Application of Information and Communication Technology (ICT) in Improving Urban Services and Increasing the Quality of Life

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Citation:

Abstract

A smart city is an urban area that utilizes Information and Communication Technology (ICT) to enhance operational efficiency, improve the quality of government services, and thereby elevate the welfare of its citizens. A sustainable smart city represents an innovative urban space that employs ICT and other tools to elevate quality of life and advance municipal services.

In recent decades, advancements in ICT, communication technologies, and the emergence of virtual spaces have empowered citizens to access engaging, dynamic environments that fulfill their innate social needs—such as human interaction and communal engagement—without requiring physical movement or relocation.

Alongside these objectives, a sustainable smart city must align with the needs of current and future generations across economic, social, environmental, and cultural dimensions. The concept of a smart city leverages government collaboration and mobile networks to sustainably improve citizens' quality of life. This approach generates significant benefits for businesses and residents alike. In such cities, data collected from infrastructure and equipment is processed to inform critical decisions across urban domains.

This study adopts a descriptive-analytical methodology to present a multifaceted overview of initiatives in smart urban settlements. It not only highlights successful case studies but also addresses the broad challenges confronting smart cities.

The research findings explore smart settlements, the conceptual framework of smart habitats (Villages and cities), diverse dimensions of smart cities, and proposals for improving current conditions through smart city design. The article emphasizes the importance of considering various dimensions—economic, technical, political, social, and others—in designing smart cities. By addressing these aspects, the study aims to contribute to the development of urban environments that holistically balance innovation, sustainability, and inclusivity.

Keywords: Smart cities, Settlements, Quality of life, Information and communication technology.

1|Introduction

Toffler [1], in his famous book "The Third Wave", outlines three waves of change to explain the nature of human evolution. He divides these three waves of human history into four major time periods.

The first is the tribal era, dating back two to three million years ago, during which early humans acquired basic capabilities. The second period is the agricultural era, approximately ten to twelve thousand years ago, when farming replaced hunting and families became somewhat larger. Toffler [1] refers to these two periods as the first wave.

Spaces are considered essential elements in the structure of a city and parts of its living organism. While being closely connected to evolving social, economic, and technical conditions, spaces also serve as social environments that encompass a network of human relationships. These include the exchange of energy, information, goods, materials, rumors, and more, where people meet, gather, and manifest various forms of social cohesion in spatial configurations [2].

The third era, known as the Industrial Age, marks the beginning of the second wave, spanning from the 18th to the 20th century. In this period, factories replaced agriculture as the driving force of the economy. Despite the shrinking of family units during this time, the world witnessed a population explosion, and cities expanded [1].

It was in this phase that societies evolved into service-based communities. Employment became increasingly service-oriented, and capital was regarded as a strategic resource. As humanity became familiar with the concepts of industry and technology, the volume of producible information grew to such an extent that it could no longer be retained in a single person's mind. At this point, individuals began to attend specialized classes, and the belief in the "great man" still existed, though not as prominently as before [3].

The third wave, as Toffler [1] describes, is the Information Age, which began in the latter half of the 20th century and continues to this day. During this era, the global industry and economy are increasingly built upon information exchange, electronic communications, and greater autonomy.

Among the broader approaches to defining modern urbanism, this section emphasizes that technology, particularly Information and Communication Technology (ICT), plays a central role in contemporary urban development practices.

In the Information Age, focus has shifted from capital to the value of information. Governance belongs to computers, communication technologies, and highly skilled professionals. Physical effort is no longer central; instead, emphasis is placed on the power of thought and intellect [4].

In this era, value-added is created by converting information into knowledge and through the speed of its transmission [5].

Overall, each of these four major eras has brought significant contributions to the structure of social organizations in its time. The first era contributed to the formation of small social groups; the second laid the foundation for hierarchies in communities; the third led to the emergence of systematic and law-based societies.

The fourth era, or the Information Age, has brought forth the development of IT, the creation of widespread information networks, and the concept of smart settlements, which are now considered essential by urban and rural policymakers and planners [6].

Importance and necessity of creating smart cities:

One of the most important goals of IT is to enhance human capacity and capability in utilizing information. The objectives and benefits of implementing IT in settlements include:

  I. Preventing waste of time and reducing traffic in residential areas

  II. Eliminating conflicts and inconsistencies among different sectors of the settlement

  III. Reducing transportation-related costs [7]

  IV. Decreasing the volume of documentation

  V. Increasing citizen participation [8]

    VI.   Improving quality of life for people [8]

2 | Information and Communication Technology in Smart Cities

The term "ICT", an expanded form of IT, was initially used by academic researchers in the 1980s. However, the term ICT gained widespread recognition after Dennis Stevenson [9] used it in a report for the UK government.

This concept emphasizes the integrated role of communications and the convergence of telecommunications (Such as telephone lines and wireless signals) with computers, enterprise software, middleware, storage systems, and audiovisual technologies, all of which allow users to access, store, transmit, and manipulate information.

The term ICT is also used to describe the merging of audio, visual, and telecommunication networks with computer networks through a single cabling or interlinking system. Although there is no universally agreed-upon definition of ICT, its underlying concepts, methods, and applications are continuously evolving on a daily basis.

In general, the scope of ICT encompasses any product or technology involved in the storage, retrieval, manipulation, transmission, or electronic reception of digital information. Examples include personal computers, digital televisions, mobile phones, email, and robots.

In a hierarchical classification of these technologies, ICT applications are categorized into four main domains: Socio-economic development, economy, education, and commerce. The common feature across all these domains is the facilitation of processes through the use of technologies that enable the electronic transfer of information and various types of communication [10].

3 | Smart Settlements

What is discussed in this article under the title of "smart settlements" encompasses all population centers, both urban and rural, where IT has led to the creation of new structures and relationships. Accordingly, this section provides brief definitions related to smart cities and smart villages:

Smart cities transition us from a one-dimensional world, represented by our traditional and current cities, to a two-dimensional world made possible through modern IT and the interconnected world of the internet. In smart cities, economic, social, and cultural relations are redefined within a new structure, and new behaviors from citizens emerge as a result of using IT tools.

The concepts related to smart cities also apply to smart villages. On the one hand, villagers carry out their economic activities—such as selling agricultural products, purchasing seeds and pesticides, and more—using IT. On the other hand, IT provides valuable opportunities for rural decision-makers, planners, and managers to enhance participatory processes and educational activities for rural residents.

4 | Dimensions of Smart City Feasibility

Feasibility studies aim to optimize current conditions by reducing a portion of uncertainty, but this does not mean that success is guaranteed, as many factors can influence outcomes. Some of these factors are predictable [11].

The feasibility of establishing and developing smart settlements in a region requires an analysis of various aspects in order to examine both current and potential future conditions thoroughly. In general, the feasibility of creating and developing smart settlements should be assessed through the following dimensions.

    I.   Technical feasibility: Technical feasibility examines the capability of the proposed plan to utilize existing technological conditions to achieve further improvements. This study considers not only the availability and suitability of current technologies but also the technical skills of the workforce.

II. Managerial feasibility: Managerial feasibility refers to the capacity of the project's infrastructure to achieve sustainable progress. Evaluating the management support capacity, the need for skilled and unskilled labor, and similar issues are key elements in clarifying managerial feasibility.

III. Economic feasibility: This aspect of feasibility analysis focuses on the potential economic benefits of proposed plans. Cost-benefit analysis and break-even analysis are significant approaches for evaluating the economic feasibility of establishing and developing smart settlements. In this context, both tangible and intangible aspects of the proposed plan are translated into economic concepts to form a solid and adaptable foundation.

IV. Financial feasibility: The financial feasibility of a project differs from its economic feasibility. Financial feasibility examines the project's ability to secure the necessary funding for its implementation. In other words, this type of analysis focuses more on investment-related issues, such as loan accessibility, project credit value, available assets, and repayment planning.

V. Cultural feasibility: Cultural feasibility assesses the compatibility of the proposed plan with the cultural context of the project environment. During planning, the project's impact must align with the values and beliefs of the local population. For instance, in many cases, cultural attitudes toward the use of IT significantly affect the implementation of smart settlements. This type of feasibility also examines the acceptance and capability of residents in adapting to the concept of smart settlements.

VI. Social feasibility: Social feasibility evaluates the impact of establishing and developing smart settlements on the social structure. The existing social framework may lack or be insufficient in providing the required human resources. To ensure compatibility with such an approach, the potential effects of development on the social status of individuals involved in innovative settlement initiatives must be assessed.

VII. Political feasibility: A politically feasible project is deemed politically acceptable. Political considerations shape the direction of smart settlement development plans. The political consideration is particularly relevant for large-scale projects with national-level implications. For example, political necessities may demand the implementation of a project regardless of its merits, while some valuable projects may be halted due to intense political opposition. Political feasibility evaluates the alignment of smart settlement development goals with prevailing political objectives.

VIII. Environmental feasibility: This aspect of feasibility studies is essential during the early stages of projects. In many cases, environmental advocates may immediately oppose projects that have been under study for years, halting their progress. Therefore, before finalizing project implementation plans, it is essential to evaluate their potential negative impacts on the natural and cultural resources of the local population.

5 | Components of Smart Cities

The rapid development of new technologies and innovation processes has given rise to a new urban model called the "smart city." A city that, through the use of emerging technologies, impacts six key areas of performance: economy, mobility, environment, citizenship, quality of life, and governance.

5.1 | Smart Economy

IT has provided a valuable opportunity for many economic activities to be conducted more easily and quickly via software platforms and the internet. Today, numerous countries have designed programs aimed at economic development and transitioning toward a smart economy. One example is Wellington, the capital of New Zealand. The goals of Wellington's smart economic transformation include increasing employment opportunities, boosting exports and production, and creating a space for nurturing innovative ideas. City managers in Wellington aim to achieve these goals by leveraging IT and other smart city infrastructures to position their city as a national communication hub and attract economic investments [12].

5.2 | Smart Transportation

The key to smart transportation lies in the Intelligent Transportation System (ITS), a well-known concept in the global transport industry. These systems consist of a range of technologies and tools, such as advanced sensors and processors that enable interaction among various components of transportation management. To achieve smart transportation, the integration of modern technologies and tools into transport fleets is essential, such as the Global Positioning System (GPS) and short-range communication systems.

5.3 | Smart Environment

A smart environment means utilizing new technologies to preserve environmental resources. Globally, specific indicators are measured to assess the quality of the environment, often relying on smart technologies to monitor and manage ecological sustainability.

5.4 | E-Citizenship

Despite all these elements, the ultimate agent in a smart city is the electronic citizen—an individual who is familiar with digital technologies and can effectively utilize e-government services. Spanish-American scholar Manuel Castells believes that "the information city requires informational citizens." This foundational requirement is essential for active participation in the online world.

5.5 | Smart Governance

This area introduces the concept of smart democracy, which refers to the effective use of ICT in various strategic domains. It ensures that all segments of society—from citizens to organizations and government officials—are influenced and engaged across economic, social, and cultural dimensions within the innovative city framework [13].

5.6 | Smart Mobility

In a smart city, access to new technologies and their application in daily urban life is made available to all citizens. Various studies have discussed multiple technological dimensions of smart cities. The concept of a digital city refers to a connected community that integrates broadband communication infrastructure, flexible service-based infrastructures, and innovative services to meet the needs of governments, employees, citizens, and businesses [14]. The aim is to create an environment that facilitates information sharing, collaboration, and integrated experiences for all citizens throughout the city [15].

6 | Feasibility Process for Smart Settlements

Although the type and cost of analysis in feasibility studies vary depending on the total amount of invested resources, as well as the size and scope of the intended project, feasibility studies are generally considered extremely complex and costly activities [11].
In general, the following steps can be envisioned for assessing the feasibility of establishing and developing smart settlements:

Step 1. Analyzing the settlement from economic, socio-cultural, and infrastructure perspectives

Such considerations help define the framework for organizing and developing smart features within the target settlement. Based on these assessments, the elements and functions of the intended settlement can be identified.
A comprehensive analysis of the economic, socio-cultural, and infrastructural profile of a smart settlement must be carried out through scientific and analytical methods. Ignoring such aspects can lead to significant challenges for residents and stakeholders in the future.

Step 2. Estimating future needs of the settlement

This stage involves forecasting the future needs of the settlement, especially in light of the integration of IT. It is crucial not to overlook potential future requirements, as underestimating seemingly minor needs—deemed unimportant by planners—can hinder or even halt the process of smart transformation within the settlement.

Step 3. Estimating investment conditions, actions, and activities in the field of IT within the settlement (Technical, managerial, and financial dimensions)

Many projects fail due to insufficient investment, which often stems from inaccurate cost estimations. Planners tend to be overly optimistic and fail to assess the costs appropriately involved. In general, investment evaluation can be classified into three categories:

  I.   Infrastructure investments

 II.   Operational investments

III.   Ongoing budgets [10]

Step 4. Estimating the benefits and losses of creating smart cities (Economic, social, cultural, political, and environmental dimensions)

When estimating the pros and cons of establishing smart settlements, a standardized calculation method must be applied. These estimations should cover periods of at least three years to allow for sustainable growth and smart development.
While analyzing profit and loss, it is essential to ensure that time and money have been factored into the assessment criteria. Two types of costs should be considered when evaluating profitability:

  I. Fixed costs

 II. Variable and controllable costs (Such as operational and administrative costs)

Step 5. Developing an implementation guide for feasibility studies

At this stage, an operational guide is developed based on the data gathered from the previous steps. The process of drafting an implementation guide for smart city feasibility studies can be carried out in four phases [16].

Phase 1. Preliminary studies:

  I.   Identify the main information factors necessary for a feasibility study's success

 II.   Determine sources of information and bibliography

III.   Assign responsibilities for data collection and appoint specific tasks

 IV.   Create a timeline for data gathering and synthesis

Phase 2. Assessing the current status

Phase 3. Synthesizing and analyzing the information:

  I.   Organize the data systematically

 II.   Analyze the data

III.   Identify steps to resolve discrepancies and address data gaps (If needed)

 IV.   Prioritize data requirements

  V.   Revise data using newly acquired information

 VI.   Synthesize findings and draw conclusions

Phase 4. Presenting recommendations and setting priorities

Step 6. Final decision-making and prioritization of actions

In this stage, decisions should be made based on the findings and results of the study.
Questions such as:

    I. Is the development of IT feasible in the given settlement?

    II. What approach should be adopted for smart development?

    III. What process is most suitable for smart settlement development?

Must be addressed.
For effective final decision-making in smart city feasibility studies, the following points should be considered:

    I. Sometimes planners recommend certain activities or sets of activities without considering their cost burden on the stakeholders or the community, while other planners take an integrated approach to IT-based settlement development [17].

    II. Managerial capacity is one of the key criteria for achieving optimal outcomes in feasibility studies, and thus must be assessed as a top priority [11].

    III. Financial support is essential and must be secured before initiating the project. Unfortunately, costs arise before benefits, which often causes projects to stall during the development phase [17].

    IV. Since all factors are interdependent, decision-makers must evaluate them collectively.

    V. Another important aspect to consider is the community's perception and response to the inherent impacts of such developments.

In addition to the above, depending on the type of settlement, other factors may also need to be studied and analyzed.

7 | Recommendations

In truth, the implementation of IT should not merely be regarded as the development of a few software systems; rather, it must be considered a developmental strategy that emphasizes vertical transformation within the organization, rather than merely horizontal expansion on the surface.
Implementing IT is essentially a process of human development and reform, and without adopting this perspective, successful execution cannot be expected.

Before any use of IT, the following questions must be clearly and decisively answered:

    I. Has a culture of using IT been established?

    II. Is there confidence and belief in the efficiency of the IT system?

    III. Are the impacts of IT on the settlement well understood?

    IV. Do the settlement and its residents possess the capability to make the necessary structural changes resulting from the adoption of IT?

    V. Have the managers and developers of smart cities received the necessary training beforehand?

    VI. Are there appropriate information, technical (Hardware and software), and human (Specialized workforce) infrastructures in place?

    VII. Have behavioral and human aspects been addressed? For example, do stakeholders (Residents, managers, and decision-makers) have a clear understanding of IT?

    VIII. Has the fear and resistance to modern technologies been eliminated, or do people and urban/rural planners still believe that IT has no place in their communities and thus resist its implementation?

If clear and appropriate answers are not provided to these questions beforehand, the negative consequences of poorly or improperly implementing IT may outweigh its potential benefits.

In addition to the above, the following recommendations are also advised:

I.   Establish and expand a specialized organization to manage and regulate the status of IT within the region.

II. It is recommended to conduct a cost-benefit analysis with the help of expert consultants before implementing IT. If the results are favorable, investment in IT should then be pursued.

III. Promoting a culture of using available technologies is essential. Urban and rural managers must make the necessary arrangements to conduct both short-term and long-term training programs.

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Conflicts of Interest

The authors proudly declare a conflict of interest with the status quo. We reject outdated urban models, bureaucratic inertia, and techno-skepticism. Our allegiance lies solely with disruptive ideas and the untapped potential of smart cities. Consider this a manifesto against mediocrity.

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