Applying the Analytical Risk Assessment Method for an Urban Regeneration Project
การประยุกต์ใช้เทคนิคการวิเคราะห์แบบเครือข่ายในการวิเคราะห์ความเสี่ยงโครงการจัดรูปแบบผังเมือง

Sukulpat Khumpaisal, Ph.D.[1], Zhen Chen, Ph.D.[2] and Emma Mulliner[3]
ดร. สุกุลพัฒน์ คุ้มไพศาล ดร. เฉิน เจิน และ เจมม่า มิลลิเนอร์

[1] Faculty of Architecture and Planning, Thammasat University
E-mail: sukulpat@ap.tu.ac.th
[2] School of the Built Environment Heriot-Watt University, Edinburgh
[3] Built Environment, Liverpool John Moores University, Liverpool, UK

Abstract

Risks cause crucial adversities to the progression and profits of urban regeneration projects. This paper aims to review practitioners' decision-making procedures in assessing the potential risks in urban regeneration projects. We introduce a multi-criteria decision making model, based on Analytic Network Process (ANP) theory. This paper commences with an introduction to the risks involved in urban regeneration projects, followed by an application of ANP as a risk assessment tool. To assess risks in the these projects effectively, assessment criteria are defined based on the Social, Technological, Economic, Environment and Political (STEEP) concerns of practitioners, which are directly involved in the urban regeneration projects. A residential and commercial mixed-use project in Liverpool City Centre has been selected as a case study to demonstrate the effectiveness of ANP. The outcome reveals that ANP is an effective tool to support decision-makers to assess the potential risks in urban regeneration projects. Although this ANP model can be applied in other types of project, the risk assessment criteria should be modified to suit the context of any particular case.

บทคัดย่อ

โครงการจัดรูปแบบผังเมือง (urban regeneration project) มีความเสี่ยงในหลาย ๆ ปัจจัย และความเสี่ยงเหล่านั้นได้ส่งผลถึงกระบวนการและงบประมาณในการบริหารโครงการประเภทนี้ การวิจัยฉบับนี้เน้นการวิเคราะห์ระเบียบวิธีการในการตัดสินใจของผู้ประกอบการหรือนักผังเมืองในการวัดประเมินความเสี่ยงในโครงการจัดรูปแบบผังเมือง ในบทความนี้ได้นำเสนอเครื่องมือในการช่วยการตัดสินใจของผู้ประกอบการบนพื้นฐานทฤษฎีของการวิเคราะห์แบบเครือข่าย (Analytic Network Process: ANP) บทความนี้จะเริ่มการชี้ให้เห็นถึงผลกระทบของความเสี่ยงต่าง ๆ ประเภทของความเสี่ยงที่เกี่ยวข้องในโครงการจัดรูปแบบผังเมือง ตามด้วยการนำ ANP มาประยุกต์ใช้เป็นเครื่องมือในการวัดประเมินความเสี่ยง ในการประเมินความเสี่ยงในโครงการประเภทนี้ให้มีประสิทธิภาพที่สุด เราได้จัดสร้างมาตรวัดความเสี่ยง (risk assessment criteria) บนมาตรวัด STEEP ซึ่งประกอบไปด้วย กลุ่มความเสี่ยงด้านสังคมวิทยา เทคโนโลยีการก่อสร้าง สิ่งแวดล้อม เศรษฐกิจ และการเมืองการปกครองกฏหมาย ซึ่งในที่นี้มาตรวัด STEEP ยังเกี่ยวพันกับการพัฒนาอสังหาริมทรัพย์อย่างยั่งยืนด้วย โดยใช้กรณีศึกษา โครงการที่พักอาศัยและพาณิชยกรรมในเมืองลิเวอร์พูล ประเทศ

สหราชอาณาจักรเพื่อทดสอบประสิทธิผลของเครื่องมือนี้ ผลการวิเคราะห์สรุปได้ว่า ANP เป็นเครื่องมือที่มีประสิทธิภาพและช่วยในการตัดสินใจประเมินและวิเคราะห์ความเสี่ยงอย่างได้ผล และสามารถพัฒนาต่อยอดเพื่อช่วยในการตัดสินใจในโครงการลักษณะอื่น ๆ ได้

Keywords (คำสำคัญ)
Analytic Network Process [ANP] (การวิเคราะห์แบบเครือข่าย)
Risk Assessment (การวิเคราะห์ความเสี่ยง)
Risk Assessment Criteria (มาตรวิเคราะห์ความเสี่ยง)
Urban Regeneration Project (โครงการจัดรูปผังเมือง)

1. Introduction

1.1 Risks in Urban Regeneration Projects

Risks in complicated urban regeneration projects are always associated with the public, potential stakeholders and community interests. These risks increase crucial adversities to the progression and profit of urban regeneration projects and will strongly affect each project stage (i.e. from the conceptual plan, project feasibility analysis, design and planning, construction and execution, until public usage). Existing risk management processes are generally ongoing and iterative processes, even though each project is different and unique (Clarke & Varma, 1999; Flyvbjerg, 2003). In this regard, a typical approach to risk management contains four basic steps: risk identification and initial assessment, risk analysis, risk assessment and risk mitigation (see Figure 1).

Each urban regeneration project normally has a range of objectives to achieve. The typical achievements of an urban regeneration project are summarised as:

- Resources are efficiently used and waste is minimised by closing cycles;
- Pollution is limited to levels which natural systems can cope with, without damage;
- The diversity of nature is valued and protected;
- Everyone has the opportunity to undertake satisfying work in a diverse economy. The value of unpaid work is recognised whilst payments for work are fair and fairly distributed;
- People's health is protected by creating safe, clean, pleasant environments and health services which assist in preventing illness;
- Access to facilities, services, goods and other people is not achieved at the expense of the environment or limited to those with cars;
- Everyone has access to skills and knowledge.

(Liverpool City Council, 1997 as cited in Couch & Dennemann, 2000)

Therefore, it is assumed that urban regeneration projects involve risks from many sources, since they are directly concerned with public and community interests; a significant cause of project risk results from a failure of the organisation responsible for the regeneration project to communicate with the local community in order to discuss the project's targets, which results in less participation from the local community (Atkinson, 1999).

Many urban regeneration projects fail because of an imbalance between the new development and the actual needs of the local community. Most urban regeneration projects have an emphasis on the physical redevelopment of existing communities, rather than a concern for the requirements of the people. For example, many cities are revitalising central business districts (CBD) as part of their urban regeneration programmes, though such projects may have less concern for the destruction of existing businesses and more concern for renovation and investment (Liverpool City Council, 2006) .

Project interests may coincide with the real estate developers' business incentives. Therefore, such projects are closely associated with risks caused by political issues (i.e. protests or group of activists). In addition, the number of jobs in the developed area may fluctuate in accordance with the size and duration of the project.

New urban regeneration projects also impact on existing real estate projects, as they may vary the land price and market capital of existing projects and cause increased competition for new developers who wish to develop their projects in regeneration areas. This is seen in the fluctuation in selling or rental prices of existing properties affected by a new developed project (Jones & Watkins, 1996).

Thus, risks in urban regeneration projects are summarised by Social, Technological, Economic, Environmental and Political (or "STEEP") factors (Morrison, 2007; Gehner et al., 2006; Clarke & Varma, 1999). For example, risks in urban regeneration projects have been identified in relation to the separation of design from construction, lack of integration between planners and community, poor communication to the local community, uncertainty, changing environment and increasing project complexity, economic changes such as inflation and deflation, and regional economic crises, including an imbalance between new development and social actual needs. Therefore, these STEEP risks must be considered and should not be underestimated since they would affect the overall project management process, cause schedule delays or activists' protests (Couch & Dennemann, 2000).

According to the aforementioned characteristics of urban regeneration projects and the sources of risk associated with them, these projects are related to the destruction of businesses, the relocation of people and the use of compulsory purchase as a legal instrument to reclaim private property for city-initiated development projects. Therefore, we found that risks in urban regeneration projects are mostly associated with public interests, city harmonisation and local community involvement. This paper will emphatically focus on the risks which are necessary to be considered when planners conduct project feasibility analysis, because feasibility analysis is a significant tool in regard to forecasting uncertainties, as well as assessing the vitality of urban regeneration projects.

1.2 Current Existing Risk Assessment Methods

Frodsham (2007) states that risks in the real estate industry could be mitigated with an overall risk management processes framework, those risks shall applying a variety of complimentary approaches, which grounded on a rigorous and preferably quantitative framework. The ideal risk management processes should include an assorted mix of "Quantitative statistical frameworks", as well as several range of techniques to evaluate the subjective risks. It is suggested that, in order to assess risks, a practical tool should be used which could analyse risks, their consequences and compute the results in a numerical format. The desirable methodology for the real business should allow the synthesis of criteria, comparisons on each factor and help the practitioners structuring the decision making process (Booth et al., 2002), thus the risk assessment process shall be supported by using the modern methods of mathematical statistics (Titarenko, 1997).

The popular "Risk Matrix" method is generally accepted by several businesses as a practical risk assessment tool (Kindinger, 2002; ioMosaic, 2002) and it is also accepted in many property development projects (Younes & Kett, 2007). However, the data used in matrix calculations is derived from panel discussions or ranking methods, which rely mostly on personal opinions rather than using quantitative measurements. Additionally it does not use reliable tools or instruments with a strong theoretical basis (see Figure 1). Other inconveniences are the limited comparisons between each criterion, the subjective nature of its results and the lack of detailed data to help developers structure their decision-making process. Risk factors are numerous, particularly in large urban regeneration projects, and the ability of humans to assess many factors at the same time is very limited (He, 1995).

According to the aforementioned problems in dealing with complicated risks in urban regeneration projects, urban planners require an effective tool to assess the potential risks associated with regeneration projects. Comprehensive risk assessment criteria, based on the requirements of Social, Technological, Environmental, Economic and Political (STEEP) factors and the decision-making support model, will be established and provided in this paper. The criteria will focus on risks associated with urban regeneration projects, based on STEEP factors, and will consist of the evaluation methods for each sub-criterion. A thorough analysis of risks in urban regeneration projects, using quantitative analysis, will also be conducted in this paper.

Given the complicacy of risks in urban regeneration, together with the requirements of urban planners to assess the consequence of each risk to the project's progress, we introduce the application of the Analytic Network Process (ANP) model to support the urban planners in their risk assessments of urban regeneration projects. Developed in accordance with the requirements of STEEP, ANP is a useful decision making support model, involving a systematic approach which deals with both quantitative and qualitative factors across multiple criteria (Saaty, 2005). The ANP process conducts analysis and comparison of multiple criteria, with the results typically represented in a statistical format: this enables further decision making in regard to risk response and mitigation.

In order to complete the calculation process and the requirements of ANP, risk criteria developed based on the requirements of STEEP factors (see Table 1) have been modified to suit the urban planners' requirements in regard to assessing the potential risks involved in the project. An urban regeneration project in Liverpool City centre has been used as a case study to demonstrate the effectiveness of the ANP model. The calculation method of ANP and the established criteria to assess risks in urban regeneration projects will be illustrated in the section 3.

2. Methodology

The methodology for this research consists of a literature review and interviews with experts in urban planning and the real estate industry in order to gain information on the current risk assessments used in urban regeneration projects. This is followed by data analysis of the ANP model and a case study to demonstrate its effectiveness to support decision-making prior to a project commencing. A risk management process and the comparison between the existing risk assessment methods and the ANP model is summarised in figure 1.

Figure 1 illustrates the entire risk management process, including a selection of risk assessment methods used in urban regeneration projects - both traditional and ANP models. The risk management process normally commences by establishing the context (process 1), comprising the strategic, organisational and additional risk management contexts: these depend on the characteristics of the project and the decision-makers' preferences. The decision-makers have to set up the entire risk management structure (process 2) in relation to the potential risks, which are associated with STEEP factors. Risk identification (process 3) is subsequently conducted to clarify the effects and the source of the risks. Then, risk analysis (process 4) is undertaken to determine risk control methods, the likelihood of risks occurring and the consequences of each risk to the project (AS/NZS 4360: 2004 risk management standard).

The aim of the risk assessment (process 5) is to compare risks against the established criteria (Chen & Khumpaisal, 2009), to rate the consequences of each risk as well as to prioritise each risk's significance, prior to conducting risk mitigation. In this process, the decision-makers (in this case: the urban planners, etc.) will select the appropriate method, whether it be the existing risk assessment method (Risk Matrix) or the Analytic Network Process (ANP). If they select the traditional method then a panel/board discussion must be undertaken to discuss the risks and their consequences, each participant drawing on their experience to identify and predict risks. Subsequently, an assessment method will be set up; in the current practice it is most likely to be the creation of a risk assessment matrix (RAM). RAM describes the likelihood and consequence of each risk in a tabular format. As a result of the risk matrix, the panel can quantity overall risk events. This method is simple to use and is also easy for laypersons to understand. However, the results derived by RAM are not based on non-linear mathematic calculations or objective assumptions related to a real business case. Additionally, it does not allow for comparisons amongst each criterion. The results calculated by matrix are normally subjective and do not provide detailed data to help decision-makers structure their decision-making process.

Alternatively, if the ANP process is selected, an ANP model shall be developed followed by a pair-wise comparison process to form a super-matrix of quantified interdependences between paired criteria against the purposing alternatives. The results calculated by the super-matrix calculation provide the project team with a numerical suggestion of the most appropriate development plan (Chen & Khumpaisal, 2008). ANP results are useful to support the decision-making process for project risk mitigation. In addition, a project knowledgebase is required to be integrated into the risk management processes in order to complete the decision-making tasks. The knowledgebase provides adequate and accurate information to achieve reliable results, and can be collected from existing or new urban regeneration projects.

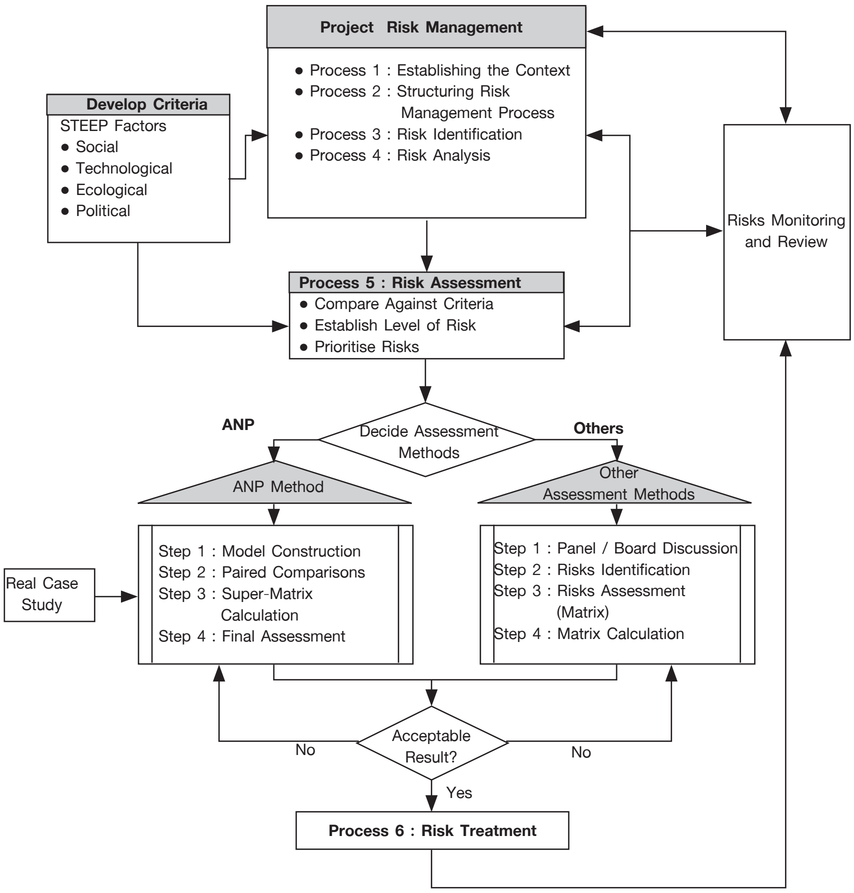

Figure 1. Risk management process and a selection of risk assessment method.

Risk Assessment Criteria

Prior to commencing an ANP calculation, the risk assessment criteria - the risks and their consequences in urban regeneration projects - are established; these are based on a literature review and the researchers' experience. The assessment criteria are set up in accordance with Social, Technological, Economic, Environmental and Political (STEEP) factors, which reflect sustainable development requirements (Chen, 2007). The criteria are necessary when urban planners conduct a project analysis before the construction or execution process commences. STEEP factors cover risks throughout each stage of the urban regeneration project, from conceptualization, feasibility analysis, and design and planning, to construction and its eventual utilisation. The assessment criteria and the evaluation method of each sub-criterion are summarised in Table 1, which classifies both objective and subjective risks. These risk assessment criteria will be affixed within ANP to evaluate risk in urban regeneration projects. The table includes five major criteria and their 30 sub-criteria (see Table 1).

Table 1. Risk assessment criteria for urban regeneration projects.

Criteria	Sub-Criteria	Evaluation Methods	Representative References
Social risks	Community acceptability	Degree of benefits for local communities (%)	Danter, 2007
	Community participation	Degree of partnership and empowerment to the community	Atkinson, 1999
	Cultural compatibility	Degree of business & lifestyle harmony (%)	Danter, 2007
	Public hygiene	Degree of impacts to local public health & safety (%)	CHAI, 2006
	Social needs	Degree of balancing between physical development and social need (%)	Jones & Wat kins, 1996
	Workforce availability	Degree of developer's satisfaction with the local workforce market (%)	Danter, 2007
Techno logical risks	Accessibility & Evacuation	Degree of easy access and quick emergency evacuation in use (%)	Moss et al., 2007
	Amendments	Possibility of amendments in design and construction (%)	Khalafallah et al., 2005
	Constructability	Degree of technical difficulties in construction (%)	Khalafallah et al., 2005
	Duration of development	Duration of design and construction per 1,000 days (%)	Khalafallah et al., 2005
	Durability	Probability of refurbishment requirements during buildings lifecycle (%)	Chen, 2007
	Facilities management	Degree of complexities in facilities management (%)	Moss et al., 2007
	Transportation convenience	Degree of public satisfaction towards transportation services after new development (%)	Couch & Dennemann, 2000
Environ mental risks	Adverse environment impacts	Overall value of the Environmental Impacts Index	Chen et al., 2005
	Land contamination	Price of the contaminated land plot	Switzer & Bulan, 2002
	Pollution during development	Degree of pollution affecting the local community	Healey, 1990
	Site conditions	Degree of difficulties in site preparation for each specific plan (%)	Danter, 2007

Table 1. Risk assessment criteria for urban regeneration projects. (continued)

Criteria	Sub-Criteria	Evaluation methods	Representative References
Economic risks	Area accessibility	Degree of regional infrastructure usability (%)	Adair & Hutchison, 2005
	Capital exposure	Rate of estimated lifecycle cost per 1 billion pound (%)	Blundell et al., 2005; Moore, 2006
	Capital value	Sale records of new developed properties	Jones & Watkins, 1996
	Demand and Supply	Degree of regional competitiveness (%)	Adair & Hutchison, 2005
	Development fund	Amount and sources of funding injected into urban regeneration project	Adair et al., 2000
	Job creation	Numbers of jobs created and lost during urban regeneration	Jones & Watkins, 1996
	Lifecycle value	5-year property depreciation rate (%)	Lee, 2002; Adair & Hutchison, 2005
	Market rental	Rental rate of properties in the new development area	Jones & Watkins, 1996
	Property type	Degree of location concentration (%)	Adair & Hutchison, 2005; Frodsham, 2007
	Purchaseability	Degree of affordability for the same kind of properties (%)	Adair & Hutchison, 2005
Political risks	Council approval	Total days of construction /design approval process by Liverpool City Council (LCC)	Crown, 2008
	Local development policy	Degree of contrast between the new development and existing local development policy (%)	LCC, 2008
	Political groups/activists	Degree of protest by the urban communities (%)	Arthurson, 2001

3. Application of Analytic Network Process (ANP)

3.1 Analytic Network Process (ANP) Model

As earlier discussed in section 2 and 3, risks in urban regeneration project are complicated, caused by various (i.e. STEEP) factors. The decision makers or urban planners require comprehensive risk assessment tools to deal with the project risks. The current risk assessment method, for example, the Risk Assessment Matrix (RM), is always employed by decision makers (urban planners, real estate developers) to assess risks. This RM is simple to use and communicate to every project participant. However, Khumpaisal (2011) pointed out that the significant disadvantage of this RM is that the data for the matrix calculation are directly derived from either panel discussions or ranking methods: these mostly contain subjective values as they rely on personal opinion without using the reliable quantitative measurements and/or a strong theoretical basis. Furthermore, it does not allow for the comparison of each criterion, and results calculated by this method are normally subjective and lacking in detailed data to help the developers to structure their decision making process (Chen and Khumpaisal, 2009). In fact, risks 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, 1995). Thus, the results calculated by RM may fluctuate during each calculation due to the experts' judgement and attitudes towards risks being inconsistent.

This paper introduces an ANP model to assess risks at the project feasibility study stage. According to the established risk assessment criteria in Table 1, the ANP model herein is based on 30 defined risk assessment criteria. The model affixed in this paper has been developed using Super Decisions software (Saaty, 2005). It comprises 6 clusters and 30 nodes, which are set up according to the assessment criteria defined in Table 1. The Alternative cluster represents the alternative development plans, to be evaluated against the risk assessment criteria in the case study: there are 2 nodes representing 2 alternative plans for a specific development. The ANP method provides an effective mechanism for developers to quantitatively evaluate interrelations between either paired criteria or paired sub-criteria; this enables the practitioners to adjust their opinions and expertise to assess the consequences of all the defined risks (see Table 1) occurring in urban generation projects.

The ANP model in Figure 2 consists of six clusters, one of which represents the Alternative Development Plans and the remaining five represent STEEP factor risks. There are 32 nodes inside this ANP model. Amongst them, there are two nodes inside the Alternative cluster, which are Plan A and Plan B, denoting the alternative plans for a specific development in Liverpool City Centre. The other 30 nodes are located in five different clusters in accordance with the groups described in Table 1. Two-way and looped arrow lines in Figure 1 describe the interdependences that exist between paired clusters and nodes (Saaty, 2005 as cited in Chen & Khumpaisal, 2008).

In order to measure all the interrelations within the ANP model quantitatively, face-to-face interviews were conducted with three (3) selected participants with a solid professional background in urban regeneration and real estate development. Their personal profiles and attributions are shown in the table below.

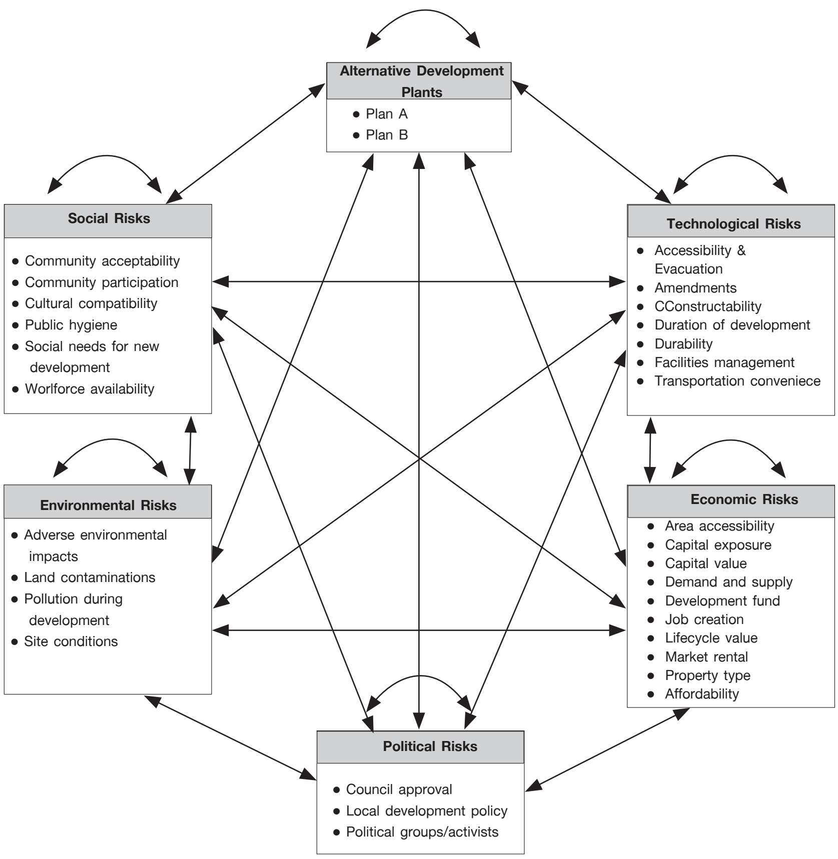

Figure 2. ANP Model for the risk assessment of urban regeneration projects.

Table 2. Schedule of interviewees.

Interviewee	Professional	Experience (years)	Background
1	Professor in urban planning and regeneration	40	Local resident in Liverpool city council area.
2	Academic	15	Educational background in urban management/planning.
3	Real estate developer	20	Employed by the case study's consultancy firm.

Due to time constraints and the nature of the ANP analysis, which requires in-depth information from the interviewees/participants (Saaty, 2005), the number of interviewees was limited to 3. However, we recommend that further researchers collect more data from practitioners and academics to gather more reliable and validated information.

Alongside the ANP calculations, the assessment checklists have been employed to compare the relative importance between paired clusters and nodes, as informed by the practitioners. The experts' knowledge and information in each specific domain was collected and concentrated into an ANP model. This model can perform as a decision-making support tool based on knowledge reuse.

3.2 A Pair-Wise Comparison of Each Sub-Criteria

The ANP model in Figure 2 structures and quantifies all possible interdependent relations inside the model, and pair-wise comparison is adopted using subjective judgements made in regard to utilise the fundamental of scale of pair-wise comparisons (Saaty, 2005). Table 2 describes how to conduct pair-wise comparison between paired clusters, as well as nodes, in regard to their interdependences defined in the ANP model (see Figure 2) and relative importance based on their specific characteristics and experts' knowledge. The ANP model is set up, based on the risk assessment criteria, to quantify the interdependences between the 30 risk assessment criteria inside cluster 2 to 6 (see Figure 2), and the specific characteristics of the alternative plans, which are used to quantify the interdependences for alternatives in the case study. In light of ANP's pair-wised comparisons for every variable in each cluster, the ANP model compared 6 clusters of STEEP factors together with each of the 30 risk assessment criteria, producing 326 comparisons that were tabulated into the super-matrix table (Saaty, 2005).

Table 3. An example of pair-wise comparisons.

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

Note:

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.

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

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

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

To pursue the requirements of ANP, with regard to the pair-wised comparison, the authors have assumed two alternative regeneration plans as the options for calculating; these will be described further in the next section.

4. Case Study

To demonstrate the effectiveness of ANP in assessing risks in urban regeneration projects, a case study of a residential and commercial mixed-used project in Liverpool City Centre is used in order to compare and select an appropriate plan (with the least impact to the community) for a specific real estate development project. A case study is conducted, based on information collected from a completed development project in Liverpool City Centre. Some scenarios have been created, namely alternative development plans, as an assumption of the study to allow for comparison between each cluster.

The studied project is located in central Liverpool with a site area of 40 acres. It is located by major retail areas, the city central business district (CBD), residential areas, walkable streets, main roads, and the historical Albert Dock. The Developer is partnering with the City Council to revitalise this area for long-term investment, in accordance with the North West region's and Merseyside County's economic strategies. For the purpose of the initial case study, two development plans are considered in this research: Plan A, a retail-led mixed-use inner Liverpool City Centre development, and Plan B, a mixed-use commercial building adjacent to the inner Liverpool City Centre development. The scenarios are assumed based on the philosophy of local urban regeneration, which aims to attract more customers to Liverpool City Centre, as well as to maximise utilisation of the transportation and infrastructure provided (Mynors, 2006). The authors employed face-to-face interviews with practitioners who had experience with urban regeneration projects, planning and development, in order to gain opinions and judgements in regard to the consequential degree of risks affecting the project.

(source: Britain Best Buildings, 2010)

Figure 3. The layout plan of the initial case study.

4.1 Adjustment of the Experts' Judgements

Table 4 represents the results gathered from the interviews. The results obtained are significantly different from one another because each participant has differing experience and backgrounds, included their professional in urban regeneration projects. To accomplish ANP pair-wise and super-matrix comparison of each node, the authors employed the Weighted Quality Score (WQS) method to adjust appropriated percentages for the ANP calculation. The results achieved by WQS are derived by the following equation.

$$V_{ij} = \sum_{k=3}^{n} W_{ijk} V_{ijk} \qquad [1]$$

Whereas

- V_{ij} is the value of each sub-criterion calculated by WQS
- W_{ikj} is the weighted of score for each sub-criterion given by participants k
- V_{ijk} is the value of each sub-criterion i for alternative j
- i is the sequential number of sub-criterion (i = 1,2, 3,.....,30)
- j is the code of alternative plan (j = A, B)
- k is the code of participants (k = 1, 2, and 3)
- n is the total number of participants in this paper (n = 3)

Table 4. Results of face-to-face interview.

Criteria	No.	Sub-Criteria	Unit	Participant 1		Participant 2		Participant 3		Weighted Quality Score	
				Plan A	Plan B	Plan A	Plan B	Plan A	Plan B	Plan A	Plan B
Social Risks	1	Community acceptability	%	25	25	50	50	30	40	32	35
	2	Community participation	%	75	75	30	60	30	50	53	65
	3	Cultural compatibility	%	25	25	30	70	40	30	31	36
	4	Public hygiene	%	15	15	80	50	50	30	39	27
	5	Social needs	%	25	35	70	30	20	40	33	36
	6	Workforce availability	%	25	35	20	60	30	60	26	48
Techno-logical Risks	7	Accessibility & Evacuation	%	15	15	50	50	30	30	27	27
	8	Amendments	%	25	25	70	50	40	30	39	32
	9	Constructability	%	25	35	20	70	30	50	26	47
	10	Duration of development	%	25	35	20	80	50	30	32	43
	11	Durability	%	25	35	20	60	50	30	32	39
	12	Facilities management	%	35	25	70	50	50	30	47	32
	13	Transportation convenience	%	50	50	70	40	50	40	54	45
Environmental Risks	14	Adverse environment impacts	%	50	40	60	40	60	40	55	40
	15	Land contamination	%	25	25	70	50	60	30	45	32
	16	Pollution during development	%	25	25	50	50	60	20	41	29
	17	Site conditions	%	25	25	70	50	30	50	36	38
Economic Risks	18	Area accessibility	%	40	30	70	50	60	30	52	34
	19	Capital exposure	%	40	40	80	50	50	30	51	39
	20	Capital value	%	35	45	50	70	30	50	37	52
	21	Demand and supply	%	35	45	70	40	50	30	47	40
	22	Development fund	%	25	35	40	70	30	60	30	50
	23	Job creation	%	25	35	20	60	40	30	29	39
	24	Lifecycle value	%	40	40	80	40	50	20	51	34
	25	Market rental	%	25	35	30	60	50	30	34	39
	26	Property type	%	25	35	40	60	40	60	33	48
	27	Affordability	%	25	35	50	50	60	40	41	40
Political Risks	28	Council approval	%	20	30	70	50	30	60	33	43
	29	Local development policy	%	20	30	40	60	30	50	27	42
	30	Political groups/activists	%	25	35	70	40	30	50	36	41

The authors have given 50% for Participant 1, 20% for Participant 2 and 30% for Participant 3. Participant 1 is a local resident of Liverpool and has a solid background in urban generation projects, as well as a familiarity with the UK's urban development context. Participant 2 is an expert urban planner, but resides outside of the UK's North West area. Participant 3 is a real estate development practitioner who is familiar with the case study. According to the WQS calculation and the supporting reasons mentioned above, the results derived by this method will be input into the ANP calculation to determine the most appropriate development plan alternative (see column "Weighted Quality Score" in Table 4).

Although the interdependence variables among the 30 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. According to the fundamental scale of pair-wise judgments (see Table 2), all possible interdependences between each alternative plan and each risk assessment criterion, and between paired risk assessment criteria in regard to each alternative plan, are evaluated; Table 2 provides the results of all the pair-wise comparisons which are used to form a two-dimensional super-matrix for further calculation. The calculation of the super-matrix aims to form a synthesized super-matrix to allow for resolutions of the effects of the interdependences existing between the nodes and the clusters of the ANP model (Saaty, 2005 as cited in Chen & Khumpaisal, 2008).

4.2 Results of the Calculation

In order to obtain useful information for development plan selection, the calculation of the super-matrix was conducted following a number of steps. Firstly, an initial super-matrix or an un-weighted one based on pair-wise comparisons, is transformed to a weighted super-matrix, then to a synthesized super-matrix. Results from the synthesized super-matrix are given in Table 4.

According to the results shown in Table 4, Alternative Plan A is identified as the appropriate plan for the specific development because it has a higher synthesized priority weight than Alternative Plan B. The difference between the results of Plan A and B indicate the likelihood of the developer selecting the appropriate development plan. The results above suggested that Plan A should be considered as the development plan of the studied project.

Table 5. Comparison of alternative development plans.

Results	Alternative Development Plans	
	Plan A	Plan B
Synthesised priority weights	0.6283	0.3717
Ranking	1	2

5. Conclusions and Recommendations

The Analytic Network Process (ANP) has been introduced in this article as a tool to assess risks in urban regeneration projects. The risk assessment criteria used in formulating the ANP calculation were established based on a literature review and valuable opinions from experts within the field. All assessment criteria are summarised under Social, Technological, Environmental, Economic and Political (STEEP) factors. STEEP factors should be considered by planners and practitioners while conducting project feasibility analysis, prior to regeneration projects commencing.

To complete this research, an ANP model has been established based on the defined risk criteria associated with STEEP factors and sustainable development requirements. The authors made an assumption that one of two alternative development plans would be suitable to develop in the Liverpool City centre area. There are 30 risks, split into five clusters, to ensure a comprehensive coverage of the possible risks that may occur in urban regeneration projects. Face-to-face interviews were conducted with three participants, who are experts in urban regeneration and real estate development, in order to gain their expertises to assist in developing a comprehensive risk assessment model.

Additionally, the participants stated that developers of the regeneration projects must focus on risks associated with social and political factors, since regeneration projects usually involve a local community and public interest. The new development must conform to the local development policy, and the developers have to balance the project's objectives and the actual needs of the local community (i.e. community health and safety issues). In regard to the raw data obtained from the experts, the factor that significantly influenced urban regeneration projects was community participation, followed by convenience of transportation and adverse environmental impact, respectively. It was therefore concluded that developers of urban regeneration or real estate development projects need to have concern for such risks, prior to the construction process of the project.

In summary, the results calculated by the ANP model indicate that Alternative Plan A, "The retail-led mixed used property", would be the most appropriate development plan. On the other hand, Alternative Plan A was also affected by higher consequences of risk than that of Alternative Plan B, "The commercial building led mixed use."

With reference to the results of the valuable opinions gained from the face-to-face interviews with practitioners and the data derived from ANP analysis, it is concluded that ANP is an effective tool to support planners in assessing risks and aid decision making in urban regeneration projects. For example, in the context of Thailand, urban planners may input criteria related to the current situation, whether flood risk, land condition (in terms of environmental risk) or the fluctuation of construction materials/ fuel prices in order to make the risk assessment criteria applicable for the particular context.

However, further research is required since a huge amount of information from urban planners and practitioners, from a variety of regeneration projects, is needed in order to modify and improve the risk assessment criteria to suit the developer's requirements.

Acknowledgement

This research is funded by Thammasat University, Thailand and supported by School of the Built Environment, Liverpool John Moores University. The authors wish to thank Professor Christopher Couch, professor of urban planning, School of the Built Environment, Liverpool John Moores University and Miss Suwadee T. Hansasooksin, Ph.D. instructor of urban planning, Faculty of Architecture and Planning, Thammasat University, Thailand for their valuable information, opinions and judgements throughout the research process.

References

Arthurson, K. (2001). Achieving locial justice in estate regeneration: The impact of physical image construction. *Housing Studies, 16*(6), 807-826.

Adair, A., Berry, J., McGreal, S., Deddis, B., & Hirst, S. (2000), The financing of urban regeneration. *Land Use Policy,* 17, 147-156.

Adair, A., & Hutchison, N. (2005). The reporting of risk in real estate appraisal property risk scoring. *Journal of Property Investment and Finance, 23*(3), 254-268.

Atkinson, R. (1999). Discourses of partnership and empowerment in contemporary British urban regeneration. *Urban Studiesm, 36*(1), 59-72.

Blundell, G. F., Fairchild, S., & Goodchild, R. N. (2005). Managing portfolio risk in real estate, *Journal of Property Research, 22*(2&3), 119-136.

Booth, P., Matysiak, G., & Ormerod, P. (2002). *Risk Measurement & management for real estate portfolios.* Investment Property Forum. London.

Britain Best Buildings. (2010). *Liverpool one layout photograph.* Retrieved September 24, 2010 from http://www.bestbuildings.co.uk/sportleisure/liverpool-one/

Chen, Z., Li, H., & 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., & Xu, C. (2006). A multicriteria lifespan energy efficiency approach to intelligent building assessment. *Energy and Buildings, 38*(5), 393-409.

Chen, Z. (2007). *Multicriteria decision-making for the sustainable built environment.* The University of Reading. Reading, UK.

Chen, Z. & Khumpaisal, S. (2009). An analytic network process for risks assessment in commercial real estate development. *Journal of Property Investment and Finance, 27*(3), 238-258.

Clarke, J. C. & Varma, S. (1999). Strategic risk management: The new competitive edge. *Journal of Long Range Planning, 32*(4), 414-424.

Commission for Healthcare Audit and Inspection [CHAI]. (2006). *Criteria for assessing core standards in 2006/2007.* Commission for Healthcare Audit and Inspection, London.

Crown. (2008). *Building regulations planning portal.* Retrieved April 20, 2009, from http://www.planningportal.gov.uk/england/professionals/en/4000000000001.html

Couch, C., & Dennemann, A. (2000). Urban regeneration and sustainable development in Britain: The example of the Liverpool Ropewalks partnership. *Cities, 17*(2), 137-147.

Danter. (2007). *A sample lodging analysis in the city of Grove, Ohio, Danter Company.* Retrieved December 30, 2007, from http://www.danter.com/PRODUCT/samplodg.pdf

Fisher, J. D., Geltner, D. M., & Webb, R. B. (1994). Value indices of real estate: A comparison of index construction methods. *Journal of Real Estate Finance and Economics, 9*(2), 137-164.

Frodsham, M. (2007). *Risk management in UK property portfolios: A survey of current practice.* Investment Property Forum, London. Retrieved December 30, 2007, from http://www.ipf.org.uk/resources/pdf/research/research_reports/Risk_Management_Summary.pdf

Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and risk: An Anatomy of ambition.* Cambridge University Press, UK.

Healey, P. (1990). Urban regeneration and the development industry. *Regional Studies, 25*(2), 97-110.

He, Z. (1995). Risk management for overseas construction projects, *International Journal of Project Management, 13*(4), 231-237.

ioMosaic. (2002). *Designing and effective risk matrix: An ioMosaic corporation whitepaper.* ioMosaic Corporation, Houston, TX 77057, USA. Retrieved December 30, 2007, from http://archives1.iomosaic.com/whitepapers/risk-ranking.pdf

Jones, C., & Watkins, C. (1996). Urban regeneration and sustainable markets. *Urban Studies, 33*(7),1129-1140.

Khalafallah, A. Taha, M., & El-Said, M. (2005). *Estimating residential projects cost contingencies using a belief network.* Proceedings of a Conference on Project Management: Vision for Better Future, 2005, Cairo, Egypt, Retrieved December 30, 2007, from http://people.cecs.ucf.edu/khalafal/publications/publications_files/EstimatingContingencies.pdf

Khumpaisal, S. (2011). *Analytical approach to risk assessment in Thailand real estate industry.* School of the Built Environment, Liverpool John Moores University, Liverpool, UK.

Kindinger, J. P. (2002). *The case for quantitative project risk analysis.* Proceeding of Tenth Annual Conference on Quality in the Space and Defense Industries, 4-5 March 2002, Florida, USA. Retrieved December 30, 2007, from http://www.lanl.gov/orgs/d/d5/ documents /case.pdf

Liverpool City Council [LCC]. (2008). *Liverpool city council property tax.* Liverpool City Council Website. Retrieved March 19, 2008, from http://www.liverpool.gov.uk/Council_government_and_democracy/Council_tax/index.asp>

Morledge, R., Smith, A., & Kashiwagi, D. T. (2006). *Building procurement*. Blackwell, London, UK.

Moss, Q. Z., Alho, J., & Alexander, K. (2007). Performance measurement action research. *Journal of Facilities Management, 5*(4), 290-300.

Mynors, P. (2006). *What do we need to consider to deliver a more sustainable city?*. Proceeding of In: CATCH Dissemination Event Conference, 28 - 29 June 2005, Liverpool, UK.

Rafele, C., Hillson, D., & Grimalai, S. (2005). Understanding Project Risk Exposure Using the Two-Dimensional Risk Breakdown Matrix, *Proceeding Papers of Project Management Institution Global Congress, Edinburgh, Scotland.,* Retrieved December 30, 2007, from http://www.risk-doctor.com/pdf-files/pmi-e-rbmpaper.pdf

Saaty, T. L. (2005). *Theory and applications of the analytic network process.* RWS Publications, Pittsburgh, USA.

Switzer, C. S. & Bulan, A. L. (2002). Basic Practice Series, Comprehensive Environmental Response, Compensation, and Liability Act (Superfund): CERCLA, American Bar Associations, Illinois, USA.

Titarenko, B. P. (1997). Robust technology in risk management. *International Journal of Project Management, 15*(1), 11-14.

UNEP. (2007). *Buildings and Climate Change - Status, Challenges and Opportunities.* United Nations Environment Programme (UNEP), Nairobi, Kenya.

Younes, E., & Kett, R. (2007). Hotel investment risk: What are the chances?. *Journal of Retail Leisure Property, 6*(1), 69-78.