

Ranking of Stakeholders Expectations from Development Plan Preparation and Implementation Process using Fuzzy Analytical Hierarchy Process

Varsha Dawle^{1*}, Sanjay Kumar Sonar²

¹Ph.D. Scholar, Civil Engineering Department, College of Engineering, Pune, Maharashtra, India

²Assistant Professor, College of Engineering, Pune, Maharashtra, India

ABSTRACT

Restructuring of development plan preparation and implementation process with a paradigm shift in planning approach is a pressing need for translating ever-increasing urban pressure and for achieving functional and sustainable planning outputs. The fuzzy analytical hierarchy process (FAHP) method is considered most suitable for prioritizing stakeholders' expectations from development plans. It deals with incorrectness and subjectiveness in the process of pairwise comparison. The outcome of this study helps the planners and decision-makers in deciding the priority of factors that need to be addressed while restructuring the planning process. As per the outcome of the study, preparation, and implementation, both aspects of the development plan need to be addressed with equal importance. The study also concludes that the priority of criterion to be addressed are, i) to identify alternate implementation mechanisms, ii) considering financial aspects, iii) inclusion of effective public participation, and iv) plan preparation as per local needs.

Keywords: Development plan, Fuzzy analytical hierarchy process, Plan implementation, Plan preparation, Stakeholders expectations.

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INTRODUCTION

Urban planning is principally a demonstration of people's expectations and aspirations regarding development in the existing socio-political framework of the country. It is a techno-legal process concerned with the use of land and design of the urban infrastructure within urban areas. It is the process, in which all the developmental activities of an urban area are planned, controlled, regulated, and monitored from time to time. These processes are formulated and envisaged in the form of a comprehensive plan, broadly known as "development plan."¹⁻⁴ A development plan is a plan for the planned development of the urban area for the projected population. It is a set of documents that set out the urban local body's policies and proposals for the development and use of land within their jurisdiction. It deals mainly with two aspects: land use planning and development control and promotion guidelines. The development plan is a comprehensive spatial plan for the orderly and systematic development of the urban area. It is a land-use plan of the urban area for a period of 20 years based on the regulatory framework.⁵ The development plan is perceived as to be a process rather than a conclusive statement, providing guidelines for physical development. The basic elements of the development plan are land use, circulation, utilities, services and facilities, civic design, and open spaces.

Corresponding Author: Varsha Dawle, Ph.D. Scholar, Civil Engineering Department, College of Engineering, Pune, Maharashtra, India, e-mail: vadawle1@gmail.com

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In Maharashtra, the development plan preparation and implementation process is governed by Maharashtra Regional and Town Planning Act, 1966. It is a statutory requirement for every urban local body to prepare a development plan before the implementation of any development proposals in their jurisdiction. The Act also provides for revision of the development plan after every 20 years and this process of revision of development plan is a continuous process in order to cope up with the needs of changing urban scenarios.⁶⁻⁹

Despite these development plans, unorganized development, and a sharp decline in the quality of life have been experienced by urban residents over the last few decades. A study conducted by the Urban Development Department of the Government of Maharashtra has observed

that implementation percentages of development plan proposals are about 20, 23, 25, and 26% for “C,” “B,” and “A” municipal councils and municipal corporations, respectively. The sanctioned development plans rarely get translated into annual action plans as there is no obligation on urban local bodies to implement the plan. The present process of preparing a development plan is time-consuming and long-drawn. Most of the plans are embroiled in legal and procedural complexities at planning, as well as, implementation stages. The development plans are often prepared without considering the financial capacity of the urban local body for the implementation of plan proposals. Development plan preparation has been accorded high priority, while development plan implementation has received less attention.¹⁰⁻¹¹

There is a strong need for restructuring of development plan preparation and implementation process with a paradigm shift in planning approach, which will incorporate stakeholders' expectations from the planning process. The objective of this study is to prioritize stakeholders' key expectations from the development plan process using the FAHP method. This study will give direction to the convergence of stakeholders' opinions, while restructuring of development plan preparation and implementation process.

ANALYTICAL FRAMEWORK

Analytic Hierarchy Process (AHP)

The AHP is a multi-criteria decision-making method (MCDM) developed by Prof. Thomas L. Saaty. It is a method to derive ratio scales from paired comparisons. Human opinion can not be consistent always, considering these, AHP allows some small inconsistency in judgment. The ratio scales are derived from the principal eigenvectors and the consistency index is derived from the principal eigenvalue. AHP helps to capture both subjective and objective aspects of a decision by reducing complex decisions to a series of pairwise comparisons and then synthesizing the results. AHP also incorporates a useful technique for checking the consistency of the decision maker's evaluations, thus, reducing the bias

in the decision-making process. In AHP, final priority listing is based on the pairwise relative evaluations of both, criteria and subcriteria.¹² It is a very flexible and powerful tool because the computations made are guided by the participants' experiences. AHP is a tool that translates qualitative, as well as, quantitative evaluations made by the participants into a multicriteria ranking. The AHP method provides a structured framework for setting priorities on each level of the hierarchy, using pair-wise comparisons that are quantified using 9 pointer scale as demonstrated in Table 1.

Fuzzy Analytic Hierarchy Process (FAHP)

Laarhoven and Pedrycz (1983) proposed the FAHP in 1983, which was an application of the combination of the AHP and fuzzy theory. The linguistic scale of the traditional AHP method could express fuzzy uncertainty when a decision-maker is making a decision. FAHP converts the opinions of experts from previous definite values to fuzzy numbers and membership functions, presents triangular fuzzy numbers in paired comparison of matrices to develop FAHP. The following steps are followed in this study based on the FAHP method.

Determine Problems

Decision problems to be solved are determined based on the earlier stages of the research study.

Set-Up Hierarchy Architecture

Evaluation criteria within the framework of FAHP have been determined. Selection of evaluation criteria and subcriteria, and their interrelationship based on the literature study and researchers' own experience.

Set-Up Fuzzy Paired Comparison Matrices

Relative importance between factors given by participants in pairs compared after setting up paired comparison matrices and after the definite values are converted to fuzzy numbers according to the definition in Table 2 and Figure 1, fuzzy evaluation values of participants were integrated based on the similarity aggregation method (SAM) concept, proposed by Hsu and Chen (1996).

Table 1: T. L. Saaty's ratio scale for pairwise comparison of importance of weights of criteria/ alternatives

<i>Intensity of importance</i>	<i>Definition</i>	<i>Explanation</i>
1.	Equal importance	Two elements contribute equally to the property
3.	Moderate importance of one over another	Experience and judgment slightly favor one over the other
5.	Essential or strong importance	Experience and judgment strongly favor one over another
7.	Very strong importance	An element is strongly favored, and its dominance is demonstrated in places
9.	Extreme importance	The evidence favoring one element over another is one of the highest possible orders of affirmation
2,4,6,8	Intermediate values between two adjacent judgments	Compromise is needed between two judgments

Source: Adapted from¹⁸



Calculate Fuzzy Weight Value

The characteristic vector value of a fuzzy matrix is obtained by using the “column vector geometric mean method” proposed by Buckley (1985).

Hierarchy Series Connection

All hierarchies in series are connected to obtain all factors’ weights. The triangular method has been used to collect the fuzzy numbers which have derived from expert’s opinion directly in this study.

Definition of fuzzy numbers: $ij = (\alpha_{ij}, d_{ij}, g_{ij}) \dots (1)$

$\alpha_{ij} = \text{Min}(b_{ijk}, k = 1, \dots, n) \dots (2)$

$d_{ij} = (b_{ijk}) / n, k = 1, \dots, n \dots (3)$

$g_{ij} = \text{Max}(b_{ijk}, k = 1, \dots, n) \dots (4)$

b_{ijk} -relative preference parameter “i” to parameter “j” from expert “k” view,

α_{ij} and g_{ij} -lower and upper limits of expert view, respectively, and

d_{ij} -geometric mean of experts views: $\alpha_{ij} \leq d_{ij} \leq g_{ij}$.

Inverted matrices: $A_{ij} = \alpha_{ij}, \alpha_{ij} \times \alpha_{ji} \approx 1, i, j = 1, 2, 3 \dots (5)$

Fuzzy relative weights: $Z = \alpha_{ij} \dots \dots \alpha_{ij} \dots (6)$

$Z_i = \alpha_{ij} \dots \dots \alpha_{ij} - 1 \dots (7)$

$W_i = Z_i (Z_i \dots \dots Z_n) \dots (8)$

Defuzzification

Defuzzification is a method of converting fuzzy numbers to definite values. The geometric mean method is adopted in this study.

Sequencing

Sequence defuzzified criteria.

Validity and Reliability of the Model

Validity

Validity is the degree to which a test measures what it is supposed to measure. The validity for the questionnaire is obtained by KMO and Bartlett’s test by SPSS19 software.

Reliability

The reliability of research is obtaining the same results on repeated trials. For a study to be reliable, it needs to be a good deal of consistency in the results obtained at different times. Values assigned to mental attributes can never be

completely precise hence, it becomes very important to test the reliability of results. The reliability of the questionnaire

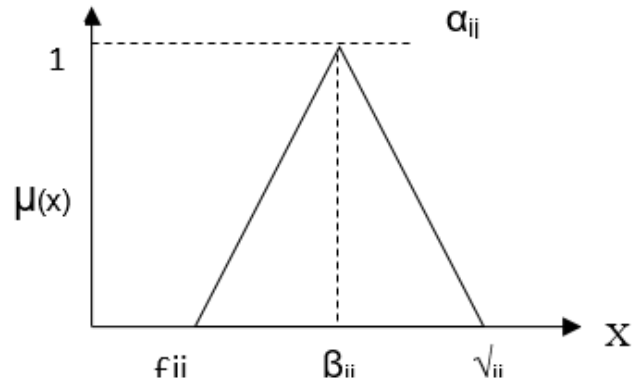


Figure 1: Triangular fuzzy number
Source: Adapted from¹³

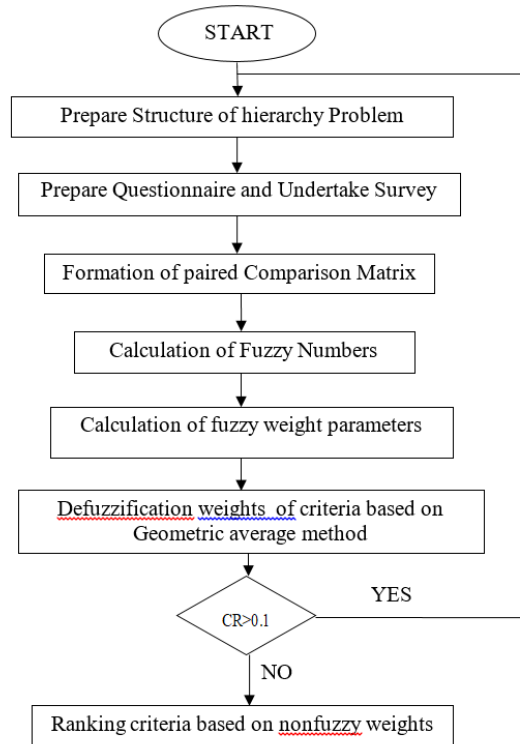


Figure 2: Flowchart of FAHP methodology
Source: Adapted from^{14,15}

Table 2: Fuzzy number definition

Crisp number	Fuzzy number	Definition
1.	(1,1,1)	Equal importance
3.	(2,3,4)	Moderate importance of one over another
5.	(4,5,6)	Essential or strong importance
7.	(6,7,8)	Very strong importance
9.	(8,9,9)	Extreme importance

Source: Adapted from¹⁰

in the present study is obtained by Cronbach's Alpha test by SPSS19 software. A flowchart of the methodology for ranking using the FAHP method is presented in Figure 2.

STAKEHOLDERS' EXPECTATIONS FROM DEVELOPMENT PLANS

Expectations of various stakeholders from the development plans are identified based on literature survey, recommendations of various committees set up by the government, recommendations of national conferences, seminars conducted by professional bodies, outputs of working groups of non-government organizations (NGOs), and citizens pressure groups, and compiled based on own experience. Criteria and subcriteria of stakeholders' expectations considered in this study are explained in detail below and presented in Figure 3.¹⁶⁻¹⁹

Expectations from the Development Plan Preparation (DPP) Process

Faster Preparation Process

Currently, the time taken for the preparation of development plans is too long. The faster planning process will result in relevant plans.²⁰⁻²¹

Public Participation in Planning

Public participation in planning will create a sense of ownership and belongingness towards the development plan, which will certainly help to reduce litigations.

Financially Viable

Financially viable plans will result in implementable plans.

Flexible

Rigid plans take too much time to accommodate local needs and effect changes accordingly.

Consideration of Local Area Needs

Every local area has a particular need which varies from locality to locality, the plan should be able to accommodate these needs.

Shorter Plan Periods

The current period of 20 years is too long, which should be reduced.

Expectations from the Development Plan Implementation Process

Obligation of Implementation

Implementation of the development plan should be made obligatory.

Public Involvement in Implementation

During the implementation stages, the active involvement

of NGOs, whistleblowers, and enlightened citizens will contribute positively.

Resource Allocation

Budgetary allocation as per the stages of implementation should be made mandatory for the timely implementation of planning proposals.

Alternative Implementation Mechanisms

As land acquisition results in interpersonal inequalities, other methods of implementation need to be promoted.

FUZZY AHP SURVEY ANALYSIS

Various stakeholders have varying opinions and expectations from the development plan and their judgment is influenced by their concern and viewpoints. For these reasons, 21 stakeholders from various classes—NGO representatives, planning professionals, urban local body officials, and academicians are selected for the survey. FAHP method is applied to take the stakeholders' subjective judgments into consideration and to minimize the uncertainty in the decision and to get a fairly accurate priority listing of the factors under consideration. Opinions of all the stakeholders are summarized in the comparison matrix and crisp numbers are translated into fuzzy numbers based on values of Table 3.

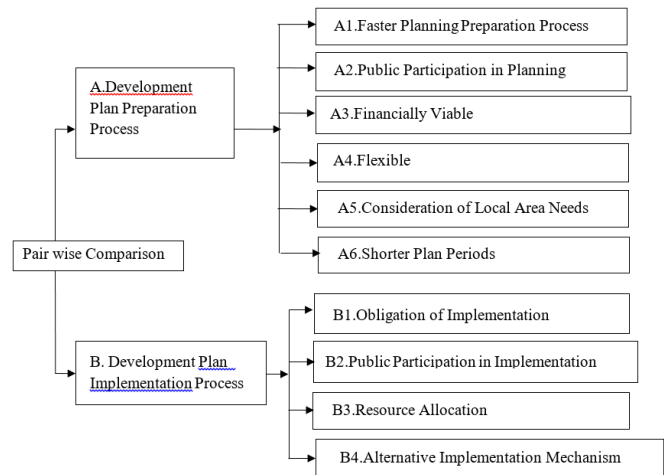


Figure 3: Stakeholders' expectations: criteria and subcriteria

Table 3: Fuzzy number definition

Crisp number	Fuzzy number	Definition
1.	(1,1,1)	Equal importance
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7.	(6,7,8)	Very strong importance
9.	(8,9,9)	Extreme importance

Source: Adapted from¹⁰



Table 4: Synthetic pairwise comparison matrix and normalized matrix for subcriteria of development plan preparation and implementation process

	Geometric means for subcriteria			Fuzzy weights		Crisp weight	Mean	Weights of measures	Mean weight
A1	0.51	0.57	0.42	0.08	0.09	0.07	0.08	0.08	6.05
A2	1.41	1.37	1.5	0.22	0.23	0.23	0.23	0.23	6.09
A3	1.39	1.43	1.45	0.22	0.24	0.23	0.23	0.23	6.08
A4	0.93	0.77	0.85	0.14	0.13	0.13	0.13	0.14	6.1
A5	1.26	1.21	1.34	0.2	0.2	0.21	0.2	0.2	6.09
A6	0.89	0.72	0.88	0.14	0.12	0.14	0.13	0.13	6.08
Sum	6.38	6.08	6.43	-	-	-	-	-	-
-	0.16	0.16	0.16	-	-	-	-	-	-
B1	0.7	0.73	0.61	0.18	0.19	0.15	0.17	0.08	2.85
B2	0.97	0.95	0.95	0.25	0.24	0.24	0.24	0.23	4.04
B3	1.04	1.04	1	0.26	0.26	0.25	0.26	0.23	4.55
B4	1.29	1.21	1.35	0.33	0.31	0.34	0.32	0.14	5.35
Sum	3.99	3.94	3.92	-	-	-	-	-	-
-	0.25	0.25	0.26	-	-	-	-	-	-

Table 5: Consistency ratio and reliability index in comparison with 0.1

Development plan	λ	RI	CI	CR
Preparation process	6.08	0.9	0.016	0.018
Implementation process	4.2	0.9	0.07	0.07

Table 6: Calculation of weights of the main criteria

S. No.	Pairwise comparison	Weight
1	Development plan preparation process	0.51
2	Development plan implementation process	0.49

Table 7: Local weights and global weights of subcriteria of development plan preparation and implementation process

S. No.	Subcriteria	Weight of criteria			Priority rating
		Local weight (X)	A and B (Y)	Global weight (Z = X × Y)	
A1	Faster planning preparation process	0.08	0.51	0.04	10
A2	Public participation in planning	0.24	0.51	0.12	3
A3	Financially viable	0.28	0.51	0.12	4
A4	Flexible	0.14	0.51	0.07	8
A5	Consideration of local area needs	0.2	0.51	0.1	6
A6	Shorter plan periods	0.13	0.51	0.06	9
B1	Implementable	0.17	0.49	0.08	7
B2	Public participation in implementation	0.24	0.49	0.12	5
B3	Resource allocation	0.28	0.49	0.14	2
B4	Alternative implementation mechanisms	0.31	0.49	0.15	1

The paired comparison matrix is developed and the geometric mean of paired comparison matrices (GMPCM) is presented in Table 3.

Fuzzy numbers have been calculated and stakeholders' opinions in a fuzzy framework have been translated. Relative fuzzy weights for each criterion and subcriterion were

calculated using the defuzzification process. Weights of each subcriteria are tabulated in normalized matrices in Table 4.

The reliability of the opinion survey in the paired comparisons matrix is confirmed ($CR \leq 0.1$), as presented in Table 5.

Table 6 shows the results of the weights of the main criteria. Calculation of local weights and global weights of all the subcriteria is performed and results are tabulated in Table 7, along with priority ranking.

CONCLUSION

Restructuring of development plan preparation and implementation process with the paradigm shift in planning approach is a pressing need for translating ever-increasing urban pressure and for achieving functional and sustainable planning outputs. It is very imperative to include stakeholders' expectations while restructuring the process. For prioritizing the stakeholders' expectations from plan outcomes, different MCDM are considered for ranking of criteria and subcriteria of stakeholders' expectations.

The FAHP method is considered most suitable for prioritizing stakeholders' expectations. The FAHP methodology deals with incorrectness and subjectiveness in the process of pairwise comparison. Considering the fuzziness in the anticipated responses to the subject matter involved and the policy-oriented nature of the topic under consideration FAHP is the best-suited decision-making process that uses a range of values to incorporate decision-makers' uncertainty. From this range, participants may select a suitable range which suits best to their opinion. The proposed method guides participants to expand their alternatives for the restructuring of the planning process. It helps the planners and decision-makers in acquiring more strong decisions, especially in deciding the factors that need to be addressed while restructuring the planning process. Moreover, it is clear from the outcome of the study that development plan preparation and implementation, both aspects need to be addressed equally. The study also concludes that as per stakeholders' expectations need to identify alternate implementation mechanisms, consideration of financial aspects, public participation, and consideration of local needs are the main criteria that need to be considered while restructuring the development plan preparation and implementation process.

ABBREVIATIONS

Development plan preparation-DPP; Development plan implementation-DPI; Multi-criteria decision making techniques-MCDMT; Fuzzy analytical hierarchy process-FAHP.

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