An Analytical Network Process for Risk Assessment in Commercial Real Estate Development

กระบวนการเครือข่ายเชิงลำดับขั้น เพื่อประเมินผลกระทบของความเสี่ยงในธุรกิจพัฒนาอสังหาริมทรัพย์

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Abstract

Risk assessment in real estate development business for strategic decision-making may have long-term impacts on competitive advantage concerning cost efficiency at the project development stage. Accordingly, this research studied impacts of risk factors on project development. The research methodologies comprised of primary observation on process activities and in-depth interviews with relevant experts and related parties. Moreover, in order to evaluate and prioritize project development issues appropriately, Analytic Network Process: ANP, a well-known multi-criteria decision-making tool, was applied to a case study in order to analyze the environmental risks and social risks associated to the project development.

Major results of the research illustrated that a proper development of environmental and social risk management for property development business should be initiated during the feasibility study stage. Next, the risk management process should be enhanced to be in accordance with corporate strategy. The research findings can also assist in improving risk management performance in order to achieve sustainable project development and investment in the long run.

Keywords: Risk assessment, Commercial real estate, Analytic Network Process (ANP)

บทคัดย่อ

การวิเคราะห์ความเสี่ยงในธุรกิจพัฒนาอสังหาริมทรัพย์ นับเป็นการตัดสินใจระดับกลยุทธ์ที่ส่งผลกระทบระยะยาวต่อขีดความสามารถในการแข่งขันทางธุรกิจในเชิงต้นทุนระดับพัฒนาโครงการ งานวิจัยนี้ศึกษาประเด็นผลกระทบด้านความเสี่ยงจากปัจจัยต่างๆ ที่เกิดขึ้นต่อการพัฒนาโครงการ โดยวิธีการวิจัยใช้การจัดเก็บข้อมูลปฐมภูมิโดยการศึกษาขั้นตอนในแต่ละกิจกรรม การสัมภาษณ์เชิงลึกกับผู้เกี่ยวข้อง และการให้ผู้ทรงคุณวุฒิทำการจัดลำดับความสำคัญของประเด็นปัญหาที่เกิดขึ้นด้วยวิธีกระบวนการเครือข่ายเชิงลำดับขั้น (Analytic Network Process: ANP) เพื่อประเมินถึงผลกระทบความเสี่ยงในการดำเนินงานที่มีผลต่อการพัฒนาโครงการต่อความเสี่ยงทางด้านสิ่งแวดล้อมและด้านสภาพสังคม ผ่านตัวอย่างกรณีศึกษา

จากผลการศึกษาพบว่า การพัฒนาตัวชี้วัดการจัดการความเสี่ยงด้านสิ่งแวดล้อมและด้านสภาพสังคมในธุรกิจพัฒนาอสังหาริมทรัพย์ ควรจะดำเนินการเป็นลำดับแรกในช่วงการศึกษาความเป็นไปได้ของโครงการ ลำดับต่อมาคือ การปรับปรุงกระบวนการบริหารจัดการความเสี่ยงที่สอดคล้องกับกลยุทธ์ของบริษัท ผลจากการศึกษาสามารถนำมาใช้เป็นแนวทางการเตรียมความพร้อมของบริษัทในการปรับปรุงประสิทธิภาพในการจัดการความเสี่ยงที่มีผลต่อบริษัทเพื่อการพัฒนาและลงทุนโครงการได้อย่างยั่งยืน

คำสำคัญ: การบริหารความเสี่ยง ธุรกิจอสังหาริมทรัพย์ กระบวนการเครือข่ายเชิงลำดับขั้น

Introduction

Risk and uncertainties are associated with overall projects in commercial real estate development and they can strongly influence all related progresses at all stages of the entire lifecycle of the properties. Specifically, those risks can occur at an initial stage of a project when developers conduct feasibility study, design and planning, bidding and tendering, construction, or even during marketing or handover period. Meanwhile, risks existing in initial stage can also influence the use of the property as well.

Risks in each commercial real estate development project can be identified at project management level using brainstorming techniques, in which they are generally defined as events that could arise and affect the critical factors of the project. For example, Huffman (2002) classified, major risks associated with commercial real estate development into three categories, including financial risks, physical risks, and regulatory risks. There are a number of direct and indirect reasons why risks may occur in commercial real estate development process. Amongst these, some common reasons are relevant to the fragments existed throughout a project lifecycle covered by design, construction and facilities management, which results in a lack of integration of building elements, communication among project partners, and even misapplication of the building structures and respective service systems.

In addition to the influences of those risks to certain specific projects, there is also a concern of their impacts on environment, communities and economic systems at local, regional and national levels in a long-term perspective under climate change scenario with regard to competitive enterprise growth and sustainable urban development. For example, according to generic characteristics of commercial real estate, one of the most significant risks and uncertainties towards investment return is the income stream. Since the income stream is uncertain, as well as the possible events affecting the income stream and uncertainty as to the probability of the outcomes from these events (IPF, 2007), therefore, affordability was adopted in Table 1 as a criterion to assess risks. Moreover, it is important to look at subjective issues that may not be revealed by objective data according to statistics, but might lead to risks of loss by some reasons. According to Booth, *et al.* (2002), there are subjective elements to be considered in risk management process, which covers

- tenant risk (multi-tenanted less risky),
- demand and supply of property type,
- demand and supply for properties in different locations (local market conditions),
- economic & property market environment (voids, rental growth, leverage and pricing), and
- Illiquidity (it may not be possible to sell certain types of property quickly, except at below-valuation prices).

Therefore, both subjective and objective issues need to be considered in defining criteria for risk assessment (see Table 1).

Generally, the risk management process can be regarded as an ongoing and iterative process despite to the differences of each project with specific characteristics. In addition, risk management approaches adopted by professionals are mostly undertaken based on the three basic steps, which consist of risk identification and initial assessment, response and mitigation, and further risk analysis (see other methods in Figure 1). The Investment Property Forum (IPF, 2007) suggested that real estate risks can only be managed within an overall framework or risk management processes, and those risks shall apply a variety of complimentary approaches, which are grounded in a rigorous and preferably quantitative framework. Therefore, risk management processes shall include an assorted mix of “quantitative statistical framework” as well as several techniques such as stress testing and a rigorous analysis of subjective issues. However, it has been noted by the authors that traditional approaches of risk assessment mostly depend on the result derived from either panel discussion or ranking method, which are sometimes not convincing enough due to a lack of quantitative measurement using reliable tools or instruments with strong theoretical bases (Bienert and Brunauer, 2007). For example, investment of a hotel is employing the risk assessment method named ‘risk matrix’, which has been accepted as the practical risk assessment tool for many project types. (IoMosaic, 2002; Kindinger, 2002; Rafele, et al., 2005) The disadvantage of the Risk Matrix is that the data used for a matrix calculation are derived from either panel discussion or ranking method by the hotel managerial levels, most data rely on personal opinion and experience, (Younes, 2007) and do not use reliable tools or instruments with strong theoretical basis. Other inconvenience of risk matrix is that the matrix does not allow the comparison of each criterion, and the results calculated by matrix are normally subjective and do not provide the detail of data to help the developers to structure their decision-making process. The reason of this inconvenience risk factors are numerous, particularly in large real estate projects, and the ability of humans to assess many factors at the same time is very limited (He. Z, 1995)

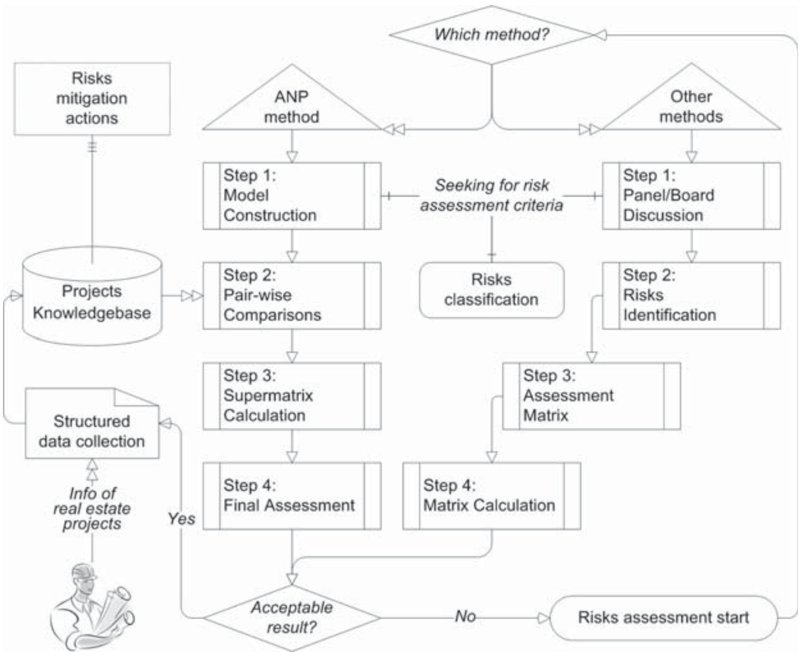
As mentioned above, commercial real estate development industry are involved with several types of risks and their consequences. For example, when risks are caused by several criteria such as finance, social, economics, environment and technology, in order to assess the risks and their consequences, it is suggested to use practical tools, which are able to analyse the risks with their consequences and to calculate the results in a numerical format. The desirable methodology for this commercial real estate development should allow the synthesis of the criterion, comparisons of each factor and help the developers to the decision-making process. (Booth, *et al*. 2002)

It is assumed that developers need alternative risk assessment methods such as Bayesian Belief Network, Monte Carlo, and Multi-Criteria Decision Analysis for risk assessment in commercial real estate development. The Analytic Network Process (ANP) is therefore suggested as one of such systematic approaches that can be used to deal with both quantitative and qualitative factors under multiple criteria (Saaty, 1999). Nakagawa (2004) and Cheng (2004) supported that ANP could deal with a multi-criteria analysis and comparison of each criterion, the outcome of this process also be in a mathematical statistics format, which can be adopted for further decision-making process. In this regard, this paper aims to introduce a novel decision-making approach to risk assessment in commercial real estate development against sustainability criteria. A multi-criteria decision-making model is therefore described based on Analytic Network Process (ANP) theory (Saaty, 2005), and an experimental case study on an urban regeneration project in Liverpool was used to demonstrate effectiveness of the ANP model.

Research Methodology

Research methods adopted in this research include literature review and interviews to understand current situation in risk assessment for commercial real estate development, questionnaire survey and data analysis to support analytic network process (ANP) modelling (Saaty, 2005), and case study to further test of the effectiveness of ANP model to support decision-making in feasibility study for commercial real estate development.

Figure 1 illustrates traditional risk assessment method associated with the adoption of ANP method to assess risks for commercial real estate development. The procedure of risk assessment started at the selection of an appropriate method about the characteristics of a specific problem and the preference of decision-makers. No matter which method is adopted, the process of risks classification is essential to define risk assessment criteria. In the case of using traditional method, as mentioned in other methods tag (see Figure 1), the first step is to conduct a panel/board discussion about risks that may affect on the project, while each participants use their experience to identify or classify predictable risk events. The next step is to set up an assessment method, and current practice is mostly to build a matrix for risks assessment (IoMosaic, 2002; Kindinger, 2002; Rafele, et al., 2005), and the matrix is used to describe the likelihood and consequences of each risk in a tabular format. Because of using the matrix, the panel may find the degree of overall degree of risk events. However, the results derived from matrix assessment method are not based on either non-linear mathematic calculation or objective assumptions related to a real business case. Alternatively, if a project manager had selected the ANP process, the first step is to set up an ANP model, then followed by the Pair-Wise comparison process to form a super-matrix of quantified interdependences between paired criteria as well as alternatives of development plans; based on super-matrix calculation results, the project team can get a numerical suggestion regarding the plan which is the most appropriate one. Moreover, this result can also be useful in supporting risk mitigation actions to be undertaken afterwards. To complete decision-making tasks, a project knowledgebase was proposed to be integrated with the process for using either traditional method or ANP method, as they require adequate and accurate information to achieve reliable results; and the knowledge can be collected from existing new projects.



Source: Adair, A., Hutchison, N., 2005

Figure 1 Risk assessment processes and procedures with the ANP method

Literature for Risks Assessment

As illustrated in Figure 1, the first step of using ANP in decision-making is to set up an ANP model. To set up an ANP model for risk assessment in commercial real estate development, it is essential to define a list of assessment criteria and their measurements to facilitate the use of ANP not only in a laboratory study but also in potential commercial applications. To improve the quality of decision-making using ANP, the criteria for risk assessment should be comprehensive and practical with regard to the sustainability issues requirement for commercial real estate development. In this regard, literature reviews were conducted to form an initial list of risk assessment. Table 1 summaries the initial criteria in four categories, including environmental risks, social risks, and economic risk, which are regarded as main issues to be covered under sustainability driven risk assessment for commercial real estate development.

To define measurement approaches for each risk assessment criterion, both qualitative and quantitative methods were adopted and this was based on current practice adopted by both academics and professionals in the risk assessment domain. For example, according to the definition given by Saaty, T.L. (2005), risk is the combination of uncertainties over the probability of events and their consequences. In case that a range of possible events could be known, risks can be identified and controlled by qualitative risk controls. Meanwhile, if the range of possibility could be known and the probability distribution of the outcomes of these events could be estimated, then the risk can be managed by employing quantitative techniques. On the other hand, Booth, *et al*. (2002) mentioned that current risk measurement methods such as symmetrical risk measures (e.g. standard deviation of returns) and single point measures (e.g. value at risk) would rather be complemented by any measures focusing more exclusively on downsize risk. Therefore, the calculation of such measures would be employed as a standard feature of risks assessment for commercial real estate development. In addition, it is also a priority in defining measures for each risk assessment criterion to make the measurement as simple and practical related as possible; and it was understood that further definitions to measure all criteria are expected based on more theoretical study.

Table 1 provides a list of risk assessment criteria used to set up ANP model, and related measurement approaches adopted to quantitatively evaluate risks for case study purpose using ANP.

Environmental Risks

According to Table 1, there are two types of risks, including the total adverse environmental impacts and the climate change impacts. The adverse environmental impacts can be measured by using a developed quantitative approach called Environmental Impact Index (EII) (Chen, et al., 2005), and the climate change impacts can be measured by using the degree of impacts to the use and value of each specific development due to regional climatic variation.

Table 1 Risk assessment criteria for commercial real estate development

Criteria	Sub-Criteria	Valuation methods	Representative references
1 Environmental risks	Adverse environment impacts	Overall value of the Environmental Impacts Index	Chen, et al., 2005; Chen, 2007
	Climate change	Degree of impacts to use and value due to regional climatic variation (%)	United Nations Environment Programme, 2007
2 Social risks	Workforce availability	Degree of Developer's satisfaction to local workforce market (%)	Danter, 2007
	Cultural compatibility	Degree of business & lifestyle harmony (%)	Danter, 2007
	Community acceptability	Degree of benefits for local communities (%)	Danter, 2007
	Public hygiene	Degree of impacts to local public health & safety (%)	NHS Standards
3 Economic risks	Interest rate	Degree of impacts due to interest rate change (%)	Sagalyn, 1990; Financial Services Authority, 2005; Nabarrol & Keys, 2005; Financial Stability Board, 2007; IPF 2007
	Property type	Degree of location concentration (%)	Adair & Hutchison, 2005; IPF, 2007
	Market liquidity	Selling rate of same kind of properties in the local market (%)	Adair & Hutchison, 2005
	Confidence to the market	Degree of expectation to the same kind of properties	Adair & Hutchison, 2005; IPF 2007
	Demand and Supply	Degree of regional competitiveness (%)	Adair & Hutchison, 2005
	Purchaseability	Degree of affordability to the same kind of properties (%)	http://www.statistics.gov.uk/
	Brand visibility	Degree of Developer's reputation in specific development (%)	Dun & Bradstreet, 2007; Adair & Hutchison, 2005; Gibson & Louragand, 2002
	Capital exposure	Rate of estimated lifecycle cost per 1 billion pound (%)	Blundell, et al., 2005; Moore, 2006
	Lifecycle value	5-year property depreciation rate (%)	Lee, 2002; Adair & Hutchison, 2005
	Area accessibility	Degree of regional infrastructures usability (%)	Adair & Hutchison, 2005
	Currency conversion	Degree of impacts due to exchange rate fluctuation	Morledge, et al., 2006; Financial Services Authority, 2005; Financial Stability Board, 2007
	Buyers	Expected selling rate (%)	IPF 2007
	Tenants	Expected annual lease rate (%)	Booth, et al., 2002
	Investment return	Expected capitalization rate (%)	Sagalyn, 1990; Watkins, et al., 2004

Source: Chen, Z., Li, H., Wong, C.T.C., 2005

Environmental management in real estate development projects may generally require managers to concentrate on a group of impact assessment criteria relevant to the adverse environmental impacts generated from processes or operations during the entire project period in regard to achieve various environmental-friendly targets with diverse managerial instruments and efforts. From this point of view, the evaluation of the adverse environmental impacts based on relatively objective rules is essential for projects management focusing on both pollution prevention and reduction. The EII is a subjective quantitative measurement of various adverse environmental impacts that could be potentially generated from processes or operations during the entire project period. The EII can be calculated by integrating the subjective judgments towards the different of the adverse environmental impacts (see Equation 1).

$$EII_i = \sum_{j=1}^{8} \lambda_{i,j} EII_{i,j} \qquad (j = 1, 2, ..., 8) \qquad (1)$$

Where

- EII_i is the total environmental impact caused by $Project_i$.
- $EII_{i,j}$ is the individual environmental impact leading to one of the eight possible pollutions and hazards, including
   - Soil and ground contamination (j=1),
   - Ground and underground water pollution (j=2),
   - Waste (j=3),
   - Noise and vibration (j=4),
   - Dust (j=5),
   - Hazardous emissions and odors (j=6),
   - Wildlife and natural features impacts (j=7), and
   - Archaeology impacts (j=8).
- $\lambda_{i,j}$ is the coefficient of $EII_{i,j}$.

For Equation 1, the value of $EII_{i,j}$ is defined as a subjective score belonging to the range of [-1, +1] in terms of the level of specific environmental impact for $Project_i$. In general, -1 represents that $Project_i$ will extremely intensify the level of adverse environmental impacts, 0 represents that $Project_i$ will bring uncertain environmental influences, and +1 represents that $Project_i$ can extremely reduce the level of the adverse environmental impacts. On the other hand, the value of $\lambda_{i,j}$ is defined as a subjective weight that belongs to the range of [0, 1] in terms of the tendency of environmental management in a project. In general, if $\lambda_{i,j}$ is set to a outer extreme, say 0, it means that specific adverse environmental impact j (j=1,2,…,8) is basically ignorable, while if $\lambda_{i,j}$ is set to 1, it means that specific adverse environmental impact j (j=1,2,…,8) is extremely considerable. Table 2 gives an example of using $EII_{i,j}$ to measure adverse environmental impacts for three alternative real estate development plans, which are used in the experimental case study of this paper.

Table 2 The environmental impacts of alternative development plans

No.	Risks of adverse impacts	$\lambda_{i,j}$	$EII_{i,j}$		
			Plan A	Plan B	Plan C
1	Soil and ground contamination	0.3	-0.5	-0.4	-0.6
2	Ground and underground water pollution	0.3	-0.5	-0.5	-0.6
3	Waste	0.7	-0.6	-0.5	-0.7
4	Noise and vibration	0.7	-0.5	-0.4	-0.8
5	Dust	0.7	-0.2	-0.1	-0.5
6	Hazardous emissions and odors	0.5	-0.3	-0.3	-0.5
7	Wildlife and natural features impacts	0.2	+0.1	+0.2	+0.3
8	Archaeology impacts	0.5	+0.2	0.0	+0.3
	Total impacts		-1.24	-1.08	-1.8

Source: Rafele, C., Hillson. D., Grimalai, S., 2005

Note: 1. Plan A: a retail-led mixed-use inner CBD development
2. Plan B: an office-led adjacent inner CBD development
3. Plan C: an entertainment-led adjacent inner CBD development

Social Risks

Social risks in commercial real estate development are mostly described in subjective forms. Most developers use qualitative analysis methods to measure and assess social-related risks. However, the measurement of interdependences inside and outside the social risk cluster (see Figure 2) requires all social risks to be quantitatively measured. As described in Table 1, there are four types of risks related to social issues, namely, workforce availability, cultural compatibility, community acceptability and public hygiene. In fact, assessment criteria for these four types of risks have also been recognized by professionals. For example, according to Danter (2006), developers should measure workforce availability by employing a consensus method or observation of workforce targets in the project trade area. While a measurement of the cultural compatibility to the project to acknowledge whether the project would be accepted can be done by conducting marketing surveys, which highlights the project's impacts to the local communities in regard to their acceptability. On the other hand, the Healthcare Commission (2006) issued the criteria for assessing core standards to establish measurement criteria for public healthcare and hygiene, and developers shall modify or apply these standards as tools for assessing risk caused by public hygiene issues. The measurements of adopted social risk assessment criteria are summarized as below:

- The risks related to Workforce availability are measured by using the degree of developer's satisfaction to local workforce markets;
- The risks related to cultural compatibility are measured by using the degree of business & lifestyle harmony, which aims to identify the compatibility of each specific development with local and regional cultural environment;
- The risks related to community acceptability are measured by using the degree of benefits that each specific development could bring to local communities with regards to their opinions; and
- The risks related to public hygiene are measured by using the degree of impacts to local public health and safety due to the development of the specific project.

Economic Risks

Risks associated with economic and financial uncertainties are the most important factors that could have a strong impact on the project development process and its vitality. Thus, that is the reason why most professionals and academics in the real estate paid their attentions to economic risks caused by a variation of interest rates, loans and developer credits (Sagalyn, 1990; Case, et al., 1995; Nabarro and Key, 2005; Strischeck 2007). However, there are other related risks caused by other factors in terms of marketing and its characteristics, investment, income and exposure, as well as buyers and tenants. For example, IPF (2007) conducted a survey in risk management practices and disclosed that, while investing in the commercial real estate assets, it will deliver a return in form of an income stream, but the income stream is uncertain to forecast as well as any events which would affected to the income stream. On the other hand, Strischek (2007) suggested that some mandatory data should be added into risks measurement criterion, including original appraised value, bank-adjusted appraised value, capitalization rate from appraisal and loan to value at inception. In addition, the following sets of data may also be necessary to measure risks by utilizing a sensitivity analysis: capitalization rate from appraisal, net operating income, vacancy rates, space rental rates, debt service coverage, maintenances rate spread, floor, and ceiling and annual principal and interest payments. In addition, Blundell, *et al.* (2005) suggested to use the following criteria to measure risks and to assess their impacts:

- Sector balance score: to measure the fund's structure and indicate the weight scores, which differ from IPD universe structure income return;
- Income return: to calculate the net income received each year as a percentage of the capital employed over the year;
- Location concentration: this measured the percentage of each fund's capital value invested in the ten most important locations;
- Development exposure: IPD and LaSalle chose the simple percentage of fund capital value in current developments as a risk measure, which included both pre-let and speculative developments;

- Asset/Lot size concentration: this measured the percentage of a fund's capital value that is bound up in 5 big assets;
- Lease length;
- TICCS Stress score: is weighted by the rent for each tenant to form the portfolio stress score;
- Tenant concentration: this measured the percentage of the annual rental payments that accounted from the biggest 10 tenants;
- Weighted Beta; and
- Void Rate or vacancy rate.

According to current literatures about economic risks, although there are a number of indicators previously identified to evaluate potential economic performance of a real estate project, this paper is only in gear with some most significant economic risks associated with commercial real estate development. As described in Table 1, there are fourteen types of risks related to economic issues, and these risks are interest rate, property type, market liquidity, confidence to the market, demand and supply, purchase ability, brand visibility, capital exposure, lifecycle value, area accessibility, currency conversion, buyers, tenants, and investment return.

Amongst those risks, according to Financial Services Authority (2005), the Interest rate is a significant indicator for measuring economic risks by the developers as changes in interest rate can affect their earnings by changing its net interest income, the level of other interest-sensitive income, and operating expenses associated with each specific real estate development. Moreover, those changes can also affect the underlying value of a firm's assets, liabilities and off-balance sheet instruments through the changes caused to the present value of future cash flows. In this regard, the interest rate is selected as one most important risk assessment criterion in commercial real estate development.

There are some other reasons for selecting other risks as defined in Table 1. For instance, the adoption of currency conversion as one risk assessment criterion in commercial real estate development is based on the assumption that risk associated with currency conversion movements can encourage currency speculation, or 'carry trade'. Whenever there is an opportunity in currency exchange, developers may have more interest to borrow foreign money to invest in higher-yielding currencies, rather than to invest in real estate development if the expected return of investment in commercial real estate is lower than yield return of investment in the currency conversion market. Similar assumptions were made for buyers and tenants whose investments may be influenced by fluctuant currency exchange rates.

The measurements of adopted economic risk assessment criteria are summarized as below:

- The risks related to interest rate are measured by using of the degree of impacts due to interest rate change;
- This risks related to property type are measured by using of the degree of location concentration in regard to the density of similar type properties for each specific development;

- The risks related to market liquidity are measured by using of the selling rate of same kind of properties in the local market;
- The risks related to confidence to the market are measured by using the degree of expectation to the same kind of properties;
- The risks related to demand & supply are measured by using of the degree of regional competitiveness in each developing of specific project;
- The risks related to Purchaseability are measured by using the degree of affordability to the same kind of properties;
- The risks related to brand visibility are measured by using the degree of developer's reputation in developing of each specific real estate project;
- The risks related to capital exposure are measured by using of the rate of estimated lifecycle cost per 1 billion pound for each specific development;
- The risks related to lifecycle value are measured by using of 5-year property depreciation rate;
- The risks related to area accessibility are measured by using of the degree of regional infrastructure usability associated with a specific development;
- The risks related to currency conversion are measured by using of the degree of both short-term and long-term impacts due to exchange rate fluctuation to a specific development;
- The risks related to buyers are measured by using of an expected selling rate of a specific development;

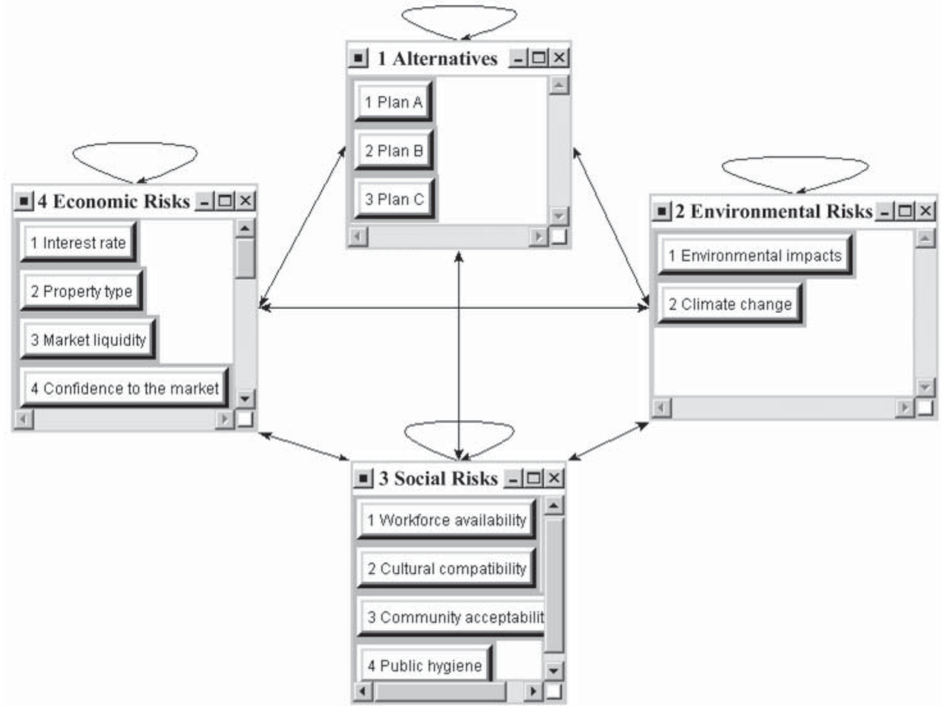
Risk Assessment Model

A multicriteria decision-making model is proposed here using of ANP to facilitate a holistic risk assessment for specific commercial real estate development at feasibility study stage. Figure 2 illustrates the ANP model based on the 20 defined risks assessment criteria (see Table 1). The model was set up by using *Super Decisions* software for decision-making. The ANP team wrote the program working for the *Creative Decisions Foundation*, which implements the ANP developed by Professor Thomas Saaty (2005). Excluding the alternative cluster, the ANP model comprises of 3 clusters and 20 nodes, which are in accordance with the criteria and sub-criteria summarized in Table 1. In addition, the alternative cluster, the important cluster of the ANP model, is used here to comprehend alternative plans to be evaluated against risk assessment criteria in an experimental case study. Moreover, there are also 3 nodes representing 3 alternative plans for a specific commercial real estate development (see Experimental Case Study section). The beauty of ANP method is that it provides an effective mechanism for decision-makers to conduct quantitative evaluation of interrelations between either paired criteria or paired sub-criteria; and this makes it possible for decision-makers to reuse expertise for commercial real estate development with regard to the assessment of all defined risk (see Table 1).

As illustrated in Figure 2, the ANP model consists of 4 clusters, including Alternatives, Environmental Risk, Social Risk, and Economic

Risk. There are total 23 nodes inside the ANP model. Amongst them, there are 3 nodes inside the Alternative cluster including Plan A, Plan B, and Plan C, which are alternative plans for a specific commercial real estate development in Liverpool and were adopted in an experimental case study in this research to demonstrate effectiveness of ANP application in finding the most appropriate plan. On the other hand, the rest 20 nodes are located in other 3 clusters in accordance with their belongingness to those clusters as described in Table 1. In addition, two-way and looped arrow lines in Figure 2 describe interdependences existing between paired clusters as well as nodes (Saaty, 2005). In other words, there are fixed interrelations between paired clusters, meanwhile there are also fixed interrelations between paired nodes inside one cluster as well as from two different clusters. To quantitatively measure all interrelations inside the ANP model, a questionnaire survey concerning the comparison of relative importance between paired clusters as well as nodes is normally required. By using the questionnaire survey, it can be expected that experts' knowledge about each specific domain are collected and the concentrated into an ANP model; as a result, the ANP model can perform as a decision-making support tool based on knowledge of reuse. In this paper, the ANP model was set up by the authors only; and the model will be further developed based on questionnaire survey after a pilot study through the experimental case study to be described below.

The structure of the ANP model is illustrated in Figure 2; however, in order to quantify all possible interdependent relations inside the model, pair-wise comparison was adopted using subjective judgments made in regard to fundamental scale of pair-wise judgments (Saaty, 2005) (see Table 3). Table 3 gives a general description about how to conduct pair-wise comparison between paired clusters as well as nodes regarding their interdependences defined in the ANP model (see Figure 2) and relative importance based on their specific characteristics and experts' knowledge. In this paper, the ANP model was set up based on authors' knowledge about risk assessment criteria, which has been used to make judgments in quantifying interdependences for the 20 risk assessment criteria inside cluster 2 to 4 except the 3 alternatives in cluster 1 (see Figure 2), and specific characteristics of alternative plans (see Table 4), which has been used to make judgments in quantifying interdependences for alternatives in the experimental case study.



(Courtesy of Creative Decisions Foundation)

Source: Nabarro, R., Key, T., 2005

Figure 2 The ANP model for risk assessment in commercial real estate development

Table 3 Judgments between paired clusters/nodes in the ANP model

Clusters/Nodes		Scale of pair-wise comparisons								
		±1	±2	±3	±4	±5	±6	±7	±8	±9
Cluster I	Cluster J	✗	✗	✗	✗	✗	✓	✗	✗	✗
Node I_i	Node J_j	✗	✗	✗	✗	✗	✓	✗	✗	✗

Source: French, N., French, S., 1997

Note: 1. The fundamental scale of pair-wise judgments: 1 = Not important, 2 = Not to moderately important, 3 = Moderately important, 4 = Moderately to strongly important, 5 = Strongly important, 6 = Strongly to very strongly important, 7 = Very strongly important, 8 = Very strongly to extremely important, 9 = Extremely important.

2. The symbol ✗ denotes item under selection for pair-wise judgment, and the symbol ✓ denotes selected pair-wise judgment.

3. J and I denote the number of Clusters, whilst j and i denote the total number of Nodes.

4. The symbol ± denotes importance initiative between compared Nodes or Clusters.

Experimental case study

To demonstrate effectiveness of applying the ANP model to select the most appropriate plan for a specific commercial real estate development, an experimental case study was conducted here based on information collected from an ongoing urban regeneration project in Liverpool; and some scenarios such as alternative plans concerning the requirements of comparison study using ANP models. Details of the experimental case are described below.

(Courtesy of Stephen Barter, Grosvenor)

Source: Blundell, G.F., Fairchild, S., Goodchild, R.N., 2005

Figure 3 A commercial real estate developments in Liverpool

The proposed commercial real estate development was located in central Liverpool. The site area was about 40 acres and it was compared with main retail areas, inner central business district (CBD), residential areas, walk streets, main roads, and the old Albert Dock along the River Mersey (see-highlighted area in Figure 3). The developer worked closely in partnership with the city council to revitalise this deprived area not only for short-term attractions such as the local event of European Capital of Culture in 2008 but also for long-term urban renaissance in regard to northwest regional economic strategy under sustainable development regime in Merseyside. For the purpose of experimental case study, three development plans were considered in this research; and they were a retail-led mixed-use inner CBD development (called Plan A), an office-led adjacent inner CBD development (called Plan B), and an entertainment-led adjacent inner CBD development (called Plan C). This scenario was made based on the philosophy of local urban renaissance, which aims to attract back to Liverpool a higher proportion of catchment population currently lost to outer retail parks and shopping centres such as the Trafford Centre, and to maximise the use of current and future transport infrastructures such as the Merseytram, focused on city centre (Mynors, 2006). Accordingly, specific assumptions were made in regard to normal characteristics of each kind of plans; and the details of those assumptions are summarised in Table 3 according to defined risk measurement methods as given in Table 1.

Based on the scenario of three alternative development plans for the specific site, further assumptions were made in Table 4. To make more reasonable assumptions, information from actual projects was considered. In this regard, one important information source was BCIS (Building Cost Information Service), which was the UK's leading provider of cost and price information for construction and property occupancy. As mentioned above, although interdependences among 20 risk assessment criteria can be measured based on experts' knowledge, the ANP model should comprehend all specific characteristics of each alternative plan, which are given in Table 4.

Table 4 Assumptions of alternative development plans for ANP evaluation

Criteria	Sub-Criteria	Unit	Alternatives		
			Plan A	Plan B	Plan C
Environmental risks	Environment impacts	%	-124	-108	-180
	Climate change	%	40	50	60
Social risks	Workforce availability	%	100	90	90
	Cultural compatibility	%	80	70	90
	Community acceptability	%	100	100	100
	Public hygiene	%	80	100	60
Economic risks	Interest rate	%	70	80	60
	Property type	%	80	80	80
	Market liquidity	%	90	80	100
	Confidence to the market	%	90	80	100
	Demand and Supply	%	100	70	90
	Purchaseability	%	100	100	100
	Brand visibility	%	100	90	90
	Capital exposure	%	90	85	75
	Lifecycle value	%	-5	-5	-5
	Area accessibility	%	90	80	70
	Currency conversion	%	30	60	20
	Buyers	%	80	50	90
	Tenants	%	100	80	100
	Investment return	%	10	7	8

Note: 1. Plan A: a retail-led mixed-use inner CBD development
2. Plan B: an office-led adjacent inner CBD development
3. Plan C: an entertainment-led adjacent inner CBD development

According to the fundamental scale of pair-wise judgments (see Table 3), all possible interdependences between each alternative plan and each risk assessment criterion, and between paired risk assessment criteria in regard to each alternative plan were valuated; and Box 1 provides results of all these pair-wise comparisons, which were then used to form a two-dimensional super-matrix for further calculation. The calculation of super-matrix aims to form a synthesized super-matrix to allow a resolution of the effects of the interdependences that existed between the nodes and the clusters of the ANP model (Saaty, 2005). In order to obtain useful information for development plan selection, the calculation of super-matrix was conducted following three steps, which transform an initial super-matrix, or un-weighted one (see Box 1) based on pair-wise comparisons with a weighted super-matrix, and then to a synthesized super-matrix. Results from the synthesized super-matrix were given in Table 5. According to the results, Plan A was identified as the most appropriate plan for the specific development because it has the highest synthesized priority weight among the 3 alternatives. As result, it is the suggestion of ANP to select Plan A for the regeneration project in Liverpool.

Box 1 Un-weighted super matrix based on initial pair-wise comparisons among paired nodes

Nodes	1.1	1.2	1.3	2.1	2.2	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	4.12	4.13	4.14
1.1 Plan A	0.00000	0.85714	0.85714	0.69600	0.70500	0.74200	0.73100	0.66484	0.66700	0.62563	0.60456	0.61441	0.44444	0.99155	0.31081	0.66667	0.61441	0.44444	0.10473	0.11301	0.63010	0.10065	0.53961
1.2 Plan B	0.75000	0.00000	0.14286	0.22900	0.21100	0.18300	0.18800	0.09023	0.22200	0.23824	0.10480	0.11722	0.11111	0.00545	0.19580	0.16667	0.26837	0.11111	0.25827	0.65193	0.21844	0.67381	0.16342
1.3 Plan C	0.25000	0.14286	0.00000	0.07500	0.08400	0.07500	0.08100	0.24493	0.11100	0.13614	0.29064	0.26838	0.44444	0.00299	0.49339	0.16667	0.11722	0.44444	0.63700	0.23506	0.15146	0.22554	0.29696
2.1 Envir~	0.50000	0.50000	0.44993	0.00000	1.00000	0.20000	0.85714	0.85714	0.90000	0.50000	0.16667	0.24998	0.16667	0.50000	0.50000	0.50000	0.16667	0.50000	0.83333	0.50000	0.50000	0.75000	0.20000
2.2 Clima~	0.50000	0.50000	0.55007	1.00000	0.00000	0.80000	0.14286	0.14286	0.10000	0.50000	0.83333	0.75002	0.83333	0.50000	0.50000	0.50000	0.83333	0.50000	0.16667	0.50000	0.50000	0.25000	0.80000
3.1 Workf~	0.25031	0.23509	0.36552	0.20939	0.31032	0.00000	0.06040	0.05605	0.46669	0.45186	0.04355	0.34302	0.06356	0.22839	0.08477	0.25000	0.25000	0.03208	0.05089	0.57143	0.05434	0.06645	0.25000
3.2 Cultu~	0.06811	0.63961	0.30503	0.06972	0.07168	0.12478	0.00000	0.20370	0.06668	0.23452	0.56782	0.09911	0.25424	0.21029	0.13251	0.25000	0.25000	0.26016	0.20205	0.14286	0.43957	0.10543	0.25000
3.3 Commu~	0.03792	0.06265	0.14604	0.09891	0.11346	0.15037	0.20992	0.00000	0.46664	0.14974	0.19385	0.09530	0.11370	0.11059	0.13252	0.25000	0.25000	0.09345	0.11022	0.14286	0.06654	0.14008	0.25000
3.4 Publi~	0.64366	0.06265	0.18341	0.62197	0.50454	0.72484	0.72967	0.74025	0.00000	0.16387	0.19478	0.46257	0.56850	0.45072	0.65020	0.25000	0.25000	0.61431	0.63685	0.14286	0.43955	0.68804	0.25000
4.1 Inter~	0.03231	0.06538	0.06138	0.03889	0.05443	0.05300	0.07143	0.06005	0.06114	0.00000	0.06456	0.06240	0.20594	0.07692	0.28535	0.06308	0.26800	0.02035	0.03548	0.06123	0.03525	0.25004	0.06357
4.2 Prope~	0.05311	0.03927	0.04610	0.05001	0.10466	0.03221	0.07143	0.09309	0.22587	0.06380	0.00000	0.07162	0.07099	0.07692	0.06758	0.13430	0.04334	0.08402	0.09442	0.02433	0.04906	0.21322	0.08648
4.3 Marke~	0.03265	0.10228	0.02330	0.03590	0.01835	0.02486	0.07143	0.06070	0.02891	0.04465	0.04392	0.00000	0.10279	0.07692	0.06373	0.07154	0.02546	0.02757	0.04073	0.21509	0.02852	0.03604	0.05653
4.4 Confi~	0.03246	0.10219	0.04601	0.10633	0.08136	0.13800	0.07143	0.09844	0.02393	0.05181	0.11882	0.08728	0.00000	0.07692	0.07630	0.04075	0.04172	0.01938	0.06577	0.12594	0.02856	0.04351	0.05032
4.5 Deman~	0.11791	0.06678	0.11919	0.03142	0.06337	0.04678	0.07143	0.03807	0.03937	0.04953	0.04849	0.07584	0.12419	0.00000	0.13595	0.09689	0.04342	0.01913	0.09097	0.15906	0.13638	0.07021	0.07933
4.6 Purch~	0.02921	0.01850	0.09939	0.02557	0.05564	0.13454	0.07143	0.05943	0.02299	0.06614	0.09041	0.06008	0.04210	0.07692	0.00000	0.06518	0.02841	0.01851	0.05050	0.07534	0.02421	0.06355	0.01528
4.7 Brand~	0.09114	0.04699	0.05497	0.09842	0.05015	0.09647	0.07143	0.12940	0.11444	0.10886	0.10768	0.13828	0.04558	0.07692	0.01994	0.00000	0.07439	0.11923	0.04784	0.02090	0.09790	0.02840	0.02127
4.8 Capit~	0.03557	0.04199	0.06791	0.06915	0.02979	0.04044	0.07143	0.02014	0.02426	0.08485	0.05683	0.02956	0.03867	0.07692	0.01395	0.03553	0.00000	0.09408	0.04365	0.07433	0.06458	0.01485	0.02838
4.9 Lifec~	0.03182	0.02303	0.11058	0.17949	0.18311	0.13057	0.07143	0.09509	0.15186	0.12947	0.08555	0.13821	0.14455	0.07692	0.06943	0.19062	0.13302	0.00000	0.12161	0.04732	0.13869	0.01801	0.10774
4.10 Area~	0.29707	0.05442	0.12489	0.05499	0.06864	0.05440	0.07143	0.13325	0.13855	0.12542	0.11922	0.14616	0.04920	0.07692	0.09460	0.08906	0.09291	0.17150	0.00000	0.01700	0.24104	0.16720	0.10887
4.11 Curr~	0.02988	0.10379	0.02064	0.00965	0.01105	0.03465	0.07143	0.01306	0.01745	0.03120	0.02330	0.03324	0.04611	0.07692	0.06250	0.01940	0.01437	0.01874	0.01131	0.00000	0.01960	0.02045	0.01772
4.12 Buye~	0.04775	0.12988	0.04987	0.08392	0.03748	0.03676	0.07143	0.06388	0.05717	0.06663	0.07273	0.05269	0.05785	0.07692	0.04695	0.07249	0.03743	0.12875	0.14005	0.04868	0.00000	0.05780	0.18227
4.13 Tena~	0.02958	0.10309	0.09035	0.08392	0.03748	0.03676	0.07143	0.06388	0.05717	0.06663	0.07273	0.05269	0.04362	0.07692	0.04695	0.07249	0.03743	0.12875	0.14005	0.04868	0.04532	0.00000	0.18227
4.14 Inve~	0.13953	0.10242	0.08542	0.13234	0.20450	0.14056	0.07143	0.07152	0.03689	0.11102	0.09577	0.05196	0.02840	0.07692	0.01677	0.04868	0.16010	0.14999	0.11763	0.08209	0.09089	0.01673	0.00000

Source: CISDM Research Department, 2006

Table 5 Comparisons of alternative development plans based on ANP modelling

Results	Plan alternatives		
	Plan A	Plan B	Plan C
Synthesized priority weights	0.5585	0.2644	0.1771
Ranking	1	2	3

Source: CISDM Research Department, 2006

Conclusions and Suggestions

This paper presents a novel approach of risk assessment in commercial real estate development at feasibility study stage in regard to a holistic evaluation of its sustainability. An ANP model was set up based on 20 defined risks associated with commercial real estate development; and these risk assessment criteria were classified under 3 clusters, including environmental risks, social risks, and economic risks, to ensure a comprehensive coverage of possible risks in generic sustainability-led assessment. The ANP model was tested in an experimental case study with necessary assumptions based on an urban regeneration project in Liverpool. Results from the experimental case study revealed that the ANP model is effective in supporting decision-making in finding the most appropriate development plan for a specific project with regard to all adopted risk assessment criteria. Therefore, it is expected that the ANP model presented here with the potentials of minimising risks could be widely adopted by developers in commercial real estate development if a convincible or reliable knowledge-driven risks assessment is required.

A four-step procedure was suggested in Figure 1 to apply ANP method on risk assessment for commercial real estate development. Accordingly, this paper demonstrated processes to achieve a final solution of ANP modelling. Comparing to other risk assessment methods such as using matrix or ratings, the ANP method has a great range of advantages such as a reliable inclusiveness of interdependences among different risk assessment criteria, and an integrated evaluation of both qualitative and quantitative risks. In this regard, the construction of an ANP model is significantly important in this procedure. Although it has adopted 20 risk assessment criteria for the ANP model, which were subjectively selected and defined based on current practice in risk analysis for real estate development, the demonstration has provided a satisfied result to support the developer's decision made for the regeneration project. However, further efforts will be put to objectively select the risk assessment criteria, and to use quantitative analysis methods from market risks research such as the CAPM (Capital Asset Pricing Model) method (Sagalyn, 1990) to objectively measure the criteria for risks assessment.

Further research will also explore more applications of the ANP model in real commercial projects with a focus on not only its effectiveness but also model improvement in terms of different network structures of the ANP model with regard to higher performance in decision-making support. Meanwhile, comparison studies with the adoption of other risk assessment methods will be conducted to further prove the advantages of using ANP method. In addition, technical risks will also need to be incorporated with sustainability assessment.

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