Factors Impinge on Development of a Smart City: A Field Study

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Research Article

Keywords: Smart City, Environmental impact, Statistical analysis, urban analytics, SEM Modelling

Posted Date: September 14th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-589772/v1

Abstract

Smart City aims at amassed connectivity at various levels in the midst of citizens, as well as amid the administration and the daily growing population. India is one of the developing country where population growth is one of the significant area is to be noted seriously. A city is a large and permanent human environment that provides its citizens with many services and opportunities. The rapid economic growth and population growth have put a huge amount of strain on urban infrastructure and service provision. India is an under developing nation to modernize urban life, the current urbanization needs good tactics and creative planning. India's government has launched 100 Smart Cities where it is expected that citizens will use new innovations and resolve the issues. Smart Cities are intended for finest usage of space and resources along with an effectual and optimum dissemination of benefits. This study is to investigate and analysis of Chennai Smart city Mission (SCM) development. This work has been undertaken to learn about the aspects of Smart Development and the factors that governing Smart City. The analysis has been split up into 4 portions as Questionaries' survey in the Chennai city, Frequency and Percentage analysis, Descriptive analysis and using Structural equation modelling (SCM). Using the SPSS (Statistical Package for Social Sciences) version 21.0, conversational interviewing, and questionnaire survey and also journal study are conducted to find factors influencing the implementation of smart city and reviewed. Using the SEM (structural equation model) AMOS 21.0 software, confirmatory factor assessment had done. This study gives in-depth knowledge in implementation of the smart city scheme aspects and also suggests solution for most affecting factor in a city.

1. Introduction

Increase in population growth leads humanity to face various difficulties in daily life. Particularly in urban areas, poor urban infrastructure, higher unemployment, traffic congestion, energy shortage, high power loss in transmission, power theft, health issue, inadequate housing, education challenges, rising crime rates, supply connection Issue, inadequate power generation capacity, frequently power failures are most common hitches, mostly in developing countries such as India in an existing city. There comes smart city scheme to give a better life to every common man to lead it with ease.

A smart city can be put it a simple words as, it's an urban area that uses various kinds of electronic systems and sensors to gather data. Insights gained from the gained data were used to bring about properties, resources and facilities resourcefully; in return, the same data is used to expand the manoeuvres across the city. In general, a smart city is a city that practices technology to provide public amenities and solve city problems. Smart cities fixes things like get better transportation and ease of access, improve social services, endorse sustainability, and give its residents a voice.

In this paper, analysis is about the vulnerabilities over implementation of the smart city scheme aspects and also suggests solution for most affecting factor in a city. This paper gets organized as follows. First, it's a review about the existing smart city development plans and suggestions. Second, it comes about

the analytical survey in the Chennai city. In addition, a comparative analysis is framed on the aforesaid content. Finally, the summarization of this paper has been noted.

2. Literature Review

The city transfers smart city and study examine transformation and frame work of smart city and discussed four key elements 1. Planning 2. Infrastructure 3.ICT 4. solution for smart city**(Harish Kumar et al 2017).**The key to solve these urban problems is the development and implementation of advanced technologies designed to expand the eminence of a city life and reducing the running costs of the city while in view of the objectives of a sustainable development **(Ahvenniemi et al.,2017)**

The huge problems are developed by urban developments in transportation, water management, solid waste management and electricity demand **(smart city 2015)** and population are exploring the by Chennai city last 50 years. **(Censes of India 2011).** the need of smart city described by the authors in a paper **(**Giffinger et al. 2007) Smart Governance, Smart People, Smart Environment, Smart Mobility and Smart Living have been defined by as six major smart city dimensions. Factors affecting smart city are detailed in a research article **(SeunghwanMyeong et al 2018)** for further clarifications on the same.

2.1 Smart City Mission (SCM)

In urban development's planning, the conception of smart city has been vital because technological evolution is rapid and also the local authorities are dealing with increasing challenges in solving climate, energy and urban difficulties. Developing and implementing advanced technology of smart city is the key solving these problems in cities **(Ahvenniemi et al., 2007).**In June 2015, the MoUD (ministry of urban development) propelled the scheme called mission of "smart city" for 100 cities together with the announcement of the "AMRUT" (Atal mission for rejuvenation and urban transformation) for infrastructure rejuvenation across 500 cities in India. To attain economic progression and to improve the standard of citizens' life, the mission smart city helps in infrastructure development and its services with the help of emerging technologies so called IoT.**(Harish Kumar et al.,2017)**Indian government is trying to explore solutions for this problem among urban people the method is change in standard of life, stability and sustainability of city by implementation of smart city. In general, a city that assimilates information and communication techniques (ICT) that enhances the quality and performance of city services like transportation, energy and services to trim down the resource consumption and all-inclusive cost. **(Kramer's et al., 2014)**

In Chennai, smart city developments are further classified into two division based on the economic and quality of common man's life. They are Pan City and Area-based development. Area-based development is the key component for the smart city proposal. Based on research and analysis about an area of the city and frequent meetings with the corresponding representatives whereas Pan City solution that modifies an entire city in all once **(Smart city mission 2015**). A smart city can also respond directly, more

rapidly and in very responsive fashion to any urban recession because it has a high level of urban effective resistance. **(**Ferrara, 2015**).**

2.2 Smart City Implementation Aspects

Few new rules and regulations are mandatory to promote the smart city facilities with common people. Resource shortage, government accountability and structure in developing countries are among the leading causes of the inability to deliver public service **(**Bertot et al., 2016). In the research article **(**Giffinger et al. 2007) authors defined a smart city by giving six dimensions of a city includes Smart Environment, Smart Governance, Smart Mobility Smart People, and Smart Living. Wireless infrastructure and modern technology are there to enhance the political and economic efficiency and sociological-economic development of the city**(Hollands,2008, 2015).**

2.3 Chenai City Profile

Chennai is capital of tamilnadu and it is forth largest population by its population of 4.6 millons **(Cences of India 2011)**. Its is smallest of all disstrict ,but its has the highest density peopleand its largest humanities,economicand education center of south India. The Tamil Nadu government hired another major plan is to guide urban areas with the help of Satellite **(Chennai city Metropolitan Development Authority [CMDA], 2008).** The city of enlarge mix of development such as residential, industrial, IT, office etc. the city as different of land users are residential, industrial and special hazards.

Table 1
Population of Chennai in last 5 decades.

(Source: censes India 2011)

Year	Population
1961	1,729,141
1971	2,469,449
1981	3,266,034
1991	3,841,396
2001	4,343,645
2011	7,088,000

3. Analytical Survey In The Chennai City

The survey follows three conceptual frameworks to recommend s for smart cities and explain the benefits of urban transformation.The data collected from the selected (200) respondents belonging to four different regions of Chennai, Tamilnadu. The entire Chennai region has been divided into four zones as North, South, East and West. Data were collected from 50 samples from each of the four zones for analytics. Thus, the total number of sample of respondents was limited to 200.

Questioner survey had conducted and analysed the most affecting factors of Chennai city when it transformed to a smart city. Based on the number of people's opinion of different categories, Frequency and Percentage analysis was done whereas the Descriptive analysis is conformation of ranking of factors affecting the city. By using SPSS model and structural equation model (SEM), the confirmatory factor analysis had executed.

3.1 Factors affecting Chennai city become smart city

3.1.1. Traffic Problem

There are several issues with traffic difficulties, counting economic costs probably due to interrupted travel times, halts and exit traffic flow also concurrent pollution and road accidents **(Ponnurangam et al., 2014).** In Chennai city, vehicular movements are increased during peak hour and thereby traffic congestion occurs and this would be one of the important topic in the city that to be resolve soon and if one path is been congested, drivers might use other roads/paths which are not inherently designed for traffic becomes overcrowded. Traffic congestion is rising at rate of 7 to 10% for every year while the growth of vehicular population is 12% per year. Here the authors (**Anush kumar et al.,)** discussed about the cause of traffic in centre city, inadequate planning of city development, unauthorised parking, reduction of public transport usage, and increase in private transport habits.

3.1.2 Parking Problem

As mentioned above, people feel comfortable with own vehicles for their transportations, everywhere traffic has been increasing which escalates to another problem called need of parking area. The **ASCE (1989)** perceives parking space as one of the biggest concerns in a metropolitan. In central city centres, three most important problems have been recognized: (i) deficiency of off - street and on - street parking; (ii) illegal use of loading places; and (iii) time limits. Parking proposals are seen as one of the powerful and dangerous measures for maintaining travelling demand patterns and redeploying travel in urban areas **(**Alho & e Silva, 2014). The search for on - street parking space was linked to environmental and social effects due to disruption of the network traffic flow, massively increased pollution level, time delays for other vehicles and other potential safety threats by the condition of vehicles. **(**Brooke, Ison, & Quddus, 2014**et al.,)**

About 5.3 million vehicles are now on road in Chennai. Parking is the one among the other factors, needs the predominant care in a City. In Chennai, two different parking ways are in role On-street parking and

Off-street parking which has been deliberated in the article (**Sampath Simon et al., 2011).** The rapid increase in traffic demand, the inequity between parking demand has created.

3.1.3 Road and Safety Problem

Due to rapid growth of the population of vehicles is increasing in the city, road accidents also an important factor that affects people in major ways includes injuries and even death. As per the Global Status Report, more than 1.2 million people been dying on roads worldwide every year and 50 million people continues to suffer non - severe injuries **(Global status report 2015)**. The accident causes over drunken drive, talking through mobile while driving, on-observance rules, etc., According to (**Krishnan et al.,)** more than 1 million people are passing on every year and 50 million people are getting injured globally in road accidents and more than 70,000 people passing on each year in India as a result of road accidents and this must be recognized as an important factor on public health. Nearly 2, 41,751 people would suffer as a result of road traffic accidents by 2030 if this situation remains constant and if strong and incorporated traffic safety processes were not in place today **(Gururaj G et al., 2017).**

3.1.4 Waste Management Problem

Industrial growth and increase in population and their needs has resulted in migration of people from rural to urban cities, turn out thousands of tons of MSW each day. Underprivileged collection and insufficient transport are blameable for MSW's. **(**Bundela et al., 2010). The development of urbanization, advancement in technology and digitalization promotes the e-waste. Common wastes are spawns by humans for daily activities from residential, public, agriculture, industries etc.,. The wastes were classified into two types Compostable and Non-compostable **(**Jha et al., 2011;**)** due to inappropriate handling of solid waste management which causes pollution, environment impact and impacts on human health safety **(**Shazwin and Nakagoshi, 2010**).** Many classifications of civic solid wastes were identified, such as food waste, commercial waste, institutional waste, waste from the street, industrial waste, waste from construction and demolition, waste from sanitation and so on. (**Syed et al.,2006).** In Chennai city the Waste management systems do not regularly collect wastes which lead people to dump wastes on water sources. Also the un-separated wastes by the public were creates difficulty in implementation of recycling the waste, collection and proper disposal, in an environmentally friendly manner (**Smart city 2015).**

3.1.5. Storm Water Management

Storm water management, the increasing the rainfall intensity in monsoon and water enter into streets, houses and causes huge strain for the people. The recent explore of Chennai flood (nov dec 2015) creates more impact on everyone. The main reason for flooding is none other than, low laying area, improper drainage, due to elevate downstream water level. **(Source: urban storm water management developing countries 2015**)

3.1.6 Pollution Problem

The need for mobility is enhanced by population growth and economic development. As a result, the environmental impact of CO2 carbon emissions can be discussed. This pollution has resulted in

increased production, increasing public services, and increased the amount of huge waste affecting the ecosystem by the increase in CO2 emissions **(Madalin-Dorin Pop et al., 2017).** There is no discussion about air pollution as a serious health issue in India. In 2006, the Central Pollution Control Board carried out a source distribution survey in six cities – Bengaluru, Chennai, Delhi, Kanpur, Mumbai and Pune (**Sarath K.et al., 2019)**. Air population mainly involves solid or liquid or gas or noise which blends with atmosphere which generate problems to humans, plants, environment and animals the pollution mainly from these two factors Vehicles and another one is Industries. Shipping, automotive industry, chemical and petrochemical industries, software services, healthcare and production takes the shape of Chennai's economic base. The pollutant air from factories, power plant, vehicle like bike, car, train, busses etc., the stunning rate of vehicular population grow in Chennai city.

In vehicular emission which create more impact problems by emitting of suspended matter SPM, carbon monoxide CO, sulphur dioxideSO2 and nitrogen dioxide NO2.

3.1.7 Drinking Water Problem

Water is a primary natural resource, a fundamental human need.the monsoon was always very bad, and so this is a cause for low water levels. Two major sources of water are surface water and groundwater. Drinking water continues to be a problem. Natural reasons and human causes can also play a major role in the issue of water shortages. Chennai city mainly 5 storage reservoirs are: 1. Poondi – 3.231TMC 2. Cholavaram-0.881TMC 3. Red hills – 3.300TMC 4. Chembarambakkam-3.645TMC 5. Veeranam-1.465TMC**(A. Murugesan et al., 2015).** It is estimated that demand will rise to 76–114% of water use in the future 2050**(G C Maheshwari et al.,).** In Chennai drinking, water transport by through pipe line and mobility. water contains impurity or mixing sludges which cause health issue to urban people.

3.1.8 Crime Rate Problem

In Chennai City is one of most secured place however minor rate of crimes takes places. The cases are murder, rape and kidnapping **(Smart city 2015).**

3.2. Frequency and Percentage Analysis

The analysis is organized in first section describes the frequency and percentage analysis of the demographic variables of the study which includes gender, age, qualification and profession.

3.2.1. Gender

The profile of the respondents of the study based on their Gender is presented in Table 2. From the data, majority of the respondents of the study are male (83.5%, N = 167). The study included only 16.5% (N = 33) of female respondents.

Table 2
Gender

Gender	Frequency	Percent
Male	167	83.5
Female	33	16.5
Total	200	100.0

3.2.2. Age

Table 3 shows the age profile of the respondents of the study. From the table, it can be seen that majority of the respondents of the study are young belonging to the age group 18–28 years (59.0%, N = 118). Around 27.5% (N = 55) of respondents belong to the age group 28–38 years. Finally, the sample of respondents belonging to the age group 38–48 years consisted of 13.5% (N = 27).

Table 3
Age Group

Age (Years)	Frequency	Percent
18–28	118	59.0
28–38	55	27.5
38–48	27	13.5
Total	200	100.0

3.2.3. Educational qualification

Table 4 shows the educational qualification of the respondents of the study. The majority of the respondents of the study are Undergraduates (39.0%, N = 78). Around 24.0% (N = 48) of the respondents were having Post Graduate qualification. 19.0% (N = 38) of respondents have “Other” qualifications like ITI, Diploma, Certification qualifications were included in the study. However, respondents with Higher Secondary and below qualification consisted of 18.0% (N = 36) of the sample.

Table 4
Educational qualification

Educational Qualification	Frequency	Percent
Higher Secondary and Below	36	18.0
Under Graduate	78	39.0
Post Graduate	48	24.0
Others	38	19.0
Total	200	100.0

3.2.4. Profession

Table 5 shows the profession of the respondents of the study. The majority of the respondents of the study are working with Private Sector (40.0%, N = 80). Around 27.5% (N = 55) of the respondents are working in Government Sector. 14.5% (N = 29) of respondents are Self-Employed. The study also included “Other” respondents consisting of home makers, job seekers and temporarily unemployed professionals consisting of 18.0% (N = 36) of the sample of respondents.

Table 5
Profession

Profession	Frequency	Percent
Self-Employed	29	14.5
Private Sector	80	40.0
Government Sector	55	27.5
Others	36	18.0
Total	200	100.0

3.3. Descriptive Statistics

The second section discuss about the descriptive statistical analyses in which statistical methods like minimum statistic, maximum statistic, mean, standard deviation, skewness and kurtosis were used to analyze the data from the respondents of the study.

The study identified that eight factors viz. Traffic Problem (TP), Parking Problem (PP), Storm Water Problem (SW), Waste Management (WM), Road Safety Problem (RS), Crime Related Problem (CR), Pollution Problem (POLN) and Drinking Water Problem (DW) were predominantly affecting the development of a sustainable smart city. These factors were identified based on an extensive review of

literature carried out by the researcher on the core topics related to the research. In total 40 items were used to measure the eight factors. The items were measured using a scale of 1 to 5 with scale options like “Completely Disagree”, “Disagree”, “Neither Agree or Disagree”, “Agree” and “Completely Agree”.

The descriptive statistics of the data collected from the industry respondents of the study is shown in Table 6. The descriptive statistics considered in the study included Minimum Statistics, Maximum Statistic, Mean Statistics, Standard Deviation, Skewness and Kurtosis Statistics.

From the Table 6, it is very clear that, as per the rating of the respondents of the study, Parking Problem (PP) with mean value of 4.30 and standard deviation of 0.40 was the top-rated factor in the development of Sustainable Smart City. This was followed by the factor Traffic Problem (TP) mean value of 4.29. Storm Water Problem (SW) was the third rated factor with mean rating of 4.04. The factor “Waste Management” received a mean rating of 3.99. The factors like Road Safety Problem (M = 3.83), Drinking Water Problem (M = 3.8). Crime Related Problem (M = 3.69) and Pollution Problem (M = 3.68 POLN) were the least rated factor influencing the development of Smart City. The values of Skewness and Kurtosis were below the prescribed limits for all the eight factors indicating that the data are normal and suitable for other statistical analyses.

Table 6
Descriptive Statistics (N = 200)

Smart City Factors	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Traffic Problem (TP)	3.40	5.00	4.29	0.45	0.34	-0.65
Parking Problem (PP)	3.80	5.00	4.30	0.40	0.74	-0.75
Storm Water Problem (SW)	3.20	5.00	4.04	0.38	1.02	1.35
Waste Management (WM)	3.40	5.00	3.99	0.50	1.13	0.01
Road Safety Problem (RS)	3.00	5.00	3.83	0.60	1.11	-0.14
Crime Related Problem (CR)	2.00	5.00	3.69	0.60	0.44	0.11
Pollution Problem (POLN)	2.80	4.60	3.68	0.53	0.11	-0.94
Drinking Water Problem (DW)	2.60	5.00	3.81	0.47	0.20	0.97

Based on the mean values the ranking of the factors is shown in the Table 7.

Table 7
Ranking of Factors Influencing Smart City Development (N = 200)

Smart City Factors	Mean	Std. Deviation	Rank
Parking Problem (PP)	4.3	0.4	1
Traffic Problem (TP)	4.29	0.45	2
Storm Water Problem (SW)	4.04	0.38	3
Waste Management (WM)	3.99	0.5	4
Road Safety Problem (RS)	3.83	0.6	5
Drinking Water Problem (DW)	3.81	0.47	6
Crime Related Problem (CR)	3.69	0.6	7
Pollution Problem (POLN)	3.68	0.53	8

4. Sem Model

SEM is very potent analytical method is the combination of multivariate statistical methods and widely used by sociologists such as economists, teachers, and marketing researchers. It is based only on the testing of a new model of the relationships between variables in the mind of the researcher before the research is done, via data obtained from the research **(J. H.** Hair et al., 1998)

The final section describes the confirmatory factor analysis using structural equation model (SEM). Statistical Package for Social Sciences (SPSS) Software Version 21.0 was used for data analysis. The SEM modeling was carried out using AMOS 21.0 software.

The confirmatory factor analysis (CFA) **(Rich H Hoyle et al., 2012)** model was developed using various Sustainable Smart City Development factors like Traffic Problem, Parking Problem, Storm Water Problem, Waste Management, Road Safety Problem, Pollution Problem, Drinking Water Problem and Crime Related Problem. The software package namely AMOS 20.0 was used to develop the Structural Equation Modeling (SEM).

Figure 2 and 3 shows the unstandardized and standardized estimates for the model on Sustainable Smart City Development factors.

From the standardized estimates, the value of loading of each variable on the factor is above 0.4 which shows that the model is valid.

The values of regression Weights of the SEM Model is presented in Table 8. The contribution of the individual variables like Drinking Water Problem, Pollution Problem, Road Safety Problem, Waste Management, Storm Water Problem, Parking Problem and Traffic Problem toward Factors Influencing Smart City Development was found to be significant as the p-value is less than 0.05.

Table 8
Regression Weights of the SEM Model

Observed Variable	Latent Variable	Standardized Estimate	Unstandardized Estimate	S.E.	C.R.	P
Crime Related Problem	Factors Influencing Smart City Development	.796	1.000	.076	12.33	***
Drinking Water Problem	Factors Influencing Smart City Development	.400	.397	.071	5.614	***
Pollution Problem	Factors Influencing Smart City Development	.661	.741	.075	9.851	***
Road Safety Problem	Factors Influencing Smart City Development	.874	1.110	.079	14.088	***
Waste Management	Factors Influencing Smart City Development	.857	.900	.066	13.709	***
Storm Water Problem	Factors Influencing Smart City Development	.496	.393	.055	7.082	***
Parking Problem	Factors Influencing Smart City Development	.533	.444	.058	7.673	***
Traffic Problem	Factors Influencing Smart City Development	.868	.819	.059	13.964	***

4.1. Model Fit Summary

The goodness of fit of the model is given in Table 9 that indicates how well the models fit the set of observations. From the given table, it's very clear that the values for measured parameters were compatible to the recommended values. Henceforth, the model can be taken into consideration as a good fit model. The values obtained for the indices like GFI (Goodness of Fit Index), AGFI (Adjusted Goodness of Fit Index), CFI(Comparative Fit Index), TLI (Tucker-Lewis Index), RFI (Relative Fit Index) and NFI (Normed Fit Index) were greater than the recommended value of 0.9 which shows that the model is perfectly fit **(Daire et al. 2008; Hu and Bentler, 1999).** RMSAE (Root Mean Square Error of Approximation) value was less near the recommended value of 0.09 **(Hair et al 2006)** indicating that model is fit. Overall fit indices values generated for the model are in conformance with standard values. Therefore, it can be

concluded that the CFA model is valid, and the chosen parameters contributes extensively to the Sustainable Smart City Development.

Table 9
Goodness of FIT – AMOS Model (Industry)

Variable	Recommended Value	Obtained Value
Chi-square value	-	72.903
P value	p > 0.05	.000
RMSEA	< 0.2	.115
RMR	< 0.08	.013
GFI	> 0.90	.917
AGFI	> 0.90	.851
CFI	> 0.90	.936
TLI	> 0.90	.911
RFI	> 0.90	.881
NFI	> 0.90	.915
Chisq/df	< 5.0	3.645

5. Summary

The smart city concept clearly defines that different aspects of cities are different things. Area-based development plays a dynamic role in terms of the smart city project that improves the quality of better living and the surroundings. Pan-city development focuses on state-of-the-art technology and is a research model to implement future projects. This study clearly defines a smart city's different methods, components, strategies and applications. From the Frequency and Percentage Analysis was the first section describes the frequency and percentage analysis of the demographic variables of the study which includes gender, age, qualification and profession and examines number of occurrences. The descriptive analysis is describing the factors affecting by ranking method which calculated by mean, standard deviation, kurtosis and kurtosis. Reliability refers to the extent to which, if the measurements are repeated several times, a scale produces consistent results. In the analysis ranking of factors influencing the smart city is based on mean value. In that case parking pollution problem is highest mean values and most affecting factor in a city and that should be resolved by the Smart City project implementation.

6. Declarations

Ethical Approval

Not Applicable.

Consent to Participate

Verbal informed consent was obtained prior to the questionnaire survey.

Consent to Publish

The participant has verbally consented to the submission of the case report to the journal .

Authors Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Priya J], [Palanisamy C] and [C Vinothini].

Funding

No funding was received for conducting this study.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

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Figures

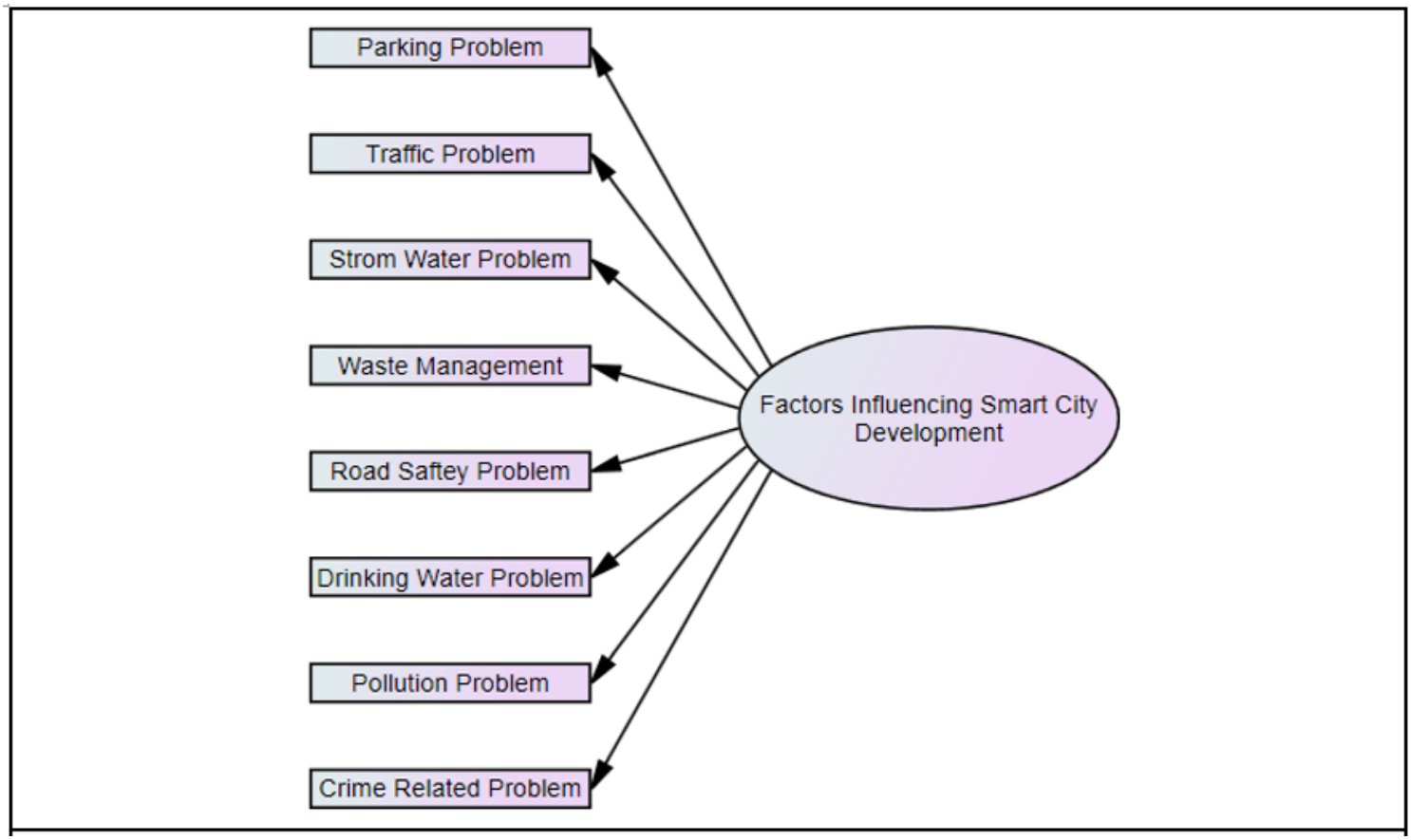

Figure 1

Factors influencing smart city

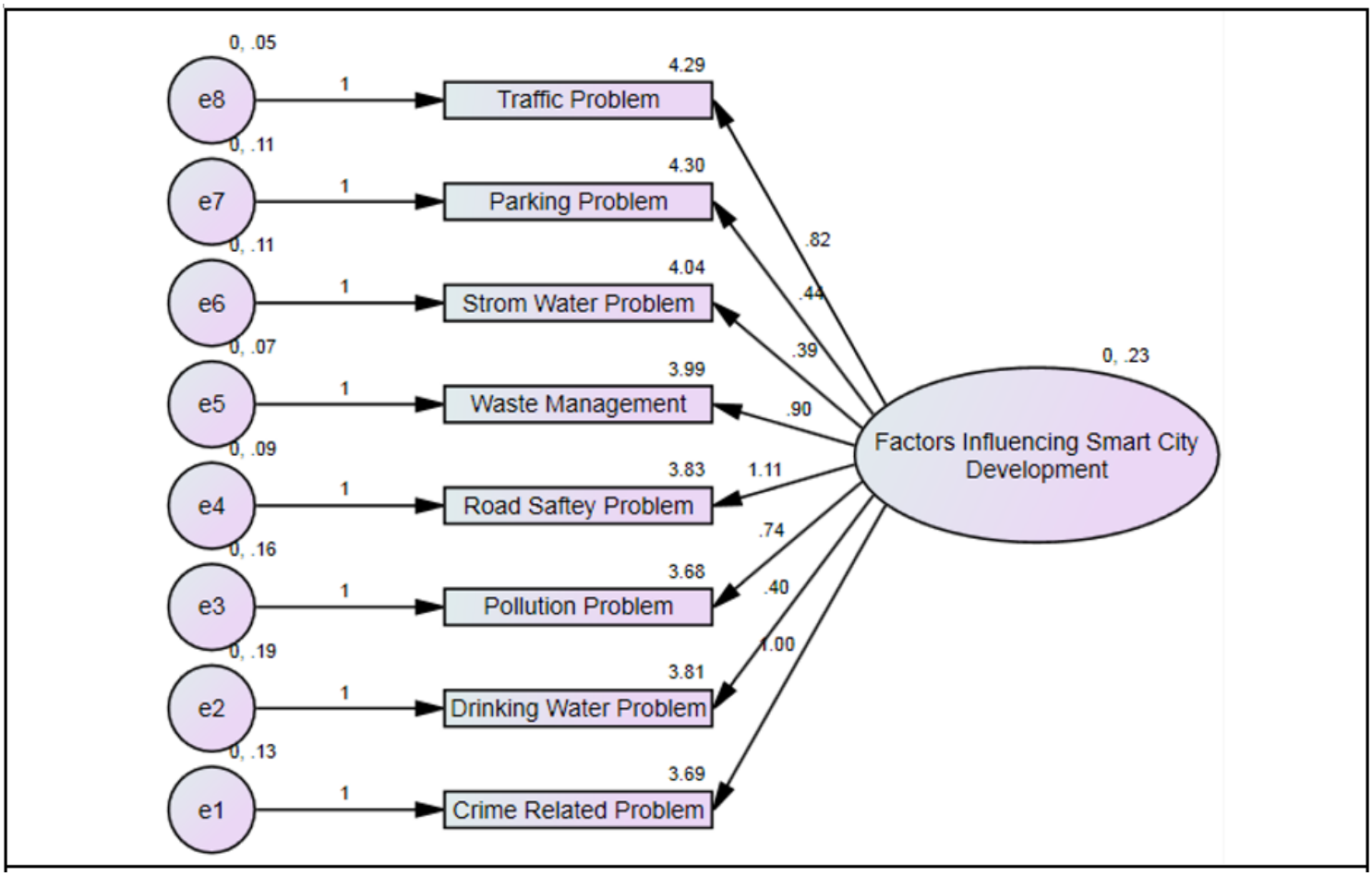

Figure 2

Unstandardized Regression Coefficient

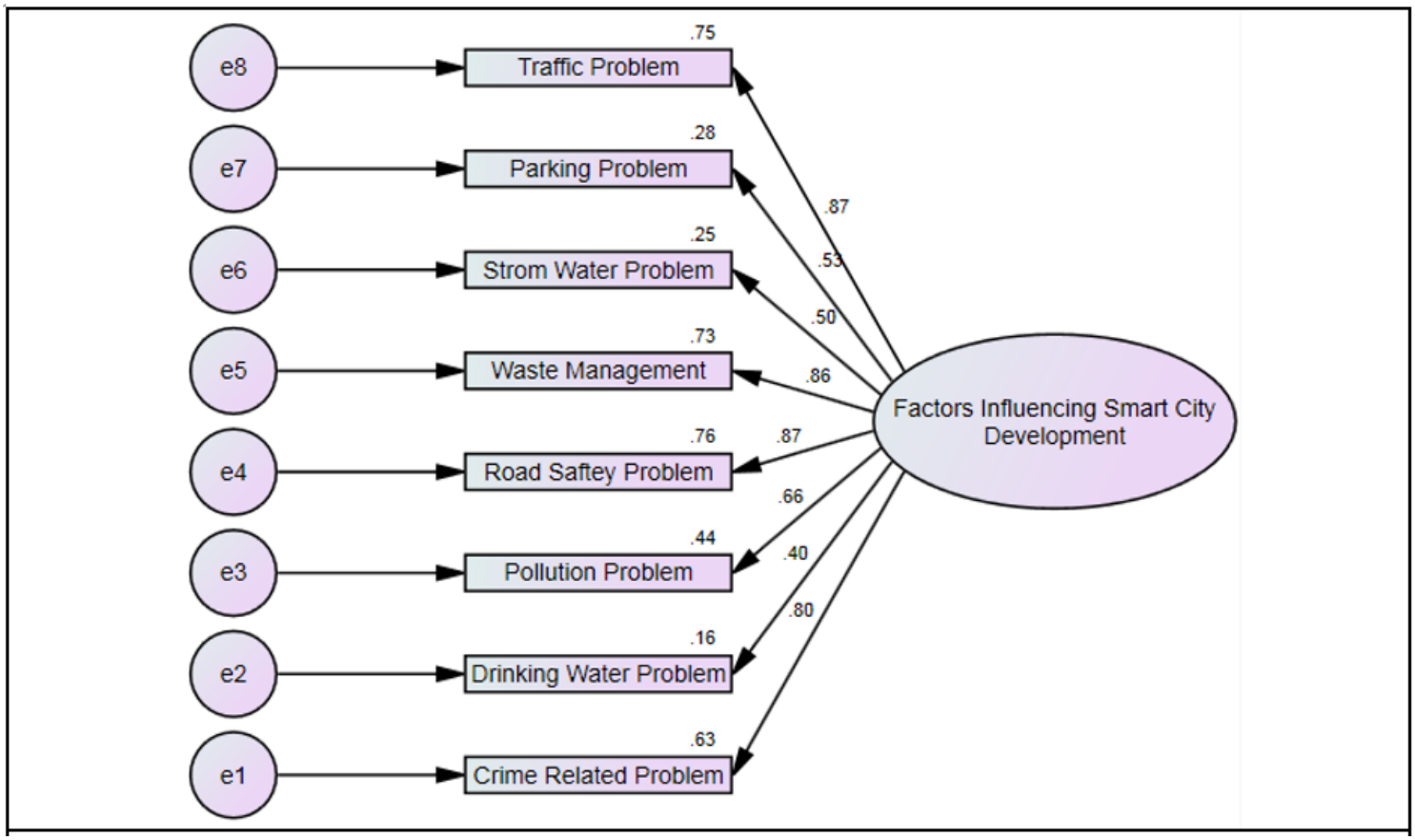

Figure 3

Standardized Regression Coefficient