Potential Sites for Mobile Aviation Infrastructure using GIS

[1]Amatul Baseer Shazia, [2]Shiwani
[1]Department of Civil Engineering, [2]Department of Civil Engineering
[1]KG Reddy College Engg & Technology, [2] KG Reddy College Engg & Technology

***Abstract*:** The global commercial aviation reports a continuous growth in the number of passengers day by day and the existing airport infrastructure is struggling to meet the increasing requirements to handle passengers. Now, throughout the world capacities of the existing operational airports are being increased and the unused airports closer to big cities or densely populated areas are being brought into operation. By this, the airports are brought into operation but they are still lacking passenger handling facilities. Sometimes capacities of airports have to be increased temporarily due to occurrence of an events, happenings or vulnerabilities. So to meet the said demands; quickly and flexibly the concept of mobile terminals for aviation infrastructure has been developed. The main advantage of these temporary mobile terminals are they can be installed in very less time and their reusability makes them a very attractive solution for addressing many issues; which aviation industry now-a-days is suffering from. The main goal of this thesis is to facilitate the airports, by setting up a spatial criteria catalog to identify the airports that meet the required constraints and to identify those airports which are suitable for installation of mobile terminals which facilitate the bridging of temporary capacity shortages, the quick provision of additional capacity and the activation of new destinations**.**

Key words: Mobile terminals, Aviation infrastructure.

Introduction

Now-a- days, the increasing air traffic is a challenging problem all over the world. The airports capacities are not grown in accordance with the increasing air traffic. To meet the projected requirements the airports need efficient passenger handling facilities. Improper check-in facilities may lead to security problems and a lot of other difficult situations. The airports also need to react to temporal capacity bottlenecks due to an event ,season or due to construction of new terminal.

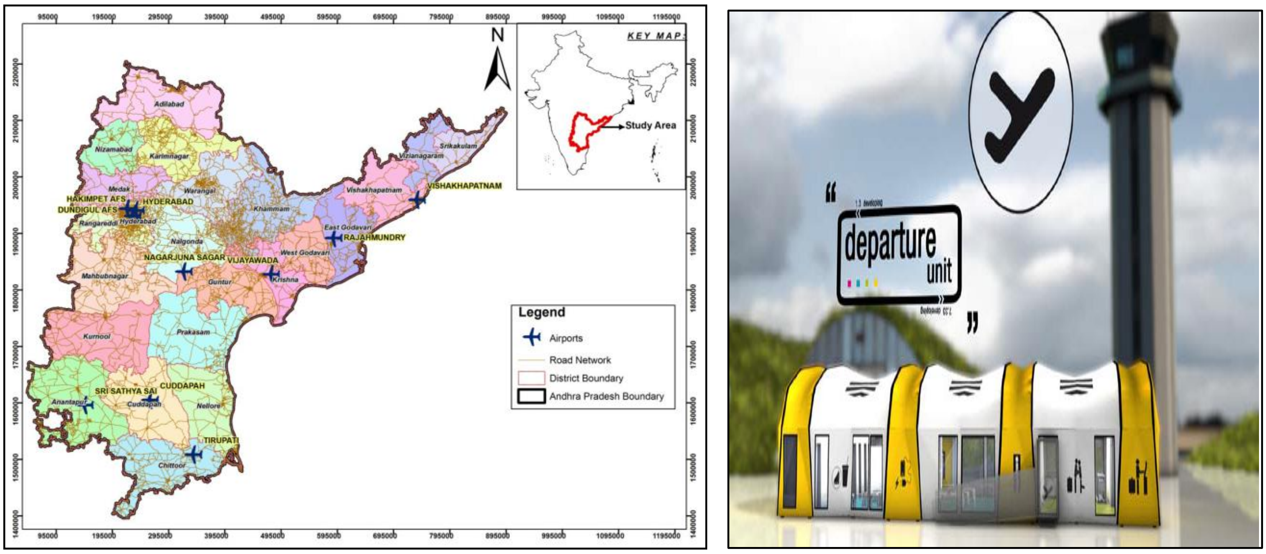


Figure 1: Typical view of mobile airport terminal

The concept of Mobile Terminals opens door for a new research and this research will definitely contribute to the Aviation Industry in the area of identification of potential sites and this is really interesting and exciting opportunity to solve a real time problem with the help of technologies learned i.e., GIS which is a powerful tool for spatial analysis which provides the functionality to capture, store, query, analyze, display and output the geographic information along with the attribute data

The present study describes an attempt to develop a Spatial Decision Support System to boost up the business by identifying the potential airports for the installation of mobile terminals. The implementation of the prototype is done using the Multi Criteria Decision Analysis (MCDM) technique Analytical Hierarchy Process (AHP) on ArcMap platform.

Analytic hierarchy process (AHP) is and continues to be one of the most popular analytical techniques for complex decision making problems and is widely used due to its flexibility and easy to use. The selected factors governing the suitability of the airport are weighted using the Analytical Hierarchy Process (AHP) which is aided by pairwise comparison matrix that uses a scale of relative importance. Once the weights are determined, the score of alternatives is evaluated to get the rank of the alternatives (Sener 2004).

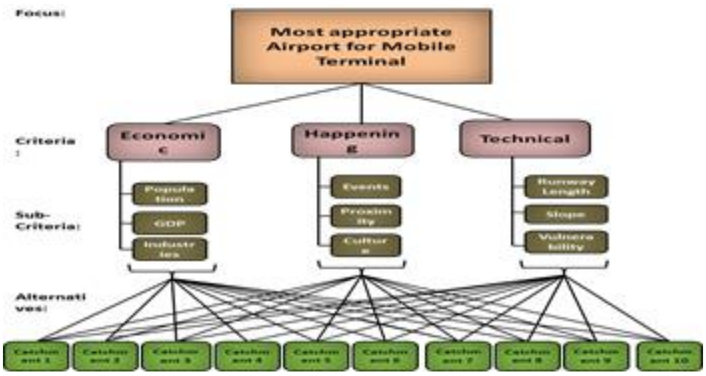
Study Area

Andhra Pradesh is situated in the South-eastern coast of the country. It is fifth largest in terms of covering 274,978 Sq. km and tenth largest in terms of population. It has 23 districts and 10 airports as shown in Figure 2.

Figure 2: Map depicting study area with Airports

The list of airports in	Airport Name	District	Usage
01	Cudappah	Cudappah	Civil
02	Dundigal	Rangareddy	Military
03	Hyderabad	Hyderabad	Civil
04	Nagarjuna Sagar	Guntur	Civil
05	Rajamundry	East Godavari	Civil
06	Sri Sathya Sai	Ananthapur	Civil
07	Vishakapatnam	Vishakapatnam	Civil
08	Vijaywada	Vijaywada	Civil
09	Tirupathi	Chitoor	Civil
10	Hakimpet AFS	Rangareddy	Military

Table 1: List of Airports in Study Area



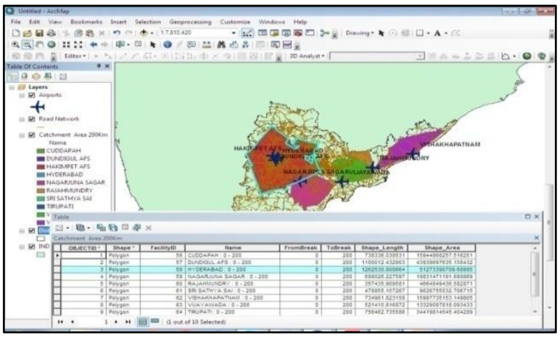


Figure 3: Map depicting stud area with Airports

Catchment Area

Catchment area for airports can be calculated by using the travel time perimeter, this technique is also known as travel time analysis methodology. This uses the Network Analyst extension of GIS software that creates a network map of Andhra Pradesh.Travel time methodology is used to calculated catchment area for 200kms in and around each airport For roads hierarchy speed limit has been given such as Primary roads, secondary roads, local roads time travel were calculated in the following way;

- Primary Roads – 80km/hr
- Secondary Roads – 60 km/hr
- Tertiary Roads – 40 km /hr
- Local roads – 20 km/hr

Polygon depicting catchment Area of 200km for each airpor is shown in Fgure 2.

Setting up of Criterion Catalog

For the basic understanding on what criterion first and foremost selected for an airport is based from the report and the expert's advice.

Table 2: List of criteria's considered for each airport

Level 1	Level II	Level III(Sub level of level II)
Economic	Population	0-10,000
		10,001 -50,000
		50,000 and above
	GDP	Below 1 US$
		1 - 10 US$
		10 US$ and above
	Industries	Large Scale
		Medium Scale
		Small Scale
Happening	Events	1 to 5
		6 to 10
		Above 11
	Culture	Permanent
		Periodical
		Occasional
	Proximity	0-5km
		6 - 10km
		10 km and above
Technical	Runway Length	10-25km
		26 - 60km
		60km and above
	Slope	0-4%
		4 - 8%
		8 - 10%
	Vulnerability	Full Operation
		Significant Interference
		Minor Interference

AHP Implementation

AHP is to be one of the most popular analytical techniques for complex decision making problems and is widely used due to its flexibility and easy to use. An AHP hierarchy can have many levels to characterize a decision condition.

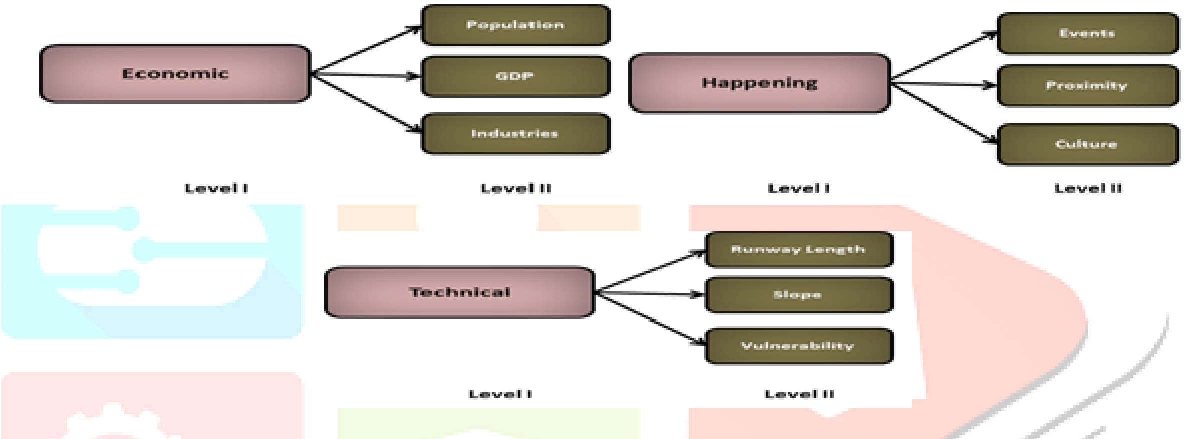
AHP is carried out using the following three principles:

1. Decomposition.
2. Decision Tables
3. Comparisions

Intensity of Importance	Definition
1	Equal Importance
2	Equal to moderate importance
3	Moderate importance
4	Moderate to strong importance
5	Strong importance
6	Strong to very strong importance
7	Very strong importance
8	Very to extremely strong importance
9	Extreme importance

Once the catchment areas are ready for each airport, and then the decision hierarchy is prepared based on the suitable criteria's for each airport. Here we are using four Level decision hierarchies which are interlinked to each level.

Decomposition



Pairwise Comparison

Once the hierarchy is constructed, elements at each level are compared to each other in pairs with respect to their parents at the next higher level. The judgements are made based on user's intuition, experience and knowledge and translated into numerical values on a scale of 1 to 9 according to the intensity of contribution to the objective. The smaller one in a pair is chosen as a unit and a larger one is estimated as a multiple of that unit and assigned a number based on the perceived intensity of importance. Similarly, the reciprocals of these numbers are used to show how many times one is lesser than the other. **Table 3: Scale of pairwise Comparision**

Analytic hierarchy process (AHP) is and continues to be one of the most popular analytical techniques for complex decision making problems and is widely used due to its flexibility and easy to use. An AHP hierarchy can have many levels to characterize a decision condition. The selected factors governing the suitability of the site are weighted using the AHP which is aided by pair wise comparison matrix that uses a scale of relative importance. Once the weights are determined, the score of alternatives is evaluated to get the rank of the alternatives (Sener 2004).

To calculate the pairwise comparison we used the values for each catchment's area as shown int he Table 4.

Catchment Area	Population	GDP	Industries	Events	Culture	Proximity	Slope	Runway Length	Vulnerability
Catchment 1	1,718,688	9,501	4,371	20	20	8	134	16.911	Average
Catchment 2	207,225	2,700	1,000	15	6	3	620	22.18	Low
Catchment 3	1,567,942	15,422	47,610	45	40	15	530	57.039	Average
Catchment 4	1,281,439	8,076	22,185	10	20	6	192	13.293	Low
Catchment 5	487,132	3,592	2,743	22	60	10	46	16.221	high
Catchment 6	1,632,459	7,657	7,000	30	28	11	478	20.675	Average

Catchment Area	Population	GDP	Industries	Events	Culture	Proximity	Slope	Runway Length	Vulnerability
Catchment 7	1,177,650	7,949	6,667	35	42	10	5	47.36	high
Catchment 8	897,269	6,390	4,210	30	47	11	23	23.108	high
Catchment 9	1,838,392	8,940	6,900	32	51	9	103	21.596	Average
Catchment 10	10,000	2,500	2,000	10	3	3	612	42.192	Average

Source: Google Earth imagery and published socio – economic data

Table 4: Values **for each Catchment Area**

Level 1			
	Economic	Happening	Technical
Economic	1	0.333333	0.2
Happening	3	1	0.333333
Technical	5	3	1

Consistency Index - 0.0193

Random Index - 0.58

Consistency Ratio - 0.0372

Synthesis of weights

By applying AHP and GIS in various layers and categorized according Relative Importance Weightage (RIW).Final weights are obtained by summarizing all the individual weight's and evaluated. As RIW includes its importance from the Level I to the Level IV the final cumulative values will give more accurate results. According to the weightages allotted the catchments areas are categorized into four classes Low,Marginal, Moderate and Highsuitable

Relative Importance Weightage(RIW)									
Ranks based on Population for each Airport	Ranks based on GDP for each Airport	Ranks based on Industries for each Airport	Ranks based on Events for each Airport	Ranks based on Culture for each Airport	Ranks based on Proximity for each Airport	Ranks based on Slope for each Airport	Ranks based on Runway Length for each Airport	Ranks based on Vulnerability for each Airport	Final Ranks
0.388442497	0.32637942	0.128297306	0.161384103	0.115173708	0.150095092	0.3693631	0.067472723	0.297339455	2.0039474
0.08001115	0.05363615	0.049298238	0.080842049	0.050931912	0.06488665	0.7071137	0.161949788	0.68683373	1.9355034
0.312978576	0.72712821	0.787186397	0.945503402	0.356307349	0.543217039	0.774719	0.924948188	0.387293696	5.7592819
0.206586858	0.19147529	0.358348755	0.051613308	0.111601873	0.108052265	0.2938988	0.093999453	0.484575079	1.9001516
0.101284006	0.0709888	0.052218595	0.207148224	0.93747475	0.25733302	0.1974096	0.083583198	0.173650102	2.0810903
0.318659129	0.18902514	0.168209424	0.307161151	0.117753113	0.359681478	0.7278973	0.136016944	0.259301662	2.5837054
0.563625506	0.36689183	0.248418421	0.416820989	0.384005812	0.214531605	0.1721453	0.627911079	0.119693203	3.1140438
0.229585105	0.20227619	0.154730209	0.339144699	0.363740098	0.34531	0.1819703	0.180178235	0.11519549	2.1121304
0.62444666	0.24500237	0.23102914	0.44080865	0.415890535	0.281243842	0.22462	0.230145625	0.321113076	3.0142999
0.055487141	0.0520935	0.058310784	0.072018729	0.05187318	0.118800342	0.6738599	0.410346265	0.483311427	1.9761012

Table 5: Pair Wise Comparison Matrix for Level I to Level IV

Conclusion

By using AHP a mathematical technique for multiple criteria decision making that gives a numerical score to each decision alternative based on how well each alternative satisfies the criteria provided by the decision maker.

The context-aware concept is based on the knowledge of each airport will help to take intelligent and better decisions for the installation of mobile terminal. This technique helps in

- Airports database can be created which in turn helps to Open currently un-operational airports
- Expanding the existing airports faster until permanent structures are built.
- Usage of alternative airports during the time of natural hazards such as floods, earthquakes etc or during the international events such as sports, cultural etc
- Providing interim solution at airports where construction works are going on
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