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Site Selection for Greenfield Domestic Airport for Pandharpur City

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Abstract: ***India is a developing country in numerous sectors like Agriculture, Transportation, Education, and Infrastructure. Last one-decade excellent changes in the transportation field, now nation focus on airway transportation development. Airway plays a vital role in economic development of a country. The aim of research is to identify best location for setting up Greenfield Domestic Airport for Pandharpur City. Selection of the best location is primarily based on various parameters and that parameters mapping by using Delphi and Analytic hierarchy process strategies. From the complete analysis select the best location for airport.***

Keywords: Transportation, Agriculture, Education, Infrastructure, Greenfield Domestic Airport, Delphi analysis, Analytic hierarchy process, Economic development, Airway.

I. INTRODUCTION

Now a day Transportation is a quickest growing region in India. India is a growing country but India's Prime Minister's vision to make India an evolved country. Because the expanding of metropolis and the increasing of roads and vehicles, the visitors gadget turn out to be more and more complex and hard to be controlled. That allows you to make better use of existing transport resources to achieve most efficient traffic scheduling also working on newly development road, rail and aviation network. In India, there are 24 International airports, 103 Domestic airports. All of this airport working with full of capacities. So there are few airports under construction and the Airports Authority of India also planning to develop new International and Domestic Airports across India. An airport is a gateway to a town. Due to this airport and airport environment become crucial. Because of these, its location is important. In this research, the airport site selection criteria, the effects of airport and site selection by planner or engineer are explained. Pandharpur is a famous pilgrimage spot within the state. [5] It attracts tourists who're on a religious quest from all around the country who come here to worship and pay respect to the Gods and Goddesses in this town. Stationary Population of Pandharpur Taluka is 4,42,368 out of this population urban area cover nearly 1,00,000 population (as per Census 2011). Normal day tourist population is more than 10000. In year nearly 2 million visitors come to Pandharpur with using various transport system. Pandharpur having four big pilgrims and total tourist population for those pilgrims is more than 4 million. Total tourist population is 6 million per year and increase by 2% per decade. [5] Nearest airport is Pune international airport, Pune is round 213 km from Pandharpur. So Pandharpur wants Domestic Airport for sophisticated tourist and regional transport. It should have positive vibes like increase standard of living, increase opportunity for locals and increase values of surrounding vicinity.

II. METHODOLOGY

Study of objectives and literature review discover major and critical problems related to site selection for airport. After objectives we collect essential data to fulfil further process. Data was analysed by various techniques like Delphi method and Analytic Hierarchy Process and achieve objectives of study.

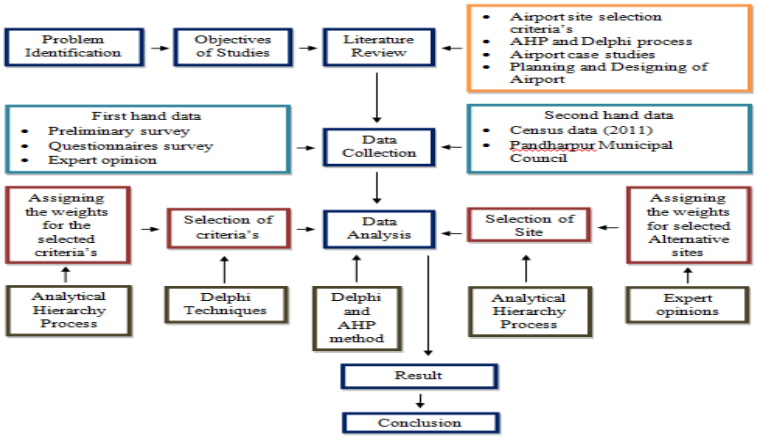

Fig. 1 Methodology

A. Study Area Profile and Location

Pandharpur is a holy place of Shri. Vitthal and Shri Rukmini. It's also referred to as the Southern Kashi of India and Kuldaivat of Maharashtra state. It's far placed at a distance of 72 km by using street from Solapur district headquarters. The historical temple of Shri. Vitthal and Rukmini become renovated in 1195 A.D. The Chandrabhaga River flows through the town. It is an important location from all aspects in Solapur district. Pandharpur is located on 17°11' north latitude and 75°11' east longitude. The entire area of Pandharpur taluka is 1,293 km² including a 1,268 km² rural area and a 25 km² urban area, and population is 442368 (as per Census 2011).

Table I
Study Area Profile

Pandharpur profile		
Sr. No.	Parameters	Description
1	City	Pandharpur
2	Taluka	Pandharpur
3	District	Solapur
4	Distance from district to Pandharpur	72 km
5	Area of Pandharpur Taluka Pandharpur urban Pandharpur rural	1293 km^2 25 km^2 1268 km^2
6	Population Male Female	442368 (as per Census 2011) 230359 212009
7	Tourist population Normal days (yearly) Pilgrims days	6 million 2 million 4 million
8	Households	88637
9	Literacy rate	77.68 %
10	Elevation	465.12 m (1525 ft)
11	Average Temperature	39
12	Average Rainfall Maximum rainfall in year of 1974 Minimum rainfall in year of 1972	600 mm 1231 mm 157 mm
13	Average Wind speed	10.8 mile per hours
14	Soil	Soft soil to hard murum

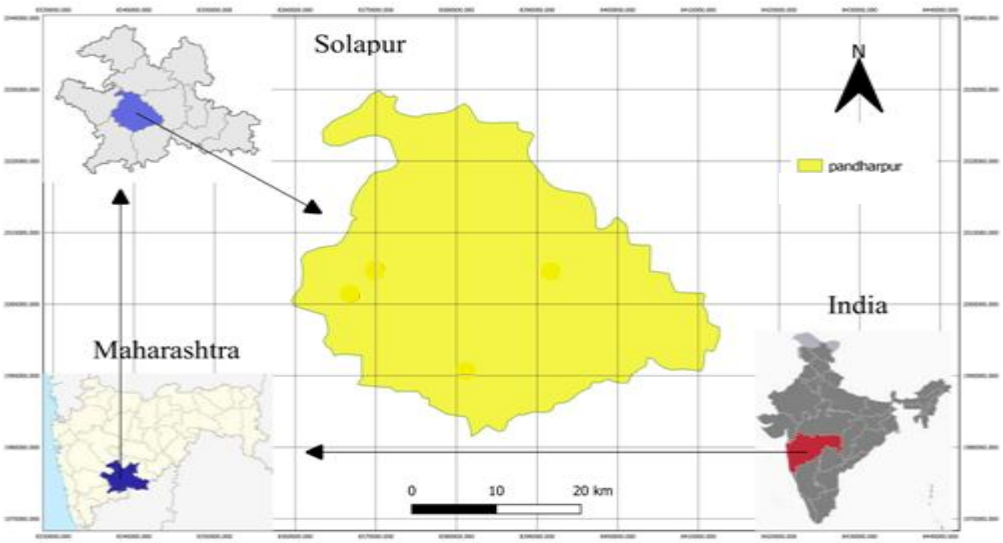

Fig. 2 Study area location

B. Site selection as Planner, Engineer, and Architect

Consist with the planner, engineer, and architect are more sensitive about site selection for airport. The planner should consider the financial, social, and physical aspects of an airport on a town. To choose the location of airport, the first step is to analyse the current situation of city. Present transportation network, wetland, agriculture region, forest area, soil features, and industrial and residential location. They put together future city plans in keeping with this analysis. After this evaluation procedure, the alternative step of use of engineers. They define standards, and compare the location, and ultimately choose the maximum suitable location according to this using software.

C. Site selection Criteria's

The choice of a site for a new Greenfield domestic Airport must be based on certain criteria which will serve as proper guidance for the select proper location and size. Humans prefer to travel via aircraft because of time-saving. Because of this, an airport is a gateway to the city for both national and global dimensions. in keeping with these facts, site selection is an important topic for the airport authority. Following factors listed for selection of an appropriate site for airport 1. Regional plan, 2. Airport use, 3. Ground facilitate, 4. Obstacle, 5. Visibility, 6. Wind, 7. Topography, 8. Noise, 9. Soil feature, 10. Environs impact, 11. Availability of Land, 12. Future planning, 13. Availability of utilities, 14. Economical study, 15. Revenues.

III. DATA ANALYSIS

A. Delphi Analysis

For the evaluation part of the observe all the required data had been accumulated and summarized inside the proceeding chapter. Within the selected fifteen factors, of being a Greenfield Domestic Airport. Fifteen factors, every selected as the influencing factor inside the Airport Planning for Pandharpur City using Delphi Techniques. [2] The weight for these selected factors and sub-factors is assigned using AHP.

First, the group facilitator selects a group of specialists based on the topic being tested as soon as all participants are confirmed, every member of the organization is dispatched a questionnaire with instructions to comment on every subject matter primarily based on their private opinion, revel in, or studies. The quit of every comment consultation, all questionnaires are returned to the facilitator who decides if some other round is vital or if the outcomes are equipped for publishing. The questionnaire rounds may be repeated as many times as important to achieving a well-known feel of consensus.

TABLE II
DELPHI ANALYSIS 1

Experts	E1	E2	E3	E4	E5	E6	E7	E8	GM	SD
Regional Plan	4	4	5	5	1	5	4	6	3.760	1.268

TABLE III
DELPHI ANALYSIS 2

Experts	x	Log x
E1	4	0.602
E2	4	0.602
E3	5	0.6989
E4	5	0.6989
E5	1	0
E6	5	0.6989
E7	4	0.692
E8	5	0.6989
	N = 8	∑ Log x = 4.601

GM = A.L. (∑Log x / N)
GM = A.L. (4.601 / 8)
GM = A.L. (0.575)
GM = 3.760

TABLE IV
DELPHI ANALYSIS 3

Experts	x	x - $\bar{x}$ = d	D^2
E1	4	-0.125	0.015
E2	4	-0.125	0.015
E3	5	0.875	0.765
E4	5	0.875	0.765
E5	1	-3.125	9.765
E6	5	0.875	0.765
E7	4	-0.125	0.015
E8	5	0.875	0.765
	N = 8		∑ Log x = 12.874

$\bar{x} = (\sum x / N)$
$\bar{x} = (4+4+5+5+1+5+4+5 / 8)$
$\bar{x} = 4.125$

$SD = \sqrt{(\sum d^2 / N)}$
$SD = \sqrt{(12.874 / 8)}$
$SD = 1.286$

1) Delphi Round 1

TABLE V
DELPHI ROUND 1

Criteria	E1	E2	E3	E4	E5	E6	E7	E8	GM	SD
Regional plan	4	4	5	5	1	5	4	5	3.760	1.268
Airport use	4	5	4	5	3	4	3	4	3.935	0.707
Ground facilitate	4	5	4	5	1	5	4	5	3.760	1.268
Obstacle	5	5	4	5	1	3	4	4	3.527	1.268
Visibility	5	5	4	5	2	3	4	4	3.847	1
Wind	5	5	4	5	1	3	5	4	3.627	1.322
Topography	4	2	4	5	2	4	5	5	3.657	1.165
Noise	4	2	4	5	3	3	4	4	3.510	0.856
Soil feature	5	3	2	5	2	4	5	4	3.527	1.198
Environs impact	5	4	4	5	1	4	5	4	3.657	1.224
Availability of land	5	5	5	5	2	4	4	4	4.100	0.968
Future planning	5	5	5	5	2	4	5	5	4.33	1
Availability of utilities	5	4	4	5	1	4	4	4	3.556	1.165
Economical study	5	4	4	5	1	4	4	5	3.657	1.224
revenue	5	4	4	5	2	4	4	3	3.988	0.927

2) Delphi Round 2

TABLE VI
DELPHI ROUND 2

Criteria	E1	E2	E3	E4	E5	E6	E7	E8	GM	SD
Regional plan	3	5	4	1	5	3	4	4	3.309	1.218
Airport use	4	3	4	5	2	4	5	4	3.741	0.927
Ground facilitate	1	5	3	5	2	5	4	5	3.326	1.479
Obstacle	4	5	4	5	2	3	3	4	3.609	0.968
Visibility	4	1	4	5	3	3	4	4	3.218	1.118
Wind	4	5	4	5	2	3	5	3	3.711	1.053
Topography	4	4	4	5	3	4	5	4	4.080	0.599
Noise	2	2	4	4	3	3	2	1	2.413	0.992
Soil feature	4	3	2	5	2	4	4	5	3.430	1.111
Environs impact	4	4	5	3	3	2	4	4	3.510	0.856
Availability of land	4	5	4	5	3	4	5	4	4.195	0.661
Future planning	4	5	5	5	4	4	5	5	4.598	0.484
Availability of utilities	4	1	4	5	2	4	3	4	3.059	1.218
Economical study	1	4	3	5	4	4	5	5	3.527	1.268
revenue	3	4	4	5	3	4	4	5	3.935	0.707

3) *Delphi Analysis Result:* The result based on experts responses. Use Geometric Mean column for calculate difference between round 1 and round 2. After this process we are ranking criteria's.

TABLE VII
Delphi analysis result

Criteria	Rank
Revenue	1
Obstacle	2
Wind	3
Availability of land	4
Soil feature	5
Economical study	6
Environs impact	7
Airport use	8
Future planning	9

B. Analytic Hierarchy Process AHP

The factors that are recognized as capacity aspects for the inexperienced metropolis element by using the use of the Delphi method are analysed to determine the weights of those selected factors using statistics amassed from AHP. The Analytic Hierarchy method (AHP) [4] is a technique for organizing and reading complicated decisions, the usage of math and psychology. The following desk suggests the enter with the aid of an expert's opinion for the pair-wise evaluation of the elements and their categorical elements. The following tables constitute the effects and their consistency. The professionals have been asked to provide their inputs according to the well-based AHP questionnaire. 5 point likert scale is use for AHP analysis.

TABLE VIII
ANALYTIC HIERARCHY PROCESS 1

Criteria's	Revenue	Obstacle	Wind	Availability of land	Soil feature	Economical study	Environs impact	Airport use	Future planning
Revenue	1	4	9	2	4	3	3	2	2
Obstacle	1/4	1	2	1/3	1	1/2	1/2	1/2	1/2
Wind	1/9	1/2	3	1/3	1/2	1/2	1/3	1/3	1/3
Availability of land	1/2	3	2	1	2	2	1	1/2	2
Soil feature	1/4	1	2	1/2	1	1/2	1/2	1/2	1/3
Economical study	1/3	2	2	1/2	2	1	2	1/2	1/2
Environs impact	1/3	2	3	1	2	1/2	1	1/2	1
Airport use	1/2	2	3	2	2	2	2	1	2
Future planning	1/2	2	3	1/2	3	2	1	1/2	1

TABLE IIX
ANALYTIC HIERARCHY PROCESS 2

Criteria's	Revenue	Obstacle	Wind	Availability of land	Soil feature	Economical study	Environs impact	Airport use	Future planning	Criteria weight
Revenue	1.00	4.00	9.00	2.00	4.00	3.00	3.00	2.00	2.00	0.258
Obstacle	0.25	1.00	2.00	0.33	1.00	0.50	0.50	0.50	0.50	0.057
Wind	0.11	0.50	3.00	0.33	0.50	0.50	0.33	0.33	0.33	0.036
Availability of land	0.50	3.00	2.00	1.00	2.00	2.00	1.00	0.50	2.00	0.132
Soil feature	0.25	1.00	2.00	0.50	1.00	0.50	0.50	0.50	0.33	0.057
Economical study	0.33	2.00	2.00	0.50	2.00	1.00	2.00	0.50	0.50	0.093
Environs impact	0.33	2.00	3.00	1.00	2.00	0.50	1.00	0.50	1.00	0.095
Airport use	0.50	2.00	3.00	2.00	2.00	2.00	2.00	1	2.00	0.158
Future planning	0.50	2.00	3.00	0.50	3.00	2.00	1.00	0.50	1.00	0.114
Sum	3.78	17.50	28.00	8.17	17.50	12.00	11.33	6.33	9.67	

TABLE X
ANALYTIC HIERARCHY PROCESS 3

Criteria weight	0.258	0.057	0.036	0.132	0.057	0.093	0.095	0.158	0.114	Weights sum values
Criteria's	Revenue	Obstacle	Wind	Availability of land	Soil feature	Economical study	Environs impact	Airport use	Future planning	
Revenue	1.00	4.00	9.00	2.00	4.00	3.00	3.00	2.00	2.00	2.407
Obstacle	0.25	1.00	2.00	0.33	1.00	0.50	0.50	0.50	0.50	0.524
Wind	0.11	0.50	3.00	0.33	0.50	0.50	0.33	0.33	0.33	0.334
Availability of land	0.50	3.00	2.00	1.00	2.00	2.00	1.00	0.50	2.00	1.240
Soil feature	0.25	1.00	2.00	0.50	1.00	0.50	0.50	0.50	0.33	0.527
Economical study	0.33	2.00	2.00	0.50	2.00	1.00	2.00	0.50	0.50	0.871
Environs impact	0.33	2.00	3.00	1.00	2.00	0.50	1.00	0.50	1.00	0.887
Airport use	0.50	2.00	3.00	2.00	2.00	2.00	2.00	1	2.00	1.490
Future planning	0.50	2.00	3.00	0.50	3.00	2.00	1.00	0.50	1.00	1.061

TABLE XI
ANALYTIC HIERARCHY PROCESS 4

Criteria's	Weights sum values	Criteria weight	CA
Revenue	2.407	0.258	9.316
Obstacle	0.524	0.057	9.257
Wind	0.334	0.036	9.361
Availability of land	1.240	0.132	9.394
Soil feature	0.527	0.057	9.253
Economical study	0.871	0.093	9.328
Environs impact	0.887	0.095	9.297
Airport use	1.490	0.158	9.439
Future planning	1.061	0.114	9.328
λmax			9.330

$\lambda max = 9.330$
$n = 9$

$CI = (\lambda max - n) / (n - 1)$
$CI = (9.330 - 9) / (9 - 1)$
$CI = (0.330) / (8)$
$CI = 0.041$

TABLE XII
RANDOM CONSISTENCY INDEX

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

n = 9
RI = 1.45
CI = 0.4125

CR = CI / RI
CR = 0.04125 / 1.45
CR = 0.0284 = 2.84 %

2.84 ≤ 10 %

TABLE XIII
FINAL WEIGHTS OF CRITERIA

Criteria's	Criteria weight	% Weights
Revenue	0.258	26
Obstacle	0.057	6
Wind	0.036	4
Availability of land	0.132	13
Soil feature	0.057	6
Economical study	0.093	9
Environs impact	0.095	9
Airport use	0.158	16
Future planning	0.114	11
Total	1	100 %

4) The Analytic Hierarchy Process AHP [1] [4] is useful as multi-criteria decision making based on pair wise comparisons. AHP is also useful for selection of best facility location for planning and developing Greenfield Domestic Airport.

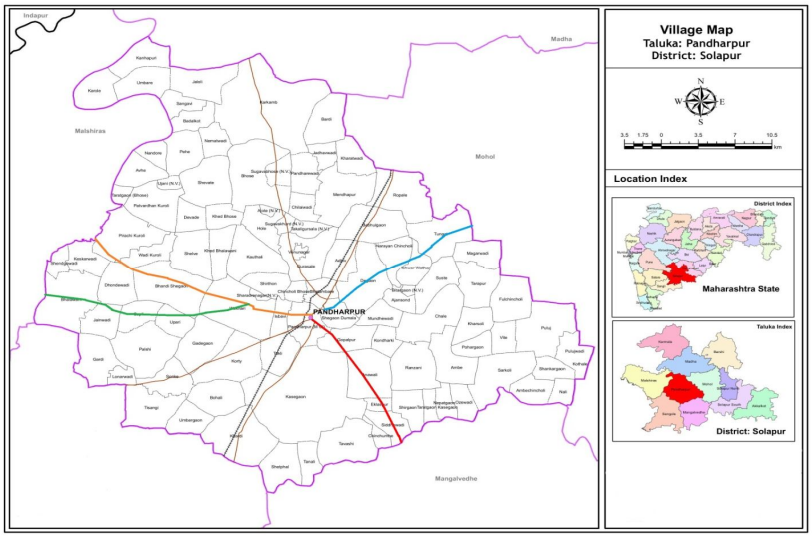

Fig. 3 Alternative road locations

Pandharpur city is well connected by roadways. There are various road networks like state highway, district road, and village road. From this entire road network there are four road networks connect to district headquarters and four road networks connect taluka places.

We are select four major road networks as site selection alternatives.

- 1 Alternative Pandharpur to Solapur -
- 2 Alternative Pandharpur to Sangali -
- 3 Alternative Pandharpur to Satara -
- 4 Alternative Pandharpur to Pune -

A. Pair-wise comparison based on Alternatives

TABLE XIV
Pair-wise comparison based on Revenue

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4
Alternatives 1	1	2	1/4	1/3
Alternatives 2	1/2	1	1/3	3
Alternatives 3	4	3	1	1/2
Alternatives 4	3	1/3	2	1

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4
Alternatives 1	1.00	2.00	0.25	0.33
Alternatives 2	0.50	1.00	0.33	3.00
Alternatives 3	4.00	3.00	1.00	0.50
Alternatives 4	3.00	0.33	2.00	1.00

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XV
Pair-wise comparison based on Obstacles

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XVI
Pair-wise comparison based on Wind

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XVII
Pair-wise comparison based on Availability of land

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XVIII
Pair-wise comparison based on Soil feature

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XIX
Pair-wise comparison based on Economical study

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XX
Pair-wise comparison based on Environs impact

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XXI
Pair-wise comparison based on Airport use

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XXII
Pair-wise comparison based on Future planning

Alternatives	Alternatives1	Alternatives2	Alternatives3	Alternatives 4	average
Alternatives 1	0.12	0.32	0.07	0.07	0.14
Alternatives 2	0.06	0.16	0.09	0.62	0.23
Alternatives 3	0.47	0.47	0.28	0.10	0.33
Alternatives 4	0.35	0.05	0.56	0.21	0.29

TABLE XXIII
AHP FINAL WEIGHTS OF CRITERIA

Criteria's	Revenue	Obstacle	Wind	Availability of land	Soil feature	Economical study	Environs impact	Airport use	Future planning
Weights	0.26	0.06	0.04	0.13	0.06	0.09	0.10	0.16	0.11

TABLE XXIII
PAIR-WISE COMPARISON FINAL SCORE

Criteria's	Revenue	Obstacle	Wind	Availability of land	Soil feature	Economical study	Environs impact	Airport use	Future planning	Final score
Alternatives 1	0.57	0.47	0.35	0.4	0.1	0.3	0.14	0.51	0.39	0.413
Alternatives 2	0.13	0.16	0.09	0.13	0.41	0.24	0.23	0.12	0.14	0.167
Alternatives 3	0.07	0.08	0.39	0.1	0.31	0.22	0.33	0.06	0.08	0.141
Alternatives 4	0.24	0.29	0.16	0.37	0.18	0.24	0.29	0.32	0.39	0.289

For Greenfield Domestic Airport a Pandharpur - Solapur Highway location is best location based on final score

IV. RESULT

The Pandharpur – Solapur State highway is best location for Airport development for Pandharpur city. This highway covers a 72 KM distance from Pandharpur to Solapur. There are many villages located on highway like Bhatumbre, Degaon, Narayan Chincholi, Penur, Tungat and boundary of Mohol - pandharpur Taluka. From all of these villages, Degaon is the nearest place from Pandharpur. It is less than 10 km from pandharpur. Chandrabhaga river is also close to Degaon. We checked the selected location to the selected parameters. And values of all parameters are shown Degaon is best suitable location from all aspects.

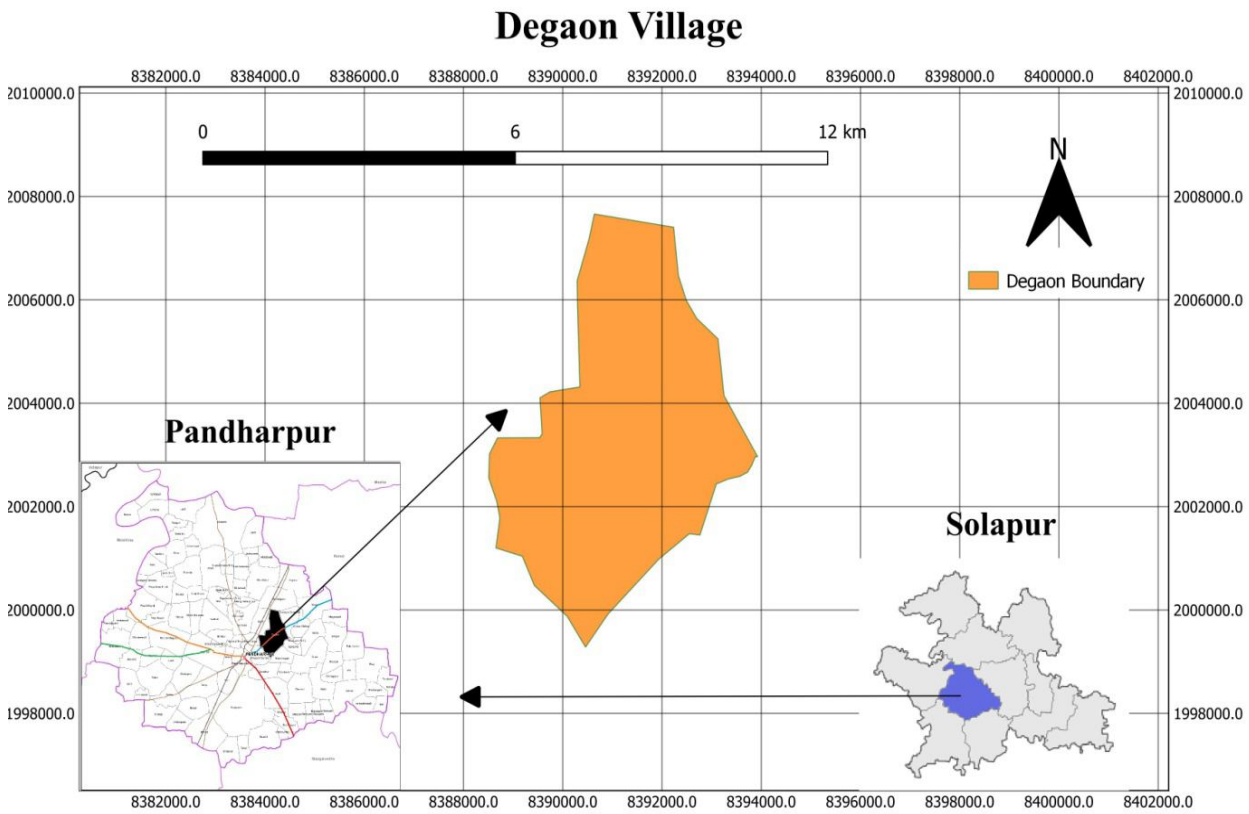

Fig. 4 Selected location (Degaon)

V. CONCLUSION

The information was received from 300 + Public responses from tourists and local residents of pandharpur city. To analyzed to provide a rating for each site selection parameter. The analysis of the study leads us to the end result chapter. This chapter covers a brief summary of the complete study.

Pandharpur is a famous spiritual city of west Maharashtra and a destination for devotees and tourists. Pandharpur is well connected by railway and road network but now airway is also important to connect Pandharpur city with nearby states. Airports are a major part of a country's infrastructure and foster economic activities by Encouraging tourism and generating employment. Planning of an Airport in Pandharpur city will result in greater connectivity and tourist inflow.

Summarized widespread ideas and tips for a comprehensive site analysis framework, and states the contributions of these studies. It also suggests destiny studies may amplify the idea and implementation of the site evaluation framework. This research views site analysis as a process of site selection and the major factors in the planning process also form the essence of site analysis and selection. The aim of the studies is to find the best location for setting up Greenfield Domestic Airport. This research has completed the following tasks:

A. Study of site analysis for site selection on the basis of a comprehensive study of various parameters.
B. Implementation of the parameters through the use of a computer simulation program, using various techniques like a Delphi analysis and Analytical hierarchy process is used.
C. Worked on-site selection process via data collection, and analysis. Interviews and questionnaires survey with different professionals to demonstrate site selection processes and discussion of results generated by the computer analysis.
D. All of the above points consider and choose the best location for the development of Greenfield Domestic Airport. Name of the selected location is Degaon village which is situated on Pandharpur – Solapur Highway and optimum distance from Pandharpur city.

VI. ACKNOWLEDGMENT

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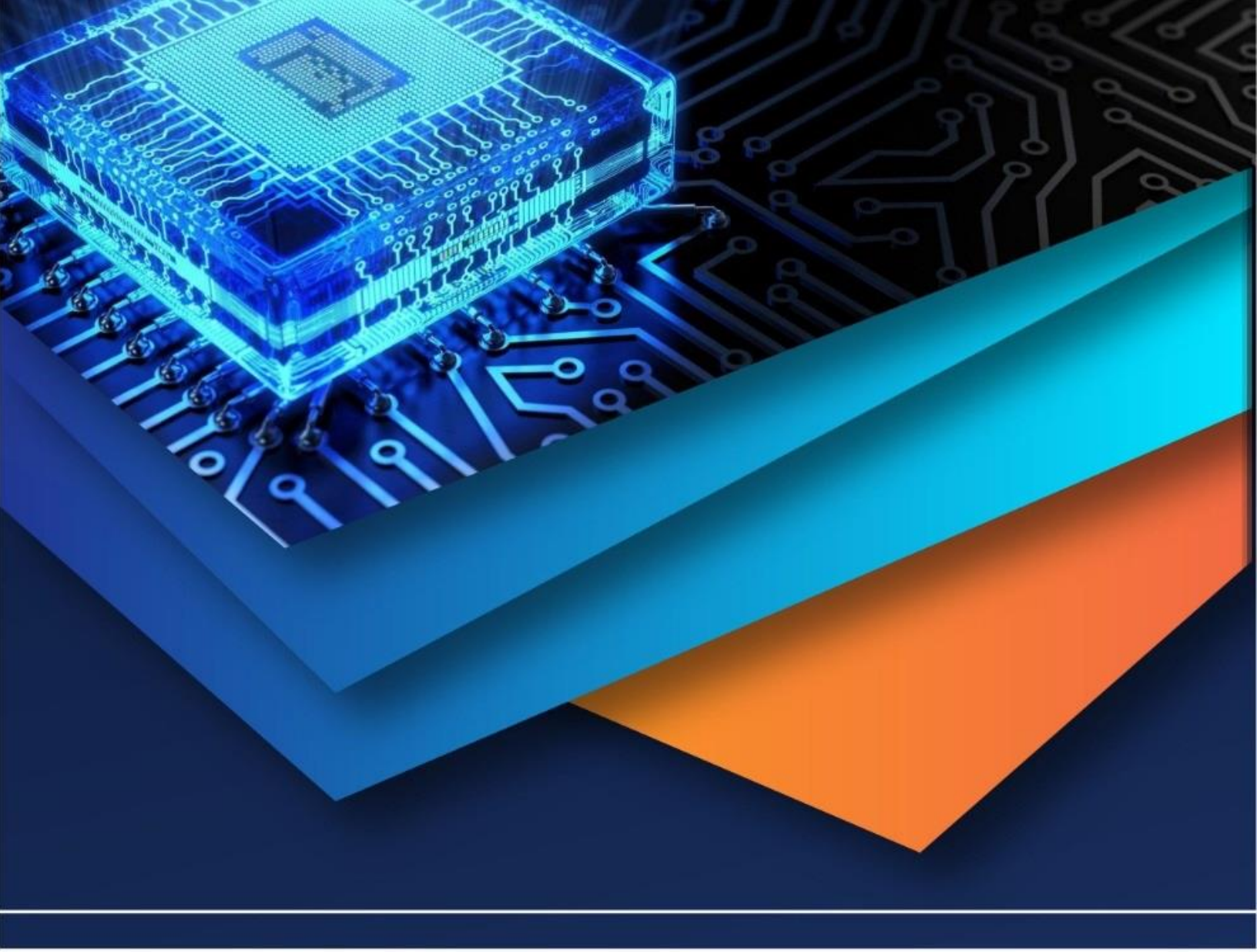

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