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Using Delphi-AHP Method to Survey Major Factors Causing Urban Plan Implementation Failure

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Abstract: This study presents a framework to evaluate factors influencing implementation of urban plans. An integrated Delphi-AHP method is utilized to identify important factors and their quantitative importance causing failure of urban plan implementation. Delphi method has been used to survey major factors and Analytical Hierarchy Process (AHP) method has been utilized to define their significance, in a case study for Tehran. This study outlines the core factors that affected urban plans implementation failure. Obtained results provide proper insights to increase success of urban plans to achieve their goals. Although, Delphi and AHP are established methods in many literatures, rarely utilized for identifying and weighting factors causing failure of urban plans at implementation phase.

Key words: Implementation failure, Delphi, AHP, urban policies, group decision making

INTRODUCTION

Tehran, capital city of Iran, is one of the larger cities of the world with a population of around 7 million (Fanni, 2006). During the first 40 years its population increased by only 50,000 people, but from 1956 to 2006 its population has increased by more than seven million people and it has transformed itself to a large metropolis.

Tehran's planning history shows early stages in which new infrastructure was designed and developed by the government as part of its strategy for modernization and growth management. It results producing Tehran's comprehensive plan in 1968. The period of reconstruction in the 1990s relaxed some of the limits of the 1968 plan, which showed the urgent need for an updated planning framework. Several planning documents which were launched during this period have emphasize on considering stronger role for the municipality and more attention to the policy developments. A firm of Iranian consultants was commissioned in 1985 to prepare a plan for the period of 1986-1996. After much delay, it was only in 1993 that the plan was finally approved by the Urban Planning High Council. This plan also focused on growth management and a linear spatial strategy, using the scales of urban region, sub-region, district, area and neighborhood. It proposed that the city be divided into 22 districts within five sub-regions, each with its own service centre.

Based on Zebardast (2006), the 1993 plan was not welcomed by the municipality, which disagreed with its assessments and priorities, finding it unrealistic, expensive and impossible to implement. The municipality produced its own strategic plan for the period 1996-2001, known as Tehran Municipality's First Plan, or Tehran 80. Rather than introducing a land-use plan as its goal, this was the first plan for the city that emphasized a set of strategies and proposed policies to achieve them. It identified the city's main problems as shortage of resources to deliver its services, the pace and pattern of urban growth, environmental pollution, the absence of effective public transport and inefficient bureaucracy. The municipality's vision for the future of the city was then outlined to have 6 major characteristics: a clean city, ease of movement in the city, the creation of parks and green spaces, the development of new cultural and sports facilities, reform of the municipal organization and planning for the improvement of urban space, including preparation of comprehensive and detailed plans for land use and conservation (Zebardast, 2006). These plans have remained unimplemented and the city continues to suffer from a range of problems, including traffic congestion, environmental pollution and unaffordable property prices (Madanipour, 2006). Since, 2004, Tehran Municipality has started to develop new detailed urban land use plans and several consultant companies are working on a strategic plan to link these detailed plans and to guide the future development of the city as a whole.

This research intends to identify major factors resulting failure of urban plans, using a Delphi method. It also utilizes AHP technique to determine the significance of the factors in comparison with each other. Following, the concepts of AHP and Delphi methods have

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been presented. Then the results of implementing the Delphi-AHP method in a case study for Tehran has been described and discussed.

MATERIALS AND METHODS

Case study: Tehran, the capital and largest city of Iran, has been selected as the case study area. Tehran is a sprawling city at the foot of the Alborz Mountain. In the 20th century, Tehran faced a large migration of people from all around Iran. Some background related to Tehran planning activities were mentioned at introduction part. This study was conducted the situation of Tehran urban planning activities till 2007.

Delphi method: Delphi method is an iterative process designed to achieve consensus among a group of experts on a particular topic. The Delphi method is the most effective means of querying experts to identify factors causing urban detailed plan implementation failure. This is especially useful in situations where no standard criteria exist for evaluation. The method is widely used in many studies and various explanations and examples are available (Dijk, 1990; Hafeznia *et al*., 2008; Hosseinali and Alesheikh, 2008; Linstone and Turoff, 2002; Okoli and Pawlowski, 2004; Shiftan *et al*., 2003). In this research the Delphi method is used as a framework to determine the major factors influencing urban plan implementation failure as well as the preference of the factors.

According to Linstone and Turoff (2002), the Delphi process today exists in two distinct forms: Conventional Delphi and Real-lucre Delphi (Delphi Conference). Although the latter approach is often preferred, in this research the Conventional Delphi approach was used because of limitations for collecting all respondents spontaneously at a special place. Conventional Delphi method comprises the following steps (Fowles, 1978; Fischer, 1978):

(i) Design the questionnaire and select the experts;
(ii) Perform the first round survey of anonymous experts;
(iii) During the first round survey, provide the experts with opinion of the others;
(iv) According to survey of the first round, request that each expert answer again the first round problem while observing whether new solutions are proposed or different perspectives are set forth;
(v) Synthesize expert opinions and reach a consensus.
(vi) Repeat steps iii and iv until a uniform result is achieved for a particular topic.

AHP method: AHP method, developed by Saaty (1980), has been studied extensively and used in numerous applications in the last 20 years (Ho, 2008; Cheong *et al*., 2008). The wide AHP applicability is due to its simplicity, ease of use and great flexibility.

As a decision method that decomposes a complex decision problem into a hierarchy, AHP is also a measurement theory that prioritizes the hierarchy and consistency of judgmental data provided by a group of decision makers (Wu *et al*., 2007). AHP incorporates the evaluations of all decision makers into a final decision by pair-wise comparisons of the alternatives (Saaty, 1980). AHP has been successfully applied to a diverse array of problems, with the calculation procedure as follows:

To establish the pair-wise comparison matrix A, Let $C_1, C_2, \ldots, C_n$ denote the set of elements, while a_{ij} represents a quantified judgment on a pair of elements C_i and C_j. The relative importance of two elements is rated using a scale with the values are presented at Table 1.

This yields an n×n matrix A as follows:

$$A = [a_{ij}] = \begin{matrix} C_1 \\ C_2 \\ . \\ . \\ C_n \end{matrix} \begin{bmatrix} 1 & a_{12} & . & . & a_{1n} \\ 1/a_{12} & 1 & . & . & a_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ 1/a_{1n} & 1/a_{2n} & . & . & 1 \end{bmatrix}$$

where, $a_{ii} = 1$ and $a_{ij} = 1/a_{ji}$; $i,j = 1,2, \ldots, n$. In matrix A, the problem becomes assigning to the n elements $C_1, C_2, \ldots, C_n$ a set of numerical weights $W_1, W_2, \ldots, W_n$ that reflect the

Table 1: Saaty's 1-9 scale for AHP preference (Saaty, 2006)

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	Activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	Importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Intermediate values	Used to represent compromise between the priorities listed above
Reciprocal of above non-zero numbers	If activity i has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

recorded judgments. If A is a consistency matrix, the relations between weights W_i and judgments a_{ij} are simply given by $W_i/W_j = a_{ij}$ (for i,j =1, 2,..., n) and assigned relative weight enters into the matrix as an element a_{ij} and reciprocal of the entry $1/a_{ji}$ goes to the opposite side of the main diagonal.

$$A=(a_{ij})=\begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdot\ \cdot & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdot\ \cdot & \cdot \\ \cdot & \cdot & \cdot\ \cdot & \cdot \\ \cdot & \cdot & \cdot\ \cdot & \cdot \\ w_n/w_1 & w_n/w_2 & \cdot\ \cdot & w_n/w_n \end{bmatrix}$$

The preferences presented by each individual expert should be aggregated to obtain a single weight for each factor. Geometric mean method (GMM) is a commonly used method in AHP to aggregate judgments of individuals within a group (Aull-Hyde *et al*., 2006). The geometric mean is consistent and satisfies the four axioms underlying the AHP theory (Escobar *et al*., 2004). The geometric mean is a summary statistic useful when the measurement scale is not linear. Given values $X_1, X_2, X_3, \ldots, X_n$, the geometric mean of these *n* values is given by: $[X_1, X_2, X_3, \ldots, X_n]^{1/n}$

Seven experts as representative of seven consultant companies supplied the survey asking for a group decision making methodology. Therefore, methodology and concept developed by Escobar *et al*. (2004) and Xu (2000) was used in this research to aggregate individual preferences; generate the aggregated comparison matrix and compute group consistency of the individual weights.

As regards group decision making, AHP considers two different approaches: the aggregation of individual judgments (AIJ) and the aggregation of individual priorities (AIP) (Rigopoulos *et al*., 2008). The AIP is used in this research. It has been proved that using the eigenvector method (EM) as the prioritization procedure and the Weighted Geometric Mean Method (WGMM) as the aggregation procedure, if the individual decision makers have an acceptable inconsistency when eliciting the judgments, results in an acceptable group decision making (Escobar *et al*., 2004). One important property of the geometric mean is its ability to dampen the effect of very high or low values; whereas, such very high or very low values might bias the arithmetic mean. In other words, the geometric mean is less affected by extreme values than the arithmetic mean.

RESEARCH AND RESULTS

The research consisted of five main steps that each is discussed further:

- Defining major factors causing urban plans implementation failure,
- Establishing the judgment matrix,
- Calculating the significance of the factors for each experts,
- Testing consistency of each expert judgments and
- Aggregating expert judgments.

Defining major factors causing urban plans implementation failure: In this stage, in adoption of Taleai *et al*. (2007) and Hsu *et al*. (2007) a modified Delphi technique is used. To elicit expert's opinions, an open questionnaire is used to identify each factor and additionally, literature review and expert interviews integrate recurrent opinions expressed in the Delphi survey.

An integrated questionnaire survey, inspection and interview approach was adopted, in this stage. Although the questionnaire satisfied all information required for the assessment, the inspection and interview could provide the authors with better understanding of the current situation. To do the assessment, seven experts as representative of 7 consultant companies working with different regional municipalities of Tehran were contributed. In meetings:

- The attendees were interviewed,
- A questionnaire was completed or attendees were requested to complete and get it back later,
- Major factors causing urban plan implementation failure were defined,

The collected information was then integrated and analyzed. With such a comprehensive study, different factors that affect implementation of urban plans were determined as follows:

1 : Insufficient skilled personnel within municipalities and private consultant companies,
2 : Inadequate attention to all factors existed in reality,
3 : Inadequate attention to Intelligence stage of planning process and preparing the plans with insufficient insight and information,
4 : Ambiguity concerning the future trend of city development,
5 : Insufficient use of new technologies and tools such as GIS, SDSS/SPSS,

6 : Using traditional planning methods resulting preparing static plans without any revision during next 5 to 10 years,
7 : Lack or unavailability of required data for decision making,
8 : Non-involvement of other urban management organizations (i.e. utilities companies) for preparing the urban plans,
9 : Less attention to public participation planning approach in preparing the plans,
10 : Unsuitable organizational structure for implementing the urban plans

Establishing the judgment matrix: At the second stage, in the context of another survey, different experts were individually requested to rank and priorities the factors. Finally, the outcomes were analyzed. AHP was used as the methodology for ranking and analysis.

Each expert makes a judgment matrix of the decision elements (major factors have been determined at previous stage) and assigns them relative scores based on AHP method. Table 2 shown the result, captured from one of the experts.

Determining the individual priorities: EM as the prioritization procedure and the GMM as the aggregation procedure were used in this stage to determine the significance of the factors respected to each expert (Table 3).

Testing consistency of each expert judgments: The consistency measures used for the EM in AHP is the consistent index (CI) proposed by Saaty (1980). Let A=(aij) be an n×n judgement matrix and $\omega=(\omega_1,\omega_2,\dots,\omega_n)$ be its priority vector, where $\omega i>0$, $\Sigma_i\omega_i=1$. The consistency in AHP is defined as the cardinal transitivity between judgments, that is to say, $a_{ij}a_{jk}=a_{ik}$ for all i, j, k. The expressions for this measure are:

$$CI = \frac{1}{n(n-1)}\sum_{i\neq j}^{n}(e_{ij}-1)$$

$$CR = \frac{CI}{RI}$$

where, $e_{ij}=a_{ij}\omega_j/\omega_i$, i,j=1,…,n. RI is Random Consistency Index that is shown in Table 4.

If the value of Consistency Ratio is smaller or equal to 10% (CR<0.1), the inconsistency is acceptable. If the Consistency Ratio is greater than 10% (CR>0.1), we need to revise the subjective judgment.

The result is shown that all individual judgment matrixes, except one, have an acceptable CR. Therefore, the priority vectors of 6 experts have been used at the next stage (Table 5).

Aggregating the expert judgments: As regards group decision making, the aggregation of individual priorities (AIP) were used to aggregate the opinion of all experts. It has been proved that using the geometric mean method

Table 2: Judgment matrix from one of the experts

Major factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
F1	1	1/3	1/3	1/5	1/5	1/7	1/5	1/7	1/5	1/7
F2	3	1	1	1/3	1/3	1/5	1/3	1/5	1/3	1/5
F3	3	1	1	1/3	1/3	1/5	1/3	1/5	1/3	1/5
F4	5	3	3	1	1	1/3	1	1/3	1	1/3
F5	5	3	3	1	1	1/3	1	1/3	1	1/3
F6	7	5	5	3	3	1	3	1	3	1
F7	5	3	3	1	1	1/3	1	1/3	1	1/3
F8	7	5	5	3	3	1	3	1	3	1
F9	5	3	3	1	1	3	1	1/3	1	1/3
F10	7	5	5	3	3	1	3	1	3	1

Table 3: Priority vectors of all experts

Experts weight of factors	$Expert_1$	$Expert_2$ (Excluded)	$Expert_3$	$Expert_4$	$Expert_5$	$Expert_6$	$Expert_7$	Aggregated weights
Wf1	0.018	0.017	0.012	0.015	0.081	0.127	0.050	0.04
Wf2	0.034	0.180	0.030	0.015	0.081	0.127	0.050	0.05
Wf3	0.034	0.180	0.030	0.029	0.036	0.048	0.050	0.04
Wf4	0.082	0.180	0.059	0.055	0.036	0.127	0.139	0.09
Wf5	0.082	0.017	0.145	0.105	0.018	0.127	0.016	0.07
Wf6	0.162	0.077	0.145	0.215	0.018	0.022	0.139	0.10
Wf7	0.082	0.077	0.145	0.215	0.081	0.279	0.139	0.17
Wf8	0.202	0.041	0.145	0.215	0.081	0.048	0.139	0.15
Wf9	0.102	0.116	0.145	0.029	0.284	0.048	0.139	0.12
Wf10	0.202	0.116	0.145	0.105	0.284	0.048	0.139	0.16

Table 4: Random Consistency Index (*RI*)

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 5: Consistency Ratio (CR) values for all experts

	$Expert_1$	$Expert_2$ (Excluded)	$Expert_3$	$Expert_4$	$Expert_5$	$Expert_6$	$Expert_7$
CR	0.043	0.442	0.017	0.035	0.028	0.012	0.008

(GMM) as the aggregation procedure, if the individual decision makers have an acceptable inconsistency, results in acceptable aggregated values as the group decision making. When the GMM is employed as the prioritization procedure, the group inconsistency is at least as good as the worst individual inconsistency for aggregation approaches (Xu, 2000).

As it can be seen from Table 3, there is not complete agreement within the experts on all factors. In order to aggregate all opinions into one in such a way that the majority of opinions are considered, the geometric mean method was applied. Last column of Table 3 presents the result.

Results: The results from the case study demonstrate that among the determined factors, 4 are more important, respectively:

- Lack or unavailability of required data for decision making especially at intelligence part of planning procedure;
- Unsuitable organizational structure for implementing the urban plans;
- Non-involvement of other urban management organizations (i.e. utilities companies) for preparing the urban plans and
- Less attention to public participation planning approach in preparing the plans.

CONCLUSION

Several Tehran's comprehensive plans developed during last decades were not welcomed by the municipality and failed in their implementation phase. As a result, the city continues to suffer from a range of problems, including traffic congestion, environmental pollution and unaffordable property prices.

To assess influencing factors can result in failure of implementing urban plans as well as their priorities, in the study a Delphi-AHP combined method was developed to define and prioritize these factors. The results show that the method is robust in clarifying different factors influencing urban plan implementation activities. This study describes that the Delphi method is a useful tools to querying and to achieve consensus among a group of planners on the major factors causing urban detailed plan implementation failure. AHP method was found useful, because the preference of all participants regarding each determined factors, were transformed into a numerical scale and were aggregated to produce a numeric indicator that can use to prioritize factors causing urban detailed plan implementation failure. In addition, the required pairwise comparisons forced the planners and decision makers to think precisely over the various factors affecting urban plan implementation.

Finally, we conclude that the Delphi-AHP approach is beneficial to define significant problems can cause failure of urban plans during their implementation. It is instrumental in identifying specific factors in from different perspectives.

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