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Moving towards smart cities: Solutions that lead to the Smart City Transformation Framework

Harish Kumar*, Manoj Kumar Singh, M.P. Gupta, Jitendra Madaan

Department of Management Studies, Indian Institute of Technology, IIT Delhi, New Delhi 110016, India

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ABSTRACT

A city is a large and permanent human ecosystem which provides a lot of services and opportunities to its citizens. The rapid urbanization and increasing population have put a lot of strains on city infrastructures and service deliveries. The current urbanization requires strong strategies and innovative planning to modernize the urban life. Many cities are enhancing quality and performance of urban services by being digitalized, intelligent and smarter. The policymakers and city authorities are exploring solutions to deliver the new services in an efficient, responsive and sustainable manner for a large population. The study explores all the possible services among various city dimensions which can make a city smart. The ideas related to smart services are collected from the peer vetted creative crowdsourcing process performed online in India. A directed qualitative conventional content analysis is used to analyze the collected ideas. The unique ideas are clustered into 19 different service categories. The findings suggest multi-dimensional service classification along with required basic infrastructural development. Further, the Smart City Transformation Framework (SCTF) is proposed to help the policy makers, urban developers, government officials and service providers in terms of understanding and to draw more insights from the suggested smart solutions for development of smart cities. There are four key areas (Planning, Physical infrastructure, ICT infrastructure and Deploying Smart solutions) discussed in the proposed framework to illustrate the city transformation. The proposed SCTF is supported by literature and examples adopted by various smart cities across the world to illustrate its effectiveness. Moreover, a mind map is designed to illustrate the interrelationships among the collected ideas in an attractive and procedural visualization for city transformation process.

1. Introduction

1.1. A huge strain on urban infrastructure and services

The urban growth and city population are growing in a fast pace causing different issues to the environment, economic and social sustainability of cities (Bibri and Krogstie, 2017; Neirotti et al., 2014). The traffic congestion, poor urban infrastructure, health issues, energy shortages, educational challenges (Lee et al., 2013), inadequate housing, increasing crime rates, higher unemployment, ageing infrastructure, power thefts, issues in supply connections, insufficient power generations capacity, high power loss in transmission, frequent power breakdowns and lack of real time data sharing are some of common concerns in existing cities mostly in developing countries like India.

The restrictions on critical infrastructures (Mattoni et al., 2015) and resource availability constraints create challenges for the healthy food, energy and clean water supply for increasing population. The cities are under strains on public finances to reduce budgets along with cost cutting measures, paradigm shifts towards online services, concerns about climate changes, economic restructuring with reducing the unemployment. Therefore, smarter ways are needed to manage the urban challenges and to revamp urban life, efficient infrastructures and quality services (Novotný et al., 2014) to its citizens.

1.2. Smart cities: a new aspect of urbanization

Wey and Hsu (2014) have argued about the new urbanism and smart growth concept to deal with city problems especially environmental, housing and citizens' well-being. European Parliament (2014) has defined smart cities as “a place where the traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefits of its inhabitants and businesses”. The focuses of smart cities development are improvements in citizens' life (Neirotti et al., 2014), environment efficiency, security and sustainability (Bulu, 2014; Niaros et al., 2017) with centrally controlled and monitored technological infrastructures. Giffinger et al.

* Corresponding author.
E-mail addresses: harishkr08@gmail.com (H. Kumar), mpgupta@dms.iitd.ac.in (M.P. Gupta), jmadaan@dms.iitd.ac.in (J. Madaan).

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(2007) have defined smart governance, smart people, smart environment, smart economy, smart mobility and smart living as six major dimensions of a smart city. The smart cities would incorporate the ICTs (Kramers et al., 2014) and Internet of Things (IoT) (Elmaghraby and Losavio, 2014) embedded into most of the sector of urban development such as government functionality, city operations, services deliveries, and intelligent analytics to optimize the services, production and usability.

Ojo et al. (2014) have discussed the objectives of smart cities such as carbon reduction, improving energy efficiency, high quality living environment, green urban areas, state-of-art infrastructure and city evolution as living and innovative laboratory to compete at global standards. The smart city transformation is a complex and multidimensional (De Santis et al., 2014) process. The process of city transformation depends upon the collective integration of technological, governance, institutional and transitional components. Smart cities can provide infrastructural and information-based services along with businesses opportunities (King and Cotterill, 2007) for the economic development.

1.3. Service planning for smart cities

To design and develop smart services, urban planners and administrators must seek the views and need of citizens' (Lee and Lee, 2014) to resolve local priorities and requirement of citizens. The new policies and regulations are required to facilitate the smart services in an easy manner in smart cities. In developing countries, paucity of resources, government accountability and structure (Bertot et al., 2016) are some major causes for the failure of public service delivery. There is a strong requirement of structured governance for designing new urban policies, participatory decisions making processes and implementation of policies by involving multi stakeholders (Novotný et al., 2014) for the effective design of smart cities.

Ministry of Urban Development (MoUD), India launched the “Smart Cities Mission” in June 2015 for 100 cities (MoUD, 2015), along with the announcement of “Atal Mission for Rejuvenation and Urban Transformation (AMRUT)” mission for upgradation of infrastructure across 500 cities in India. Smart city mission involves improvements in infrastructure and services with the use of technology to derive economic growth and to upgrade the quality of citizens' life. Pan-city development initiatives were also launched to implement smart solutions to a larger parts across the cities. The clear outline and step wise coordination for smart initiatives are not available in the smart cities mission guideline. Therefore, it is a need of systematic study for strategic and integrated planning to design smart city services to transform cities. The development of smart cities via upgrading existing cities or designing new cities require a comprehensive and universal approach for service design, service deliveries and city transformations.

The study suggests various initiatives that can be incorporated for the development of basic infrastructure and smart solutions to transform a city into a smart city. This research has come up with an efficient list of services across the various domains of a city. The study proposes a Smart City Transformation Framework (SCTF) to show the complex process of smart city design. Furthermore, a Mind map representation of crowdsourced ideas layout an approach to interlink the various smart initiatives into a visualized format. The study creates a part of knowledge about smart city transformation and design of services for smart cities development. This article would drastically benefits to the prior and transdisciplinary research in terms of the gathered knowledge. The policy makers and service providers would get benefitted from the proposed framework in terms of smart city planning and deploying smart solutions.

The research starts with urban issues and challenges (Section 1) in current scenarios, smart cities as a potential solutions to solve the existing urban problems and service planning for smart cities. Literature studies (Section 2) thoroughly discuss previously proposed service typologies and service deliveries models; technological adoption; technological advancements for smart service design and delivery; and environment protection and mitigating natural calamities in smart cities design. Section 3 describes the used methodologies to find the smart service solutions and smart city transformation. Results (Section 4) explain the various basic infrastructural and smart solutions across the various dimensions. The Smart City Transformation Framework (SCTF) is proposed and validated through various literature and smart cities examples in Section 5. Section 6 illustrates interlinkages among the various ideas in the form of a mind map design. Section 7 discusses the study contribution and implications. Section 8 concludes the study while Section 9 provides the limitations and further research opportunities.

2. Literature studies

The outdated infrastructures and inadequate integration of various components of technological developments always increase the cost of operations (King and Cotterill, 2007; Angelidou, 2014; Belanche et al., 2016). For the prompt improvement and innovation in existing services, smart services design are timely need especially for smart cities development. To discuss the previous work and earlier models related to service planning and smart city design, the literature has been divided into four parts as i). Previously proposed service typologies and service deliveries models; ii). Technological adoption and citizens' engagement; iii). Technological advancements for smart service design and delivery; and iv). Environment protection and mitigating natural calamities in smart cities.

2.1. An overview to previously proposed service typologies and service delivery models

To deliver public services digitally, enhanced government capabilities are required along with i) service architectures to deliver context-aware smart services; ii) processes to define, design and deliver co-created services; iii) policies to ensure privacy, personal data protection, and the equity principle for service delivery; and iv) reference models that are able to consider specific local context (Bertot et al., 2016). Giffinger et al. (2007) suggested six categories for smart city services; people, governance, mobility, environment and living. Chang et al. (2007) were focused on “one-stop resources and services” in their proposed Community model.

Kuk and Janssen (2011) discussed eight categories of service providers based on e-business model. Lee et al. (2014) proposed smart city analysis framework while focusing on urban openness, partnerships formation, infrastructure integration, urban proactive-ness, smart governance and service innovation. Novotný et al., 2014 overviewed smart city services and application areas. Lee and Lee (2014) have classified 228 smart city services in 11 categories (Administration; environment; public health; transportation; crime & disaster prevention; education; distribution; facility management; culture, tour, sports; working environment and Miscellaneous). Lee and Lee (2014) have proposed four dimensional service typology based on technology, service authority, purpose of service and mode of delivery.

Sá et al. (2016) have suggested four domains of e-government services as Technical (Usability, design, and technical quality); organization (customer support, transparency, customization, politician's role, e-governance); Safety (privacy, safety, reliability and delivery); and Information (information quality, task information). Li et al. (2017) have discussed about service delivery models based on inputs, output and outcomes process. The inputs include all resources used to produce and deliver required output product or services. Examples of inputs include available funds, time, equipment, raw materials, etc. The output include all of the products and services produced from the inputs. The producers' charges the consumer based on the output products or services. The outcomes are the measurable impacts delivered by service providers that can be assessed by consumers.

2.2. Technological adoption and citizens' engagement in smart city development

Smart cities are mostly technology oriented advanced cities. The people must be motivated to use technology to get benefitted from the smart system. Davis (1985, 1989) explained the behavior intension to accept technology and IT usage. In his "Technology Acceptance Model" (TAM), he discussed i). Perceived usefulness and ii). Perceived ease of use. When a person believes that a particular technology can help to perform better on a task and improves performance, this can be considered as perceived usefulness while perceived ease of use is related with situation when a person believes that technology is useful and easier to use (Davis et al., 1989). Age, gender and experience also decide the behavioral intention as well as technology usage (V. Chang et al., 2018) ability among people. Ryan et al. (1997) have discussed Self-Determination Theory (SDT) to deal with human motivation behind the choices people make. There are two types of motivation i.e. extrinsic motivation when people make decisions for a purpose; and intrinsic motivation when people perform activities for fun and enjoy.

For the effective participation of the citizens into planning and decision making process, various social sites, public forums and online platforms (Kumar et al., 2016) can be used. The social networks capture the structural level of human relationships and community behavior in real time (Li et al., 2017). People usually interact, share opinions and express their feelings over the social sites (Karyotis et al., 2018). The sentiment and network analysis of social sites illustrate the concept of Internet of People (IoP) (Chang, 2018c) to improve the quality of products and services, by incorporating their needs, views, feedbacks and expectations. The valuable information can be retrieved from social network analysis that is composed of i) information extraction in terms of shared content and activities, ii) processing the posted information and network strengths of an individual and iii) visualization of processed data in terms of graphs, analytics and reports (Chang, 2018c).

2.3. Technological advancements for smart service design and delivery

There is a huge demand for better quality of services with ease of use approaches (Chang, 2018a) especially in developing countries like India. For the interoperability and effective integration of advanced techniques such as artificial intelligence in smart services, internet of things (IoT) based platforms are necessary (Moreno et al., 2017). The IoT is a network of connected devices which are uniquely addressable that communicate in the real time through the standard IP based communication protocols (Mital et al., 2017). IoT is a convergence of sensors, actuators, telecommunication, cloud computing and big data, interconnecting them through the Internet to provide goal-oriented services (Farahani et al., 2018), monitoring and control applications.

Moreno et al. (2017) have proposed a four layered IoT architecture that can be deployed to facilitate different services and applications in smart cities. This architecture contains (i) Technologies layer which is consist of wireless sensor networks, wired sensors, gateways, etc. to capture the data generated by multiple channels; (ii) Middleware layer where all input data from various sources are expressed as it is collected; (iii) Management layer which is in-charge of determining decisions based on advanced analytics to target services provided in smart cities; and (iv) Services layer which can be enforced to provide smart applications in various city domains such as environmental monitoring, energy efficiency, traffic control, multi-modal transport, location based services, education, tourisms responses in emergencies, and other civic services.

The intelligent algorithms and systems are required to extract, process and to make sense of the information from vast amount of generated data (Chang, 2018c). The cloud computing can be deployed (Weinhardt et al., 2009) to facilitate fast services. Chang et al. (2013) proposed a "Cloud Computing Business Framework" (CCBF) to help businesses and service providers to maximize added value offered by cloud computing and to deliver solutions. The quality of services over cloud platforms affect pricing model, costs and effectiveness (Buyya et al., 2009). Karyotis et al. (2018) have talked about Ambient Intelligence (AmI) to develop truly intelligent systems for the understanding the human behavior, especially emotions. Human emotions usually influence decision-making ability, interpretation, and knowledge assimilation. The intelligent machines can be developed through Affective computing to facilitate a higher level of human-machine interaction (Karyotis et al., 2018) in smart cities.

In designing the smart services, Moreno et al. (2017) have emphasized some challenges such as sensors integration, processing of complex data, providing dynamic human centric services, managing privacy of users and cybersecurity mechanisms. Cognitive Internet of Things (CIoT) solution is a system with feedback control loop that often pose dynamic requirements for processing and analyzing data from sensors, derive decisions, and apply control through actuators (Li et al., 2017). The resilient IT infrastructures are essential for supporting the CIoT capabilities (Li et al., 2017) so that all the data can be analyzed and outputs can be presented and delivered in a smooth way (Farahani et al., 2018). Fog computing is an architecture that uses end-user edge of the network devices for communication, storage, configuration, control, local resource pooling and latency reduction for improving the quality of service (Li et al., 2017).

Sohal et al. (2018) has elaborated a three layers of fog computing. First, the real-time data generation devices such as sensors, RFID tags, CCTVs, IoT devices and actuators. Second, the network devices that send the data from data devices to the cloud infrastructure. This acts as fog layer to reduce the latency of the network. Third, the cloud layer which is consist of virtual machines. Fog computing is highly recommended for running latency sensitive applications (Luan et al., 2015) from mobile devices to cloud architecture in case of smart cities.

The processing, analysis and visualization of data are required (Chang, 2017) for better service delivery and management. The data visualization presents multiple data analysis (Chang, 2018c) and insights in an attractive and understandable format. In a smart city, the big data applications can address different problems (Moreno et al., 2017). The available libraries, APIs, algorithms, outputs and user interfaces can be effectively used for designing software as a service (SaaS) to meet the service demands and expected deliveries. Chang (2017) has expressed "Everything as a Service" (EaaS) to ensure the efficient service delivery.

Farahani et al. (2018) have talked about security and privacy for devices, network, cloud and human. The devices are usually connected sensors, personal gadgets, edge nodes and mobile devices that capture, aggregate, process and transfer the data. The most common attacks at device layer are spoofing, Radio Frequency jamming, tag cloning, cloud polling and direct connection. The network layer is responsible to establish appropriate connections between sensors, IoT devices, fog nodes and cloud depending on network protocols. To secure the network layer, it is very important to use trusted routing mechanisms, message integrity verification techniques and encryption techniques. At human level, adequate training must be provided to individuals to prevent disclosure of their critical data. The continuous monitoring and detection of increased vulnerability, randomized variations of sections or components of the software and changing the hardware resources (Li et al., 2017) can reduce the cyberattacks.

2.4. Environment protection and mitigating natural calamities

Apart from cyberattacks, the adverse atmospheric conditions, either naturally induced (such as volcanic eruptions, earthquakes, flood etc.) or man-made (such as harmful chemical emissions, terrorist attacks, wars etc.) can have significant disruptive effects on societies (Li et al., 2017). Chang (2017) explained an innovative weather data analysis through cloud computing with the use of supercomputers, intelligent algorithms, data analytics and visualization techniques. Plale et al.

(2006) talked about two major weather forecasting systems, “Collaborative Adaptive Sensing of the Atmosphere (CASA)” and “Linked Environment for Atmospheric Discovery (LEAD)” while Droegemeier et al. (2005) discussed the use of “Service-Oriented Grid Computing” for dynamic analysis of weather (Chang, 2017).

In addition to weather and extreme conditions, the earthquakes or tsunami also cannot be predicted easily and cannot be forecasted in advance (Chang, 2018a). The adoption of emerging service and analytics can be advantageous in such scenarios. Cloud, Big Data, Fog computing, intelligent systems and web technologies are imperative for deploying the emerging service and analytics to deliver the services in various domains of a city (Chang, 2018a) such as transport, health, economic sector, education, online shopping, mobile services, energy, natural environment, and other physical domains of smart cities.

Therefore, the emerging efforts, service planning, adequate infrastructure development are required to develop smart services and connected communities to improve livability, affordability and efficiency in the smart cities. The work done and frameworks proposed previously do not provide a clear process about city transformation as a smart city. To implement smart solutions, some basic infrastructural requirements are essential. The earlier discussed models or frameworks do not provide any information about pre-requisite basic infrastructure development on which the suggested smart solutions can be implemented. The study tries to fill such gaps and proposes a Smart City Transformation Framework (SCTF) to illustrate the complex process of city transformation.

3. Methodology

The study follows three methodological approach to suggest the smart city solutions and to explain city transformation procedure. The crowdsourcing has been used to collect the ideas related to smart service solutions. The content analysis has been used to analyze and categorize the received ideas. SCTF framework has been proposed for smart city transformation based on the categorization. To represent the interlinkages of smart ideas into a visual diagram, the mind mapping technique has been used to illustrate the smart city transformation.

3.1. Crowdsourcing

Crowdsourcing is a well-recognized technique for getting ideas, content, support or other solutions from users or a group of people through the internet-based platforms (Liu and Lu, 2016). The crowdsourcing initially was referred as “a web based business model requiring voluntary open collaboration to develop innovative solutions” (Howe, 2006). In literature, two main focuses of crowdsourcing have been found i.e. i). The creativity and problem-solving capacities (Poetz and Schreier, 2012) of the crowd and ii). To explore value creation and capture in crowdsourced-based businesses (Fedorenko et al., 2017).

Schemmann et al. (2016) have discussed some empirical research areas where online crowdsourcing have been successfully deployed as stimulus of the idea creators (Dahlander and Piezunka, 2014), online idea contests, idea generation (Schweitzer et al., 2012). The crowdsourcing process usually depends on idea quality (Poetz and Schreier, 2012), idea innovativeness and market potential of crowd sourced ideas. Schuurman et al. (2012) have used crowdsourcing method for ICT innovation in a city context. The crowdsourcing has been used successfully in urban planning, public administration, medicine, journalism, and social science research.

Kozinets et al. (2008) were focused on appropriate targeting and engagement of the participants (Fedorenko et al., 2017) in crowdsourcing process. The sample might be a small group of persons to tens of thousands of people to perform crowdsourcing. Generally, the crowd is a large group of unknown people. The selected target should be heterogeneous to ensure significant variance. The crowds are of six type's i.e. social production, averaging crowds, data miners, networking crowd, transactional crowd, and event crowds.

The crowd participation styles are of four type i). Communal in which individual identity usually not identified. The identity mesh with the crowd, ii). Utilizers that create social capital by developing their individual skills through online site, iii). Aspirers those who helps in selecting crowdsourcing content but don't contribute in production of original content and iv). Lurkers who are simply observer of the event. The motivation of crowd participation may be intrinsic where crowd take challenge to solve the raised issues and extrinsic where crowd participate to get financial rewards, fame, or due to social pressure. The nature of crowdsourcing process can be simple, complex and creative.

In earlier studies, the four dominant forms of crowdsourcing have been explained as a). Knowledge discovery and management approach in which online participants are challenged and asked to uncover the existing knowledge, b). Broadcast search to solve empirical problems such as scientific where single specialist can also perform the complete process, c). Peer-vetted creative production to create innovative ideas. This is ideal for events where solutions are matters of users' choice and preferences and d). Distributed human intelligence tasking - in which crowds analyzing large amounts of information.

This study has followed peer-vetted creative production crowdsourcing process in which participant were large unknown group of people from India. The link was shared through groups, forums and social media platforms. The participation style was communal where the study did not capture the personal identity of any individual. The chosen type of crowd was social production and type of individual was competent. The nature of the complete process was creative and function for crowdsourcing was idea platform.

3.2. Content analysis

Content analysis is a method of analyzing the text of social investigation among the set of empirical methods (Kohlbacher, 2006; Titscher, 2000). Holsti (1968) has defined it as “a systematic analysis for making inferences and identifying specified characteristics from the messages”, Prasad (2008). Krippendorff (2004) has described it “as a research technique for making replicable and effective interpretations from data to their context”. According to Weber (1990) it is a method that uses a set of measures to make significant interpretations from text (Kerlinger, 1986).

The generating concepts from previous studies or existing theory are significant and helpful in qualitative studies, especially for initialization of data analysis (Zhang and Wildemuth, 2005). The qualitative content analysis was developed by German researcher Philipp Mayring (Kohlbacher, 2006). This can be broadly classified in three categories - i). Conventional qualitative content analysis which derives the coding categories inductively from the raw data, ii). Directed content analysis which derives initial coding from a theory or research findings (Zhang and Wildemuth, 2005) and iii). Summative content analysis in which analysis starts with keywords selected from literature studies. The unit of analysis can be a symbol, single word, a letter, a theme, a news story, a short story depending on the purpose of research. It is of two types i). Recording units in which the occurrence of fact is considered and ii). Context units which are ideal for large content.

The results of content analysis must be proofed through validity check and reliability analysis. The validity is related with truthfulness in results. The types of validity are a). Material oriented validity that can be classified into semantic and sampling validity. The semantic validity is known as reconstruction of material, while the sampling validity can be checked through precise sampling method, b). Results oriented validity can be performed in two ways i). Correlative validity that defines the correlation with the same criterion (observations/experiments) and ii). Predictive validity, if the predictions can reasonably be made from the collected material and c). Process oriented validity can be checked through construct validity that relates to previous theories.

The reliability states that the data should remain constant throughout variations in the meaning of reading process of textual data. The research results must be replicable elsewhere. The reliability is of three types i.e. stability, replicability and accuracy. Stability refers to obtain the similar results from the same set of text. If the same results are achieved under various circumstances for an instance with different coders, signify the reproducibility. Accuracy relies on stability, reproducibility and an extent to meet a precise functional standards (Titscher, 2000; Krippendorff, 2004; Kohlbacher, 2006).

The study has followed directed quality content analysis which starts with relevant literature studies and established theories. The categories development process was deductive type. Some new categories were also formed to cover the scope and context of the study. Unit of analysis were context type to analyze a large content received through the crowdsourcing process. The results are validated through pilot phase, validity check and reliability analysis.

3.3. Mind mapping

A diagram can be developed to help in organizing the categories and ideas (Hsieh and Shannon, 2005). To represent the ideas, generated through content analysis, into a visual diagram, the mind mapping technique has been used around central problem (Buzan and Buzan, 1995; Somers et al., 2014). Mind maps provide clear visualization and insights by capturing whole concepts relevant to a specific concern (Kern et al., 2006) and paying attention to relationships among concepts (Lăcrămioara, 2015). The conceptual maps stimulate the generation of ideas, quick results, visual graphic representation and interrelationships of the generated ideas (Lăcrămioara, 2015). The digital form of mind maps generally have a much more consistent appearance than paper mind maps (Bennis and O'Toole, 2005). Digital mind maps arrange information or ideas in an expandable and collapsible topic trees.

Mind maps have been used in many fields such as in nursing education to diagnose a problem and develop a care plan (Kern et al., 2006; Somers et al., 2014), to understand practice-based problem (Bennis and O'Toole, 2005) in management education, in engineering to study depth of knowledge and the level of cognitive complexity demonstrated in problem solving.

4. Results

The crowdsourcing has been performed online in India from Jan, 2017 to mid of June 2017. Respondents were asked open ended suggestions related to smart cities and its services aiming to support the everyday life of its residents. The URL was distributed through social media, public forums and blogging sites. The process of crowdsourcing activities was focused on idea generation related to smart city and its services. A large number of ideas were received across various domains of a smart city. The qualitative content analysis was performed to analyze the collected responses. The qualitative content analysis is useful to find patterns, themes, and categories that are important to social concerns but it does not provide statistical significance.

The evaluation of the received content was performed by an internal team of research professionals. Some categories were formed from the theory and previous studies but some were newly designed based on received suggestions. The categories were revised through feedback process. Finally, 19 categories (Fig. 1) were formed to classify all the service solutions received from crowdsourcing process. The identical ideas were merged and some ideas were integrated based on similar context in coding schemes. All the 19 categories (Annexure 1) further classified into two sub categories as i). Basic infrastructure related city solutions and ii). ICT oriented smart service solutions.

To maintain the consistency of coding, a coding manual (Weber, 1990) comprises of name, definition of categories and rules for assigning codes had been provided to all coders. In order to validate the findings, ideas classifications, the experts were also consulted (Annexure 2). Ambiguous solutions were removed at this phase after the experts' consultation. All the experts have been provided the same definition of the service dimensions formulated in categorization phase.

The results of content analysis are thoroughly checked for validity and reliability. The ability of material to be reconstructed and appropriate categorization prove the semantic validity. The pilot phase of analysis was checked through sampling method. The predictive validity and process oriented validity were judged through previous studies, as some classifications were similar to the previously work done, established models and theories. The study results can be replicable elsewhere under different circumstances that prove the results reliability.

5. Our proposal: Smart City Transformation Framework (SCTF)

Based on the obtained 19 categories (Fig. 1) in Results section for developing basic infrastructure and deploying smart solutions (Annexure 1), the Smart City Transformation Framework (Fig. 2) is proposed. The proposed framework contains four key areas i.e. planning phase, physical infrastructure, ICT infrastructure and deploying smart solutions to transform a city into smart city. The framework is proposed to offer -

- An exhaustive list of services and classification of various services (basic pre-requisite and smart) to implement across the major city domains to make a city smart.
- A structured framework to illustrate the complex process of city transformation as a smart city.
- Usage of ICT and advanced technologies to deploy smart solutions for the enhancement of living environment, service planning and delivery.
- To deal with smart city design either via upgrading the existing city or developing a new smart city.

5.1. Planning phase

Lee et al. (2014) focused on the governance to enable the coordination and integration across city departments to set up platforms for better service delivery. Nam and Pardo (2014) favored for efficient government management to build the smart cities. For example, with city's strong leadership, the San Francisco smart city is trying for effective policy reforms (DuPuis and Stahl, 2016). In order to build a common platform to create synergies in terms of technology infrastructure and capacity building within the city administration, a strategic early planning is required for a range of services delivery and for optimized resource consumption. In case of Birmingham smart city, the city government has planned for digital infrastructure via development of digital blueprint, regulating infrastructure and open data initiatives (Slater and Khandelwal, 2016).

In a smart city, the services should be facilitated based on the nature (Lee et al., 2013) and demand of citizens. To develop the smart city services, the government must plan for mix land use, collaborate among the different levels of governments, effective fund distribution, housing facility and should form appropriate rules and regulations for various domains of a city. While designing the public services, the government focus must be on cost-effective, innovative and timely services deliveries. The department of environmental protection has started the Operational Excellence Program in New York City as public-private partnership for effective procurement, developing workforce, technology, materials and financial strategies to gain significant budget savings (Slater and Khandelwal, 2016). The Open Data Policy of San Francisco smart city has increased government efficiency and citizens' engagement (DuPuis and Stahl, 2016).

The government must spread necessary information among the people to make the government transparent and open. In Philadelphia, the government uses Philly311 app as a real-time forum to

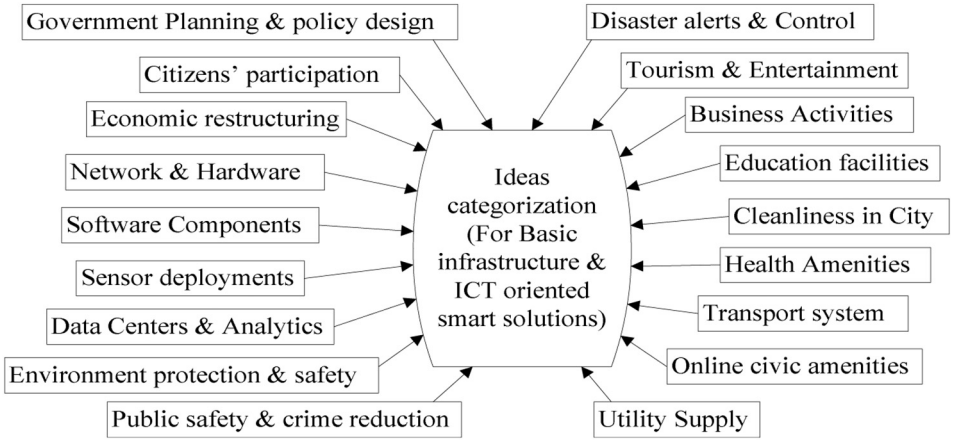

Fig. 1. The categorization of received ideas. All the categories are further divided into i) basic infrastructure and ii) ICT oriented smart solutions (Annexure 1).

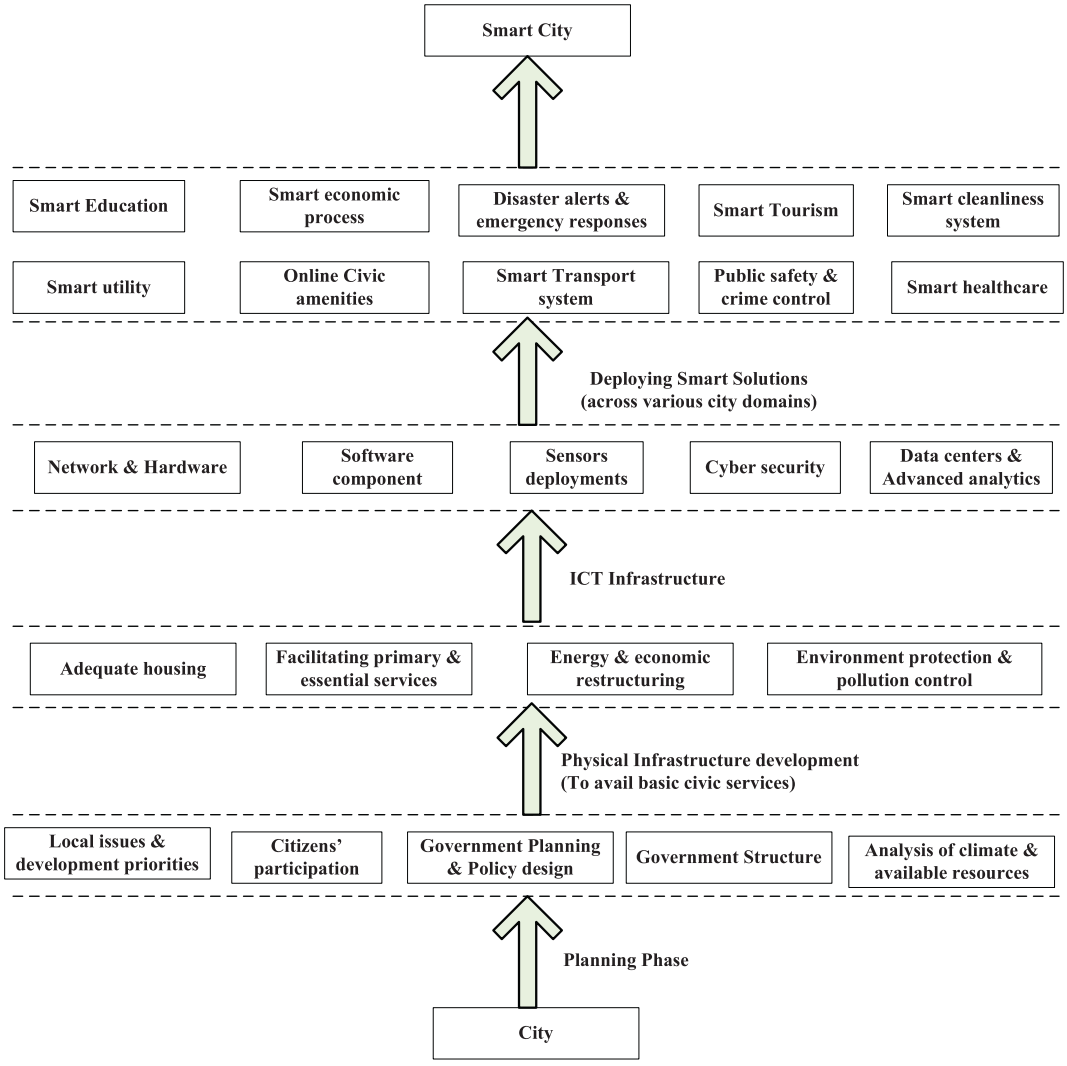

Fig. 2. Proposed framework for smart city transformation (Planning phase, Physical infrastructure, ICT infrastructure, and deployment of smart solutions).

communicate with citizens (N.B. Chang et al., 2018). The municipality of Tel-Aviv smart city is highly active on Facebook to share all the information to ensure maximum outreach. Online inspection and vigilance system must be strongly developed. Cashless payment systems must be avail for essential services such as smart card payment system for multi-modal transport services in Barcelona, Hong Kong, London, Sydney and many other smart cities. The government has a huge role in mobilizing the funds for business activities. To make a city as an industrial hub, the industrial clusters, incubation centers, IT parks, manufacturing centers and industrial corridors should be developed. The e-business practices should be encouraged and more employment opportunities must be generated to make a city economic viable.

To understand the local issues and need of people, citizens' participation (Giffinger et al., 2007) and collaboration among stakeholders (Odendaal, 2003) are important. The service delivery must be facilitated through multi-channels as there are number of factors such as various age groups, service preferences, digital literacy and readiness of digital technology infrastructure. In Seoul, the government is reducing digital gaps by providing IT education to the elderly, disabled and low-income groups. Smart devices have been donated to the citizens at subsidized rates (Slater and Khandelwal, 2016) for the maximum usage of digital infrastructure.

5.2. Physical infrastructure development

In terms of physical components of a smart city, the core infrastructural development should be focused on adequate housing, water/energy supply, proper sanitation facility, waste recycle, efficient mobility, multi-modal transport, telecom connectivity, networked communication, safety of citizens especially for children, women and differently abled people, pollution free environment, health and education facilities. In Barcelona, most of buildings are energy efficient. Barcelona “Solar Thermal Ordinance” has regulated all large buildings to produce domestic hot water (Slater and Khandelwal, 2016) with lowering emissions. In Seoul, most of infrastructure have been built including data centers consuming renewable energy sources.

The competitive economy can be built in smart cities via promoting entrepreneurship, innovation and partnerships capabilities. The interconnection of physical infrastructure, people, and business worlds through ubiquitous instrumentation, has the potential to create more efficient and safer intelligent IoT solutions (Li et al., 2017) for smart cities. The examples include personal environment (wearable devices and smart phones), home environment (home security devices, appliances), power grid (implementation of eMeters, Power Management Units), transportation (sensors on vehicles, roads, traffic lights, congestion alert and control devices), structural monitoring (deployment of sensors on bridges, buildings, vehicles, aerial platforms), water systems (formation of distribution grids, asset management and preventive maintenance). The stellar transit bus system in Barcelona (Slater and Khandelwal, 2016) consists of horizontal, vertical and diagonal lines to make the travel faster, easier, and more frequent. The city has separate lane for cycles. Similarly, Copenhagen has extensive network of cycle lanes (Manville et al., 2014). MASDAR smart city is known for its Well-designed connectivity.

5.3. ICT infrastructure development

The software components (Annexure 1) comprise of computer programs, application software, data science, information system, data visualization and mobile apps for various services. The shared infrastructure reduces the service costs. The Smart cities must develop a dynamic, demand-based pricing model to influence citizens' behavior and service usage. The implementation of smart technology can be advantageously if it can quickly detect or monitor various spatial or unusual events happening in and around the city. ICT, telecom and advanced network infrastructure deliver better e-services to its stakeholders (Novotný et al., 2014). For example, ‘LinkNYC’ is a system of high-tech public communications structures installed across the New York City to provide completely free, ultra-high speed encrypted Wi-Fi service (Slater and Khandelwal, 2016). The system also provides free cell phone charging stations, free emergency 911 calls, free domestic phone calls and non-emergency 311 calls etc.

The facility of wireless, optical and sensor networks represent the maturity of IT infrastructure (Lee et al., 2014) in a smart city. The network architecture of a city comprises of high performance computing, cloud computing, internet of things, artificial intelligence, CCTVs, sensors and multi-agent systems. For example, Beijing Government cloud data center (Lucky Cloud Project) provides server, security and storage devices, firewall, switches and cloud platform. It also facilitates resource integration at multiple levels, planning services and service transfer ability using cloud platforms (Zubizarreta et al., 2015).

RFID technology and wireless sensor technologies (WSN) technologies provide the means of communications and network infrastructure (Farahani et al., 2018). In smart cities, a lot of improvements have been expected such as quality of life, governance, effective usage of natural resources and public facilities (Al Nuaimi et al., 2015; V. Chang et al., 2018) as compared with traditional cities. For example, the RFID is variedly used in many sectors such as healthcare, supplying goods, smart homes, retail management, logistics and inventory management, transportation and warehouse management (Gao and Bai, 2014; Mital et al., 2017). The users are able to scan QR code to pay money electronically for used services or to purchase the goods (V. Chang et al., 2018; Turban et al., 2018).

The different needs and contexts (Neirotti et al., 2014) can be understood through analyzing the pattern of usage across the cities. The advancement in communication and mobile technologies have enabled the capability of sensing and analyzing the user's environment (Liao et al., 2017). Tel-Aviv smart city has launched Residents smart city card for all residents who have crossed 13 years of age. The card facilitates citizens to receive personalized information through emails, messages along with a personal resident account (Slater and Khandelwal, 2016) to choose desire set of services.

The analytical software, embedded control systems, complex engineering and management solutions, recognition and processing of texts, images and video, big data technology, fog computing are required to develop the analytical capability of a city authority. Monitoring and remote controlling are necessary (Novotný et al., 2014) for the better utilization of city resources. Advances in sensing technology and global positioning systems (Liao et al., 2017) make enable to track the geolocation services. For example, Open311 interface is a GPS based touch card payment system for taxis to collect real-time traffic data to improve commuting in Seoul (Slater and Khandelwal, 2016). The smart environment can be developed based on information generation and analysis (Al Nuaimi et al., 2015; Chang, 2018c) using advanced technologies.

The wireless sensors, IoT, networked and sharing technologies can offer a substantial service solutions for smart cities. A typical IoT system consists of sensors, communication interfaces, advanced algorithms, and cloud interface. The cloud computing offers computing resources through internet and remote processing to manage, storage, share huge volume of internet of things (IoT) data and backend capabilities for data analytics and control (Liao et al., 2017). Sensors can be applied to collect data from various connected devices (Farahani et al., 2018). For example, sensors have been installed in bicycles to measure noise, congestion and road condition in Copenhagen (Manville et al., 2014). In Barcelona, sensors and radio frequency tags are used on rubbish and recycling bins to develop automated waste collection system.

IoT facilitates more advanced integration with cloud computing, internet services, cyber physical systems and interconnections between hardware and software devices (Farahani et al., 2018). The IoT technologies highly influence the feasibility of smart cities development (V. Chang et al., 2018; Hashem et al., 2015). Fog computing enables to run smart applications and processing on network devices such as routers, gateways or switches to make it faster instead sending data to cloud centers (Osanaiye et al., 2017; Sohal et al., 2018).

5.4. Deploying smart solutions

The establishment of various sensors and data centers give the data storage capability, processing and visualization ability to city administrations to develop new digital solutions. Sensors are embedded on the objects or “things”, which are linked through networks (wired or wireless). “Smart” is the collective intelligence of software, hardware,

cloud and sensing technologies to capture and communicate real time sensor data of the physical world for advanced analytics and intelligent decision making process (Mital et al., 2017). For example, the government of Chicago smart city is the one of most data-driven government that has deployed advanced digital surveillance system, green roof, and Array of Things (AoT). AoT is a network of sensors that can be mounted on streetlight traffic signal poles to measure pollution, sound intensity, traffic flow, temperature, barometric pressure etc. (Zubizarreta et al., 2015).

The availability of green spaces in the city has become an important dimension of smartness, which in turn benefits socio-economic advantages. The use of green building technologies, dust management, public transport and low carbon technology can reduce the pollution level in a city. The sensors can be deployed at various places to collect the pollution data and to send the alerts for the concern actions. Collecting, recycling and waste recovery are effective urban sustainable practices for the well-being of people and environment. For example, the smart waste management system have been deployed in Hong Kong (Anthopoulos, 2017).

In smart cities water, gas, and energy should be continuously supplied. The real time data and dashboard monitoring can support city administration to manage smart services and control for better governance (Novotný et al., 2014). Implementation of smart meters technologies in households (Lee et al., 2014) can provide consumption patterns to optimize the usage and supply. Integrated monitoring system has been deployed in Masdar city to measure and analyze daily energy consumption and requirement of each building. The leakage sensors can assist in identifying the faults in supply. The utility supply should be managed dynamically by smart grids based on the demand patterns. The apps can be developed and integrated with home appliances to suggest the smart consumption and to make auto switched off. To promote the civic facilities for the citizens, the information modelling of city infrastructure with all the key locations and online help platforms must be developed.

Public safety and crime control are also important dimensions for the citizens residing in cities. Satellite monitoring, CCTV surveillance, use of global positioning system (GPS) and analysis of unexpected events happening in a city based on sensor data and availability of panic buttons can reduce the crime rate in a city. For example, In Georgia smart city, travelling apps have been developed to alert police about suspicious activities in city. Weather, climate changes, disasters preventive measures and impacts analysis can save more lives (Chang, 2018a) in a city. The assurance of privacy and security of all digital devices improve the people trust to use digital services and transactions.

The value of data is highest when real-time decisions and proactive responses are possible (Li et al., 2017). For example, the traffic flow can be maximized through traffic maps and real time information about the congestion. The multimodal transport system can reduce the travel time. The smart transport system (Annexure 1) improves the mobility and energy usage. The integrated transport system can aid ease of access, public safety, better emergency responses and quick recovery (Elmaghraby and Losavio, 2014) from any damage. Bus network should be designed based on public movement. Solutions such as efficient street junctions, freight capacity utilization, sensors based street lighting, app based smart parking and smart payments systems have been deployed in Birmingham smart city. Ride sharing, dynamic carpooling and vehicle rental facility will reduce the pressure on public transport.

Smart transport system has been designed in most of smart cities such as Barcelona, Birmingham, HafenCity, Dublin, Seoul, Rio de Janeiro, New York, Singapore, Masdar city, Copenhagen, Songdo smart city, Dubai and many other smart cities across the world. Singapore has designed intelligent smart transport system by integration of mixed land use, bus lane enforcement system, accurate sensing, fast processing, zero-causalities, integrated rail and bus services, cycling facilities, traffic news broadcasting, use of green vehicles, real-time service information, integrated multi-modal payment system and parking guidance system (Haque et al., 2013). In addition to data collection through sensors on ground, the radar system is also used to detect incidents and to provide quick response to restore normal traffic flow in Singapore.

Smart devices must be deployed to measure and monitor public health conditions also to share health feedbacks and experiences to reduce the long term health cost. The children, elderly and chronically-ill must be monitored through distant health programs. Li et al. (2017) have talked about structural monitoring and public health surveillance. The ICT has changed the traditional relationship between patients and physicians (V. Chang et al., 2018) and facilitate integrated e-health system.

With the advent of multiple wearable devices and smartphones, the various IoT based devices are changing and evolving the typical old healthcare system into a smarter and more personalized one (Mital et al., 2017). For example hearing aids, a high technology oriented wearable device which is connected to network to avail online healthcare services (V. Chang et al., 2018; Wright and Keith, 2014). Through this device, users can access medical services online such as medical check-up, and consultation with doctors. Such devices improve the accessibility to better treatments, high standards of living, comfort, feeling connected with society and great happiness (V. Chang et al., 2018).

Farahani et al. (2018) have proposed a transition from the clinic-centric treatment to patient-centric healthcare where each agent such as hospital, patient, and services are inter connected. Mobile hospitals and nursing center can facilitate the emergencies services for needy and disabled people. The use of smart ambulances, Mobile clinics and medical imaging simulations (Chang, 2018b) are the increasing interest among the globe. The telemedicine services can reduce the number of visits to hospitals and clinics, especially for patients and persons with special needs (Farahani et al., 2018). The mobile health (m-health) has made easy accessibility to a number of healthcare services and has strengthens the capabilities of indoor monitoring and early detection of emergency and abnormal situations (V. Chang et al., 2018). In advance to m-health, combining sensing capabilities of smart city can develop smart health system (V. Chang et al., 2018; Solanas et al., 2014).

Development of ICT specialized economic zones promote the business activities. The demand can be analyzed for accurate manufacturing and supply. The collections of citizens' experience and requirement would help the industries to become more competitive in the market. In Manchester, the state-of-art technologies have been developed for business, IoT based services, Innovation lab and to facilitate Open data (Manville et al., 2014) for designing new services. In Seoul, virtual purchase store have been installed at bus stops (Slater and Khandelwal, 2016), so that citizens can place online order while waiting for a bus. Similarly, Birmingham smart city has developed i-Tech Hubs to grow e-Businesses and innovation. The government is developing new markets through public procurement and funding support for SMEs.

A city must be a place for the tourists for various purposes. The complete tour guide, virtual city tour and appropriate assistance will attract more tourist in the city. The city must be equipped with shopping malls, multiplex, sports activities, and cultural activities. To make the city hygiene and clean, the waste should be removed in completely covered manners. Recyclable materials should be used to make the city greener and to reduce the waste. Sensor based garbage collection, automated recycling, use of smart bins, waste to power generation, and converting waste into manure can help municipalities to make the city cleaner in best possible manner.

Using ICT and IoT devices, people can connect with smart learning programs, workforce training and educational programs at various levels. The course information, program completion certificate, interactive tutorials and smart learning labs can be provided online to make the education smart. The dashboard can be developed to check the

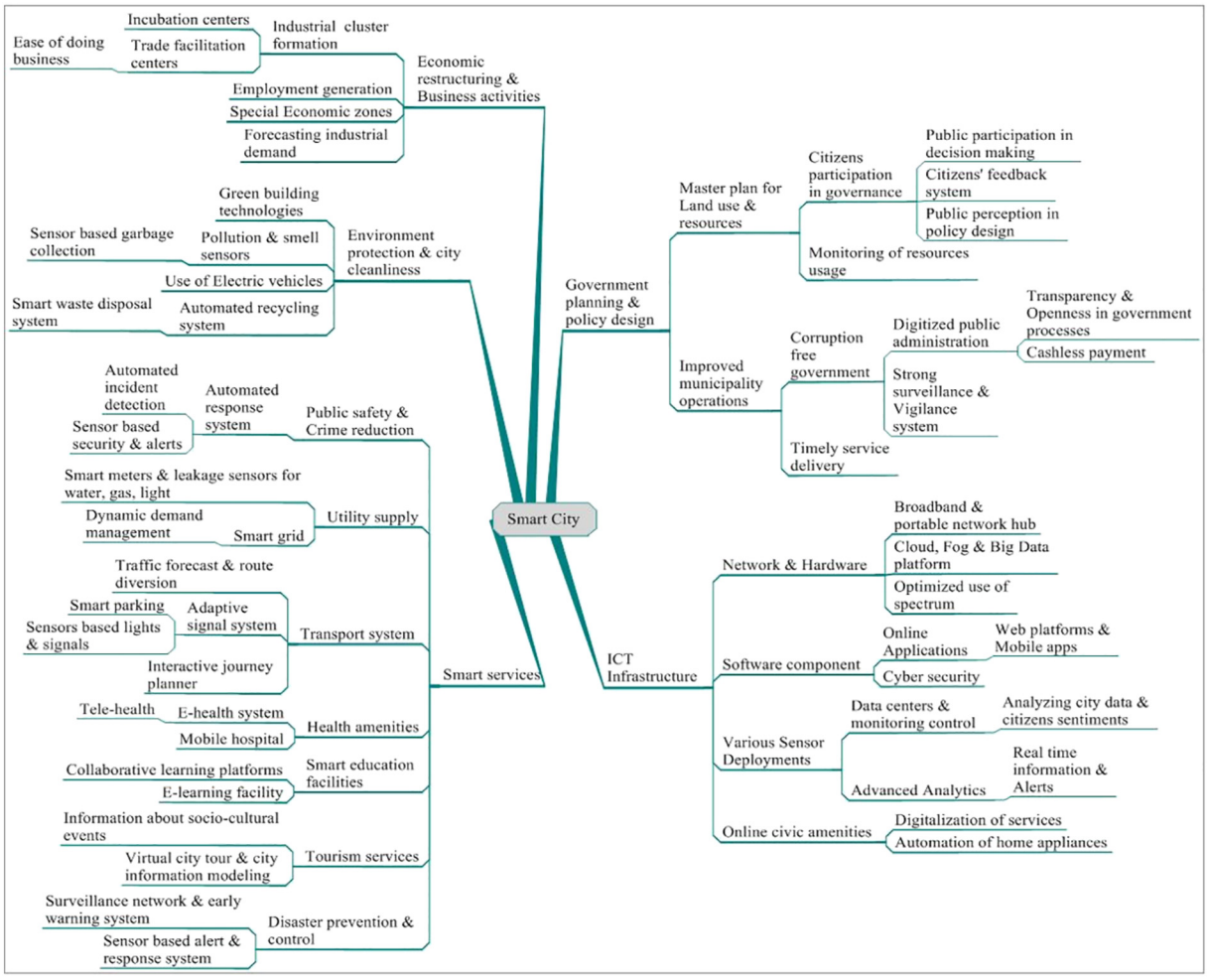

Fig. 3. Mind map visualization for smart city transformation and smart service design.

performance and other details in an interactive and summarized format.

Seismic surveillance networks and earthquake, cyclone, tsunami, flood etc. early warning system can reduce the loss of city infrastructure and human being. Sensors can be deployed at key points in the city and near surroundings as an integral part of city infrastructure. The apps can developed to provide the alerts and message during the emergencies. The government of Tel-Aviv smart city has developed an emergency readiness network (Slater and Khandelwal, 2016).

Building smart urban infrastructure lays large scale opportunities for both service developers and users. The smart services across the various domains of civic life such as transport, public safety, crime reduction, health, education facilities, city cleanliness, business activities tourism and entertainment services etc. can be designed and delivered through the adequate planning, advancement of physical infrastructure, ICT infrastructure and deploying smart solutions (Fig. 2).

6. A mind map visualization for smart city transformation

To visualize the transformation of smart cities, a mind map (Fig. 3) was developed using MindManager ×5 software with the help of research professionals and experts' opinion.

Mind map is a visual picture of ideas or concepts to see how ideas are related to one another. Every node in a mind map can be a new mind map. The smart city was placed as a center point to build the mind map. The process was continued to connect the ideas based on relevance. The mind map model was refined in best possible manner with the help of experts (Annexure 2).

Bibri and Krogstie (2017) have stated about the urban sustainability and talked about enhancement of four dimensions as physical, environmental, economic, and social to attain urban sustainability. To transform a city into smart city, five simultaneous branches (government planning & policy design; Economic restructuring & business activities; ICT infrastructure; Environment protection; and smart services) have been considered for the overall and sustainable growth of a smart city. The different solutions (Annexure 1 and Fig. 2) have been mapped to develop the mind map of smart city transformation.

7. Research contributions and implications

In terms of theoretical contributions, the study suggests an efficient list of services (Annexure 1) across the major domains of a city to make improvements in city as well as in citizens' life. The Smart City Transformation Framework (SCTF) is proposed to provide a clear understanding about complex process of city transformation based on four key areas (planning, physical infrastructure, ICT infrastructure and deploying smart solutions). The framework suggests the effective usage of ICT and advanced technologies to enhance living environment, service planning and delivery to enhance the quality of citizens' life. The framework effectively deals with smart city design process either via upgrading the existing city or developing a new smart city.

From practitioners' (government officials, policy designers and city planners) perspectives, the proposed SCTF (Fig. 2) specifies a clear step by step solution about smart city transformation. The designed Mind map (Fig. 3) provides the more insights about interlinkages among the various ideas collected through the designed methodologies used in this

study. From technological consultants and service providers' perspectives, the study suggests the different usage of ICT and advanced technologies to deploy smart solutions. From citizens and multi stakeholders' perspectives, the proposed solutions provide clear understanding among the citizens about the smart services design and role of the effective participation to build service typology for smart cities. From academic and research perspectives, the study contributes in knowledge creation to the previous research and provides directions for future research modifications in approaches based on local contexts and time being demand.

The different insights can be drawn from the proposed frameworks to contribute in terms of research implications. The policy design, delivery of e-services and smart solutions should be implemented to meet the services demand for developing a smart city. The structure of governance in a smart city should be transparent, open, highly collaborative (Gil-Garcia et al., 2014) and must be efficient in participatory planning, service delivery capabilities, economic restructuring, designing and implementing new initiatives for public sectors.

The advanced information centric platforms and ICT oriented services (Piro et al., 2014) coupled with sensors and IoT devices can make the services smart. The technological components should be installed to sense, collect, coordinate, integrate, process, analyze and model (Bibri and Krogstie, 2017) the data to share information for monitoring, understanding and better planning for modern services in smart cities. The Network infrastructure should be scalable with increasing number of users, lower latencies, and higher bandwidths (Farahani et al., 2018). The planned e-services and adequate use of technological platforms such as Big data, fog computing and cloud computing can reduce the services costs (Chang, 2017).

The data mining and pattern recognition in time-series data, feature extraction, machine learning, light-weight signal processing, event processing, automated reasoning, embedded web server (Farahani et al., 2018) incorporate the smartness in service design and deliveries. New age technologies like augmented reality, 3D printing and wearable technologies can help to create newer services based on evolving needs to the current age consumer (Mital et al., 2017). Multi-layered security solution (Chang, 2018a), network authentication and network firewall (Farahani et al., 2018) ensure a strong cybersecurity (Liao et al., 2017) solutions for smart city applications.

The services can be co-created and co-designed with the involvement of citizens. The citizens must be engaged directly in planning and service design. The sentiment analysis over social platforms can be applied towards creating new applications in different contexts (Karyotis et al., 2018). The technological capability enhances emerging services and analytics (Chang, 2018a), municipality management, e-transactions, mobile applications and smart services across various domains of city. The designed services should be scalable to extend in nearby places also to make neighborhood smart (Kumar et al., 2017). The government should release non-confidential government data freely open for reuse and application development by third parties and citizens to promote citizens' driven innovative initiatives for resource optimization and sustainable urban growth.

8. Conclusions

The cities are usually complex systems which include different stakeholders, citizens, economic activities, physical infrastructure, housing, services and utilities. The urban planning is mostly concerned with policy design, effective administration, strategic implementation, resource monitoring and activities control in a city space to improve efficiency, sustainability and livability. Defining visions and appropriate roadmap strategies for implementation through crowd participation and partnerships are essential to develop an innovative smart urban eco-system.

The study uses the online peer vetted crowdsourcing approach to get the service ideas in diverged service domains for the smart city development in India. While analyzing the collected data, 19 unique service categories were defined through qualitative content analysis method. All the categories again were divided into two classes as primary or basic infrastructure and ICT based smart solutions. Based on the crowdsourced service solutions, a Smart City Transformation Framework (SCTF) has been proposed in terms of planning phase, development of physical infrastructure, ICT infrastructure and deploying smart solutions. To represent the outcomes in visual format and to develop interrelationships among the ideas, a mind map has been created.

The findings suggest proper planning and integration of infrastructure (city physical infrastructure, IoT devices, sensors, network platform and data analytics) improve the service delivery and efficiency. Development of technology solutions and adaptive use of technology are required for smart cities that can react quickly to the changing citizens' needs and demands. The smart city planning enables resource sharing and use of common citizens' applications to optimize the services. Based on city data analysis, new services can be designed. To get the user value, the smart city governance should work closely with citizens and different stakeholders to identify the set of services, prioritizing the needs, quickly deliver, lower costs services for a long term city transformations that can accelerate smart city development.

9. Limitations and future research

The development of smart services require incorporation of advanced technology into urban activities across different domains. The study suggests the various smart solutions, framework for city transformation and mind map visualization for smart city but it does not explain the proper layout for the integration and interconnection of physical layer, ICT and IoT infrastructure. The service design, implementation and delivery of new services require a period of time. The study does not estimate any time frame to understand the real-time implementation and impacts to the citizens. The required time frame for effective implementation usually depends on many factors such as country layout, government structure and urgency of the requirement etc. Hence, it may vary for different cities as well as countries.

The cyber security, privacy and authentication are major challenges for digital infrastructure in the smart cities. The study does not cover these issues in detail and does not provide resolving solutions while discussing the city transformation layout and smart solutions. The citizens' participation is elementary for participative governance and citizens centric smart services but the participation of citizens are totally voluntary process and it depend on willingness of citizens to participate or don't. The study has not covered the digital literacy and willingness of citizens to take part in such process.

In content analysis, developing the coding scheme always involve interpretation. Therefore, some risks of similar biases can be faced by other measurement techniques. The inferences and suggestions are limited to the content received in this study through the discussed methodology in the study. The qualitative content analysis method analyzes the data but cannot test casual relationships among variables. The present study shows the technological oriented smart services to improve the city functions, government accountability and e-service delivery through multiple channels. However, the given service typology and mind map do not provide any institutional ranking or hierarchy of services to measure the smart city maturity. In future research such issues can be addressed and potential solutions can be developed with the use of appropriate methodologies.

Appendix A

Annexure 1
Suggested solutions for smart city development (through crowdsourcing and content analysis process).

Categories	Infrastructural basic solutions	ICT oriented smart service solutions
Government planning and policy design	• Master plan for land use • Collaboration among all levels of government • Centralized fund distribution and control • Slums redevelopment plan • Direct benefit transfer schemes • Plan for routine health programs for citizens • Increased housing and transportation capacity • Facility of public gardens, parks and library • Effective laws to reduce greenhouse gas emissions • Crop-wise management of irrigated area under land use statistics	• Management and monitoring of the resources across the cities • Auto assessment of policies and inclusions of improvements • Cost effective public services • Transparent procurement and implementations of projects • Timely services delivery to the citizens • Municipality operations and public inspection on various services • Promotion of open data platforms to improve services and communication • Issue of various certificates to public through online platforms
Citizen participation & engagement in governance	• Public participation in decision making • Equality of participation to all citizens • Engagement of multi-stakeholders and communities in policy implementation and policy evaluations • Consider public perception in policy design	• Community engaging portals like 'MyGov' • Online citizens' feedback systems to government • Social media platforms • Toll free number, live chat, official blogs, and responses over social sites via multichannel ways
Corruption free government	• Spread awareness among people to fight against corruption • Transparency and openness in government processes • Process automation to reduce manual discretion	• Promoting digitized public administration • Cashless payment system for essential services • Online inspection and vigilance system • Use of anti-bribery software system and CCTV surveillance in offices
Economic restructuring	• Usage of renewable energy sources • Financial management to mobilize funds • Industrial cluster formation • Development of startup incubation centers • Making ease of doing business with in the city and across the cities • Developments of IT parks and trade facilitation centers in the city • Implementation of FDI and flexible labor laws • Entrepreneurship opportunities at local and global market • Flexible working hours	• Smart system for recycling waste and conservation of resources • Promote advanced farming techniques • Encourage e-business practices • Employment generation and e-entrepreneurship facility • Employment through social innovation
Network & hardware	• Deployment of broadband networks and portable network hubs for Internet • Increased network coverage and wireless connectivity • Maintaining data security and privacy • Interactive Voice Response (IVR) to facilitate city information and response to queries • Deployment of security cameras throughout the city	• Configuration of high-security authentication on all camera connected ports • City cloud services, fog computing and use of big data to offer value added solutions • Telecom connectivity with city and home appliances like CCTV, traffic lights, different sensors, bike racks, car parks, energy meters, elevators etc. • Optimized use of spectrums and use of smart antennas
Software components	• Adaptive and tangible user interfaces for various civic services	• Development of web applications to digitalized services Cybersecurity and software protections frameworks and initiatives • Different mobile apps facility like — ambulance, fire brigade, multi-modal transport, ridesharing, women safety, healthcare, education, payments, locate restaurants, hospitals and parks, energy consumption and carbon released, suggest ways to consume energy smartly etc.
Sensor deployments	• Setting up of security cameras and pollution sensors on phone towers • Detection system for vehicles that violate rules • Sensors enabled bridges, rail tracks, roads and • Street lighting system • Panic buttons in mobiles to request assistance • Environmental data collection	• Automated warning and counter safety systems • Alert systems for buildings • Smart bins to collect the garbage • Leakage sensors for water/gas/electricity • Sensor based switching system for electronic items • Sensor based security and alert systems across the city

(*continued on next page*)

Annexure 1 (*continued*)

Categories	Infrastructural basic solutions	ICT oriented smart service solutions
Data centers & analytics	• Development of data centers for detailed and analyzed information about activities of cities • Bus/train/public transport network design based on data analysis of the most common traffic flows including interchanges • Dashboard to show real time usage of utilities	• Automatic alert to police and hospital in case of accident • Automated call analyzer for any security threat • Intelligent tracking of city resources • Turning social media data related to city issues into events and sentiment analysis • Citizen alert services in case of disaster or emergencies
Environmental protection and safety	• Develop public parks to increase greenery • Development of noise free zones in the city • Usage of green building technology • Dust management and control system • Improved transportation capacity by sharing vehicles, use of CNG vehicles and public transportation • Use of electric vehicles	• Pollution detecting sensors at various key points in the city to check air/water/noise quality and alerts system • Deployment of sensors in industrial areas to check emissions • Develop mobile apps that can help individuals to track amount of carbon released by cars, refrigerators and other devices to get timely repair services
Public safety and crime reduction	• Unique identification numbers for everyone • 24 * 7 helpline and response facility • Aggressively investigation of civil/criminal cases • IRIS scanners at airports and other sensitive zones for verification • Emergency call boxes and panic buttons at various places in the city • Gun-shot detection system at horde places	• App to contact police in case of emergency • Embedded chips in number plates to identify unregistered vehicles in the city • Sensors and CCTVs at most of the outlets to reduce theft cases • Live feeds and alerts from HD cameras embedded in the city's LED streetlights • Sensor based security and alert systems • Automated incident detection and corresponding response
Utility supply and consumption monitoring (water/ gas/fuel)	• 24 × 7 water & electricity supply • Water quality compliance monitoring system • Geospatial gas pipeline integrity • Waste-to-power generation plants • Rain water harvesting system • Natural reservoir management system • Onsite energy generation and storage capacity • Development of green buildings - intelligent management of temperature, lighting, security, energy etc. • Structures to utilize more of daylight • Formation of smart grid	• Smart meters for monitoring water, energy and fuel usage • Leakage sensors for water/gas/electricity supply • Water and gas distribution based on consumption of households through data analytics • Dynamically managing grid energy load and usage • Optimizing requirement of lighting in the city based on sensors and LED lighting • Apps to suggest ways to consume energy smartly • Sensor based appliances that automatically monitors and reduce energy usage • Future demands prediction of energy based on consumption trends • Integration of alternate renewal energy sources • Sensors to inform faults in power lines across the city • Real time information on power cuts for maintenance purpose
Promoting civic amenities online	• Digitalization of information and services • Information modelling of city infrastructure • Develop online platform like AskGov that can be a centralized contact center for a wide array of government departments	• Advanced city maps and location finding facilities like restaurants, hospitals, petrol pumps, parks and sanitation • SMS updates to all citizens about new policy decisions • Integration of single Identity card like Aadhar to link various services • Turning social media data related to city issues into events and sentiment analysis • Intelligent advisory system for farmers • Analysis of the customers' satisfaction with various services • Mobile/digital payments facilities • Online grocery & retail shops • Automation of home appliances

(*continued on next page*)

Annexure 1 (*continued*)

Categories	Infrastructural basic solutions	ICT oriented smart service solutions
Transport system	• Increased bicycle lanes in the city • Bus network design based on data analysis of the most common traffic flows including interchanges • Traffic forecast and rerouting information • Dynamic digital message signs on roads • Driving lane guiding apps • Ride sharing, dynamic car-pooling, car and bike rental facility • Interactive journey planner for all transport modes • Special transport facilities for babies/special need people in public transport • In-vehicles - safety alert systems	• Real time traffic and congestion information • Smart parking and direction system • Smart card payment system • Vehicle tracking system - GPS navigation • Chip embedded number plate recognition to monitor vehicles • Mobile apps for multi-modal transport information • Alert system for vehicles that are violating signal • Automatic road enforcement system • Automatic alert to police and hospital in case of accident • Adaptive traffic signals based on mass flow • Transport infrastructural predictive maintenance alerts • Sensor based street lighting system • Sensor based vehicle communication system to prevent the accidents
Health amenities	• Smart health card facility • Panic buttons in mobiles to request medical assistance from nearby hospitals • Online health portal and appointment facility • Mobile hospital and nursing facility center	• Tele-health to provide clinical health care at distance • App to check availability of medicines in nearby medical stores • ICT enabled home care for differently abled and old age people • Smart wearable to measure blood pressure, sugar and heart rate etc. • Online portal for blood bank
Cleanliness in city	• Waste should be transported in completely covered vehicles • Advanced water purification and effluent treatment plants • Waste collection scheduling plan • Solid waste management system • Water disposal and sewage treatment plants • Hazardous and non-hazardous waste sorting • Proper disposal of industrial waste • Promoting greener cities by using recyclable material	• Sensor based garbage pickup and dumping services • Automated recycling system • Use of smart bins (alerting when near full, transmitting to nearest garbage collector) • Separation of waste on the basis of the materials like bio-degradable and non-bio-degradable • Usage of dumping bio-waste to make manure instead of burning them which leads to pollution • Smell sensors near dust-bins/dump yards that can send signal to municipality for waste collection
Education facilities	• Smart classrooms & collaborative learning platforms • Distance education solution for working people • Skills development centers • Bio-metric attendance system • Audio-visual aids for disabled students • Digital library facility • Cycle dock (bicycle sharing system) in the campus to make green campus	• Online availability of educational resources • Online portal for syllabus and course registrations • Global lecture series through video conferencing • Interactive tutorials through videos, images and games • E-newsletters and mobile alerts to students and parents • Virtual e-learning center for rural areas • Dashboard facility for faculty, students and staff • Smart learning labs with real time simulations
Business activities	• ICT enabled Special Economic Zones (SEZ) in the city • Online business discussion forums and communities • IT outsourcing to support the quick launch of new businesses and the streamlining of operations • BPO service beyond the framework of ordinary IT to reduce the burden of indirect operations of business	• Online applications and approvals for trade license etc. • e-Invoicing facility • Smart supply chain for storage and transit • Respond to citizens' needs and demands in product design • Forecasting consumer demand • Integration of social media to promote business
Tourism & entertainment services	• Eminent facilities for foreigners in the city • City to city support for travel information • Advance information on socio-cultural events in the city • Establishment of shopping malls, sports facilities and multiplex.	• Online boards to provide information regarding city attraction points to visit • Information regarding tourism activities in the city • Virtual city tour and authorized guides to help foreigners • Online information regarding the city events and suggestions for activities to perform in leisure time.
Disaster prevention alerts and controls	• Weather intelligence systems and forecasting • Centralized contact point for all emergency services for rapid actions • Early detection and control on forest fire • 24 × 7 online relief support centers and helpline numbers • Seismic surveillance networks and earthquake early warning system	• Disaster warning alerts to registered mobile numbers of citizens • Cyclone/tsunami/flood/volcanic mitigation and evacuation strategies • One-touch app for fire brigade services in city • Sensors at coastline to detect variations in sea levels • Sensors based alert systems as an integral part of city infrastructure

Annexure 2

List of experts consulted for building the consensus on categories and corresponding solutions (Annexure 1) and to finalize the smart city Mind map (Fig. 3). The personal information such as names, organization details and contact details are not provided for data and information privacy concerns.

Experts	Expert profile/designation	Experience in years	Affiliation
Expert 1	Professor, Urban planning	> 22 years	Academician, Delhi, India
Expert 2	Solution Architect, Green Technology	> 16 years	Industry, Government of India
Expert 3	Executive Officer, City development authority	> 13 years	Government Official, India
Expert 4	Sr. Engineer, Public works department (PWD)	> 11 years	Government Officials, India
Expert 5	Professor, e-Governance	> 15 years	Academician, Delhi, India
Expert 6	Chairperson, Municipality	> 15 years	Government Official, City in State, India
Expert 7	CEO, Planning & IT	> 15 years	Private industry, India
Expert 8	General Manager (Telecom & network infrastructure)	> 12 years	Government official, India
Expert 9	Professor, Urban development	> 22 years	Academician Uttar Pradesh, India
Expert 10	Manager-service excellence (network coverage)	> 11 years	Telecom Industry, India
Expert 11	Cyber security expert	> 13 years	Consultant, India
Expert 12	Associate Professor, Competitiveness & Strategy	> 11 years	Academician, State University, India
Expert 13	Consultant (Urban design and economic evolution)	> 12 years	Service providing firm, India
Expert 14	Consultant, Planning	> 10 years	Affiliated to Government, India
Expert 15	CEO, Urban development and Smart city project	> 8 years	Government officials, India
Expert 16	Solution providers (wireless services & 4G)	> 9 years	Private firm, India
Expert 17	Project manager, Operations	> 11 years	Consulting firm, India
Expert 18	Technology consultant, IT Applications	> 9 years	Private firm, India
Expert 19	Engineer, Road Development	> 8 years	Government officials, India
Expert 20	Sr. Architect	> 7 years	Private firm, India
Expert 21	Consultant, Urban business	> 9 years	Private firm, India
Expert 22	Officer, monitoring & control (urban infrastructure)	> 8 years	Government officials, India
Expert 23	Senior adviser (smart city, m-Governance)	> 10 years	Secretariat, Government of India

References

Al Nuaimi, E., Al Neyadi, H., Mohamed, N., Al-Jaroodi, J., 2015. Applications of big data to smart cities. J. Internet Serv. Appl. 6 (1), 25.

Angelidou, M., 2014. Smart city policies: a spatial approach. Cities 41, S3–S11.

Anthopoulos, L., 2017. Smart utopia VS smart reality: learning by experience from 10 smart city cases. Cities 63, 128–148.

Belanche, D., Casaló, L.V., Orús, C., 2016. City attachment and use of urban services: benefits for smart cities. Cities 50, 75–81.

Bennis, W.G., O'Toole, J., 2005. How business schools lost their way. Harv. Bus. Rev. 83 (5), 96–104.

Bertot, J., Estevez, E., Janowski, T., 2016. Universal and Contextualized Public Services: Digital Public Service Innovation Framework.

Bibri, S.E., Krogstie, J., 2017. Smart sustainable cities of the future: An extensive interdisciplinary literature review. Sustain. Cities Soc. 31, 183–212.

Bulu, M., 2014. Upgrading a city via technology. Technol. Forecast. Soc. Chang. 89, 63–67.

Buyya, R., Yeo, C.S., Venugopal, S., Broberg, J., Brandic, I., 2009. Cloud computing and emerging IT platforms: vision, hype, and reality for delivering computing as the 5th utility. Futur. Gener. Comput. Syst. 25 (6), 599–616.

Buzan, T., Buzan, B., 1995. The Mind Map Book: Radiant Thinking the Major Evolution in Human Through.

Chang, V., 2017. Towards data analysis for weather cloud computing. Knowl.-Based Syst. 127, 29–45.

Chang, V., 2018a. An overview, examples, and impacts offered by emerging services and analytics in cloud computing virtual reality. Neural Comput. & Applic. 29 (5), 1243–1256.

Chang, V., 2018b. Computational intelligence for medical imaging simulations. J. Med. Syst. 42 (1), 10.

Chang, V., 2018c. A proposed social network analysis platform for big data analytics. Technol. Forecast. Soc. Chang. 130, 57–68 .

Chang, V., Mills, H., Newhouse, S., 2007. From Open Source to long-term sustainability: Review of Business Models and Case studies. In: Proceedings of the UK e-Science All Hands Meeting 2007. University of Edinburgh/University of Glasgow (Acting through the NeSC).

Chang, V., Walters, R.J., Wills, G., 2013. The development that leads to the cloud computing business framework. Int. J. Inf. Manag. 33 (3), 524–538.

Chang, N.B., Lu, J.W., Chui, T.F.M., Hartshorn, N., 2018. Global policy analysis of low impact development for stormwater management in urban regions. Land Use Policy 70, 368–383.

Chang, V., Wang, Y., Wills, G., 2018. Research investigations on the use or non-use of hearing aids in the smart cities. Technol. Forecast. Soc. Chang. http://dx.doi.org/10.1016/j.techfore.2018.03.002. (in press).

Dahlander, L., Piezunka, H., 2014. Open to suggestions: how organizations elicit suggestions through proactive and reactive attention. Res. Policy 43 (5), 812–827.

Davis, F.D., 1985. A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results (Doctoral dissertation). Massachusetts Institute of Technology.

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 319–340.

Davis, F.D., Bagozzi, R.P., Warshaw, P.R., 1989. User acceptance of computer technology: a comparison of two theoretical models. Manag. Sci. 35 (8), 982–1003.

Droegemeier, K.K., Gannon, D., Reed, D., Plale, B., Alameda, J., Baltzer, T., ... Joseph, E., 2005. Service-oriented environments for dynamically interacting with mesoscale weather. Comput. Sci. Eng. 7 (6), 12–29.

DuPuis, N., Stahl, E., 2016. Trends in smart city development-case studies and recommendations. In: National League Of Cities. Center For City Solutions And Applied Research.

Elmaghraby, A.S., Losavio, M.M., 2014. Cyber security challenges in smart cities: safety, security and privacy. J. Adv. Res. 5 (4), 491–497.

European Parliament, 2014. Mapping Smart Cities in the EU. Study. Policy Department A: Economic and Scientific Policy, European Parliament, Brussels.

Farahani, B., Firouzi, F., Chang, V., Badaroglu, M., Constant, N., Mankodiya, K., 2018. Towards fog-driven IoT eHealth: promises and challenges of IoT in medicine and healthcare. Futur. Gener. Comput. Syst. 78, 659–676.

Fedorenko, I., Berthon, P., Rabinovich, T., 2017. Crowded identity: managing crowdsourcing initiatives to maximize value for participants through identity creation. Bus. Horiz. 60 (2), 155–165.

Gao, L., Bai, X., 2014. A unified perspective on the factors influencing consumer acceptance of internet of things technology. Asia Pac. J. Market. Logist. 26 (2), 211–231.

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., Meijers, E., 2007. Smart Cities: Ranking of European Medium-Sized Cities. Centre of Regional Science (SRF), Vienna University of Technology, Vienna, Austria.

Gil-Garcia, J.R., Helbig, N., Ojo, A., 2014. Being smart: emerging technologies and innovation in the public sector. Gov. Inf. Q. 31, I1–I8.

Haque, M.M., Chin, H.C., Debnath, A.K., 2013. Sustainable, safe, smart—three key elements of Singapore's evolving transport policies. Transp. Policy 27, 20–31.

Hashem, I.A.T., Yaqoob, I., Anuar, N.B., Mokhtar, S., Gani, A., Khan, S.U., 2015. The rise of "big data" on cloud computing: review and open research issues. Inf. Syst. 47, 98–115.

Holsti, O.R., 1968. Content analysis. In: The Handbook of Social Psychology. 2. pp. 596–692.

Howe, J., 2006. The rise of crowdsourcing. Wired Mag. 14 (6), 1–4.

Hsieh, H.F., Shannon, S.E., 2005. Three approaches to qualitative content analysis. Qual. Health Res. 15 (9), 1277–1288.
Karyotis, C., Doctor, F., Iqbal, R., James, A., Chang, V., 2018. A fuzzy computational model of emotion for cloud based sentiment analysis. Inf. Sci. 433–434.
Kerlinger, F.N., 1986. Foundations of Behavioural Research, 3rd ed. Holt, Rinehart and Winston, New York.
Kern, C.S., Bush, K.L., McCleish, J.M., 2006. Mind-mapped care plans: integrating an innovative educational tool as an alternative to traditional care plans. J. Nurs. Educ. 45 (4).
King, S., Cotterill, S., 2007. Transformational government? The role of information technology in delivering citizen-centric local public services. Local Gov. Stud. 33 (3), 333–354.
Kohlbacher, F., 2006, January. The use of qualitative content analysis in case study research. In: Forum Qualitative Sozialforschung/Forum: Qualitative Social Research (Vol. 7, No. 1).
Kozinets, R.V., Hemetsberger, A., Schau, H.J., 2008. The wisdom of consumer crowds: collective innovation in the age of networked marketing. J. Macromarket. 28 (4), 339–354.
Kramers, A., Höjer, M., Lövehagen, N., Wangel, J., 2014. Smart sustainable cities–exploring ICT solutions for reduced energy use in cities. Environ. Model Softw. 56, 52–62.
Krippendorff, K., 2004. Content Analysis: An Introduction to its Methodology. Sage.
Kuk, G., Janssen, M., 2011. The business models and information architectures of smart cities. J. Urban Technol. 18 (2), 39–52.
Kumar, H., Singh, M.K., Gupta, M.P., 2016, September. In: Smart Governance for Smart Cities: A Conceptual Framework from Social Media Practices. Conference on e-Business, e-Services and e-Society. Springer International Publishing, pp. 628–634.
Kumar, H., Singh, M.K., Gupta, M.P., Madaan, J., 2017. Smart neighbourhood: a TISM approach to reduce urban polarization for the sustainable development of smart cities. J. Sci. Technol. Policy Manag. http://dx.doi.org/10.1108/JSTPM-04-2017-0009.
Lăcrămioara, O.C., 2015. New perspectives about teacher training: conceptual maps used for interactive learning. Proc. Soc. Behav. Sci. 180, 899–906.
Lee, J., Lee, H., 2014. Developing and validating a citizen-centric typology for smart city services. Gov. Inf. Q. 31, S93–S105.
Lee, J.H., Phaal, R., Lee, S.H., 2013. An integrated service-device-technology roadmap for smart city development. Technol. Forecast. Soc. Chang. 80 (2), 286–306.
Lee, J.H., Hancock, M.G., Hu, M.C., 2014. Towards an effective framework for building smart cities: lessons from Seoul and San Francisco. Technol. Forecast. Soc. Chang. 89, 80–99.
Li, C.S., Darema, F., Chang, V., 2017. Distributed behavior model orchestration in cognitive internet of things solution. Enterp. Inf. Syst. 1–21.
Liao, D., Sun, G., Li, H., Yu, H., Chang, V., 2017. The framework and algorithm for preserving user trajectory while using location-based services in IoT-cloud systems. Clust. Comput. 20 (3), 2283–2297.
Liu, A., Lu, S.C.Y., 2016. A crowdsourcing design framework for concept generation. CIRP Ann. Manuf. Technol. 65 (1), 177–180.
Luan, T.H., Gao, L., Li, Z., Xiang, Y., Wei, G., Sun, L., 2015. Fog Computing: Focusing on Mobile Users at the Edge. (arXiv preprint arXiv:1502.01815).
Manville, C., Cochrane, G., Cave, J., Millard, J., Pederson, J.K., Thaarup, R.K., ... Kotterink, B., 2014. Mapping Smart Cities in the EU.
Mattoni, B., Gugliermetti, F., Bisegna, F., 2015. A multilevel method to assess and design the renovation and integration of smart cities. Sustain. Cities Soc. 15, 105–119.
Mital, M., Chang, V., Choudhary, P., Papa, A., Pani, A.K., 2017. Adoption of Internet of things in India: a test of competing models using a structured equation modeling approach. Technol. Forecast. Soc. Chang. http://dx.doi.org/10.1016/j.techfore.2017.03.001. (in press).
Moreno, M.V., Terroso-Sáenz, F., González-Vidal, A., Valdés-Vela, M., Skarmeta, A.F., Zamora, M.A., Chang, V., 2017. Applicability of big data techniques to smart cities deployments. IEEE Trans. Ind. Inform. 13 (2), 800–809.
MoUD, 2015. Smart Cities Mission Statement and Guidelines. Ministry of Urban Development, Govt. of India.
Nam, T., Pardo, T.A., 2014. The changing face of a city government: a case study of Philly311. Gov. Inf. Q. 31, S1–S9.
Neirotti, P., De Marco, A., Cagliano, A.C., Mangano, G., Scorrano, F., 2014. Current trends in smart city initiatives: some stylised facts. Cities 38, 25–36.
Niaros, V., Kostakis, V., Drechsler, W., 2017. Making (in) the smart city: the emergence of makerspaces. Telematics Inform. 34 (7), 1143–1152.
Novotný, R., Kuchta, R., Kadlec, J., 2014. Smart city concept, applications and services. J. Telecommun. Syst. Manag. 3 (2), 1.
Odendaal, Nancy, 2003. Information and communication technology and local governance: understanding the difference between cities in developed and emerging economies. Comput. Environ. Urban. Syst. 27 (6), 585–607.
Ojo, A., Curry, E., Janowski, T., 2014. Designing Next Generation Smart City Initiatives-Harnessing Findings and Lessons From a Study of Ten Smart City Programs.
Osanaiye, O., Chen, S., Yan, Z., Lu, R., Choo, K.K.R., Dlodlo, M., 2017. From cloud to fog computing: a review and a conceptual live VM migration framework. IEEE Access 5, 8284–8300.
Piro, G., Cianci, I., Grieco, L.A., Boggia, G., Camarda, P., 2014. Information centric services in smart cities. J. Syst. Softw. 88, 169–188.
Plale, B., Gannon, D., Brotzge, J., Droegemeier, K., Kurose, J., McLaughlin, D., ... Yalda, S., 2006. Casa and lead: adaptive cyberinfrastructure for real-time multiscale weather forecasting. Computer 39 (11).
Poetz, M.K., Schreier, M., 2012. The value of crowdsourcing: can users really compete with professionals in generating new product ideas? J. Prod. Innov. Manag. 29 (2), 245–256.
Prasad, B.D., 2008. Content analysis. Res. Methods Soc. Work 5.
Ryan, R.M., Kuhl, J., Deci, E.L., 1997. Nature and autonomy: an organizational view of social and neurobiological aspects of self-regulation in behavior and development. Dev. Psychopathol. 9 (4), 701–728.
Sá, F., Rocha, Á., Cota, M.P., 2016. From the quality of traditional services to the quality of local e-government online services: a literature review. Gov. Inf. Q. 33 (1), 149–160.
De Santis, R., Fasano, A., Mignolli, N., Villa, A., 2014. Smart City: Fact and Fiction.
Schemmann, B., Herrmann, A.M., Chappin, M.M., Heimeriks, G.J., 2016. Crowdsourcing ideas: involving ordinary users in the ideation phase of new product development. Res. Policy 45 (6), 1145–1154.
Schuurman, D., Baccarne, B., De Marez, L., Mechant, P., 2012. Smart ideas for smart cities: investigating crowdsourcing for generating and selecting ideas for ICT innovation in a city context. J. Theor. Appl. Electron. Commer. Res. 7 (3), 49–62.
Schweitzer, F.M., Buchinger, W., Gassmann, O., Obrist, M., 2012. Crowdsourcing: leveraging innovation through online idea competitions. Res. Technol. Manag. 55 (3), 32–38.
Slater, R., Khandelwal, R., 2016. Report on Case Studies of Smart Cities International Benchmark, MPUIIP. ICF International.
Sohal, A.S., Sandhu, R., Sood, S.K., Chang, V., 2018. A cybersecurity framework to identify malicious edge device in fog computing and cloud-of-things environments. Comput. Secur. 74, 340–354.
Solanas, A., Patsakis, C., Conti, M., Vlachos, I.S., Ramos, V., Falcone, F., ... Martinez-Balleste, A., 2014. Smart health: a context-aware health paradigm within smart cities. IEEE Commun. Mag. 52 (8), 74–81.
Somers, M.J., Passerini, K., Parhankangas, A., Casal, J., 2014. Using mind maps to study how business school students and faculty organize and apply general business knowledge. Int. J. Manag. Educ. 12 (1), 1–13.
Titscher, S., 2000. Methods of Text and Discourse Analysis: In Search of Meaning. Sage.
Turban, E., Outland, J., King, D., Lee, J.K., Liang, T.P., Turban, D.C., 2018. Electronic commerce payment systems. In: Electronic Commerce 2018. Springer, Cham, pp. 457–499.
Weber, R.P., 1990. Basic Content Analysis (No. 49). Sage.
Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W., Stößer, J., 2009. Cloud computing–a classification, business models, and research directions. Bus. Inf. Syst. Eng. 1 (5), 391–399.
Wey, W.M., Hsu, J., 2014. New urbanism and smart growth: toward achieving a smart National Taipei University District. Habitat Int. 42, 164–174.
Wright, R., Keith, L., 2014. Wearable technology: if the tech fits, wear it. J. Electron. Resour. Med. Libr. 11 (4), 204–216.
Zhang, Y., Wildemuth, B.M., 2005. Qualitative analysis of content. In: Applications of Social Research Methods to Questions in Information and Library Science. 2009. Google Scholar, pp. 308–319.
Zubizarreta, I., Seravalli, A., Arrizabalaga, S., 2015. Smart city concept: what it is and what it should be. J. Urban Plan. Dev. 142 (1), 04015005.

Harish Kumar is pursuing his Doctoral degree in the field of smart governance at department of management studies, IIT Delhi. His area of interest includes smart cities, smart governance, policy design, policy assessments, management information system, decision science, urban planning, social media and healthcare. He has received his M. Tech. in Bioinformatics from IIIT Hyderabad, India. He has published many research articles and book chapters in reputed journals and books series.

Manoj Kumar Singh is pursuing his Doctoral degree in the field of Competitiveness of manufacturing industries at department of management studies, IIT Delhi. His research includes wide areas of market competitiveness, operation planning, strategy, industrial engineering, manufacturing competitiveness, and policies for manufacturing of electronics goods. He has completed his M. Tech. from IIT Delhi, India. He has published many research articles and book chapters in reputed journals and books series.

M.P. Gupta is a Professor at Department of Management studies, IIT Delhi. He is Dhananjaya Chair Professor of Information Systems & Coordinator of 'Center for Excellence' in E-gov at IIT Delhi. He is Known for pioneering works in the area of e-governance [that include 24 Doctoral thesis, 13 sponsored projects worth > 5 crores, co-authored book 'Digital Nations - Smart Cities, Innovation & Sustainability', 'Advances in Smart Cities – Smarter People, Governance and Solutions', 'Government Online', two other edited books 'Towards E-government' & 'Promise of E-governance' and 190 research papers appeared in National and International Journals/Conference Proceedings]. Reputed journals where his publications appear are 'Government Information Quarterly (GIQ)', 'International Journal of E-government Research (IJEGR)', 'Journal of Enterprise Information Management', and 'Transforming Government: People, Process and Policy'; A regular reviewer of these and other Journals (Public Administration Review, Omega, Decision Support Systems, DATA BASE for Advances in Information Systems). He is also steering a European Union funded (Horizon-2020) project, which deals with the setting up of cluster to cluster partnerships between India and EU for the convergence of Future of Internet & Digital Media (FI-MEDIA). He is involved in several policy making committees on ICT in the Centre and State Governments in India. Also on jury of prestigious awards committees viz. Data Security Council of India (DSCI), Computer Society of India (CSI) E-gov Awards and Web Ratna Awards. A recipient of the prestigious Humanities & Social Sciences (HSS) fellowship of Shastri Indo Canadian Institute, Calgary (Canada) 1996 and was a Visiting Fellow at the University of Manitoba. Conferred Best Professor award in 2012 at Singapore by World Education Congress and CMO Asia.

Jitendra Madaan received his B.Tech Degree in Production and Industrial Engineering from M.B.M Govt. Engg College, Jodhpur (JNV University), India, and obtained his M. Tech in Manufacturing System Engg. from Department of Mechanical Engg. MREC (Now MNIT), Jaipur and PhD in Mechanical Engineering from the Indian Institute of Technology (IIT) Delhi, India. Prior joining IIT Delhi, he has many years of working experience in other universities including IIT Roorkee; GGSIP University Delhi. His current research interests are Reverse Logistics and Supply Chain Management, Sustainable Operations Management, Production Management, information and governance effectiveness, Systems Modelling and Simulation, etc. To date, he has published over 4 book chapters, over 25 refereed international journal papers and 48 peer reviewed international conference papers. He is a reviewer of several international journal of repute.