Original Article

An examination of Thai practitioners' perceptions of risk assessment techniques in real estate development projects

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ABSTRACT Owing to the existence of risks in real estate development projects, there is a need for risk assessment techniques that can be used to evaluate their impact. Using Thailand as a case study, this article examines the expectations of real estate practitioners regarding risk assessment techniques. It also examines their perception of risks caused by social, technological, environmental, economic and political factors. The article is based on an exploratory survey, and data were collected through questionnaires and interviews with representatives of Thai real estate development companies. Bivariate or correlatives tests were carried out. The study revealed that Thai practitioners are concerned with the impact of economic and political risks, and that there are no systematic risk assessment techniques to deal with their consequences. Therefore, risk assessment techniques need to be

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developed. This article proposes an analytical network process model that can be used to assess the impact of risks in the Thai real estate industry.

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INTRODUCTION

There are risks associated with every investment, and real estate development as an investment is not an exception. Real estate development has its own risks, particularly in relation to the decision-making process for a new development project. Risks affect the entire project management process in terms of schedule delay, cost overrun and quality of products (Khallafalah, 2002; PMBOK, 2002; Flyvbjerg *et al*, 2003; Gehner *et al*, 2006). As regards the nature of real estate development projects, Booth *et al* (2002) and Blundell *et al* (2007) suggest that real estate development risks can only be managed within an overall framework of risk management processes.

There are various techniques that can be used to assess both systematic and non-systematic risks in the real estate sector, for example the Project Risk Ranking and the Construction Risk Management System (Al-Bahar and Crandall, 1990; Baccarini and Archer, 2001; Choi *et al*, 2004). These techniques have, however, been developed based on certain parameters. Thus, a technique that might be applicable in one country and have the desired impact may not be applicable in another country owing to differences in the business environments. These techniques are also subjective in nature, as they are not based on quantitative statistical measures (Choi *et al*, 2004). There is therefore a need for risk assessment techniques that are based on a rigorous and quantitative statistical framework.

In the light of the above and using Thailand as a case study, the aim of this article is to examine the possible causes of risks in the real estate sector, as well as the perceptions of real estate practitioners towards existing risk criteria and risk assessment techniques in order to develop an appropriate risk assessment technique. Thailand was the starting point of the global economic crisis in 1997 (Warr, 2000; Hilbers *et al*, 2001). The main factor responsible for economic crises is often traced to the behaviour of players in the real estate sector with regard to risks. It is argued that they did not pay enough attention to the impact of risks on their businesses because they lacked the appropriate techniques that could be used to assess risks and deal with their impact (Lauridsen, 1998; Quigley, 2001). In recent years, the current global economic recession has also had significant effects on the entire Thai business sector. However, according to Kritayanavaj (2007) and Pornchokchai (2007), Thai developers still lack the appropriate risk assessment techniques to deal effectively with risks in the changing business environment.

The remainder of the article is organised as follows. The next section provides an overview of investment risks, while 'Real estate development in Thailand' section looks at real estate development in Thailand. 'Research Methodology' section describes the research methodology adopted for the study. 'Presentation of data, analysis and discussion' section presents, analyses and discusses the empirical data collected, and the last section deals with conclusions.

AN OVERVIEW OF INVESTMENT RISKS

Classification of investment risks

There are various definitions of risk. It is a concept that denotes a potential negative impact on an asset, project or some characteristic of value that may arise from some current process or future event (Crossland *et al*, 1992). Baum and Crosby (2008) define risk as the uncertainty of an expected rate of return from an investment, while Hargitay and Yu (1993) define it as the unpredictability of the financial consequences of actions and decisions. Similarly, according to Huffman (2002), risk is the extent to which the actual outcome of an action or decision may diverge from the expected outcome.

Risks can be classified into systematic risks and unsystematic risks (Hargitay and Yu, 1993; Brown and Matysiak, 2000; Baum and Crosby, 2008). According to the authors, systematic risk (uncontrollable risk) is the type of risk caused by external factors that affect all investments; examples include market risk, inflation or purchasing power risk, and interest rate risk. Unsystematic or specific risk refers to risk over which the investor has limited control, and is specific to a particular company or investment decision-making process.

Risks can also be classified according to the perceptions of decision makers. In this regard, risks are described as multidimensional, with a particular meaning to different people and different things in different contexts (Crossland *et al*, 1992). Pidgeon *et al* (1992) classify risk into 'objective' or statistical risk and 'subjective' or perceived risk. By this classification, objective risk is unique, substantive and physically measurable, and can be determined by quantitative risk assessment methods. According to Spaulding (2008), subjective risk is what an individual perceives to be a possible unwanted event; the degree of subjective risk depends on people's experience of their history and the expectation of its occurrence. Subjective risk also involves subjective probability or the perception of the decision maker of the likelihood and consequence of the event.

However, relating to real estate development in particular, there are risks that derive from social, technological, environmental, economic and political (STEEP) factors (Morrison, 2007), and these factors are often of concern to developers during the project feasibility analysis stage (Matson, 2000; Millington, 2000; Thompson, 2005). The STEEP factors have been widely used in the business context, but with different names, such as PEST, TESP and STEP. (In this regard PEST is an abbreviation of Political, Economic, Social and Technological, these factors shall be concerned while the decision makers decide to

continue his project) (Chapman, 2008). The classification of risks into STEEP factors is pragmatic as well as simple and clearly understood by all project participants (Nezhad and Kathawala, 1990). It is this classification of risks into STEEP factors that this article addresses.

As indicated earlier, risks affect real estate project development processes in terms of schedule delay, cost overrun and quality of products. They also affect the progress of projects at all stages of their lifecycles. Findings from the Dutch real estate sector in 2006 show that most real estate developers consider project risks to be caused by several subjective factors such as policy change, and social or community objections. Such factors delay the project's progress with many indirect consequences, which lead to delays in completion dates, the marketing process and the project revenue in the following manner: 'decrease in rental/sale price, decrease in velocity of sales, cause a higher vacancy rate and lower investment value' (Gehner *et al*, 2006).

Real estate risk assessment process

Real estate developers mostly rely on non-systematic assessment methods such as panel discussion or use their own background experiences (Gehner *et al*, 2006; Khumpaisal, 2009). One popular risk assessment technique used by real estate developers is the 'Risk Assessment Matrix' (RAM). The RAM describes the likelihood and consequence of each risk in a matrix format that is generally accepted by many decision makers owing to its simplicity and the fact that it provides more understanding of projects at every level (ioMosaic, 2002; Kindinger, 2002; Rafele *et al*, 2005; Younes and Kett, 2007). However, the RAM also has disadvantages. One demerit relates to the data used in the calculation; the data are based on personal opinions and not on reliable sources with a strong theoretical basis. The RAM also measures the likelihood and consequences of risk based on a single criterion, and is therefore not suited to real estate developers aiming to understand the correlation and the effects of each factor (Chen and Khumpaisal, 2008).

Booth *et al* (2002) and Frodsham (2007) note that there is a need for an idealistic risk assessment model that can analyse the impact of risks and compute results in a numerical format to be introduced in real estate business. According to the authors, such a model would allow the synthesis of risk assessment criteria and comparisons among factors, and would also help developers to structure the decision-making process.

It is against this background that the Analytic Network Process (ANP) model has been introduced as an alternative risk assessment technique to respond to these requirements. The model adopts the principles of Multi Criteria Decision Making and it is developed based on the grounded theories of Analytic Hierarchy Process (AHP). The ANP model is a powerful and flexible decision-making tool that helps investors or decision makers to set priorities and make the best decision when both qualitative and quantitative aspects of a decision need to be considered (Cheng and Li, 2004; Saaty, 2005). The model has been used in several areas of construction research and practice since the late 1970s, including construction planning, location selection and environmental impact assessment (Chen, *et al*, 2005; Cheng *et al*, 2005). In addition, recently

Chen and Khumpaisal (2008) used the ANP model to assess risks in Liverpool commercial real estate projects. This study shows that the ANP model is an effective model to assess risks.

Saaty (2005), Cheng, *et al* (2005) and Chen *et al* (2006) summarise the construction of the ANP model as follows:

- decomposing the problem into a hierarchy in which the highest level of the structure denotes the primary goal of the problem and the lowest level refers to the alternatives;
- inviting experts to conduct pair-wise comparisons of each element with regard to their respective adjacent higher level. The scale of interval employed in this pair-wise comparison is usually the 9-point scale of measurement;
- calculating the relative importance weights (eigenvectors) in each pair-wise comparison matrix and computing the consistency of the comparison matrices;
- placing the resulting relative importance weights (eigenvectors) in pair-wise comparison matrices within the super-matrix (un-weighted);
- conducting pair-wise comparisons on the clusters;
- weighting the unweighted super-matrix, by the corresponding priorities of the clusters, which becomes the weighted super-matrix; and
- adjusting the values in the super-matrix so that it can achieve column stochasticity. This means that the decision maker will take the resultant relative importance weights (eigenvectors) and place them in the matrix.

A comparison of the typical risk assessment methods and the ANP model is shown in Figure 1. The risk management process normally starts with the establishment of the context in terms of strategic, organisational and further risk management, as well as the preference of decision makers depending on the characteristics of a specific project (Process 1). The decision makers then set up the project risk management structure (Process 2); in this case, the assessment criteria are associated with the requirements of STEEP factors. Risks identification (Process 3) is conducted to clarify the effect of each risk and to identify sources of risk. Risk analysis (Process 4) is undertaken to determine the impact of each risk on the project and its likelihood.

The risk assessment process is then undertaken to compare each risk with the established criteria and rank the consequences and prioritise each risk. In this process, the decision makers can select either the existing risk assessment method or the ANP. In the case of using the risk assessment method, project managers rely on information gained from panel/board discussion, which is associated with their experience in identifying or classifying predictable risk events and setting up the RAM (Khumpaisal, 2007).

Alternatively, if the ANP is used, the first step is to develop an ANP model and construct a pair-wise comparison process to form a super-matrix to quantify the interdependences among the criteria and the alternative solutions. The results from the super-matrix calculation provide the project team with the numerical results (in terms of the degree of synthesised weight priority), and suggest the most appropriate solution

Figure 1: The risk management process with an alternative risk assessment method.
Source: AS/NZS 4360: 2004 risk management standard (ACT Insurance Authority, 2004).

or alternative plan to be developed. In addition, a project knowledge base that provides adequate and accurate data needs to be integrated into the process in order to use either the traditional or ANP method.

Risk assessment criteria

The real estate risk assessment criteria developed in this section are based on an extensive review of the relevant literature and the researchers' experience, including experts' suggestions. They are developed on the basis of the STEEP factors' requirements (Morrison, 2007), which are necessary for real estate developers when conducting a project feasibility analysis. The various risks that occur at each stage of a development project are normally caused by STEEP factors. In this regard, the main assessment criteria are defined by STEEP requirements, while sub-criteria are classified based on systematic and subjective risk formation and the

evaluation methods are gathered from reliable sources. There are 5 major criteria and 31 sub-criteria, as shown in Table 1.

The risk assessment criteria have been developed based on the UK real estate business context, which can be adapted for any country, including Thailand.

Table 1: Risk assessment criteria for a real estate development project

Criteria	No.	Sub-criteria	Evaluation methods	Source
1. Social risks	1.1	Community acceptability	Degree of benefit to local communities	Danter (2007)
	1.2	Community participation	Degree of discourse on partnership and empowerment to community	Atkinson (1999)
	1.3	Cultural compatibility	Degree of business and lifestyle harmony in the context of London Metropolitan Area	Danter (2007)
	1.4	Public liability	Degree of impacts to local public health and safety	CHAI (2006)
	1.5	Workforce availability	Degree of the project sponsor's satisfaction with local workforce market	Danter (2007)
2. Technological risks	2.1	Accessibility and evacuation	Degree of easy access and fast emergency evacuation in use	Moss <i>et al</i> (2007)
	2.2	Amendments	Possibility of amendments in design and construction	Flyvbjerg <i>et al</i> (2003)
	2.3	Constructability	Degree of technical difficulties in construction	Khalafallah (2002)
	2.4	Duration of development	Total duration of design and construction per 1000 days	Khalafallah (2002)
	2.5	Facilities management	Degree of complexity in facilities management	Moss <i>et al</i> (2007)
	2.6	Transportation convenience	Degree of public satisfaction with transportation services after new development	Couch and Dennemann (2000)
3. Environmental risks	3.1	Adverse environmental impacts	Overall value of the Environmental Impacts Index	Chen <i>et al</i> (2005)
	3.2	Environmental assessment	Total days of Environmental Impact Assessment report approve	Harrop and Nixon (1999)
	3.3	Pollution during development	Degree of pollution effect on local community	Harrop and Nixon (1999)
	3.4	Site conditions	Degree of difficulty in site preparation for each specific plan	Khalafallah (2002); Danter (2007)
4. Economic risks	4.1	Area accessibility	Degree of regional infrastructure usability	Adair and Hutchison (2005)
	4.2	Brand visibility	Degree of developer's reputation in specific development	AREA (2008); REIC (2009)
	4.3	Capital value	Sale records of new developed properties	AREA (2008); REIC (2009)
	4.4	Demand and supply	Degree of competitiveness with other developers	Adair and Hutchison (2005)
	4.5	Development fund	Amount and sources of funding injected in mega project construction	Adair and Hutchison (2005)
	4.6	Fluctuation of interest rate	Degree of impact of the increment of loan rate to project debt	Sagalyn (1990); FSA (2005); Nabarro and Key (2005))
	4.7	Investment return	Expected Internal rate of return and capitalisation rate	Sagalyn (1990); Watkins <i>et al</i> (2004)
	4.8	Life cycle value	Degree of Net Present Value achieved from the investment	Adair and Hutchison (2005)
	4.9	Market liquidity	Selling rate of same kind of properties in the local market	AREA (2008); REIC (2009)
	4.10	Market price	Degree of competitive selling price of the same kind of property	AREA (2008); REIC (2009)
	4.11	Project cash flow liquidity	Project monetary cash-flow	Lam <i>et al</i> (2001)
	4.12	Property type	Degree of location concentration	Adair and Hutchison (2005)
	4.13	Purchase ability	Degree of affordability of the same kind of properties	Adair and Hutchison (2005)
5. Political risks	5.1	Political groups/activist	Degree of protest by urban communities	Arthurson (2001)
	5.2	Council approval	Total days of construction, design approval process by planning committee	Crown Copyright (2008)
	5.3	Public inquiry	Total days of public inquiry and effect on operating time	Pellman (2008)

REAL ESTATE DEVELOPMENT IN THAILAND

The collapse of the global economic crisis in 1997 was caused by the downfall of Thailand's real estate development business (Warr, 2000). Lauridsen (1998) and Quigley (2001) indicate that the key reasons for this crisis were the financial institutions and real estate developers who lacked monetary discipline and neglected risks in real estate business, as well as lack of practical risk assessment and management techniques to resolve the consequences of risks.

Vanichvatana (2007) and Kritayanavaj (2007) predict that the future trend of the Thai real estate sector will be similar to the circumstances in the 1997 crisis, as practical risk assessment techniques are yet to be developed. This prediction is supported by the incidents of the current global recession (2008–2009) and the US sub-prime crisis, which has significantly affected the Thai real estate sector owing to the shortage of housing purchasing demand and less funding injected into the housing and residential sub-sector.

Despite the fact that Thai real estate developers have experienced this crisis and acknowledged its main causes, they are still less concerned with risks and their effects on real estate projects. Pornchokchai (2007) and Kritayanavaj (2007) note that this is because of the lack of appropriate knowledge to assess, identify and understand the risks, as well as the fact that they are only interested in realising a maximum return from their investment.

This article focuses on the real estate development projects in the Bangkok Metropolitan Area (BMA) and vicinity (see Figure 2). This is the heart of the Thai economic and political system, with the highest density of housing projects in comparison to the rest of Thailand (ONESDB, 2007; REIC, 2009). This area also has the highest number of real estate developers – approximately 250 (APTU, 2006).

Figure 2: The study area.
Source: Courtesy of ASA Thailand, (2008)

RESEARCH METHODOLOGY

The quantitative, qualitative and mixed methodologies approaches were considered with regard to their appropriateness and the mixed-methodologies approach was finally adopted. Truthfulness or reality typifies quantitative and qualitative methodologies, but it is the criteria for judging it that differ. The mixed methodologies approach combines the quantitative and qualitative methodologies in a single study. Johnson and Onwuegbuzie (2004) and Sale *et al* (2002) support the mixed methodologies approach as it uses both quantitative and qualitative research techniques in a single research project, thereby benefiting from the advantages of both methodologies. Thus, adopting the mixed methodologies approach enables broader perspectives to be gained from the research. During the data collection process, both quantitative and qualitative data were collected. Questionnaires and the interviews were used to collect the data, and the respondents were mainly representatives of Thai real estate development companies.

Fifty sets of small-scale questionnaires were distributed to selected participants in Thailand. The issues covered in the questionnaires included the practitioners' perceptions of risks caused by STEEP factors, the consequences of these risks on real estate development projects, and the need for risk assessment techniques. This category of data was analysed using SPSS. Parametric statistical techniques such as independent *t*-test, ANOVA and Rank Correlation were employed.

Two in-depth interviews were conducted with real estate developers' representatives, who had vast experience in decision making in their projects. These interviews aimed to gain a deeper understanding of the characteristics of real estate development projects and the current risk assessment practices. Based on the ANP model, the interviewees were asked to rank the level of consequences of each risk element in the assessment criteria in Table 1. In order to use this ANP model effectively, an alternative solution needs to be incorporated in order to compare two or more solutions against the set criteria (Chen *et al*, 2006). Therefore, the interviewees were asked to consider the differences between their existing plan (Plan A) and the alternative development plan (Plan B), which was assumed in order to gather the participants opinions about risks associated with their projects. The raw data were expressed in percentage (percent) forms. The data collected from these interviews were analysed using an ANP application called 'Superdecision 1.6.0', developed by Saaty (2005).

PRESENTATION OF DATA, ANALYSIS AND DISCUSSION

Characteristics of the survey participants

The response rate of the questionnaires distributed was 78 per cent (39 out of 50). The first section of the questionnaires dealt with respondents' characteristics and the type of real estate projects they had dealt with. The survey data revealed that the respondents occupy various positions in real estate companies: 36 per cent (14 out of 39) are quantity surveyors or estimators; 25 per cent (9 out of 39) are project managers/directors; and 25 per cent are engineers/architects. Fifty-six per cent (22 out of 39) are

decision makers but only 43 per cent (17 out of 39) have risk assessment experience in real estate projects and 15 per cent (6 out of 39) have ever used risk assessment models. Only 10 per cent (4 out of 39) are aware of AHP or ANP. Most (56 per cent) have an undergraduate education and their working experience ranges from 0 to 5 working years. Most respondents (61 per cent or 24 out of 39) are involved in low-rise housing residential projects, while others are involved in hotel projects (15 per cent), 10 per cent (4 out of 39) are in high-rise residential projects, and 2.6 per cent (1 out of 39) are involved in retail projects. Twenty-five per cent of the projects are located outside of the BMA and the same percentage of projects is located within the BMA.

Practitioners' perceptions of risks from STEEP factors

The second section of the questionnaire aimed to investigate Thai practitioners' perceptions of STEEP factors. As discussed earlier in the methodology section, several analysis techniques were used to test the perceptions of the consequences and likelihood of risks stemming from STEEP factors. The following tables show the descriptive statistics. Table 2 shows the descriptive statistics on the perceptions of respondents of the consequences of risks from STEEP factors, while Table 3 shows their perceptions of the likelihood of the occurrence of risks from STEEP factors.

Table 2 shows that Thai practitioners are mostly concerned with the consequences of risks caused by economic and political factors; the percentages are 66.7 and 53.9 per cent, respectively. The effects of risks from social factors are considered to be the lowest (23.0 per cent). In terms of the likelihood of the occurrence risks from STEEP factors, Table 3 shows that economic factors were ranked the highest (59 per cent) compared to other factors, while environmental factors were ranked the lowest (25.7 per cent).

Table 2: Thai practitioners' perceptions of the consequences of risks from STEEP factors

	Very high (%)	High (%)	Neither high nor low (%)	Low (%)	Very low (%)	Not responded (%)
Social	15.4	17.9	30.8	17.9	5.1	12.8
Technological	10.3	12.8	33.3	17.9	12.8	12.8
Environmental	2.6	30.8	28.2	17.9	7.7	12.8
Economical	46.2	20.5	5.1	2.6	12.8	12.8
Political	23.1	30.8	10.3	10.3	10.3	15.4

Table 3: Thai practitioners' perceptions of the likelihood of risks from STEEP factors

	Very high (%)	High (%)	Neither high nor low (%)	Low (%)	Very low (%)	Not responded (%)
Social	15.4	12.8	33.3	17.9	7.7	12.8
Technological	15.4	12.8	23.1	23.1	12.8	12.8
Environmental	5.1	20.5	35.9	15.4	10.3	12.8
Economical	38.5	20.5	7.7	10.3	5.1	12.8
Political	23.1	25.6	20.5	10.3	7.7	15.4

Table 4: Thai real estate practitioners' perceptions of risks from STEEP factors

<i>Rank</i>	<i>Thai practitioners' perceptions STEEP factors risks</i>	<i>Ratio(%)</i>
1	Economic	32
2	Political	26
3	Social	16
4	Environmental	16
5	Technological	11

Table 5: Comparison of risk assessment techniques used by Thai practitioners

<i>Systematic/non-systematic</i>	<i>Technique(s)</i>	<i>Percentage</i>
Non-systematic techniques	Work experience/intuition	10
	Panel discussion/ranking of risk	70
Systematic/pragmatic techniques	Using reliable sources from secondary data such as Bank of Thailand, research centres	20

In order to verify these results and to understand the relationship among the STEEP factors, the Pearson test was used to establish the correlation between the position of respondents and perceptions of STEEP factors. This results from the tests show that there are eight factors that are strongly correlated ($P < 0.05$) – economic and political factors – while the remaining factors do not show any significant correlation (see Appendix B). Based on these results and Table 4, it can be concluded that Thai practitioners consider economic risks to have the highest influence on their perceptions of STEEP factors, in terms of both consequences and likelihood of occurrence. The second factor that influences Thai real estate practitioners' perception is the political factor, followed by social and environmental factors. Thus, according to the data analysis, it could be concluded that the economic factors portray the highest impact to the real estate project's vitality. Meanwhile, they pay less attention to the impact of risks stemming from technological factors.

Current risk assessment practices in Thai real estate sector

Regarding the use of risk assessment techniques, only 10 out of 39 respondents (26 per cent) indicated that they have ever used any risk assessment techniques in real estate projects. Panel discussion was the most popular technique, used by approximately 70 per cent (7 out of 10) of the decision makers. Twenty per cent (2 out of 10) indicated that they employed secondary information from reliable sources such as financial institutions or real estate research centres, while 10 per cent (1 out of 10) used background experience to adjust and assess risks. The details of the current risk assessment techniques used in the Thai real estate industry are shown in Table 5.

Thai real estate practitioners need practical risk assessment techniques to help them assess the consequences of risks in this highly competitive

sector. As found in this study, most Thai practitioners (80 per cent) use non-systematic assessment methods, particularly the panel discussion technique, which does not provide precise details on how to deal with risks (Chen and Khumpaisal, 2008).

There was a low response rate to the question on practitioners' satisfaction with risk assessment techniques: six respondents (15.40 per cent). The descriptive statistics (see Appendix A) show a mean value of 3 (based on the Likert scale where 1 is very dissatisfied, 3 is neutral and 5 is very satisfied). This implies that the respondents are neither satisfied nor dissatisfied with the current risk assessment techniques. To verify these results, the independent *t*-test was conducted to test the equality of the mean of this set of respondents. Results derived from the *t*-Test show that the significance level is 1.0, meaning that there is no significant difference between means (see Appendix B).

Interview results

The aim of the interviews was to investigate practitioners' personal perceptions of risks and the reliability and validity of the established risk criteria. Two interviews were conducted. Interviewee A, who is a construction project manager of one of Thailand's well-known real estate developers, indicated that his company is more concerned with risks caused by factors like workforce availability; accessibility and transportation to workplace; the duration of development; and pollution during the development process. This is because such factors directly affect the developer's reputation. This interviewee also indicated that project cash-flow illiquidity risk affects the income stream of the real estate project. During the interview process, the interviewee was asked to use his existing project as Plan A, which was the housing project. Plan B, which was the mixed residential project of detached houses and shop-houses, was assumed to fulfil the requirement of ANP calculation. Interviewee A's judgements were computed using the Superdecision application. The results show that Plan B (the mixed residential project) was considered a more appropriate development plan than the existing project; according to the degree of synthesised priority weight, Plan B shown the higher prioritised weight than the existing plan. The results are shown in Table 6.

Finally, even though he acknowledged that ANP has been implemented in the construction and real estate industry, he has never used this model.

Interviewee B was the vice president of a Thai developer, responsible for the marketing financial strategy and decision making. His opinion was that his company is more concerned with risks caused by factors such as

Table 6: Comparison of alternative development plans based on ANP modelling

Results	Alternative development plans	
	Plan A (the existing)	Plan B (the mixed residential)
Synthesised priority weights	0.464	0.536
Ranking	2	1

Table 7: Comparison of alternative development plans based on ANP modelling

Results	Alternative development plans	
	Plan A (the existing)	Plan B (the mixed residential)
Synthesised priority weights	0.3943	0.6057
Ranking	2	1

public liability impacts and total duration of development, as they will directly affect the marketing image of the developers. Regarding risks caused by project cash-flow illiquidity, he indicated that they are also important because they directly affect the selling rate of the project and the depreciation of properties. To pursue the requirements of ANP calculation, he was asked to use his project as the alternative Plan A; his project was a luxurious detached house in Bangkok Central Business District. Plan B was assumed as the mixed residential project combined with middle-class residential units and low-rise condominium.

Similar to the judgement of Interviewee A, the judgement of Interviewee B was computed using Superdecision, Plan B. The results are shown in Table 7. Plan B (the mixed residential project) was considered to be more appropriate than the existing project.

The synthesised priority weights show that there is a significant difference between each development plan (0.2114). This implies that the interviewee recognised that there were some problems in his existing project, and he stated that Plan B would be the appropriate development plan for this situation.

Finally, the interviewee talked about the need for useful risk assessment criteria that are suitable for the Thai real estate sector. In this regard, he suggested that any criteria developed should consider the Stock Exchange of Thailand index; the fluctuation of fuel prices and the price of construction materials, particularly reinforced steel; the Customer Confident Index; the Customer Potential Index; and the current political situation. According to the interviewee, these must be considered in order to establish proper and reliable risk assessment criteria for the Thai real estate sector.

CONCLUSIONS

This article has examined Thai practitioners' perceptions of risk assessment techniques in real estate development projects. It has been established that Thai real estate practitioners are more concerned with risks caused by economic and political factors, and less with risks emanating from other STEEP factors. This study has also shown that proper and practical risk assessment techniques are yet to be implemented in the Thai real estate sector, and it appears that techniques suitable for this sector are currently non-existent.

Regarding the ANP model, the synthesised priority weights calculated based on interviewees' opinions of risks show that there is a non-significant difference between the development plan because of the similar types of real estate project. This affected the interviewees' ability to rank or

compare the consequences of risks in each alternative. Thus, in any further research, there will be a need to distinguish between physical and functional attributes in the application of an ANP model.

The Thai real estate sector needs innovative risk assessment techniques that are flexible and have proper assessment criteria that can be used in the decision-making process. Such assessment techniques would help users to measure both objective and subjective risks. Therefore, it is recommended that the analysis methods (constructed based on multi-criteria analysis attributes and a mathematical framework) be developed and implemented as the risk assessment models in this industry. Risks in the real estate sector are complicated, and require functional assessment tools. ANP is part of the multi-criteria decision-making supporting model, which has proven to be effective and efficient in various industries. Thus, the ANP model needs to be improved through further research and implemented as the risk assessment model in the Thai real estate sector.

REFERENCES

- ACT Insurance Authority. (2004) *Guide to Risk Management: AS/NZS 4360: 2004 Risk Management Standard*. Australia: Australian Capital Territory Insurance Authority.
- Adair, A. and Hutchison, N. (2005) The reporting of risk in real estate appraisal property risk scoring. *Journal of Property Investment and Finance* 23(3): 254–268.
- APTU. (2006) Residential project feasibility study; New Bangkok International Airport area. Submitted to National Housing Authority (Thailand), Faculty of Architectural and Planning Thammasat University, Thailand.
- AREA. (2008) *Housing Yellow Page, Agency for Real Estate Affair*. Bangkok: Veeruch Printing, ISBN 1905-3797.
- Arthurson, K. (2001) Achieving social justice in estate regeneration: The impact of physical image construction. *Housing Studies* 16(6): 807–826.
- ASA Thailand. (2008) Bangkok metropolitan land usage plan. Association of Siamese Architects under Royal Patronage Website, Thailand, 26 April, <http://www.asa.or.th/download/03media/04law/cpa/mr49-bma-landuse.jpg>.
- Atkinson, R. (1999) Discourses of partnership and empowerment in contemporary British urban regeneration. *Urban Studies* 36(1): 59–72.
- Baccarini, D. and Archer, R. (2001) The risk ranking of projects: A methodology. *International Journal of Project Management* 19: 139–145.
- Bahar, J.F. and Crandall, C.K. (1990) Systematic risk management approach for construction projects. *Journal of Construction Engineering and Management* 116(3): 533–546.
- Baum, A. and Crosby, N. (eds.) (2008) Principles of investment analysis. *Property Investment Appraisal*. Oxford, UK: Blackwell Publishing.
- Blundell, G.F., Fairchild, S. and Goodchild, R.N. (2005) Managing portfolio risk in real estate. *Journal of Property Research* 22(2&3): 119–136.
- Booth, P., Matysiak, G. and Ormerod, P. (2002) Risk Measurement and Management for Real Estate Portfolios. London. Report for the IPF, Investment Property Forum (IPF).
- Brown, R.G. and Matysiak, A.G. (eds.) (2000) Risk, return and diversification. *Real Estate Investment: A Capital Market Approach*. Essex, Financial Times: Prentice Hall.
- CHAI. (2006) *Criteria for Assessing Core Standards in 2006/2007*, London: Commission for Healthcare Audit and Inspection, http://www.choicementalhealth.com/pdf/Criteria_assessing_core_standards_2006_2007.pdf, accessed 30 December 2007.
- Chapman, A. (2008) PEST analysis method and examples with free PEST template, www.businessballs.com, <http://www.businessballs.com/pestanalysisfreetemplate.htm>, accessed on 23 March 2009.
- Chen, Z. and Khumpaisal, S. (2008) An analytic network process for risks assessment in commercial real estate development. *Journal of Property Investment and Finance* 27(3): 238–258.
- Chen, Z., Li, H. and Wong, C.T.C. (2005) Environmental planning: An analytic network process model for environmentally conscious construction planning. *Journal of Construction Engineering and Management* 131(1): 92–101.

- Chen, Z., Clements-Croome, D., Hong, J., Li, H. and Xu, C. (2006) A multicriteria lifespan energy efficiency approach to intelligent building assessment. *Energy and Buildings* 38(5): 393–409.
- Cheng, E.W.L. and Li, H. (2004) Contractor selection using the analytic network process. *Journal of Construction Management and Economics* December: 1021–1032.
- Cheng, E.W.L., Li, H. and Yu, L. (2005) The analytic network process (ANP) approach to location selection: A shopping mall illustration. *Journal of Construction Innovation* 5: 83–97.
- Choi, H.H., Cho, N.H. and Seo, J.W. (2004) Risk assessment methodology for underground construction projects. *Journal of Construction Engineering and Management* March–April: 258–272.
- Couch, C. and Dennemann, A. (2000) Urban regeneration and sustainable development in Britain: The example of the Liverpool ropewalks partnership. *Cities* 17(2): 137–147.
- Crossland, B. *et al* (1992) Estimating engineering risk. *Royal Society Risk: Analysis, Perception and Management*, 2nd edn. London: The Royal Society.
- Crown Copyright. (2008) Building regulations. Planning Portal, <http://www.planningportal.gov.uk/england/professionals/en/4000000000001.html>.
- Danter. (2007) *A Sample Lodging Analysis in the City of Grove, Ohio*, Columbus, OH: Danter Company, <http://www.danter.com/PRODUCT/samplodg.pdf>, accessed 30 December 2007.
- Easterby-Smith, M., Thorpe, R. and Lowe, A. (2004) *Management Research: An Introduction*, 2nd edn. London: SAGE Publications.
- Flyvbjerg, B., Bruzelius, N. and Rothengatter, W. (2003) *Megaprojects and Risk: An Anatomy of Ambition*. UK: Cambridge University Press.
- Frodsham, M. (2007) Risk management in UK property portfolios: A survey of current practice. London: Investment Property Forum, http://www.ipf.org.uk/resources/pdf/research/research_reports/Risk_Management_Summary.pdf, accessed 30 December 2007.
- FSA. (2005) *Strengthening Capital Standards*, London: Financial Services Authority (FSA), http://www.fsa.gov.uk/pubs/cp/cp05_03.pdf, accessed 30 December 2007.
- Gehner, E., Halman, J.I.M. and de Jonge, H. (2006) Risk management in the Dutch real estate development sector: A survey. 6th International Postgraduate Research Conference; 6–7 April, University of Salford, pp. 541–552.
- Hargitay, S. and Yu, S.M. (1993) *Decision Criteria – Return and Risk, Property Investment Decisions: A Quantitative Approach*. London, UK: E&FN Spon.
- Harrop, D.O. and Nixon, A.J. (1999) *Ecological Assessment in Practice*, 1st edn. London, UK: Routedledge.
- Hilbers, P., Lei, Q. and Zacho, L. (2001) Real Estate Market Developments and Financial Sector Soundness, IMF Working Paper, WP/01/129, International Monetary Fund.
- Huffman, F.E. (2002) Corporate real estate risk management and assessment. *Journal of Corporate Real Estate* 5(1): 31–41.
- ioMosaic. (2002) *Designing and Effective Risk Matrix: An ioMosaic Corporation Whitepaper*, Houston, TX: ioMosaic Corporation, <http://archives1.iomosaic.com/whitepapers/risk-ranking.pdf>, accessed 30 December 2007.
- Johnson, R.B. and Onwuegbuzie, J.A. (2004) Mixed methods research: A research paradigm whose time has come. *Educational Researcher* 33(7): 14–26.
- Khalafallah, A.M.G.E.I. (2002) Estimating cost contingencies of residential buildings projects using belief networks. Cairo, Egypt: Faculty of Engineering, Cairo University.
- Khumpaisal, S. (2007) Risks in construction project procurement process and risks mitigation methods. *Journal of Architectural/Planning Research and Studies* 6 2007, Faculty of Architecture and Planning Thammasat University, Thailand.
- Khumpaisal, S. (2009) Analytic Approach to Risk Assessment in Real Estate Development. Transfer from Mphil to PhD report, School of the Built Environment, Liverpool John Moores University, Liverpool, UK.
- Kindinger, J.P. (2002) The case for quantitative project risk analysis. Tenth Annual Conference on Quality in the Space and Defense Industries, 4–5 March, Florida, USA, <http://www.lanl.gov/orgs/d/d5/documents/case.pdf>, accessed 30 December 2007.
- Kritayanavaj, B. (2007) Housing bubble. *Government Housing Bank Journal* 1(1): 70–76.
- Lam, K.C., Tiesong, H., Cheung, S.O., Yuen, R.K.K. and Deng, Z.M. (2001) Multi-project cash flow optimization: Non-inferior solution through neuro-multiobjective algorithm engineering. *Construction and Architectural Management* 8(2): 130–144.
- Lauridsen, S.L. (1998) The financial crisis in Thailand: Causes, conduct and consequences? *Journal of World Development* 26(8): 1575–1591.
- Matson, J. (2000) *Cooperative Feasibility Study Guide*, United States Department of Agriculture, Rural Business Cooperative Service, <http://www.rurdev.usda.gov/rbs/pub/sr58.pdf>, accessed 24 October 2009.
- Millington, A.F. (ed.) (2000) Risk and uncertainty, and risk control. *Property Development*. London: EG Books, pp. 219–228.

- Morrison, L.J. (2007) *The STEEP Factors*, Chapel Hill: University of North Carolina. Learning Resources Website, <http://horizon.unc.edu/onramp/>, accessed 30 January 2008.
- Moss, Q.Z., Alho, J. and Alexander, K. (2007) Performance measurement action research. *Journal of Facilities Management* 5(4): 290–300.
- Nabarro, R. and Key, T. (2005) Performance measurement and real estate lending risk. in Real estate indicators and financial stability, BIS Papers No 21, Bank for International Settlements (BIS), April 2005, pp. 70–90, <http://www.bis.org/publ/bppdf/bispap21.htm>, accessed 30 December 2007.
- Nezhad, G.H. and Kathawala, Y. (1990) Risk assessment for international investment. *Management Research News Emerald Backfiles* (2007). pp. 1–8.
- Office of the National Economic and Social Development Board: NESDB (ONESDB). (2007) *Thailand in Brief: 2006*, Bangkok, Thailand: Office of the National Economic and Social Development Board, <http://www.nesdb.go.th/Default.aspx?tabid=136>, accessed 30 December 2007.
- Pellman, R. (2008) Heathrow Terminal 5: gaining permission, *Proceedings of ICE: Civil Engineering* 161, May, pp. 21–24.
- Pidgeon, N., Hood, C., Jones, D., Turner, B. and Gibson, R. (1992) *Risk Perception*. London, UK: Royal Society.
- Pornchokchai, S. (2007) Rethinking the real estate cycle. *Government Housing Bank Journal* 1(1): 48–59.
- Project Management Institute: PMBOK (2002) *A Guide to the Project Management: Body of Knowledge*, Automated Graphic Systems, Charlotte, NC, USA.
- Quigley, M.J. (2001) Real estate and the Asian crisis. *Journal of Housing Economics* 10: 129–161.
- Rafele, C., Hillson, D. and Grimalai, S. (2005) Understanding project risk exposure using the two-dimensional risk breakdown matrix. Proceeding papers of 2005 Project Management Institution Global Congress, Edinburgh, Scotland, <http://www.risk-doctor.com/pdf-files/pmi-e-rbmapaper.pdf>, accessed 30 December 2007.
- REIC. (2009) *Summary of Thailand Real Estate Condition*, Thailand: Real Estate Information Center, http://www.reic.or.th/SummaryRealEstate/SummaryRealEstate_index.asp.
- Saaty, T.L. (2005) *Theory and Applications of the Analytic Network Process*. Pittsburgh, USA: RWS Publications.
- Sagalyn, L.B. (1990) Real estate risks and the business cycle: Evidence from security markets. *The Journal of Real Estate Research* 5(2): 203–220.
- Sale, E.M.J., Lohfeld, H.L. and Brazil, K. (2002) Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality & Quantity* 36: 43–53.
- Spaulding, W.C. (2008) Risk, <http://thismatter.com/money/insurance/risk.htm>, accessed 20 March 2009.
- Thompson, A. (2005) Business feasibility study outline, entrepreneurship and business innovation: The art of successful business start-ups and business planning, http://bestentrepreneur.murdoch.edu.au/Business_Feasibility_Study_Outline.pdf, accessed on 30 October, 2009.
- Vanichvatana, S. (2007) Thailand real estate market cycles: Case study of 1997 economic crisis. *Government Housing Bank Journal* 1(1): 38–47.
- Watkins, C.J., Hughes, S.C., Sims, R., Hildebran, M.E. and Hoyer, B.D. (2004) *Assessing Real Estate Portfolio Risk*, Washington, USA: Supervisory Insights, Federal Deposit Insurance Corporation, http://www.fdic.gov/regulations/examinations/supervisory/insights/cre_lending.html, accessed 30 December 2007.
- Warr, G.P. (2000) *What Happened to Thailand?* Blackwell Publishers: Oxford, UK.
- Younes, E. and Kett, R. (2007) Hotel investment risk: What are the chances? *Journal of Retail Leisure Property* 6(1): 69–78.

APPENDIX A

Descriptive statistics

See Tables A1–A8.

Table A1: Positions held by respondents in real estate development projects

	<i>Position</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Project manager/director	10	25.6	25.6	25.6
	Project coordinator	5	12.8	12.8	38.5
	Engineer/architect/designer	10	25.6	25.6	64.1
	Other	14	35.9	35.9	100.0
	Total	39	100.0	100.0	—

Table A2: The decision maker role in the real estate project

	<i>Decision maker</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative percent</i>
Valid	Yes	22	56.4	57.9	57.9
	No	16	41.0	42.1	100.0
	Total	38	97.4	100.0	—
Missing	0	1	2.6	—	—
Total	—	39	100.0	—	—

Table A3: Working experiences (years)

	<i>Working experience (years)</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	0–5	17	43.6	43.6	43.6
	6–10	12	30.8	30.8	74.4
	11–15	5	12.8	12.8	87.2
	16–20	3	7.7	7.7	94.9
	21 and above	2	5.1	5.1	100.0
	Total	39	100.0	100.0	—

Table A4: Experience in risk assessment

	<i>Experience in risk assessment</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Yes	17	43.6	45.9	45.9
	No	20	51.3	54.1	100.0
	Total	37	94.9	100.0	—
Missing	0.00	2	5.1	—	—
Total	—	39	100.0	—	—

Table A5: Used of any risk assessment models/techniques

	<i>Used of any model</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Yes	6	15.4	19.4	19.4
	No	25	64.1	80.6	100.0
	Total	31	79.5	100.0	—
Missing	0.00	8	20.5	—	—
Total	—	39	100.0	—	—

Table A6: If they did not employ risk assessment model, how could they assess risks in real estate project?

	<i>How to assess if no model</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	By working experience	1	2.6	10.0	10.0
	Panel discussion	7	17.9	70.0	80.0
	Secondary information	2	5.1	20.0	100.0
	Total	10	25.6	100.0	—
Missing	0.00	29	74.4	—	—
Total	—	39	100.0	—	—

Table A7: The knowledge in analytical network process (ANP) or analytical hierarchical process (AHP)

	<i>Knowledge in AHP or ANP</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Yes	4	10.3	11.4	11.4
	No	31	79.5	88.6	100.0
	Total	35	89.7	100.0	—
Missing	0.00	4	10.3	—	—
Total	—	39	100.0	—	—

Table A8: Type of the real estate projects

	<i>Type of project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Low-rise/housing project	24	61.5	66.7	66.7
	High-rise condominium/apartment	4	10.3	11.1	77.8
	Retail	1	2.6	2.8	80.6
	commercial	1	2.6	2.8	83.3
	Other	6	15.4	16.7	100.0
	Total	36	92.3	100.0	—
Missing	0	3	7.7	—	—
Total	—	39	100.0	—	—

APPENDIX B

Statistical analysis of data

See Tables B1–B3.

Table B1: Questionnaires reliability

<i>Cronbach's α</i>	<i>No. of items</i>
Reliability statistics 0.644	31

Table B2: t-Test to verify mean of respondents who used the risk assessment models

<i>Group statistics</i>	<i>Experience in risk assessment</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>SE</i>
Satisfaction with model	Yes	6	3.0000	0.63246	0.25820
	No	1	3.0000	—	—
Satisfaction with model's effectiveness	Yes	6	3.0000	0.63246	0.25820
	No	1	3.0000	—	—

Table B3: Independent samples test

		<i>Levene's test for equality of variances</i>		<i>t-test for equality of means</i>						
		<i>F</i>	<i>Sig.</i>	<i>t</i>	<i>df</i>	<i>Sig. (two-tailed)</i>	<i>Mean difference</i>	<i>SE difference</i>	<i>95% confidence interval of the difference</i>	
		<i>Lower</i>	<i>Upper</i>	<i>Lower</i>	<i>Upper</i>	<i>Lower</i>	<i>Upper</i>	<i>Lower</i>	<i>Upper</i>	<i>Lower</i>
Satisfaction with model	Equal variances assumed	—	—	0.000	5	1.000	0.00000	0.68313	−1.75604	1.75604
	Equal variances not assumed	—	—	—	—	—	0.00000	—	—	—
Satisfaction with model's effectiveness	Equal variances assumed	—	—	0.000	5	1.000	0.00000	0.68313	−1.75604	1.75604
	Equal variances not assumed	—	—	—	—	—	0.00000	—	—	—

APPENDIX C

The perceptions of steep factors

The consequence of each risk for real estate projects

See Tables C1–C12.

Table C1: Social risk

	<i>Level of social risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	6	15.4	17.6	17.6
	High	7	17.9	20.6	38.2
	Medium	12	30.8	35.3	73.5
	Low	7	17.9	20.6	94.1
	Very low	2	5.1	5.9	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C2: Technological risk

	<i>Level of technological risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	4	10.3	11.8	11.8
	High	5	12.8	14.7	26.5
	Medium	13	33.3	38.2	64.7
	Low	7	17.9	20.6	85.3
	Very low	5	12.8	14.7	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C3: Environmental risk

	<i>Level of environmental risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	1	2.6	2.9	2.9
	High	12	30.8	35.3	38.2
	Medium	11	28.2	32.4	70.6
	Low	7	17.9	20.6	91.2
	Very low	3	7.7	8.8	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C4: Economic risk

	<i>Level of economical risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	18	46.2	52.9	52.9
	High	8	20.5	23.5	76.5
	Medium	2	5.1	5.9	82.4
	Low	1	2.6	2.9	85.3
	Very low	5	12.8	14.7	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C5: Political risk

	<i>Level of political risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	9	23.1	27.3	27.3
	High	12	30.8	36.4	63.6
	Medium	4	10.3	12.1	75.8
	Low	4	10.3	12.1	87.9
	Very low	4	10.3	12.1	100.0
	Total	33	84.6	100.0	—
Missing	0.00	6	15.4	—	—
Total	—	39	100.0	—	—

Table C6: Social risk

	<i>Frequency of social risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	6	15.4	17.6	17.6
	High	5	12.8	14.7	32.4
	Medium	13	33.3	38.2	70.6
	Low	7	17.9	20.6	91.2
	Very low	3	7.7	8.8	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C7: Technological risk

	<i>Frequency of technological risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	6	15.4	17.6	17.6
	High	5	12.8	14.7	32.4
	Medium	9	23.1	26.5	58.8
	Low	9	23.1	26.5	85.3
	Very low	5	12.8	14.7	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C8: Environmental risk

	<i>Frequency of environmental risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	2	5.1	5.9	5.9
	High	8	20.5	23.5	29.4
	Medium	14	35.9	41.2	70.6
	Low	6	15.4	17.6	88.2
	Very low	4	10.3	11.8	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C9: Economic risk

	<i>Frequency of economical risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	15	38.5	44.1	44.1
	High	10	25.6	29.4	73.5
	Medium	3	7.7	8.8	82.4
	Low	4	10.3	11.8	94.1
	Very low	2	5.1	5.9	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C10: Political risk

	<i>Frequency of Political risk to project</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid percent</i>	<i>Cumulative percent</i>
Valid	Very high	9	23.1	26.5	26.5
	High	10	25.6	29.4	55.9
	Medium	8	20.5	23.5	79.4
	Low	4	10.3	11.8	91.2
	Very low	3	7.7	8.8	100.0
	Total	34	87.2	100.0	—
Missing	0.00	5	12.8	—	—
Total	—	39	100.0	—	—

Table C11: One-way ANOVA to test the mean value

	ANOVA	Sum of squares	df	Mean square	F	Sig.
Level of social risk to projects	Between groups	1.448	4	0.362	0.246	0.910
	Within groups	42.670	29	1.471	—	—
	Total	44.118	33	—	—	—
Level of technological risk to project	Between groups	7.666	4	1.917	1.394	0.261
	Within groups	39.863	29	1.375	—	—
	Total	47.529	33	—	—	—
Level of environmental risk to project	Between groups	5.466	4	1.367	1.343	0.278
	Within groups	29.504	29	1.017	—	—
	Total	34.971	33	—	—	—
Level of economical risk to project	Between groups	8.221	4	2.055	0.981	0.433
	Within groups	60.750	29	2.095	—	—
	Total	68.971	33	—	—	—
Level of political risk to risk to project	Between groups	5.927	4	1.482	0.794	0.539
	Within groups	52.255	28	1.866	—	—
	Total	58.182	32	—	—	—
Frequency of social risk to project	Between groups	6.762	4	1.691	1.203	0.331
	Within groups	40.767	29	1.406	—	—
	Total	47.529	33	—	—	—
Frequency of technological risk to project	Between groups	5.056	4	1.264	0.694	0.602
	Within groups	52.826	29	1.822	—	—
	Total	57.882	33	—	—	—
Frequency of environmental risk to project	Between groups	5.028	4	1.257	1.110	0.371
	Within groups	32.854	29	1.133	—	—
	Total	37.882	33	—	—	—
Frequency of economical risk to project	Between groups	4.628	4	1.157	0.710	0.592
	Within groups	47.254	29	1.629	—	—
	Total	51.882	33	—	—	—
Frequency of political risk to risk to project	Between groups	1.531	4	0.383	0.218	0.926
	Within groups	50.939	29	1.757	—	—
	Total	52.471	33	—	—	—

Table C12: The correlation between each STEEP factor risk

	<i>Correlations</i>	<i>Position</i>	<i>Ranking the affect of social risk to project</i>	<i>Ranking the affect of technological risk to project</i>	<i>Ranking the affect of environmental risk to project</i>	<i>Ranking the affect of economical risk to project</i>	<i>Ranking the affect of political risk to project</i>
Position	Pearson correlation	1	0.362	-0.034	-0.414*	0.374*	0.037
	Sig. (two-tailed)	—	0.058	0.860	0.029	0.035	0.851
	N	39	28	29	28	32	29
Ranking the affect of social risk to project	Pearson correlation	0.362	1	-0.209	-0.154	-0.402 *	-0.274
	Sig. (two-tailed)	0.058	—	0.286	0.432	0.034	0.159
	N	28	28	28	28	28	28
Ranking the affect of technological risk to project	Pearson correlation	-0.034	-0.209	1	-0.169	-0.370	-0.450*
	Sig. (two-tailed)	0.860	0.286	—	0.389	0.053	0.016
	N	29	28	29	28	28	28
Ranking the affect of environmental risk to project	Pearson correlation	-0.414*	-0.154	-0.169	1	-0.261	-0.328
	Sig. (two-tailed)	0.029	0.432	0.389	—	0.180	0.088
	N	28	28	28	28	28	28
Ranking the affect of economical risk to project	Pearson correlation	0.374*	-0.402*	-0.370	-0.261	1	0.324
	Sig. (two-tailed)	0.035	0.034	0.053	0.180	—	0.086
	N	32	28	28	28	32	29
Ranking the affect of political risk to project	Pearson correlation	0.037	-0.274	-0.450*	-0.328	0.324	1
	Sig. (two-tailed)	0.851	0.159	0.016	0.088	0.086	—
	N	29	28	28	28	29	29

*Correlation is significant at 0.05 level (two-tailed).