ASSESMENT OF CRITICAL SUCCESS FACTORS FOR SMART CITIES USING SIGNIFICANCE INDEX METHOD

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ABSTRACT

Smart development emphasis on a holistic development with combination of all key dimensions of urbanization focusing on Economy, infrastructure, Environment, Governance, Quality of Life and People. India has spread out its mission for upon Smart Cities along with other key initiatives in each of these dimensions. The concept can be full filled with the smart people who form a core stakeholder committee which include Policy makers, urban planning professionals, academicians, architects, project managers and researchers working hard to making of smart cities. This needs to have an understanding of factors affecting the development and design of the Smart cities. Smart Cities focus on their most pressing needs and on the greatest opportunities to improve lives. The India Smart Cities Challenge is designed to inspire greater creativity from municipal officials and their partners, more involvement and inspiration from citizens, and the development of proposals that will produce concrete benefits in people's lives. This paper focusses on the smart cities design factors which are critical for the success of the smart design. The work carried out in this research is based on the questionnaire survey where in the perceptions of different stakeholders including the architects, urban planners and project managers are included. The data obtained is analyzed through Significance Index Method.

Keyword: - *Smart Cities, Critical Success Factors, Significance Index*

1. INTRODUCTION

Urbanization is an index of transformation from traditional rural economies to modern industrial one. It is a long term process through which the ratio of population between rural and urban gets changed in favor of urban settlement. Quite often the Indian urbanization has been considered as over urbanization due to its rapid growth of urban population especially in large cities. It has been observed that high rate of population growth in urban areas particularly in large cities is the result of high natural growth and poverty driven rural to urban migration in short and long run.

Cities are engines of growth for the economy of every nation, including India. Nearly 31% of India's current population lives in urban areas and contributes 63% of India's Gross Domestic Product (GDP). With increasing urbanization, urban areas are expected to house 40% of India's population and contribute 75% of India's GDP by 2030. This requires comprehensive development of physical, institutional, social and economic infrastructure. All are important in improving the quality of life and attracting people and investments to the City, setting in motion a virtuous cycle of growth and development. Development of Smart Cities is a step in that

direction. The urban initiatives in India have first time fallen in line with global development paradigms. Irrespective of Indian priorities being different, there is need to understand these development paradigms. In this context the Smart city concept needs to be looked from different perspectives such as Government and Institutions, City Councils, Market agencies and last but not least the Citizens. These perspectives will lead towards the final outcomes and aspirations as well as provide a tool to develop city vision.

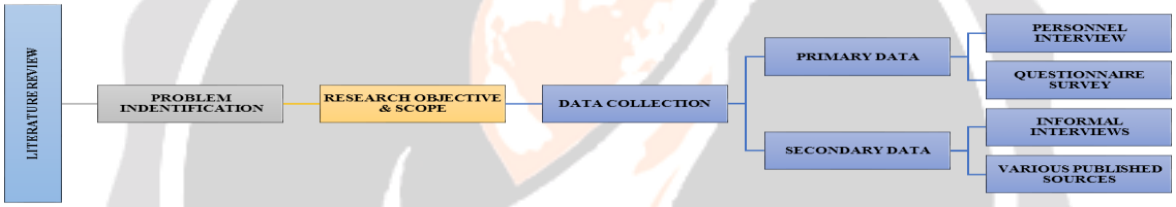
This research work deals with the perception analysis of the data collected through the questionnaire survey where in different factors identified are framed. The survey method adopted is questionnaire survey and the data is analyzed through significance index method. The paper involves ranking of the critical success factors for smart city development.

2. OBJECTIVES OF THE STUDY

1. To study Smart City concept and identify critical success factors for smart design.
2. To identify the most affecting parameters from the stakeholder's survey which influence the designing of Smart City by significance index.

3. RESEARCH METHODOLOGY

Moving on towards the details of research methodology and techniques it is important to have a glance on the research process. Research process is series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps. Figure 1 well illustrates a research process adopted in this research work.



2.1 Problem Identification

This study aims at providing glance to the drivers to the smart city development. The necessity of identification of the factors affecting smart city design is highlighted due fast growing Indian economy. This research explains which factors are responsible for the upliftment of smart cities along with Indian characteristics. In this stage 66 factors were identified and grouped in 9 groups.

2.2 Data Collection

The data collection stage is one of the crucial stage of the research process which provides an input to the data analysis stage. Primary data includes information collected from sources such as personal interviews, questionnaires surveys which is concerned with a specific intention and on a specific subject and observation and discussion by the researcher him or herself and can be self-assessed further. It is a direct approach. Secondary data includes information already available somewhere, whether it be in journals or on the internet, publications or records. Secondary data allows for comparison. In this research data was collected in three cities among three stakeholders.

2.3 Questionnaire Survey Approach

The questionnaire designed on the bases of the literature review was distributed among various stakeholders in the three cities of Gujarat i.e. Ahemedabad, Surat and Vadodara. The perceptions of experts from the field of smart cities were collected and the perspectives were analyzed. The results of the data analysis from this perceptions are considered to be accurate due to expert advice and perceptions.

2. STAKEHOLDERS DETAIL

To obtain statistically representative sample size of the population, following equation used:

$$n= m/ (1+ [(m-1)/N])$$

Where, n, m and N represents the sample size of limited, unlimited and available population respectively. Here, m is calculated by following equation.

$$m= (z^2*p*(1-p))/e^2$$

Where,

z = the statistic value for the confidence level used, i.e. 1.96 and 1.645 for 95% and 90% confidence level respectively;

p = the value of the population that estimated and

e = the sampling error to estimated.

Because the value of p is unknown.

According to the targeted City and Stakeholders, the total no. of available population comprises of (1218) urban planner and architects which belongs to Institute of Town Planner, India (ITPI) and Indian Institute of Architects (IIA) respectively for targeted cities. Thus,

$$m= ([1.645])^2*0.5*(1-0.5))/([0.1])^2$$

$$m = 67.65$$

Here, the confidence level is taken as 90%.

Now,

$$n= 67.65/ (1+ [(67.65-1)/1218])$$

$$n = 64.1402$$

$$n =65$$

Thus, contact with minimum 65 respondents must be made for this study. To overcome the risk of not responding from the respondents and to reflect higher reliability and benefits for the study, the sample of 81 responses are received.

120 questionnaire forms were distributed through personal meetings and mails. The response received are the 81, which is 67.5% response rate which is considered good for such type of survey works. The 81 respondents consist of 33 town planners, 21 architects and 27 project managers. The repetition of the respondents as different stakeholders is shown in table 1.

Table: 1 number of respondents from different cities

Category of respondents	No. of Respondents				Total	Percentage (%)
	City					
	Ahmedabad	Surat	Vadodara	Delhi		
Town Planner	13	11	6	3	33	40.74
Project Manager	12	8	7	-	27	33.33
Architect	8	7	6	-	21	25.93
Total	33	26	19	3	81	100
Percentage (%)	40.74	32.10	23.46	3.70	100	

3. RANKING OF THE RISK FACTORS BY CRITICALITY INDEX METHOD

Zhang [2005] used this Significance Index [S.I.] method to analyze the relative significance of the Critical Success factors and Success Sub factors. The following simple formula is developed to convert linearly the 1–5 scale used in the questionnaire survey to a 20–100 scale with 20 representing the lowest and 100 the highest significance. This means that "5," "4," "3," "2," and "1" have significance indexes of 100, 80, 60, 40 and 20 respectively.

$$Significance\ Index\ Si = \frac{[20R_{i1} + 40R_{i2} + 60R_{i3} + 80R_{i4} + 100R_{i5}]}{R_{i1} + R_{i2} + R_{i3} + R_{i4} + R_{i5}}$$

Where,

Si = significance index for the ith factor;

Ri1 = number of responses as "1" for the ith factor;

Ri2 = number of responses as "2" for the ith factor;

Ri3 = number of responses as "3" for the ith factor;
Ri4 = number of responses as "4" for the ith factor;
Ri5 = number of responses as "5" for the ith factor.

The factors were analyzed as per the significance index method. Each category of the factors were analysis individually and ranked internally so as to give importance to each main factor. The results of the ranking through SI for environmental factors are shown in table 2. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 2.

Table 2: Environmental Factors Ranking Based on Significance

Environmental factors		Town planner		Project manager		Architect		Combined	
		SI	Rank	SI	Rank	SI	Rank	SI	Rank
1	Availability of Natural resources	74.55	6	69.63	5	71.43	7	72.10	6
2	Greenhouse gas emission	68.48	7	64.44	8	79.05	5	69.88	7
3	Consumption of energy from renewable sources	80.00	3	68.15	6	80.95	4	76.30	4
4	Quality of resources	76.97	5	76.30	1	67.62	8	74.32	5
5	Environmental protection	77.58	4	71.85	4	82.86	3	77.04	3
6	Sustainable resource management	81.21	2	76.30	1	83.81	2	80.25	2
7	Biodiversity	65.45	8	67.41	7	78.10	6	69.38	8
8	Recycling of used resources	84.24	1	74.07	3	90.48	1	82.47	1

The results of the ranking through SI for economic factors are shown in table 3. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 3.

Table 3: Economical Factors Ranking Based on Significance

Economic factors		Town planner		Project manager		Architect		Combined	
		SI	Rank	SI	Rank	SI	Rank	SI	Rank
9	GDP growth per capita	73.33	3	60.74	8	63.81	6	66.67	6
10	Global partnership	67.88	6	59.26	9	52.38	8	60.99	8
11	Cost of the project	66.06	7	74.07	4	69.52	2	69.63	3
12	Entrepreneurship	68.48	5	68.89	5	65.71	5	67.90	5
13	Stakeholder participation	89.09	1	77.04	2	77.14	1	81.98	1
14	Profitability	61.21	8	77.04	2	59.05	7	65.93	7
15	Domestic investment	69.70	4	67.41	6	67.62	3	68.40	4
16	Foreign direct investment (FDI)	60.61	9	65.19	7	48.57	9	59.01	9
17	Land acquisition	74.55	2	82.96	1	66.67	4	75.31	2

The results of the ranking through SI for physical factors are shown in table 4. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 4.

Table 4: Physical Factors Ranking Based on Significance

Physical factors		Town planner		Project manager		Architect		Combined	
		SI	Rank	SI	Rank	SI	Rank	SI	Rank
18	Water supply	89.09	4	86.67	2	89.52	1	88.40	1
19	Sanitation	90.30	3	84.44	3	85.71	4	87.16	2
20	Storm water management	87.27	7	77.78	7	83.81	6	83.21	8
21	Urban development	91.52	1	76.30	9	79.05	8	83.21	8
22	Solid waste management	89.09	4	82.96	5	86.67	2	86.42	3
23	Infrastructural facilities	91.52	1	77.04	8	83.81	6	84.69	6
24	Educational facilities	87.27	7	80.00	6	86.67	2	84.69	6
25	Heritage maintenance	72.73	10	71.11	10	67.62	10	70.12	10
26	Power supply	89.09	4	87.41	1	79.05	8	85.93	4
27	Affordable housing	85.45	9	84.44	3	85.71	4	85.19	5

The results of the ranking through SI for social factors are shown in table 5. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 5.

Table 5: Social Factors Ranking Based on Significance

Social factors		Town planner		Project manager		Architect		Combined	
		Si	Rank	Si	Rank	Si	Rank	Si	Rank
28	Poverty	70.30	4	74.07	5	71.43	5	71.85	6
29	Demographic changes	67.27	9	62.96	9	67.62	8	65.93	9
30	Recreational & cultural facilities	71.52	7	65.93	8	69.52	7	69.14	8
31	Immigration friendly environment	62.42	10	61.48	11	58.10	10	60.99	10
32	Healthcare facilities	83.64	2	79.26	2	77.14	4	80.49	2
33	Smart people	81.21	3	74.07	5	70.48	6	76.05	5
34	Safety & security	86.06	1	80.74	1	80.95	1	82.96	1
35	Employment rate	76.36	5	76.30	3	78.10	2	76.79	4
36	Literacy rate	80.61	4	75.56	4	78.10	2	78.27	3
37	Tourist attractivity	61.21	11	62.22	10	57.14	11	60.49	11
38	Social cohesion	73.33	6	67.41	7	67.62	8	69.88	7

The results of the ranking through SI for mobility factors are shown in table 6. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 6.

Table 6: Mobility Factors Ranking Based on Significance

Mobility factors		**Town planner**		**Project manager**		**Architect**		**Combined**	
		SI	**Rank**	**SI**	**Rank**	**SI**	**Rank**	**SI**	**Rank**
39	Intelligent transport system	85.45	4	81.48	5	80.95	5	82.96	4
40	Modification in public transport	83.03	6	82.22	3	84.76	3	83.21	3
41	Quality of public transport system	89.70	1	82.22	3	86.67	2	86.42	1
42	Public transport vehicles management & passenger info	84.24	5	76.30	6	87.62	1	82.47	5
43	Pedestrian walkways & cycle paths	89.70	1	83.70	1	83.81	4	86.17	2
44	Parking facilities	86.67	3	83.70	1	73.33	6	82.22	6

The results of the innovation and learning through SI for environmental factors are shown in table 7. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 7.

Table 7: Innovation & Learning Factors Ranking Based on Significance

Innovation & learning factors		Town planner		Project manager		Architect		Combined	
		SI	Rank	SI	Rank	SI	Rank	SI	Rank
45	Research & development	85.45	1	80.00	2	80.95	2	82.47	1
46	Innovative spirit	80.00	3	76.30	4	81.90	1	79.26	3
47	Open mindedness	80.61	2	81.48	1	80.00	3	80.74	2
48	Ability to develop content & application	76.97	4	78.52	3	79.05	4	78.02	4

The results of the ranking through SI for Political factors are shown in table 8. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 8.

Table 8: Political Factors Ranking Based on Significance

Political factors		Town planner		Project manager		Architect		Combined	
		SI	Rank	SI	Rank	SI	Rank	SI	Rank
49	Transparent governance	84.24	2	82.96	1	83.81	1	83.70	2
50	Public and social service	83.03	3	82.96	1	75.24	4	80.99	3
51	Political interference of inhabitants	73.33	5	73.33	6	66.67	6	71.60	6
52	Political strategies & perspective	79.39	4	75.56	5	74.29	5	76.79	4
53	E-governance	90.91	1	82.96	1	82.86	2	86.17	1
54	Change in housing bylaws, codes etc.	72.73	6	77.04	4	80.00	3	76.05	5

The results of the ranking through SI for operational and managerial factors are shown in table 9. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 9.

Table 9: Operational & Managerial Factors Ranking Based on Significance

Operational & managerial Factors		Town planner		Project manager		Architect		Combined	
		Si	Rank	Si	Rank	Si	Rank	Si	Rank
55	Speed of work	79.39	3	73.33	6	78.10	2	77.04	4
56	Service condition & quality	76.97	5	76.30	3	80.00	1	77.53	3
57	Flexibility in labour market	66.06	8	70.37	8	63.81	8	66.91	8
58	Availability of workforce	69.09	7	73.33	6	71.43	6	71.11	7
59	Productivity	70.91	6	74.81	4	72.38	5	72.59	6
60	Disaster management	86.06	1	81.48	1	76.19	3	81.98	1
61	Building information modeling	79.39	3	74.07	5	71.43	6	75.56	5
62	Advance construction management	81.21	2	77.04	2	74.29	4	78.02	2

The results of the ranking through SI for Information Communication and Technological factors are shown in table 10. The ranking of the factors each for the three stakeholders i.e. town planner, project manager, architect are shown in table 10.

Table 10: Information Communication and Technological Factors Ranking Based On Significance

Innovation & learning factors		Town planner		Project manager		Architect		Combined	
		Si	Rank	Si	Rank	Si	Rank	Si	Rank
63	City wide it infrastructure	86.67	2	79.26	2	67.62	2	79.26	3
64	Internet accessibility	86.67	2	80.74	1	67.62	2	79.75	2
65	Location based service & spatial planning	90.30	1	77.78	3	72.38	1	81.48	1
66	Sensor systems & detectivity	76.97	4	77.04	4	60.00	4	72.59	4

The results in table 11 shows the combined ranking of each factor. The ranking of the factors by perceptions each for the three stakeholders i.e. town planner, project manager, architect are shown in table 11.

Table 11: Ranking by SI Mean of Main Groups

Factors affecting developing of smart city	Town planner SI mean	Rank	Project managers SI mean	Rank	Architects SI mean	Rank	Combined SI mean	Rank
Environmental factors	76.06	7	71.02	7	79.29	4	75.22	6
Economical	70.10	9	70.29	9	63.39	9	68.42	9
Physical	87.33	1	80.81	2	82.76	2	83.90	2
Social	73.99	8	70.91	8	70.56	7	72.08	8
Mobility	86.46	2	81.60	1	82.86	1	83.91	1
Innovation & learning	80.76	4	79.07	4	80.48	3	80.12	3
Political	80.61	5	79.14	3	77.14	5	79.22	4
Operational & managerial	76.14	6	75.09	6	73.45	6	75.09	7
Information communication & technological	85.15	3	78.70	5	66.90	8	78.27	5

From the above it can be seen that as per the perceptions of the town planners the physical factors are important for smart city design. Likewise for project manager and architects mobility factor plays important role. Also the combined ranking shows that the mobility factor is foremost factor for smart city design. The factors as per significance index can be arranged in decreasing order as mobility, physical factors, innovation and learning, political factors, information communication and technological factors, environmental factors, operational and managerial factors, social factors and economical factors.

4. CONCLUSIONS

As per the perceptions of the town planners the physical factors are important for smart city design. Likewise for project manager and architects mobility factor plays important role. Also the combined ranking shows that the mobility factor is foremost factor for smart city design. The factors as per significance index can be arranged in decreasing order as mobility, physical factors, innovation and learning, political factors, information communication and technological factors, environmental factors, operational and managerial factors, social factors and economic factors. The mobility factors as considered to be of the foremost importance contains sub factors and among them Pedestrian walkways & cycle paths and parking facilities are ranked as most important. Smart city design is a vision and every factor ranking should be given importance in the design of a smart city. So we can say that we shape the cities and cities shape us.

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