EVALUATING THE PRIORITY INDEX FOR THE INFRASTRUCTURAL PLANNING OF SMART CITY- A CASE STUDY OF VADODARA

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Abstract

The Infrastructure sector contributes about 5% of GDP to the Indian economy and is highly responsible for the development of the country. As per the planning commission infrastructure investments are estimated to touch 8% GDP. Almost 37% of the investment in infrastructure came from the private sector. As per the census 2011, India's current population is 130 crore and 31% of the population is residing in urban areas. India stands at 58th rank out of 80 countries in the Quality of life Index 2020, which is based on various indicators like literacy rate, life expectancy rate, etc. To achieve a better quality of life and livelihood, more people are migrating from rural areas to urban areas, which is leading to urbanization. For accommodating this huge population in the cities, the government of India has initiated the Smart City Program. Under this program, 100 cities in India have been selected. A total of 6 cities of Gujarat is nominated for the same, amongst which Vadodara is one of them. This study comprises evaluating the best indicator suitable for the development of smart city- Vadodara and also providing the suitable recommendations for that indicator.

Keywords: Indicators, Infrastructure, Smart city, Urbanization, Vadodara

I. Introduction

Cities are prospering due to an increase in infrastructural facilities. Infrastructure sector is highly responsible for driving India's overall development. According to the planning commission, infrastructure investments are about to touch 8% GDP and about 37% of the investment in infrastructure comes from the private sector. India jumped 19 places to rank 35th among 160 countries in the World Bank's Logistics Performance Index (LPI) 2016 (source: lpi.worldbank.org). India's current population as per census 2011 is 130 crores, out of which 31% of India's population lives in urban areas and contributes 63% of India's GDP **Ошибка! Источник ссылки не найден.**. Urban areas are expected to house 40% of India's population and contributes 75% of India's GDP by 2030. In India, nearly 45.36 crore people are migrants which is around 37.8% of the total population of India. The main explanation for migration is urbanization.

The Urbanization rate is increasing in India. In 1901, only 11.4% of people were living in urban areas whereas it has increased to 31.6% in 2011. It is expected that by 2030, 40.76% population will be living in urban areas. The Issue of Sustainable urbanization can only be achieved by controlling the migration of people. For solving the problem of urbanization, the government of India has initiated

the smart city mission. This mission will help in improving the quality of life of the people in cities. As per the study of Quality of life index, India stands at 58th rank among 80 countries. This study includes various parameters that are related to the daily life of the people living in cities i.e health and well-being, happiness, travel, digital life, safety and security, etc. From Gujarat, total of 6 cities were selected under the project of smart city development **Ошибка! Источник ссылки не найден.**. Vadodara is one of the leading cities in terms of growth and infrastructural development, so it has been selected for this study.

II. Objectives of Study

- To evaluate and prioritize the smart city indicators, which have been identified by the existing infrastructural facility of the Vadodara city.
- To provide the appropriate technology and recommendations for the most inspiring indicators for the city

III. Data Collection

From various literature reviews, we have found out that a Smart city has many dimensions [1]. These dimensions were shortlisted from the review and also from the reccommedations of local experts which will create an impact on the smart city development of the Vadodara city. These are- Economic factor, Environmental factor, Innovation and Learning factor, Information Communication & Technological Factors, Mobility Factors, Operational & Managerial Factors, Physical Factors, Political Factors, and Social factors. For all these given dimensions, we have found out 66 sub-factors which was used for the survey work of the smart city. In this research work, we had evaluated the priority index for the infrastructural planning of the smart city.

The method adopted for data collection is a primary survey. A total of 125 survey forms were distributed via emails and social networking sites. Overall 80 responses were recorded and data are collected from it. This survey is conducted at a professional level. So, all respondents are experts in their respective fields.
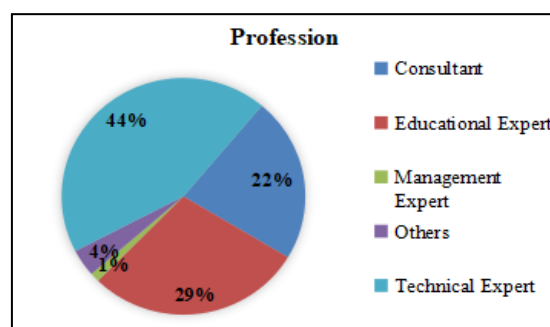

Figure 1: *Profession*

Figure 1, shows the percentage of responses given by the experts till now. 44% of the responses were given by technical experts, 29% were from educational experts and around 22% of responses were provided by consultants.

The response collected are divided into 5 major categories-

- Not Significant
- Fairly Significant

- Significant
- Very Significant
- Extremely Significant
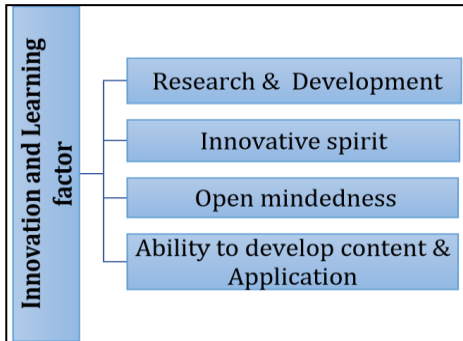
Indicators with their sub-factors are listed below-

Figure 2: *Sub-factors of Innovation & Learning*
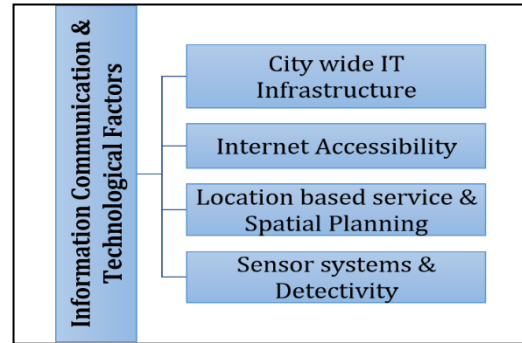
Figure 3: *Sub-factors of Information Communication & Technological*
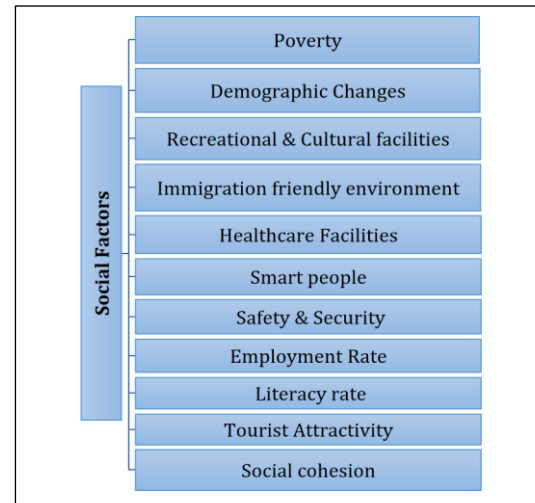
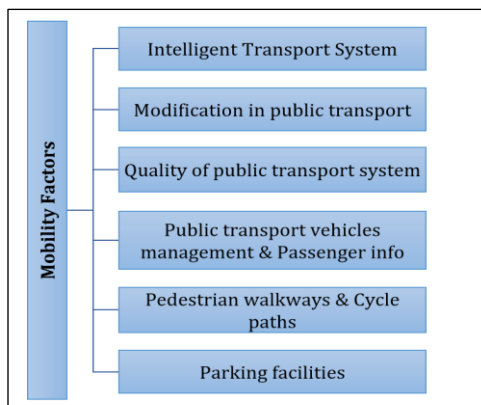**Figure 4:** *Sub-factors of Physical*

Figure 5: *Sub-factors of Social*

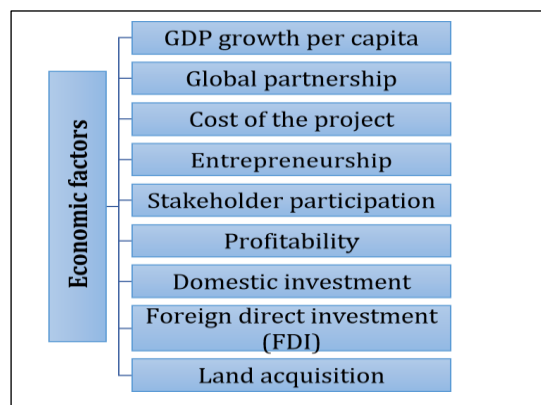**Figure 6:** *Sub-factors of Mobility*

Figure 7: *Sub-factors of Economic*
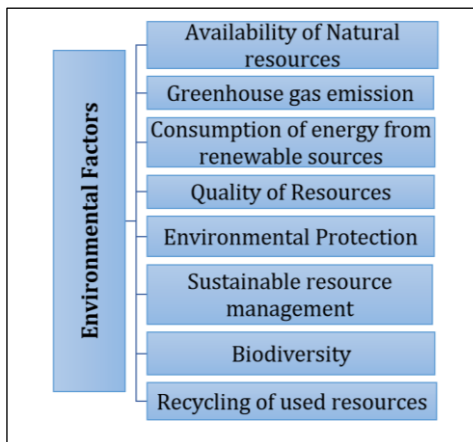
Figure 8: *Sub-factors of Environmental*
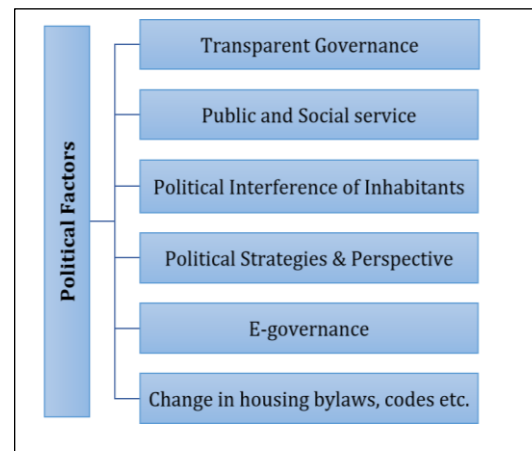
Figure 9: *Sub-factors of Political*
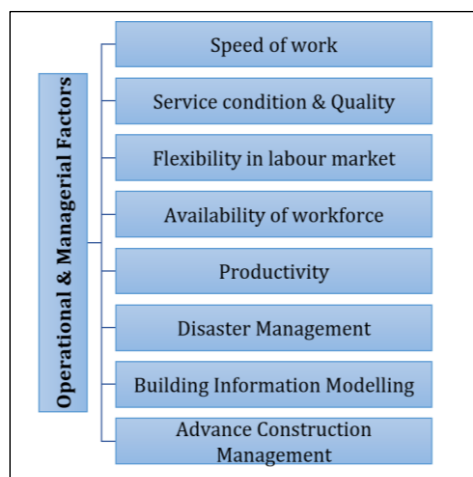
Figure 10: *Sub-factors of Operational & Managerial*

IV. Data Analysis

The primary data collected from the questionnaire survey were analyzed using the Relative Importance Index method for the ranking of these factors from the perspective of technical experts, educational experts, management experts, etc.

Relative Importance Index or weight is a type of relative importance analysis. RII method is used for providing the priority index to the factors of a smart city. RII was used for the analysis because it best fits the purpose of this study.

RII = Sum of weights (W1 + W2 + W3 + ……+ Wn) / A x N

where,

W = weights given to each factor by the respondents and will ranges from 1 to 5 where '1' is less significant and '5' is extremely significant

A = highest weight (i.e. 5 in this case)

N = total number of respondents.

I. Data Analysis for Indicators

Table 1: *RII for Smart City Indicators*

Sr.	Indicators	RII
1	Political Factor	0.62
2	Economic Factor	0.71
3	Operational & Managerial Factor	0.74
4	Social Factor	0.77
5	Innovation & Learning Factor	0.81
6	Physical Factor	0.83
7	Mobility Factor	0.88
8	Information Communication & Technological Factor	0.89
9	Environmental Factor	0.92

The table 1 shows the RII for the smart city indicators. It represents the overall ranking given to the indicators. Most priority is given to Environmental factors, followed by Information Communication and Technological factor.

II. Data Analysis for Sub-factor

Table 2: *RII for Economical Factors*

Sr.	Sub-Factors	RII
1	GDP growth per capita	0.63
2	Global partnership	0.64
3	Cost of the project	0.70
4	Entrepreneurship	0.56
5	Stakeholder participation	0.73
6	Profitability	0.66
7	Domestic investment	0.65
8	Foreign direct investment (FDI)	0.71
9	Land acquisition	0.89

Table 2 shows the RII for the economical factors. It has been divided into 9 sub-factors. Amongst them, land acquisition is given the most priority for the formation of a smart city followed by the participation of stakeholders.

Table 3: *RII for Environmental Factors*

Sr.	Sub-Factors	RII
1	Biodiversity	0.70
2	Green house gas emission	0.75
3	Availability of natural resources	0.79
4	Quality of resources	0.86
5	Consumption of energy from natural resources	0.90
6	Sustainable resource management	0.91
7	Recycling of used resources	0.93
8	Environmental Protection	0.95

Table 3 shows the RII for environmental factors. It consists of 8 sub-factors. Environmental Protection factor seems to be the most significant factor among all. In the same way the second most important factor is the recycling of used resources chosen by the stakeholders.

Table 4: *RII for Innovation & Learning Factors*

Sr.	Sub-Factors	RII
1	Ability to develop content and application	0.71
2	Open mindedness	0.73
3	Innovative spirit	0.78
4	Research and Development	0.86

Table 4 shows the RII for Innovation and Learning factors. It is divided into 4 sub-factors. Research and development is the most significant factor followed by Innovative spirit.

Table 5: *RII for Information, Communication & Technological Factors*

Sr.	Sub-Factors	RII
1	Location based service and spatial planning	0.71
2	Sensor system and detectivity	0.86
3	City wide IT infrastructure	0.86
4	Internet Accessibility	0.91

Table 5 signifies the RII for Information Communication & Technological Factors. It has 4 sub-factors and Internet accessibility is the most significant factor and its priority index is 0.91.

Table 6: *RII for Mobility Factors*

Sr.	Sub-Factors	RII
1	Public transport vehicle management & passenger info	0.72
2	Intelligent transport system	0.86
3	Quality of public transport system	0.87
4	Pedestrian walkways and cycle path	0.91
5	Modification of public transport	0.92
6	Parking facilities	0.93

Table 6 represents the RII for mobility factors. It has 6 sub-factors. Parking facilities are the most important factor for the development of smart cities followed by modification in public transport.

Table 7: *RII for Operational & Managerial Factors*

Sr.	Sub-Factors	RII
1	Flexibility in labour market	0.49
2	Availability of workforce	0.54
3	Productivity	0.58
4	Service condition and quality	0.59
5	Speed of work	0.60
6	Building Information Modelling	0.67
7	Advance construction management	0.83
8	Disaster Management	0.90

Table 7 shows the RII for operational & Managerial factors. It has been divided into 8 sub-factors. Disaster management is found to be the most important factor with an index of 0.90.

Table 8: *RII for Physical Factors*

Sr.	Sub-Factors	RII
1	Affordable housing	0.71
2	Power supply	0.76
3	Heritage maintenance	0.79
4	Water supply	0.81
5	Urban Development	0.83
6	Educational Facilities	0.85
7	Sanitation	0.86
8	Infrastructural Facilities	0.88
9	Storm water management	0.90
10	Solid waste management	0.96

Table 8 depicts the RII for Physical factors. It has 10 sub-factors. Solid waste Management tops the list having RII 0.96 followed by the stormwater management.

Table 9: *RII for Political Factors*

Sr.	Sub-Factors	RII
1	Political interference of inhabitants	0.48
2	Political strategies & perspective	0.49
3	Public and social service	0.57
4	E-Governance	0.58
5	Transparent Governance	0.60
6	Change in housing bye-laws codes etc	0.70

Table 9 displays the RII for Political factors. It has been divided into 6 sub-factors. Change in housing bylaws, codes, etc. has received the highest priority index of 0.7 followed by Transparent Governance.

Table 10: *RII for Social Factors*

Sr.	Sub-Factors	RII
1	Poverty	0.57
2	Demographic changes	0.59
3	Social Cohesion	0.65
4	Tourist Attractivity	0.66
5	Smart people	0.69
6	Employment rate	0.70
7	Literacy rate	0.71
8	Immigration friendly environment	0.72
9	Recreational and cultural facilities	0.75
10	Health care facilities	0.91
11	Safety and security	0.94

Table 10 shows RII for Social Factors. It has been divided into 11 sub-factors. Safety & security is the priority for the building of smart city.

Table 11: *Ranking of Sub-factors*

Sr. No.	Factors	Main group	RII	Rank
1.	Solid Waste Management	Physical factors	0.96	1
2.	Environmental Protection	Environmental factors	0.95	2
3.	Safety & Security	Social factors	0.94	3
4.	Parking facilities	Mobility factors	0.93	4

5.	Modification in public transport	Mobility factors	0.92	5
6.	Recycling of used resources	Environmental factors	0.92	5
7.	Healthcare Facilities	Social factors	0.91	7
8.	Internet Accessibility	ICT Factors	0.91	7
9.	Sustainable resource management	Environmental factors	0.91	7
10.	Storm Water Management	Physical Factors	0.90	10
11.	Disaster Management	Operational & managerial factors	0.90	10
12.	Pedestrian walkways & Cycle Paths	Mobility factors	0.90	10
13.	Consumption of energy from renewable sources	Environmental factors	0.90	10
14.	Land Acquisition	Economical factors	0.89	14
15.	Infrastructural Facilities	Physical factors	0.88	15
16.	Quality of public transport system	Mobility factors	0.87	16
17.	Sanitation	Physical factors	0.86	17
18.	Intelligent Transport System	Mobility factors	0.86	17
19.	Sensor systems & Detectivity	ICT Factors	0.86	17
20.	City wide IT Infrastructure	ICT Factors	0.86	17
21.	Research & Development	Innovation and learning factors	0.86	17
22.	Quality of Resources	Environmental factors	0.86	17
23.	Educational Facilities	Physical factors	0.85	23

24.	Urban Development	Physical factors	0.83	24
25.	Advance Construction Management	Operational & managerial factors	0.83	24
26.	Water supply	Physical factors	0.81	26
27.	Heritage Maintenance	Physical factors	0.79	27
28.	Availability of Natural resources	Environmental factors	0.79	27
29.	Innovative spirit	Innovation and learning factors	0.78	29
30.	Power supply	Physical factors	0.76	30

Table 11 shows the ranking of the top 30 factors using RII based on stakeholders' choice. Total 26 factors are extremely significant as the RII is more than 0.80.

V. Discussion

Total of 26 factors have been identified as "Extremely Significant" for development of smart cities as their Relative Importance Index is more than 0.80.

Overall top 10 factors by relative importance index in decreasing order are:

- Solid Waste Management
- Environmental Protection
- Safety and Security
- Parking facilities
- Recycling of used resources
- Modification of public transport
- Internet Accessibility
- Health care facilities
- Sustainable resource management
- Pedestrian walkways & Cycle paths

Solid waste management can be made more effective by the use of smart dust bin. Smart Community Bins consisting of Level indicators and RFID tags which can signal to Control center and real-time communication with Collection vehicles. Use of low emission incinerators. These incineration systems not only eliminate garbage, but they also generate steam which can be used to produce electricity.

Environmental Protection can be done by various methods which include usage of E-vehicle.

Safety and security can be insured by usage of Artificial Intelligence. The computer based intelligence coordinated well-being measures incorporate a concentrated video reconnaissance and the executives framework that screens and keeps beware of traffic developments, resources, wrongdoing, and security of open and their notoriety.

Parking management by removing private vehicular parking from the public space as much as possible, the public space can be retrofitted, shifting the focus to Pedestrians and Public Transportation. Limiting parking is only possible in combination with the creation of a network of footpaths, MSCPs (multi-story Car Parking's), Smart Bus + E Rickshaws System.

VI. Conclusion

From the research study, we have found out top ten factors based on the relative importance index. These factors are creating major difference while choosing for infrastructural facilities or planning for the smart cities. All these factors should be kept in mind specially for the country like India where population is increasing day by day. So from the perperception of stakeholders and professionals, these core facilities should be designed first and the rest thing should be parallelly or after the main core infrastructural facility can be designed for ovverall society development.

VII. Future Scope

This study was done considering Vadodara only, this type of study can be replicated for the other city, such as Surat, Ahmedabad, Rajkot, and also for the other states. It included the survey done from stakeholders only. Similarly, the city people and government organizations can be included. The ranking methods like the Critical Index Method, Significance Index can be used for the same as well as other cities. Different analytical methods and case studies also can be used. A Smart City model can be made using different model making software [3].

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