievement of project RM objective. Risk analysis methods ranging from traditional independent event probability-based such as Decision Analysis [15], Stochastic Simulation [44] to deterministic methods [17], [18], [45] h*ave been developed. But with increasing complexity and uncertainty in the

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construction system which diminishes the ability of human beings to make precise judgement, as earlier opined by [37], more modern conceptual models that are based on artificial (computational) intelligence (AI) and more robust techniques are favoured. In recent years, according to [43], the computational techniques in fuzzy set [41], [5], fuzzy logic [32], etc. and the hybrid fuzzy techniques such as Fuzzy Neural Network [46], [20], Analytic Neural Network [4], Fuzzy Expert System [10], Analytic Hierarchical Process [38], [14], Bayesian Hierarchical Network [22], etc. have increasingly been applied due to the techniques' interfacing humans with computers capability and better modelling of uncertainties.

Despite the growing challenges of risk and uncertainty in housing development projects and the adverse effects to the attainment of project objectives caused by the use of informal approach vis-à-vis the potential benefits associated with successful deployment of RM system in project environment, no effort have been made to deploy suitable method and technique that can identify and analyses the key risk factors bedevilling the mass housing development. This paper introduces a novel model that uses multi-techniques identification framework in combination with analytic hierarchical process (AHP) as a risk prioritization method to identify and analyse the risks involved in such development.

II. Literature Review

Construction projects are fraught with risks due to complexity caused partly by multi-tasks, multi-stakeholders, dynamic technology, use of innovative procurement systems, often volatile environment, long project duration, etc. These factors in turn result in an array of major risks including political and legal risks [6], social risks [39], [47], technical risks [21], financial risks [16], etc. RA within the plan-assess-control RM framework is the most difficult (process) task involving identification of the risk, measuring the impact of the risk, analysing using suitable tools to determine the level of priority [35]. Baba et al. [3] highlighted that it involves evaluation of the probability of occurrence of risk events and their impacts on projects, objectives such as time, cost, quality and safety.

A. Risk Identification

The first step in risk identification task involves sourcing the risks, which entails identifying sources of risk, sometimes in a source-event-effect manner. The need to outline the type, cause, description, state, likely consequence, chances of occurrence in qualitative and quantitative and incidence of the occurrence has also been highlighted by other scholars [23]. Rezkhani [28] opined that risk grouping (classification) is an important second step as it attempts to structure the diverse risks that may affect a project. The information generated from risk sourcing and grouping is essential for setting up of a systematic hierarchical structure of risks or risk breakdown structure (RBS) as the case may be, according to [23]. The classification process provides the basis for subsequent structuring of risks by distinguishing each with characteristic features. Accordingly, scholars [7], [19] classified construction risks in different ways. However, the essential factor to successful risk identification is the selection and deployment of suitable techniques, methods and tools for risk sourcing and providing the detail information that ensures risks are interlink coherently and in orderly manner that facilitate structuring. Raz and Hillson [27], Hillson [12] outlined these techniques, methods and tools ranging from interviews, survey and research, external expert consultation, literature review, project document review, influence diagram use, etc.

B. Risk Analysis

The second step in the RA process is the risk analysis. It involves thorough and systematic measurement of key variables that tends to define risk within the project environment. To evaluate the impact of risk on project objectives, many approaches have been developed essentially differentiated based on the technique use in analysing the risk data obtained from measurement. The analyses range from qualitative to quantitative. Similarly, within the realm of the quantitative assessment, various techniques have been employed such as Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Probability and Impact Grids, Sensitivity Analysis, Estimation of System Reliability, Failure Mode and Effect Analysis, etc., which are mostly probability based assessment that depends on mutuality of events (precise and discrete). However, the inadequacy of high quality data in construction projects and the difficulties in analysing statistical data have hampered the use of most statistically based methods for RA and more analytical techniques that are Fuzzy Set Theory [37] based with strong ability for vague data, are favoured according to scholars [25], [43]. These analytic approaches have been based on using linguistic assessment, which is better in agreement with subjective human mind (blunt boundaries) instead of numerical values. To this end, several research studies [11], [14], [42] on assessment of construction projects using fuzzy approaches have been undertaken.

C. The Analytic Hierarchical Process (AHP) Analysis

Chan, Chan & Yeung [43], after review of fuzzy techniques in construction research, submitted that the use of fuzzy techniques have been found to be effective and practical, especially in developing models to make decisions and analysing problems encountered in CI, which are regarded as complex and full of uncertainties. The AHP is one variant of the fuzzy set concept that extends the concept beyond conventional usage. Baba et al. [3] asserts that the AHP uses fuzzy reasoning, in terms of measurement of variables, to advance prioritization approach by structuring. The AHP approach has been greatly used in RA [19], [38], [42] and involves building of a model of the whole project. It is a robust and flexible multi-criteria decision (MCDM) analysis methodology and the concept is based on three general principles [30] as heighted by [29]: i) Hierarchy representation and decomposition: breaking down the problem into separate elements; ii) Priority discrimination and synthesis: ranking the elements by relative importance; and, iii) Logical consistency: ensuring that elements are grouped logically and ranked consistently according to a logical criterion. According to [30], the first principle of the AHP concept involves construction of a functional hierarchy to decompose complex systems into their constituent parts according to their essential relationships. The top level of the hierarchy is the focus, consists of only one element i.e. the broad, overall system objective (riskiness of the project). Having constructed the system hierarchy, the AHP concepts are used to analyse the priorities of elements in the hierarchy in terms of their contribution to the focus of the hierarchy (system objective). Zhang & Zou [40] also concur that the element priority analysis begins by making pairwise comparison; that is, to compare the elements in pairs against a given criterion in a matrix format.

In this RA approach, usually the expert judgments are defined in linguistic scales such as "low probability", 'serious impact', or 'high risk' etc., according to [48], these crisp judgments are not easy task to assess because of the imprecise information and the uncertainty nature of risks hence use of fuzzy set. Yoo, Yang, Kang, & Lee [49] proposed the adoption of computerized systems to overcome some of these challenges.

III. Research Methods

The research focuses on the two vital processes of RA in construction projects: identification and analysis, hence the approach too. The study explored two survey approaches in eliciting data from respondents: general survey for identifying risk factors (RF) and Delphi survey involving focal group to elicit the critical pairwise judgements needed for AHP based analysis and prioritisation.

- *Identification Survey*: The study employed a novel multi-techniques (three) identification framework. This involves a systematic review of literature cases on similar projects generally to extract a pool of risk factors associated with construction in general and housing development projects in particular. A total of 54 RFs were collected. The study subjected this extracted risk factors to experts' review. After diligent reviewed by experts the RFs were reduced to 50. The third identification technique employed is the general questionnaire based survey. A total of 220 structured questionnaires were distributed to mass housing developers and 42 questionnaires were returned duly completed. The data were used to analyse the significance of the RFs.
- *Delphi Survey*: In order to solicit data for the analysis of the identified significant RFs using the AHP methodology, which is laborious and skill based, and to enhance reliability of the data, a focal group of five respondents were selected from the identification survey pool, based on years of experience on job and educational qualification. With the growth of AHP methodology, the technique has been adopted into computer software to facilitate easy processing. This study employed the *SuperDecisions* software [33] in carrying out the AHP pairwise judgement analysis.
- ***Data Analysis:*** The data collected from the study were subjected to quantitative analysis. Two approaches were adopted for the analysis of the data: significant and severity analysis and prioritization analysis. In order to carry out an initial assessment of the potential RFs to determine the significance and severity, data on likelihood of occurrence and possible impact of the RFs were soughed. Likert scale of 1-5 using natural linguistic terms (Table I) were employed in the measurements. It is noteworthy that the study used singular (integrated) measurement of the impact on key project objectives (cost, time, quality, scope, etc.) (as presented in Table II). The study used the mean values of the two measurements (likelihood and impact) to determine and filter the significance or otherwise of each of the RFs. This is to allow easy restructuring and final AHP prioritization analysis. Using the Significance Index (SI) formula by [31] given in (1) below, the criticality of each of the RFs was calculated for both the likelihood of occurrence and the impact of the RF. The RFs were, accordingly, ranked based on criticality ranking method which uses Mean Scale value [31].

The Shen et al. [31] Significant Index is given by:

$$RS^i = \frac{\sum_{i=1}^{n} S_j^1}{n} \qquad (1)$$

where:

$$S_j^1 = \propto_j^i \beta_j^i$$

RS^i = Significant Index of risk i; $\propto_j^i$ = the likelihood of risk i occurrence assessed by respondent j (in scale weight =1, 2, 3, 4 or 5); β_j^i = the degree of impact of risk i occurrence assessed by respondent j (in scale weight =1, 2, 3, 4 or 5); n = number of risks in the assessment. S_j^1 = Signifcant score assessed by respondent j for risk i. Further, the results of the significance indexing, in terms of both likelihood of occurrence and impact, was used to determine the most significant risks for further structuring and final assessment.

TABLE I
Likelihood of Risk Events Scaling

Score	Descriptor	Explanation
1	Rare	Not expected to happen
2	Unlikely	Small likelihood but could well happen
3	Possible	50 – 50 chance
4	Likely	More than 50 – 50 chance
5	Most likely	Almost certain that it will happen

In the final AHP based prioritization analysis, the identified significant RFs were restructured in hierarchical way and subjected to pairwise comparison as outlined by AHP procedure in *SuperDecisions* software using Delphi assessment methodology. The relative priority index (weight) of each RF and RF clusters were determined. Natural linguistic terms were used as inputs in the *Questionnaire* mode and the system converts the terms to numerical values in line with the fuzzy arithmetic computations.

TABLE II
IMPACT OF RISK EVENTS SCALING

Score	**Very low** 1	**Low** 2	**Moderate** 3	**High** 4	**Very High** 5
Cost	Insignificant cost increase	< 5% cost increase	5 – 10% cost increase	10-20% cost increase	>20% cost increase
Time/Schedule	Insignificant schedule slippage	Schedule slippage less than 5%	Overall project slippage 5-10%	Overall project slippage 10-20%	Overall schedule slips >20%
Scope	Scope decrease barely noticeable	Minor area of scope affected	Major area of scope affected	Scope reduction unacceptable to the developer	Project end product is effectively useless
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction requires developer's approval	Quality reduction unacceptable to the client	Project end product effectively unusable

TABLE III
RISK FACTORS IDENTIFICATION AND SEVERITY RANKING

S/No.	Risk ID#	Risk Factor	LoO** Mean score	Impact Mean score	Significant Index *	Remark
1	A11	Changes in demand for houses	2.70732	3.647619	15.7381	Significant
2	A08	Interest rate fluctuation	3.59524	3.64286	14.7857	Significant
3	A16	Outbreak of war and conflict	2.73810	3.57143	12.7381	Significant
4	A05	Exchange rate fluctuation	3.80952	2.90476	12.8810	Significant
5	B07	Delay in design approval	4.30952	3.38095	12.3333	Significant
6	A01	General insecurity in the economy	2.57143	2.09524	12.1429	Significant
7	B25	Cost overrun	3.71429	1.71429	10.4047	Significant
8	A15	Industrial strike	2.66667	2.21429	9.3095	Significant
9	A17	Community resistance	2.73810	2.59524	8.8095	Significant
10	B14	Scheduling (time) overrun	3.80952	3.69048	8.4528	Significant
11	A06	Inflation in the economy	4.04762	2.42850	7.9286	Significant
12	A02	Lack of policy continuity	1.92838	1.71429	7.4762	Significant
13	B05	Defective design	2.07143	1.66667	7.1905	Significant
14	B18	Site condition variation	3.71429	1.95238	6.9524	Significant
15	A04	Instability in government	1.85714	1.73810	6.5476	Significant
16	B04	Illegal title to land	2.02381	1.88095	5.7143	Significant
17	B26	Cash-flow challenges	3.73810	1.66667	5.5000	Significant
18	B24	Bankruptcy of suppliers	1.69048	3.21429	5.3571	Significant
19	B01	Delay in land acquisition	3.33333	1.71429	5.1904	Significant
20	B11	Adoption of wrong procurement system	1.69048	1.80952	4.9781	Insignificant
21	A14	Inclement weather	2.11905	2.16670	4.9524	Insignificant
22	A18	Theft and vandalism	3.26190	1.66667	4.9286	Insignificant
23	A07	Lending policy changes	2.64286	1.85714	4.9286	Insignificant
24	A13	Inefficient legal procedure	1.76190	1.52381	4.7857	Insignificant
25	B17	Raw material and equipment non-availability	2.69048	2.04762	4.5000	Insignificant
26	B03	Inaccessibility to land	1.92857	1.66667	4.4524	Insignificant
27	B16	Productivity challenges	3.07143	2.00000	4.1191	Insignificant
28	B13	Unenforceability of contract	1.64286	1.95238	3.6667	Insignificant
29	B08	Inadequate Specification	1.88095	1.52381	3.6429	Insignificant
30	A12	Changes in-law and regular	2.04762	1.88095	3.5000	Insignificant
31	A09	Price control system	2.07143	2.42850	3.4286	Insignificant
32	B12	Inappropriate documentation	1.57143	1.61905	3.3810	Insignificant
33	B15	Health and safety inadequacies	2.38095	1.61905	3.3095	Insignificant
34	B21	Variation in scope	2.30902	1.95238	3.2857	Insignificant
35	B23	Delay in payment to supplies	3.61905	2.16670	3.2619	Insignificant
36	B10	Failure in negotiation	1.45238	1.42857	3.2381	Insignificant
37	B20	Technology changes	2.09524	1.61905	3.1905	Insignificant
38	B19	Quality system inadequacies	2.76190	1.61905	3.0714	Insignificant
39	A10	Tax changes	2.09524	2.16670	3.0714	Insignificant
40	B06	Changes in design	3.59524	1.52381	2.9762	Insignificant
41	B27	Claims and variations	2.59524	1.85714	2.8333	Insignificant
42	B29	Project execution strategy challenge	1.66667	1.59524	2.5714	Insignificant

S/No.	Risk ID#	Risk Factor	LoO** Mean score	Impact Mean score	Significant Index *	Remark
43	B22	Damage to work	1.97619	1.88095	2.5714	Insignificant
44	B09	Failure in bidding system	1.52381	1.40476	2.5476	Insignificant
45	B02	Illegal encroachment in land	3.42857	1.57143	2.5476	Insignificant
46	B28	Project team selection challenges	1.92857	1.71429	2.4762	Insignificant
47	B03	Inaccessibility to land	1.92857	1.66667	2.4534	Insignificant
48	B32	Project stationers challenges	1.97619	1.54762	2.3333	Insignificant
49	B30	Decision challenges	1.64286	1.45238	2.22381	Insignificant
50	B31	Technical and managerial complex	1.69048	1.30952	1.9048	Insignificant

*Using Arithmetic Mean Scales Value of 5.0 **Likelihood of Occurrence

IV. Results and Discussions

A. Results of the Analysis of Severity of Risks

The study used the likelihood of occurrence and impact of the RFs measurements to assess the severity of the RFs for initial assessment and structuring for final prioritization analysis. Table III shows the computed mean values for both the Likelihood of Occurrence (LoO) and impact for each of the RFs based on the respondents' submissions. '*Delay in the approval of designs by public supervising agencies (B07)*' has the highest likelihood of occurrence while '*Inappropriate documentation (B12)'* with mean score of 1.57 has the lowest possibility of occurrence. Similarly, the computed results show that "*schedule (time) overrun (B14)'* with mean score of 3.69 is ranked highest in terms of impact on project whereas '*Technical and managerial complexity (B31)'* and *'Failure in bidding system (B09)'* with mean scores of 1.31 and 1.41, respectively, are regarded as least impactful RFs.

It is imperative to carry out an initial severity assessment of the identified risk factors in order to determine and filter significant risk factors that have potentials to severely affect project objective from the insignificant ones, so that effort can be focused on significant risks in the final prioritization assessment as opined by [5].

Based on the responses, Table III shows the outcome of the calculations of the relative significance index of each of the RFs. The results of the severity calculations and ranking shows that 19 RFs have relative significance index of 5.0 and above, whereas 31 RFs have significance index value below 5.0 threshold which suggests those RFs are insignificant.

The outcomes of the severity of the RFs computations and the subsequent categorization as significant or insignificant provided the basis for the restructuring of the RFs, as presented in Table IV below. The result of this restructuring shows remarkable changes, a reduction in the number of both macro-level (groups of risks), which dropped from 10 to 7, and the Micro-level (RFs) which also reduced from 50 to 19 RFs. This, among others, ensures that the final AHP-based analysis is handy and focused on significant RFs.

B. Results of Fuzzy-AHP Based Risk Prioritization Analysis

In order to achieve high precision, Delphi survey methodology was deployed with a group of five experts to measure and determine the relative priority indexes (weights) of each of the RFs and each RF cluster (RF group) in line with the AHP prioritization assessment technique which uses pairwise comparison judgments. The evaluation of this analysis data was carried out using computer-based AHP-structured software – *SuperDecision* (version 2.2). Data were solicited using natural linguistic terms provided within the *Questionnaire mode* and these inputs are automatically converted in line with fuzzy arithmetic to numerical values by the system. It is worth noting that maintaining lowest level of inconsistency in judgment is important and key in *SuperDecision Software* as CR above 0.10 is not acceptable.

TABLE IV
Reviewed Risk Hierarchy Structure

Risk ID#	Risk Factor	Risk ID#	Risk Factor
L0101	**Political**	**L105**	**Land Acquisition**
A01	General insecurity in the economy	B01	Delay in land acquisition
A02	Lack of policy continuity of government	B04	Illegal title of land
A04	Instability in government	**L106**	**Design**
L102	**Economic**	B05	Defective design
A05	Exchange rate fluctuation	B07	Delay in design approval
A06	Inflation in the economy	**L108**	**Construction**
A08	Interest rate fluctuation	B14	Scheduling (time) overrun
A11	Demand for house change	B18	Site condition variation
L104	**Force Majeure**	**L109**	**Financial**
A15	Industrial strike	B24	Bankruptcy of suppliers
A16	Outbreak of war and conflict	B25	Cost overrun
A17	Community resistance	B26	Cash-flow challenges

Presented in Table V are the relative priorities of the Macro-level (cluster/group) RFGs, which indicates that Economic risk group (L102) has the highest ranking while Force Majeure group (L104) has the least risk priority.

At the micro-level (RFs level), the result after synthesis of the pairwise judgements data submitted by the five panel shows significant variations in the weightings between each RF. The highest average weight score by the RF is 0.2019 for RID#A11, while the lowest weighting is 0.0105 for RID#A02. Other RFs average relative priorities range from 0.1308 (RID#A08) to 0.0110 (RID#B24). Table VI shows details of the relative priorities of each RF and the overall ranking of the RFs as submitted by the experts and synthesised in *SuperDecisions*. To ensure that consistency is within the threshold level of 0.10, the respondents were offered repeated chances to review their judgments.

Similarly, the average weight scoring was used to prioritise and ranked the RFs accordingly. Top highest ranking is an economic RF '*Changes in demand for houses'* (RID#A11). The second ranked risk factor by experts is another economic risk group element *'the interest rate fluctuation'* (RID#A08). Placed third (3rd) and fourth (4th) are two construction execution risk factors that are so regular in construction management: '*Cost overrun'* (RID#B25) and '*scheduling (time) overrun*' (RID#B14). Least ranked, among the lowest of the 19 RFs are '*defective design*' (RID#B05), '*bankruptcy of suppliers'* (RID#B24) and *'lack of policy continuity'* (RID#A02) probably due to the prototype nature of housing development projects which allows defect in designs to be corrected easily.

The study results show that the most critical risk cluster is the Economic group (RID#L102). Economic risk is one of the general risk events that affect the industry as a whole and not tied to specific projects. The most critical RF that contributes more to the high exposure of housing development projects to economic risk is the demand for housing (RID#A11) during the study period, as shown in the micro-level prioritisation analysis results.

TABLE V
RELATIVE PRIORITIES AND RANKING OF MACRO-LEVEL RISK FACTORS GROUPS

S/N	Risk ID#	Risk factor Group	Priorities by respondents					Average weight	Ranking
			A	B	C	D	E		
1	L102	Economic	0.3845	0.3905	0.4128	0.4371	0.3816	0.4013	1st
2	L105	Land Acquisition	0.2602	0.2180	0.2549	0.2765	0.2418	0.2502	2nd
3	L106	Design	0.0973	0.1821	0.1682	0.0890	0.0734	0.1220	3rd
4	L109	Financial	0.1031	0.0784	0.1386	0.1246	0.1056	0.1101	4th
5	L108	Construction	0.0798	0.0596	0.0512	0.0604	0.0557	0.0613	5th
6	L101	Political	0.0403	0.0515	0.0428	0.0386	0.0470	0.0440	6th
7	L104	Force Majeure	0.0109	0.0357	0.0414	0.0092	0.0091	0.0211	7th
	Consistency Ratio (CR)		0.0414	0.0510	0.0313	0.0159	0.0258		

TABLE VI
RELATIVE PRIORITIES AND RANKING OF MICRO-LEVEL RISK FACTORS

S/No	Risk ID#	Risk Factor	Weights (Priorities) by respondent					Average weight value	Ranking
			A	B	C	D	E		
1	A11	Changes in demand for houses	0.2328	0.1894	0.1718	0.2379	0.1775	0.2019	1st
2	A08	Interest rate fluctuation	0.1183	0.1283	01008	0.1580	0.1458	0.1303	2nd
3	B25	Cost overrun	0.0753	0.1398	0.0963	0.1308	0.1117	0.1108	3rd
4	B14	Scheduling (time) overrun	0.0579	0.1078	0.1024	0.0804	0.0795	0.0856	4th
5	B04	Illegal title to land	0.0478	0.0467	0.0703	0.0502	0.1082	0.0647	5th
6	B07	Delay in design approval	0.0703	0.0802	0.0533	0.0402	0.0302	0.0548	6th
7	A16	Outbreak of war and conflict	0.0506	0.0417	0.0703	0.0511	0.0402	0.0508	7th
8	A01	General insecurity in the economy	0.0328	0.0996	0.0525	0.0236	0.0324	0.0482	8th
9	B26	Cash-flow challenges	0.0503	0.0618	0.0229	0.0412	0.0408	0.0434	9th
10	A06	Inflation in the economy	0.0731	0.0211	0.0311	0.0415	0.0289	0.0391	10th
11	A04	Instability in government	0.0523	0.0492	0.0310	0.0320	0.0291	0.0387	11th
12	B01	Delay in land acquisition	0.0253	0.0470	0.0529	0.0263	0.0358	.0.0375	12th
13	B18	Site condition variation	0.0275	0.0110	0.0117	0.0313	0.0133	0.0190	13th
14	A15	Industrial strike	0.0157	0.0295	0.0182	0.0026	0.0195	0.0171	14th
15	A05	Exchange rate fluctuation	0.0079	0.0133	0.0122	0.0073	0.0249	0.0131	15th
16	A17	Community resistance	0.0142	0.0229	0.0131	0.0114	0.0003	0.0124	16th
17	B05	Defective design	0.0021	0.0107	0.0015	0.0047	0.0453	0.0111	17th
18	B24	Bankruptcy of suppliers	0.0232	0.0253	0.0032	0.0021	0.0001	0.0110	18th
19	A02	Lack of policy continuity in government	0.0118	0.0069	0.0151	0.0097	0.0091	0.0105	19th
		Consistency Ratio (CR)	0.0346	0.0675	0.0513	0.0482	0.0611		

The results of this study are distinctively clear as to the 19 RFs that are significant and relevant to housing project development in Nigeria. The results also show that each RF can distinctively be identified and analysed in both direct and relative (by weight) to other RFs in order to provide a prioritised risk ranking that can serve as a basis for sound mitigatory decision. This approach is quite distinct to the practice of including lump sum as a cover for all kind of risk events as practiced in the informal RM environment.

V. CONCLUSION AND RECOMMENDATIONS

The study, using multi-techniques identification framework, identifies 19 significant and relevant risk factors militating against housing project development with the *Changes in demand for houses* as the highest priority risk adjudged by developers. The findings of the study have revealed and underscored the importance of the two strategic processes of identification and analysis towards achieving a robust systematic RM system. A sound identification framework and an efficient and flexible risk analysis method and tools are keys to the achievement of robust risk RM. The study was able to properly identify and adequately analysed the risks associated with housing construction projects using fuzzy-based AHP prioritization assessment technique of *SuperDecisions software*. The study recommends the use of multi-techniques identification framework and deployment of computer-based AHP software for efficient and effective analysis of construction projects risks.

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