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Smart Cities: A Study of Prospects Beyond Information and Communication Technology (ICT)

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Abstract: Smart city development primarily pertains to the contributions from parameters associated with Information and Communication Technology (ICT). ICT which is indicator of smart governance is generally considered to be the major parameter for building a smart city. This paper is an attempt to explore and provide justification for other smart parameters which are also equally important in comparison to ICT in Indian context. This study describes critically the identified parameters of smart city by carrying out opinion survey with professionals. Reponses of opinion survey was analyzed on Likert scale to generate frequency index values. This index values generated were verified by Cronbach's alpha to provide new index values justifying importance of other parameters in comparison to ICT. It has been observed that "smart infrastructure", "smart mobility", "smart governance", "smart environment & smart living", "smart economy" and "sector ranking" are some major parameters that can be considered as equal or even more significant to that of parameters related to ICT for development of smart city. The computed values of Smart Impact Index (SII-KMO) and SII-EV for Ahmedabad are 0.588 and 0.765 respectively. As both these values are greater than 0.5 they are adequately significant. Thus the parameters considered for this study have adequately high impact for development of a smart city like Ahmedabad and should be treated carefully along with other factors associated with ICT.

Keywords: Smart city, Information and Communication Technology (ICT), Smart Impact Index, Frequency index.

I. INTRODUCTION

Economic growth of any nation is dependent on growth of city, including India. With increasing urbanization, urban areas will be covering near about 40% of India's population and contribute about 75% of India's GDP by 2030. Therefore comprehensive development will be needed in physical, institutional, social and economic infrastructure.

Definition of smart city is not been established worldwide as of now. This definition varies from city to city, country to country in different manner. Level of development depends upon willingness to change resources within the city. The main objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment to live within.

The core infrastructure elements in a smart city would include, adequate water supply, assured electricity supply, sanitation, including solid waste management, efficient urban mobility and public transport, affordable housing, especially for the poor, robust IT connectivity and digitalization, good governance, especially e-Governance and citizen participation, sustainable environment, safety and security of citizens, particularly women, children and the elderly, and health and education.

In order to establish this facilities in a city of India proper norms would be needed so that work can carry on properly.

II. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Smart cities represent a concept for development of urban model which is used for utilization of human, collective, and technological capital for the development of urban areas. Concept of smart city should be developed properly as there are different nomenclature, context and meanings around globe.

The conceptualization of smart city, therefore, varies from city to city and country to country, depending on the level of development, willingness to change and reform, resources and aspirations of the city residents. A smart city would have a different connotation in India than, say, Europe. Even in India, there is no one way of defining a smart city. Cities which represent a multidisciplinary field, constant change in shape shaped by advancements in technology and urban development can be said to be a smart city in its own concept. In this sense, by tracing the history of smart cities up to the current smart city idea, one

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may hope to achieve a better understanding of what it means to be 'smart' in a city context. The impression is often that a smart city is the same as a digital city, and sometimes its meaning is close to that of a sustainable city. (http://www.smartcitymission.com, 3.9.2015)
As per Indian context, smart city would be dealing for the adequacy of infrastructure facility.

The core infrastructure elements in a Smart City would include:

i. Adequate water supply
ii. Assured electricity supply,
iii. Sanitation, including solid waste management,
iv. Efficient urban mobility and public transport,
v. affordable housing, especially for the poor,
vi. Robust IT connectivity and digitalization,
vii. Good governance, especially e-Governance and citizen participation,
viii. Sustainable environment,
ix. Safety and security of citizens, particularly women, children and the elderly.

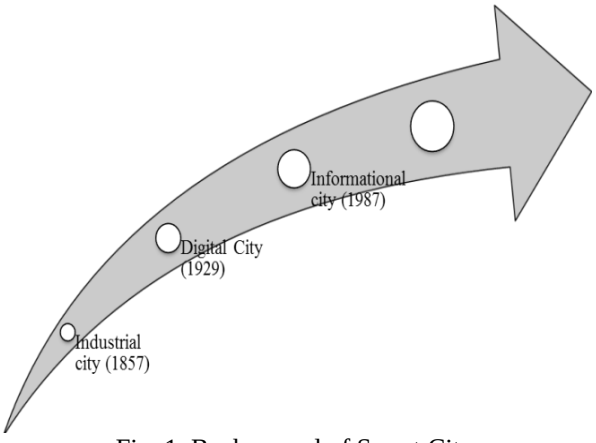

Fig. 1. Background of Smart City
(Ahmed and Anguluri, 2014)

Ahmed and Anguluri (2014) in above figure explains about emergence of the types of cities in a time span of about 130 years. "Industrial city" emerged due to the economic crisis in 1857 A.D. This was second technological revolution which gave an up gradation to digital city. In 1929 A.D. "Digital city" evolved as third technological revolution of the world in which computers were brought in to keep in digital data rather than having pile of papers. "Informational city" was conceptualized in 1987 A.D. This gave rise to informational technological revolution. This revolution gave an access to the information on basis of sharing through digital advancement. This gave a boost to economic advancement of various countries in the world. Recently a new term for the cities in various parts of world has evolved as Smart city in 2008 A.D. This is an emergence of new step for technological advancement. An attempt was made to group various parameters of services under one roof. This grouping of services with technology has helped in up gradation of city's image and value.

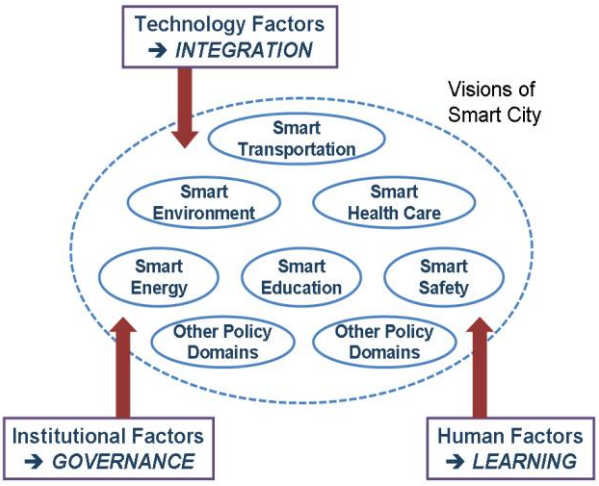

Fig. 2 Directions for Smart city
(Nam and Pardo, 2011)

Nam and Pardo (2011) have explained about integration of technologies to form an efficient smart city. Smart city integrates technologies, systems, infrastructures services, and capabilities into an organic network that is sufficiently complex for unexpected emergent properties to develop. There are challenges as well as opportunities where integrative service of smart city is implemented. The perception of technology in smart city initiatives, stresses integration of systems, infrastructures and services mediated through enabling technologies. Technological innovation is a means to smart city. Information Technology (IT) is just a facilitator for creating a new type of innovative environment, which requires the comprehensive and balanced development of creative skills, innovation-oriented institutions, broadband networks, and virtual collaborative spaces.

Types of Development for Smart City

There are majorly four types of development related to smart city. Area based development components of the smart city deals with:-

1. Retrofitting will introduce planning in an existing area to make it in accordance to the smart city objectives, along with other objectives, to make the existing area more efficient and liveable. 500 acres of area would be identified and developed as smart city by consulting citizens of that area. Depending on the existing level of infrastructure services in the identified area and the vision of the residents, the cities will prepare a strategy to become smart. Part of city taking a particular ward level would be defined as smart city.
2. Redevelopment will effect a replacement of the existing built-up environment and enable co-creation of a new layout with enhanced infrastructure using mixed land use and increased density. Redevelopment deals for an area of more than 50 acres identified by urban local bodies in consultation with citizens.
3. Greenfield development will introduce most of the smart solutions in a previously vacant area (more than 250 acres) using innovative planning, plan financing

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and plan implementation tools (e.g. land pooling / land reconstitution) with provision for affordable housing, especially for the poor. GIFT city is one of the example for this type of area development for smart city.

4. Pan-city development describes the application of smart solutions for an existing city infrastructure. Application of smart solutions will involve the use of technology, information and data to make infrastructure and services better. (http://www.researchgate.net/publication, 18-9-2015).

Zubizarreta et al. (2015) has discussed in their work about "smart city concept: what it is and what it should be" According to them European classification of smart city applications will be reviewed and the relationship between the different European smart classification standards are analyzed. Moreover, in order to see how reality aligns with the theoretical concept of smart cities, the author analyzed 61 applications from 33 smart cities distributed in North America, South America, Europe and Asia. Analyzing the parameters of different cities with European classification system author has reviewed upon the level of integration in parameters as "High", "Medium", "Low", & "No Integration" within parameters.

Angelidou (2015) describes in "smart cities: a conjuncture of four forces" that he has identified the forces shaping the smart city conception and, by doing so, to begin replacing the currently abstract image of what it means to be one. Their work commences by dividing the recent history of smart cities into two large sections namely, urban futures and the knowledge and innovation economy. The urban futures strand shows that technology has always played an important role in forward looking visions about the city of the future. The knowledge and innovation economy strand shows that recent technological advancements have introduced a whole new level of knowledge management and innovation capabilities in the urban context. The research route of this paper eventually allows the identification of the underlying and often forgotten principles of what it means to be 'smart' in an urban context and yields conclusions about strategic planning for the development of smart cities today. Belanche et al. (2015) studied the use of urban services for benefits of smart cities. Halepoto et al. (2015) have carried out a Strengths Weakness Opportunities and Threats (SWOT) analysis for the transformation of a smart city project. The primary category for transformation would include "smart city vision and status assessment", "smart city transformational initiatives" and "smart city development and implementation". Table 1 represents the SWOT analysis carried out by them. It has been observed that developing an intelligent and sustainable city is the way forward. The concept of making city 'smart' is evolving as a strategy to manage urban infrastructure and ease the urbanization challenges. The SWOT analysis has been used as a strategic tool to identify the gap between existing resources and pre-requisites of smart city transformation.

Table 1. SWOT Analysis for Smart City Transformation (Haleopoto et al., 2015)

Smart City Transformation			
Strengths	Weakness	Opportunities	Threats
Technological innovation & integration	Managerial and organizational issues	Large scale space time & service platform	Lack Standardized framework
Govt involvement	Cross section co-operation challenges	Handling of multi-source heterogeneous systems	Information security & risk control
Business opportunities	Lack of multi source & multi temporal data	Institutional interactions	Data privacy & security issues
Smart is bigger stage of digital and intelligent city	Lack of real time decision mechanism	Innovation and entrepreneourship	Standards and interpretability issues
Optimized goal	Citizen awareness and involvement	Citizen centric governance	Economic uncertainty
Application integration platform			Political Components & policy contents

Chourabi et.al (2012) describes that making a city "smart" is emerging as a strategy to mitigate the problems generated by the urban population growth and rapid urbanization. Yet little academic research has sparingly discussed the phenomenon. To close the gap in the literature about smart cities and in response to the increasing use of the concept, this paper proposes a framework to understand the concept of smart cities. These factors form the basis of an integrative framework that can be used to examine how local governments are envisioning smart city initiatives. The framework suggests directions and agendas for smart city research and outlines

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practical implications for government professionals. The list of smart indicators as indicated by Chourabi et al., 2012 is presented in Table 2.

Table 2 List of Smart Indicators (Chourabi et al., 2012)

Smart Mobility	Smart Environment	Smart Living
• Local accessibility • International accessibility • Availability of ICT-infrastructure • Sustainable, innovative & safe transport system	• Pollution • Environmental protection • Sustainable resource management • Attractivity of natural conditions	• Cultural facilities • Health conditions • Individual safety • Housing quality • Eqcation facilities • Social cohesion • Touristic attractivity

III. CASE STUDY AND RESEARCH METHODOLOGY

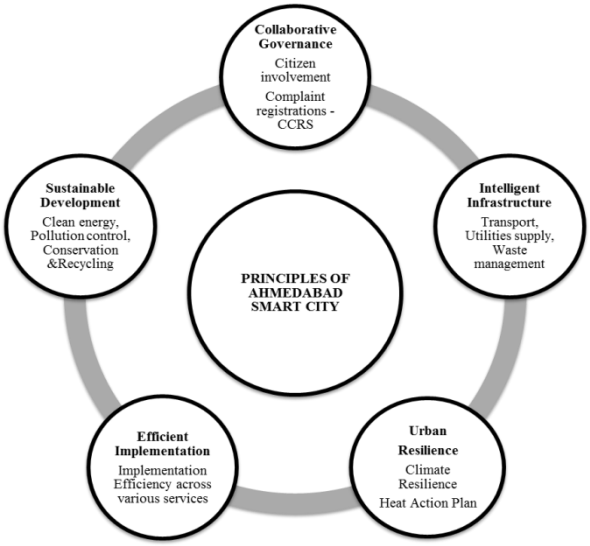

Fig. 1. Principles of Ahmedabad Smart City

Ahmedabad was considered as the study area for this work as it was chosen for primary selection amongst first ten smart cities from the smart city mission under taken in Atal Mission for Rejuvenation and Urban Transformation (AMRUT) guidelines. Ahmedabad is the administrative headquarters of Ahmedabad district and the seat of the Gujarat High Court. With a population of more than 6.3 million and an extended population of 7.2 million, it is the sixth largest city and seventh largest metropolitan area of India.

These are above mentioned smart city principles adopted by Ahmedabad's authority to produce an efficient example of the retrofit development of smart city. In accordance with the smart city principles adopted by the authority in the study area, principles lying in the category of smart parameters are mentioned in the below table.

Below Table 3, shows the components represented for the selected case in smart city mission. This study adapts these components for selected case. Components comprising with the indicators and their relation to smart city parameters are mentioned in the above table. Table 4 highlights the parameters affecting smart economy, smart people and smart governance.

Table 3 Components of Smart City Mission, Ahmedabad

Components	Indicators	Smart Parameters
Collaborative Governance	Citizen involvement Complaint registrations -CCRS	Smart People
Sustainable development	Clean energy, Pollution control, Conservation &Recycling	Smart Environment
Efficient Implication	Implementation, Efficiency across various services	Smart Infrastructure
Intelligent infrastructure	Transport, Utilities supply, Waste management	Smart Mobility
Urban Resilience	Climate Resilience, Disaster planning,	Smart Living

Table 4. Parameters affecting Smart Economy, People and Governance

Smart Economy	Smart People	Smart Governance
• Innovative spirit • Entrepreneurship • Economic image & trademarks	• Level of qualification • Affinity to long learning • Social & ethnic plurality	• Participation in decision-making • Public & social services • Transparent governance

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• Productivity • Flexibility of labor market • International embeddeness Ability to transform	• Flexibility • Creativity • Participation in public life Open mindedness	Political strategies & perspectives

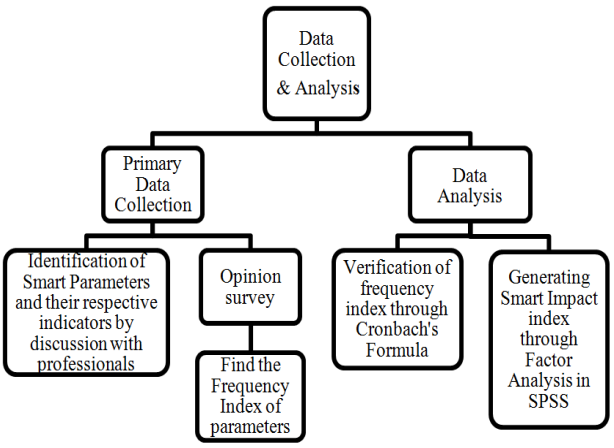

Fig. 2. Research Methodology for Study

The research methodology adopted for the study is presented in Fig. 2. After collection of data primary and secondary analysis was carried out. Primary data collection comprised of identification of smart parameters and their respective indicators by discussion with professionals. Opinion survey was also carried out and the frequency index of parameters was also found. Opinion survey of professionals was carried out through questionnaire survey. Total sample size selected for opinion survey was 40. The questionnaire was prepared based on the parameters affecting the development of smart city. The respondents were required to give a rating based on likert scale. The rating varied from 5 (very high) to 1(very low). Data analysis was carried out for verification of frequency index through Cronbach's formula and then generating smart index through factor analysis method using SPSS software. The generated smart index would indicate the relative importance of each of the identified factors affecting the development of the smart city under study.

IV. CASE ANALYSIS

Primary analysis was carried out for ranking of indicators which depicts importance of smart indicators lying under respective smart parameters. Cronbach's Alpha test was carried out for reliability values of frequency index which gives double assurance about smart parameters ranking. Further analysis was carried out by factor analysis through SPSS software. Factor analysis was used to identify the most important parameters affecting the development of a smart city.

Fig. 3 shows the general parameters affecting the development of smart city. It has been observed that "infrastructure improvement" has a maximum frequency index of 0.77 followed by "financial gain for cities" and "financial gain for companies" with frequency index of 0.72 and 0.69 respectively.

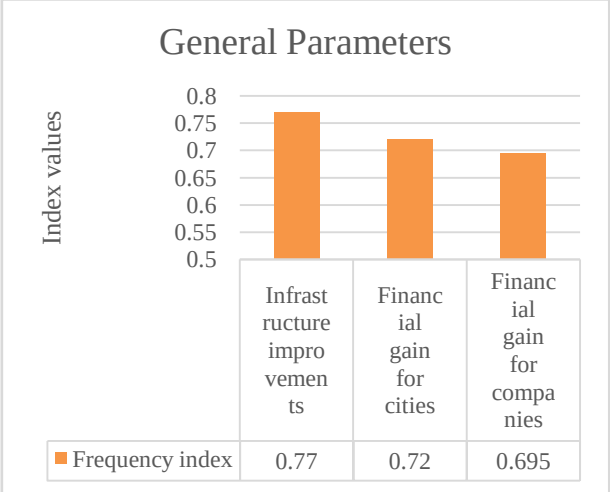

Fig.3. General Parameters Affecting Smart City Development

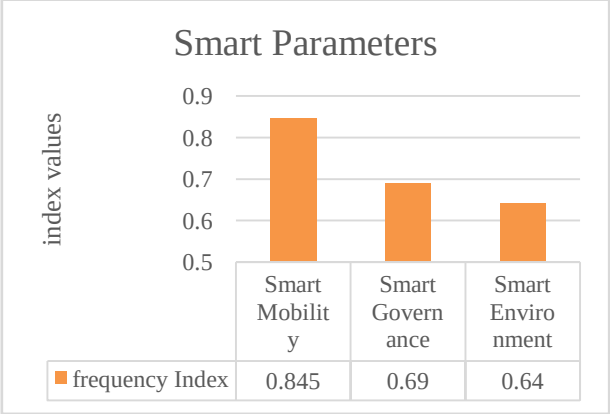

Fig.4. Smart Parameters Affecting Smart City Development

Fig. 4 shows the smart parameters affecting the development of a smart city. It has been observed that "smart mobility" has the maximum frequency index of 0.845 followed by "smart governance" and "smart environment" with frequency index of 0.69 and 0.64 respectively.

The values of "Cronbach's alpha" and "Mean frequency index" as obtained from the analysis are presented in Table 5. The ranking of the parameters are also presented in Table 5.

According to the analysis presented in Table 5, the value of "Conbach's alpha" is maximum (0.88) and also the value of "Mean frequency index" is maximum (0.753) for for "smart infrastructure". Thus "smart infrastructure" can be considered as the most important parameter affecting the development of the smart city and can be given first rank.

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Table 5. Comparison of Smart Parameters

Parameters	Cronbach's Alpha	Mean of Frequency Index	Rank
Smart Mobility	0.86	0.745	2
Smart Governance	0.84	0.740	3
Smart Economy	0.79	0.731	5
Smart People	0.80	0.745	3
Smart Environment	0.81	0.735	4
Smart Living	0.81	0.735	4
Smart Infrastructure	0.88	0.753	1
Sector Ranking	0.77	0.721	6

Similarly depending upon the values of "Conbrach's alpha" and "Mean frequency index" "smart mobility", "smart governance", "smart environment & smart living", "smart economy" and "sector ranking" can be given rank second, third, fourth, fifth and sixth respectively.

Factor analysis has also been used to compute KMO values and Extraction Values (EV) of the different smart city parameters considered under study. Smart Impact Index (SII-KMO) and Smart Inpact Index (SII-EV) has been generated from the obtained values of KMO test and EV for the smart city parameters. Generally the mean of the obtained values can be considered as the "Index values" The values of KMO test, EV, Smart Impact Index (SII-KMO) ans Smart Impact Index (SII-EV) are presented in Table 6. This SII would indicate how effectively the smart city parameters considered for study would contribute to the development of "Ahmedabad Smart City".

Table 6. Smart Impact Index Values of Ahmedabad

Parameters	KMO Test Value	Mean of Extraction values (EV)	Smart Impact Index (SII-KMO)	Smart Impact Index (SII-EV)
Smart Mobility	0.507	0.780		
Smart Economy	0.527	0.729		
Smart Environment	0.588	0.949		
Smart People	0.491	0.696		
Smart People	0.622	0.78		
Smart People	0.596	0.743	0.588	0.765

V. CONCLUSION

After carrying out adequate study for identifying parameters which are equally significant in comparison to Information & Communication Technology (ICT), it has been observed that "smart infrastructure", "smart mobility", "smart governance", "smart environment & smart living", "smart economy" and "sector ranking" are some major parameters that can be considered as equal or even more significant to that of parameters related to ICT for development of smart city. According to the analysis "smart infrastructure" appears to be the most significant followed by "smart mobility", "smart governance", "smart environment & smart living", "smart economy" and "sector ranking".

The computed values of Smart Impact index (SII-KMO) and SII-EV for Ahmedabad are 0.588 and 0.765 respectively. As both these values are greater than 0.5 they are adequately significant. Thus the smart city parameters considered for this study which are beyond the parameters directly pertaining to ICT have adequately high significance in development of a smart city.

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