# Effective policies to overcome barriers in the development of smart cities

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**Abstract.** The world is facing substantial challenges related to population growth and the derived pressure on environment, energy, and other natural resources. Cities contribute to these problems due to the ever-increasing urbanization. As a solution, smart cities are managed and optimized across traditional boundaries and through the exchange of information between physical objects, citizens, and stakeholders. However, there are barriers in the development of smart cities that should be overcome in order to meet these challenges through smart cities. The main barriers identified in this work are poor private-public participation, utilization of fossil fuels, lack of attention to the environment, insufficient internet technology (IT) infrastructure, and old technology throughout the cities. To overcome these barriers, policies must be implemented to improve private-public participation by encouraging public investments and a wider adoption of electrical vehicles that may act as storage device and provide ancillary services to the electricity grid; reduce the use of private cars; strengthen IT infrastructure, deployment of smart technology to allow residents to monitor and control their energy consumption, installation of roof-top solar panels, and better mobility and efficient public services supported by smart technologies such as IoT (Internet of Things) and information and communication technology (ICT) to enhance the interconnection among smart city systems.

**Keyword:** Smart cities, policy, indicators, barriers

## 1.Introduction:

Global warming is strongly correlated with energy supply [1], and governments around the globe are introducing policy measures to lower greenhouse gas emissions [2]. Cities are

responsible for 75% of the global greenhouse emissions, with transportation being the major contributor. Developing smart cities may be a key solution to reducing the negative contributions of cities as smart cities offer powerful services for enhancing livability, overall efficiency, and sustainability [3].

In recent years, the concept of smart cities has been rapidly gaining momentum worldwide, and many countries have planned to adjust their policies to promote the development of smart city projects [4]. This is a complex task which requires a holistic and integrated approach with appropriate strategies and policies but the benefits that smart cities bring to the life of citizens and businesses outweighs the corresponding difficulties [5]. For instance, in smart cities, it is expected that energy losses can be minimised while offering affordable energy to citizens [6] and improving the environmental performance with the modernization of the electricity systems, with energy-efficient technologies, and the adoption of clean renewable energy resources [7].

Smart cities have the potential to offer better living standards for future generations. In fact, a smart city is a framework, predominantly composed of several sectors, and promotes sustainable development practices to minimize the challenges of urbanization in the future. Actually, smart cities should be created so that inhabitants of the cities have less problems than before. So far many efforts have been taken [8], but the important question is whether these efforts have been fruitful so far or not; If yes, how will these measures remain in place, and if not, what actions should be taken.

The initial step towards developing smart cities could be defined as providing appropriate policy and appropriate technology. In other words, we need to know how a smart city works and how to develop such cities. Therefore, it is important to know the factors essential to developing smart cities [9]. The aim of this work is to identify the barriers of smart cities with a view to defining policies that can contribute to the development of these smart cities.

To this end, we present a comprehensive overview of smart cities, and then the impact of policies on the major sectors are investigated. Finally, we consider barriers against smart cities development and then propose an effective solution for each of them.

### 1.1. Global approach: Background and literature review

The trend of the increasing urbanization in the world due to the attractions that exist in cities and lack of attracting factors in rural areas, is an undeniable fact that has accelerated in the

movement towards smart cities. A smart city is a city that is well on its way towards the six characteristics (smart people, smart mobility, smart governance, smart life, smart economy, and intelligent environment), created by means of an intelligent combination of assets, and with crucial, independent, and informed citizens activities.

In recent years, numerous efforts and researches have been done in this direction. Albino et al. [10] elaborated on the definition of the word "smart" in smart cities based on a review of several studies. This research investigated the context of the word "smart" for cities using relevant studies and official documents from international institutions. The authors then specified what the difference is between urban smartness and smart city. The features and performance of smart cities were compared with traditional cities. They demonstrated that the difference between a smart city and the traditional city is determined based on their initiatives and performance measures. Also, to create smart cities, it is essential to provide good infrastructure, proper equipment, appropriate indicators, investigating sustainability, and urban development [10].

Dameri [11], in 2014, investigated relations between digital city concepts and the smart city concept in the context of Amsterdam and Genoa. They showed that there is no clear definition of a digital city or smart city, and therefore, these two terminologies are still mingled or overlapping. According to this research, the key role of governance and policymakers, in realizing digital or smart cities is most importantly to enhance the quality of life of the inhabitants in these areas.

Kim et al. investigated a systematic review from smart homes to sustainable smart cities related to smart energy conservation systems. In this paper, through a quantitative review, the authors showed remarkable solutions for advanced energy conservation systems in sustainable smart cities. Among these, the adoption of a new strategy for energy trading in distributed energy systems; implementation of integrated energy network technologies at the city level; construction of infrastructure for advanced energy conservation systems; development of real-time energy monitoring, diagnostics, and controlling technologies; and application of intelligent energy management technologies are the most important solutions [12].

Yigitcanlar et al. [13] explored the trend and progress of smart city development in recent years. They investigated a clearer understanding of smart cities by identifying and linking the main drivers of a smart city. They showed that there are three types of drivers in smart cities,

such as community, technology, and policy, and these drivers are linked to five objectives such as sustainability, governance, accessibility, liveability, and wellbeing.

A review of smart city initiatives around the world was presented by Angelidou [14]. The author investigated the main factors and strategies for the creation of smart cities and reported their main advantages and disadvantages [14]. However, there are many barriers to the development of smart cities as well.

Rana et al [15], investigated the key barriers that cause problems in smart cities. They studied different categories that influence the development of smart cities and showed that the most important category of barriers for smart city development is governance and economic, followed by legal and ethical, and environmental economics. They also stated that the results of this research can be used to eliminate the potential interferences in smart city development initiatives, especially in developing countries, by the government and policymakers. In this study, different sources including opinions of smart city experts and published literature were considered to identify the barriers and propose a fuzzy Analytical Hierarchy Process (AHP) approach to evaluate these barriers.

Mosannenzadeh et al. [16], studied 43 communities implementing smart city projects in the European Union. The most important barriers in these countries were investigated with a deep political view. Their study demonstrated that problems such as lack of political support, good cooperation, and insufficient external financial support are considered as the main barriers against smart city development [16].

Research conducted by Honarvar et al. [17], indicates the importance of integrating information and the use of information technology in the development of smart cities. In this study, the importance of physical devices such as networks to enhance the performance of services for the inhabitants of smart cities was emphasized.

Vanolo et al. [18], critically discussed the problems of smart city projects within the European Union. They analyzed the concept of smart city by focusing on the knowledge implications and power for a contemporary city in Italy as a case study. The authors also showed that as smart city policies support new methods such as organizing, imagining, and managing, these policies also present a moral order in the city by introducing specific technical parameters to distinguish between the ‘bad’ and ‘good’ city; and therefore, city

discourse can be a powerful and useful tool for the production of docile subjects and mechanisms of political legitimization [18].

Gerosa et al. showed that smart cities where all activities are monitored by inhabitants could lead to a reduction of crime and traffic, and enhance the quality of the transportation system and water supply networks [19]. Perera et al. [20], showed an improvement in waste management and other public services with the use of accurate monitoring systems. In fact, in smart cities, citizens can control different equipments using monitoring systems, which leads to an enhancement in the public services and the prevention of potential problems in the future.

Table 1 shows previous studies on smart cities from 2015 to 2021. This table is made based on effective politics, strategies, and development of smart cities.

Table 1. Previous studies on smart cities in the last five years (2015-2021).

| Aim of study | Results | Year | Reference |
|---|---|---|---|
| Investigating predominant challenges from the municipal decision-makers' perspective in smart city initiatives for medium-sized cities of European countries. | The results of this study that was conducted through 39 interviews in 25 different European cities showed that the major challenges are awareness of technology, economics, collaboration, and governance. In addition, the lack of validated business models has caused that many cities may not have enough confidence for funding smart city initiatives. | 2017 | [21] |
| Analysing the effects of smart governance on the quality of life in smart cities. | The results of this study demonstrated that there are strong and remarkable relations among the constructs. In fact, identification of strategic drivers is able to help policymakers and municipal executives to take appropriate actions and implement policies to involve the citizens in the sustainable development of the city. | 2020 | [22] |
| Evaluating concepts and technologies of smart cities in cities. | The empirical results of this study revealed that the most popular smart city concepts are governance, sustainability, and innovation; and the most popular technologies are Artificial Intelligence, Internet-of-Things and autonomous vehicle technology. The leading Australian smart cities are Brisbane, Melbourne, and Sydney, and systematic geo-Twitter analysis is a useful approach for better investigating | 2020 | [23] |

| | | | |
|---|---|---|---|
| | perceptions and concepts of technology in smart cities. | | |
| Identification of differences, similarities and relevant factors to become a smart city | The results of this study, demonstrated that smart city levels are related to the gender of the governors and geographical location of the cities but the determination of political ideology based on the type of association was not possible. Therefore, it can be concluded, that the cities governed by women and those cities located in the western region have better smart cities scores. In addition, they showed that stimulating investment by government administrations and concentration on the implementation of proper policies will lead to sustainable development. | 2020 | [24] |
| Large-scale evaluation of the relationship between smart urban policies and urban smartness, and bridging this important gap. | The results of this study were collected from 314 European Union cities and are based on an empirical relationship. It was shown that smart city strategies and policies are more likely to be implemented in cities that previously had smart characteristics. Also, this study has emphasized that these strategies and politics are more likely to be implemented in denser and wealthier cities. | 2015 | [25] |
| Investigating smart city characteristics for the implementation of strategies and policies in fifteen different cities | The results that were related to 15 different cities demonstrated that the role of communication technologies and information is important for advancing knowledge transfer, and improving innovation networks and the functionality of urban systems. But due to problems such as security inadequacy and issues of privacy, it is possible that most strategies were not able to accommodate the local needs of related areas. | 2017 | [26] |
| Analysing possibility of creating smart cities in Iran using an indicator | Results of this work that was based on analysing smart city initiatives in Iran demonstrated that the biggest problem in Iran in this regard, is political, and to overcome this issue, there is a need to change the governance model. Therefore, data sharing and open data policies should be promoted while also making reforms especially in government structures. | 2020 | [27] |
| Investigating the social factors of sustainability in a smart city | The results of this research demonstrated that recovering development appropriate strategies to recognize the real needs of the society is an important | 2015 | [28] |

| | | | |
|---|---|---|---|
| | operational action in smart city development. This action will lead to redefining proper politics and rethinking the city. Therefore, the key role of public actors in society, to strengthen these politics, is vital and leads to the enhancement of justice, human rights, and social-spatial relationships. | | |
| Investigating fundamental shortfalls around smart city conceptualization and practice | The results of this study showed that a key to achieve sustainable development, especially for smart cities, is to find new methods to change the mentality and having appropriate politics in order to integrate policy, technology, and community, are more important than every other thing. As such, populist, short-term politics that are major roadblocks should be changed to convince the general public and authorities before it is too late. | 2020 | [29] |
| Investigating critical perspectives of smart cities in India | The results demonstrated that Indian cities require synergy across appropriate strategies and urban policies to overcome excisting problems and for better achievement of planned investments. They showed that the unification of smart city visions and proper integration of plans can better support local innovation and effective urban transformation. | 2018 | [30] |

## 2. Motivation and objective of the study

A smart city is a sustainable and efficient urban center that provides a high quality of life to its inhabitants through optimal management of its resources. Therefore, attention to all sections of a smart city leads to the development and reduction of global criticals, especially in environmental and energy sectors. With rapid population growth, especially in urban areas, and critical issues such as increase in energy demand and costs, internet accessibility problems, and $CO_2$ emission, the adoption of smart cities is an essential and appropriate solution for every country.

Fortunately, so far, proper actions have been taken, in line with smart cities adoption, which will, without a doubt, lead to the effective deployement of smart cities. Such actions include the deployment of IoT technology to enhance citizens safety and well-being; new energy management tools to actively engage citizens in the monitoring and control of their energy usage; utilization of energy-efficient LED technology for street lighting; planning for large-

scale adoption of low-carbon transportation in the future using clean energy in order to reduce $CO_2$ footprint, developing green spaces for inhabitants; enhancement of security especially in information technology; and more attention to public participation in policy, policymaking, and development programs.

However, the major problems with these actions are the lack of integration of different sectors together and lack of proper investment in smart city development, which should also be investigated and improved by policymakers and city planners. Therefore, with sustainability-enhancing factors such as public security or municipal services, traffic management, improving security, or resilience, every community can create rational and persuasive reasons for stakeholders to invest in smart city technologies.

The novelties of this study includes a comprehensive consideration of the smart city concept, investigating potential sectors for the development of smart cities, investigating policy impacts on smart city development, investigating existing barriers against the development of smart city, and presenting appropriate solutions for each of these barriers.

## 3. Methodology

Smart cities are emerging concepts that take full advantage of new technologies to address public issues and achieve sustainable economical and social developments. This work aims to identify the potential barriers to smart city development and find the most effective solutions to address these challenges. This research has been carried out in five steps:

1) Smart cities are comprehensively investigated with emphasis on policy.
2) The key role of intelligent systems in important sectors such as transport and energy is investigated.
3) The key role of policy in creating and developing a smart city, and implementation of specific goals is also investigated.
4) Different policies and barriers against the development of smart cities are investigated and then appropriate solutions are proposed for each of them.
5) Finally, feasible indicators that have the most impact on energy sustainability in smart cities are selected and presented.

To obtain the information required for the study, in the first stage, we used the smart city development, barriers, and solutions for smart cities development, policy and strategy for smart cities, and energy “sustainability” as titles, abstracts, and keywords in the search engine

and started the search process into established scientific databases, such as Google Scholar, Scopus, Web of Science and journal sites (Elsevier, Springer, Tylor & Francis, MDPI, Willey and etc,.).

Based on the above-detailed search and given and eligibility criteria and their accessibility, we have during two years identified and conducted an exhaustive review of more than 200 relevant publications and scientific reports related to energy sustainability and smart cities such as European energy reports, EU Smart Cities Marketplace, European Commission (EC) and governmental reports.

After this stage, we assessed a journal based on titles, abstracts, and introductions, selected the appropriate articles to form a collection of 97 articles. Next, a literature review was carried out on two categories of articles:

1) Review articles and reports to have a global understanding of energy sustainability and smart cities development issues and find the appropriate solutions to address these problems. These groups of studies helped us enhance our knowledge and background for writing this manuscript.

2) Technical articles. These types of articles were useful to identify effective policies to overcome barriers in the development of smart cities, and determine the correct pathway for the study.

This information gathered from the studies reported in ths literature review was used in the validation of the approach adopted to determine the principal barriers in the development of smart cities.

Figure 1, depicts the study flowchart. After collection of information, two categories of articles were investigated. Then the methodology required was established.

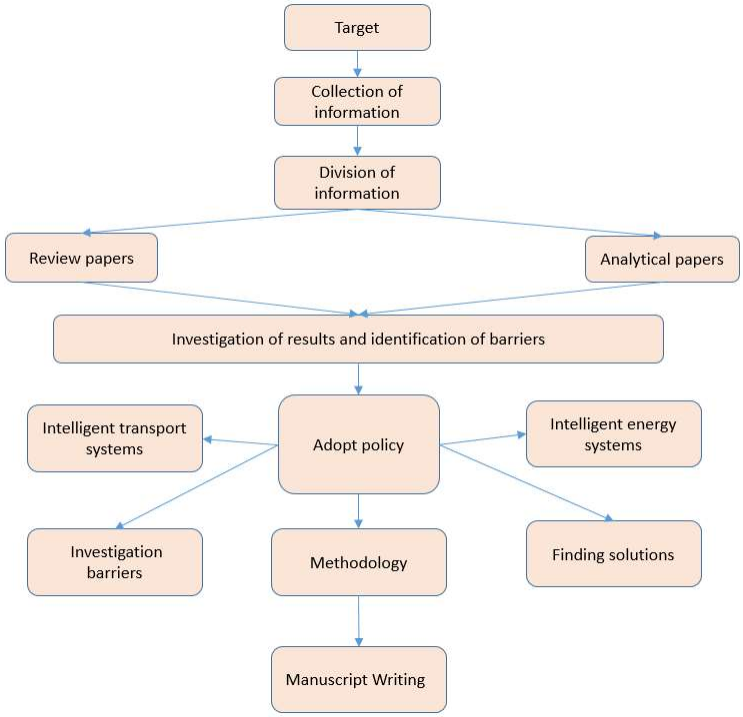


Fig 1. Study flowchart.

## 4. Importance of intelligent systems for smart cities

In this section, we consider and analyze the key role of intelligent systems in two important sectors such as transport and energy, which have the highest impacts on smart cities. These factors are able to create significant positive changes in smart cities.

### 4.1. Importance of intelligent transport systems for smart cities

The transportation system is one of the most important sections for urban areas, especially smart cities; therefore, smart transportation should be considered for smart cities. Smart transportation provides a high degree of welfare for inhabitants of cities which has a positive effect on the community [31]. In cities, usually, different kinds of transportation like private cars, and public transportation such as trains and bus are used, but they have a serious environmental impact, and therefore, public transportation is the best option. However, public

transportation powered by fossil fuels is also a major contributor to $CO_2$ emissions. As mentioned earlier, $CO_2$ emissions are the major problems of smart cities. Sustainable transport systems to reduce $CO_2$ emissions are significant challenges for policymakers worldwide.

One of the best alternative vehicle technology for smart cities are electric vehicles (EVs) [32]. The development of new sustainable modes of transportation systems has become one of the priorities for all countries around the globe because there are innumerable successful examples of sustainable, smart transport systems across the world like Paris, Boston, Singapore, and Germany. Also, the development of a sustainable transport system is beneficial for all aspects of a smart city, especially economic growth and $CO_2$ emission reduction [33].

Moreover, it is argued that smart transportation is the main branch of smart cities as major problems such as accident detection, automatic fare collection, lack of road safety, and traffic congestion can be alleviated through smart transportation [34]. In this regard, an intelligent transport system is needed in which vehicles are equipped with intelligent devices and sensors to provide vehicle-to-vehicle communication and enhance the safety and security of drivers and passengers on the road. Furthermore, an intelligent transport system is able to provide advanced traveller information, enhanced vehicle control, public rural transport, traffic management, and commercial vehicle operations that these measures can be different for countries, depending on their policies and regulations [35].

### 4.2. Importance of intelligent energy systems for smart cities

As explained in the previous sub-section, reliable and sustainable energy supply is an essential factor in designing successful smart cities [36]. Indeed, without a reliable energy supply, most activities in cities will be affected and communications between cities and countries will be interrupted. Both fossil fuels and renewable energy are major resources of energy, however as environmental factors are of paramount importance for developing smart cities, renewable energy sources are the best solution for meeting the future energy needs of smart cities [2]. Therefore, the exploitation of abundant renewable energy sources should be on the agenda of policymakers and urban planners during the development of smart city projects.

It should be noted that mere provision of abundant energy sources for consumers is not sufficient and that other factors such as affordability and availability in the line of sustainability also should be taken into account by policymakers and urban planners [37]. In this regard, investigating proper strategy for public transport systems such as the deployment of IoT technology is important in order to reduce pressure of traffic in areas with growing population. On the other hand, as renewable energy sources are essential resources for future global development, especially for tackling climate change, the integration of new emerging technologies like artificial intelligence (AI) has the potential to help address energy sustainability challenges in the future.

However, providing sustainable energy for a smart city will require an integrated infrastructure with emerging technologies such as the IoT and the next generation of mobile communication. This plan is more useful for energy supply, transmission, distribution, and demand [38]. Also, the utilization of energy systems with new technological options such as photovoltaic (PV)-driven heat pumps for heat provision, bio-methane injection into grids, passive buildings, small-scale Combined Heat and Power (CHP) with heat storage, are appropriate and efective in order to alter the strategies for energy provision to larger settlements [39].

In addition, policies such as utilization of EVs [40], evaluation of common frameworks in order to interact between intelligent transportation and EVs in smart cities [41], having a regular and reasonable electricity pricing strategy contributing to grid security [42], and appropriate investment and good support from the government [43] are important to create intelligent energy sytems for smart cities.

## 5. Result and discussion

This section discusses the key impact of policy on several important factors, barriers, and solutions related to the development of smart cities. Based on previous discussions on the transport system, energy, and the importance of technology sectors, it is crucial that suitable corresponding policies be investigated for each of them. The factors impacted by policy include creating and developing information technology, energy security, and implementation of effective strategies.

### 5.1. The key role of policy in creating and developing a smart city and implementation of specific goals

Undoubtedly, policy is an important factor for achieving progress and development around the world. This is why governments in countries with strong policy programs have the potential ability to overcome most of the existing problems [44]. Moreover, due to interfering policy sector with the social sector, policymakers have the opportunity to attract public support for implementing their plans effectively, and successfully achieve their targets [45]. Adopting appropriate strategies and policies by policymakers will contribute to the creation and development of smart cities [46].

As mentioned above, implementing a policy requires public acceptance and support which is not easy to achieve. In fact, the diversity of stakeholders' rationales to implementing participatory processes should be investigated, and in addition, appropriate methods and instruments should be used to engage the community in the process [47]. Therefore, to succeed in implementing their policies, policymakers should integrate stakeholder perceptions in the decision-making process, which leads to improving the policy design to implement appropriate policies and prevent public opposition. For instance, providing energy for the present and future generations is a big challenge that needs an appropriate strategy [48].

In this regard, in order to satisfy the current energy needs, prevent energy shortage for the future generation, and protect the environment, proper strategies and actions such as the use of renewable energy, attention to energy safety and suitable storage systems, fast development of energy efficiency using new technology, utilization of various energy systems related to residential refrigeration, deployment of smart transportation like plug-in EVs), and development of green buildings should be implemented but in line with sustainable development goals [49].

The diversity of stakeholders' rationales, especially in cities, should be investigated by policymakers as people living in cities need to have a suitable transportation, affordable energy, energy security, and access to internet. Thus, to achieve the targets mentioned and overcome the problems, governments should focus on implementing appropriate actions in this regard.

### 5.2. The key role of policy in developing information technology sector for smart city citizens

The world has never been as interconnected as it is today; sharing information and knowledge across countries and communities are increasing every single day. Access to information and its positive exploitation can be very effective in improving the future of individuals and brings many advantages to the societies they live in [50]. Thus, another essential factor for smart cities is a reliable and fast internet network [51]. In fact, such internet networks in smart cities facilitate communication and access to information to its citizens. Overall, the utilization of smart devices such as smart sensors, internet smartphones, wearable smart devices, and social network services provide a good opportunity for citizens of smart cities to enhance their knowledge and improve the quality of their life [52].

Governments have different policies and specific plans for the development and utilization of new technologies such as IoT for accessing information and facilitating communication among citizens in smart cities. In fact, through investment in the technology sector, governments are trying to enhance the knowledge, skills and engagement of citizens, create advanced transportation, environmental protection, prevent crime in cities, and monitor waste management [53].

### 5.3. Investigation of important barriers categories for smart cities

For creating and developing smart cities, it is crucial to consider and apply various indicators and strategies [54]. A smart city requires a smart economy, smart industry, smart people, smart education, smart governance, smart mobility, smart environment, and smart living [55].

While various factors are involved in building smart cities, policy is considered to be the most important factor. Policy has always played a central role in the development of various sectors of the economy. Proper policymaking will also play a crucial role in the creation and development of smart cities [56]. They can accelerate the construction and development of smart cities using their authorities, interests, and management leverage [57]. This means that politicians are capable of implementing the correct policies in order to create and develop smart cities [58].

Barriers of five important categories should be investigated for the development of a smart city:

- governance (G),
- social (S),
- technology (T),
- environmental (ENV) and
- economic (EC).

Each of these categories also includes other key barriers, the impact of which can be reduced or removed as necessary to facilitate the creation and development of smart cities. These barriers are presented in Table 2.

Table 2. Categories of the key barriers against the development of smart cities.

| | |
|---|---|
| 1. Weak and improper cooperation between policymakers and urban planners (G) | 12 System failure issues (T) |
| 2. Weak IT management (G) | 13. Weakness of IT networks' infrastructure (T) |
| 3. Improper policy and regulatory norms (G) | 14. Interest in more use of fossil fuels instead of clean energy (EN) |
| 4. Poor private-public participation (G) | 15. Poor interaction between local goverments and citizens (S) |
| 5. Lack of appropriate strategies for development (G) | 16. Insecurity of energy sustainability (EN) |
| 6. Irresponsible citizens (S) | 17. Lack attention to environment (EN) |
| 7. Lack of attention to public welfare such as parks and entertainment for people (S) | 18. Weak and improper IT infrastructures (EC) |
| 8. Low knowledge and weak communication by citizens (S) | 19. Lack of public training (EC) |
| 9. Inadequate environmental and geographic assessment before the construction of smart cities (S) | 20. Higher operational and maintenance cost (EC) |
| 10. Discrimination and inequality (S) | 21. Lack of plans for attract foreign investment (EC) |
| 11. Old technology and improper access to new technology (T) | 22. Lack of attention towards participation of all the stakeholders (S) |

There are many reasons why the identification of barriers is important in the development of smart cities. Smart cities development is strictly associated with having comprehensive information on the existing challenges and problems of the cities. With an awareness of these challenges and problems of cities, we can find an appropirate solution to reduce or remove each one of them.

Most challenges and barriers in the line of smart city development are associated with five important categories: governance, social, technology, environment, and economy. Table 3 provides some relevant references to each one of these indicators.

Table 3. Relevant references for the selected indicators.

| **Category studies** | **Related references** |
|---|---|
| Govermence | [60], [61], [63], [70], [72], [78], [91], [93], [94], [96] |
| Social | [59], [62], [63], [89] |
| Technology | [60], [63], [65], [67], [69], [71] [72], [74], [75], [77], [83], [85], [88] |
| Environment | [60], [63], [64], [66] |
| Economy | [63], [65], [67], [68], [73], [76], [77] |

### 5.4. Correct and incorrect policies of countries for developing smart cities

The anticipation of tomorrow's world requirements for developing smart cities can be clarified to some extent based on the existing conditions. Therefore, a comprehensive study of the existing problems and issues must be carried out beforehand and then devise an appropriate strategy to resolve them. Cities today are grappling with various problems and issues such as air pollution, population growth, and traffic. However, these problems can be eliminated and minimized with the creation and development of smart cities. Thus, identifying weaknesses and addressing the barriers of smart cities from now gives us the opportunity to overcome the existing obstacles in this regard.

Table 4 summarises the aim of this study and shows the barriers of smart cities based on six of their characters.

Table 4. Barriers and solutions of smart cities based on governance (G), social (S), technology (T), environmental (ENV) and economic (EC).

| Characters | Barriers | Solution |
|---|---|---|
| Smart people | Avoidance of community; old technology, lack of knowledge, irresponsible community | New technology, more communication, caring community, radical harmony, skilled and talented people |
| Smart governance | Insufficient budget, old technology, poor private-public participation, incorrect legislation (Policy and Strategy), discrimination and inequality | Appropriate policy and strategy, new technology, correct legislation, public participation, establishing equality and justice |
| Smart economy | Inefficient financial support, insufficient investment, unemployment | Attract investment, entrepreneurship, innovative economic, equitable wealth Distribution |
| Smart mobility | Weak ICT infrastructure, weak public transport, lack of sufficient green spaces, lack of sufficient transport, lack of proper resiliency, lack or improper of traffic management system | More use of IT , development internet infrastructure, green spaces development, efficient road and accessibility, public participation, improve energy intensity |
| Smart environment | Utilization of fossil fuels, lack of sufficient water and sanitation, Lack or a few green spaces | More use of clean energy, green spaces development, Sufficient water and sanitation, utilization of electrical vehicles |
| Smart living | Lack of internet access and sources, insufficient information technology, old technology | Sufficient information technology, new technology, electrical vehicles, utilization of robots, safety and security information development |

Figure 2 is a schematic description of Table 4. This diagram illustrates the smart city dynamic schematic based on policy sector. As can be seen, six important sectors of smart cities are connected to policy sector, and this shows the importance and impact of policy on smart city development.

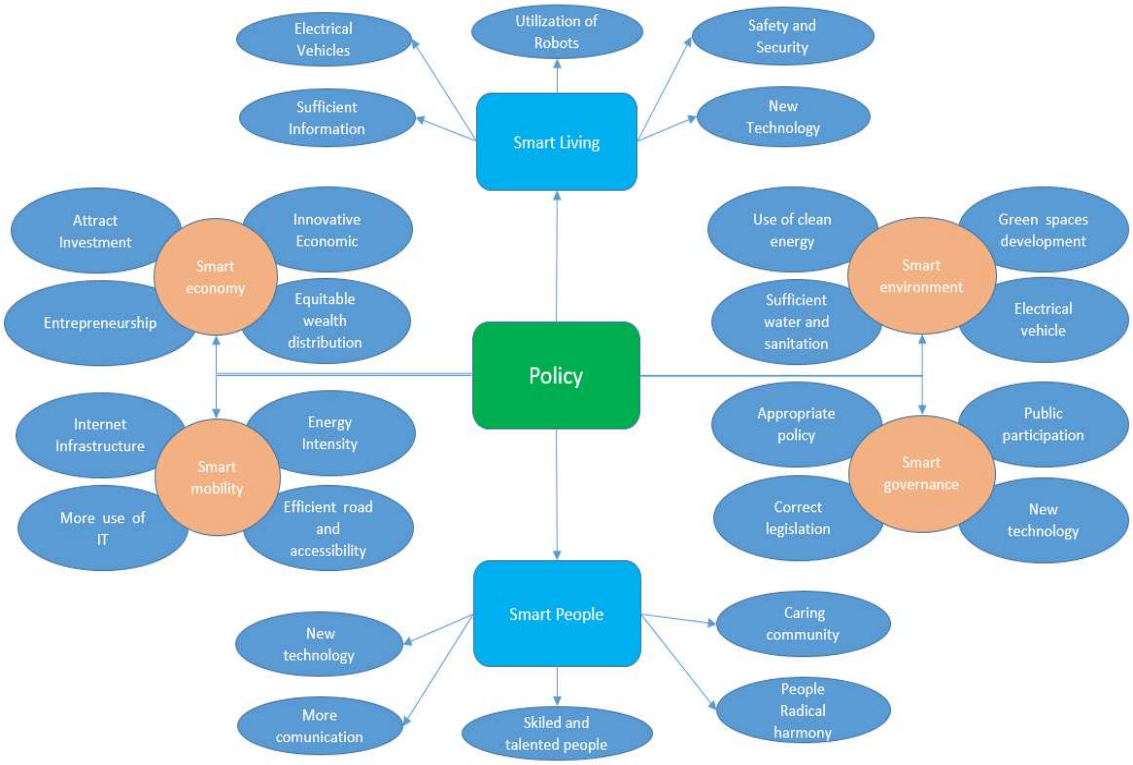


Fig 2. Smart city dynamic schematic based on policy sector.

### 5.5. Important findings of this study and suggestions for improving the existing obstacles in the development of smart cities

The smart city concept was previously defined more as dealing with various urban problems such as infrastructure, urban environment, and transport flow in a city. With the newly emerging smart technologies however, this concept has changed with the use of Information technology, and is better defined now as a means to accelerate urban management in various sectors of a city. Smart city development is not easy and needs specific plans and appropriate policies. Therefore, recognizing obstacles will give us a deeper understanding on how to deal with them and; this would be useful to both theory and practice.

In this regard, the study based on the [79-97] provides new insights into smart cities development issues and challenges, and how to recognize existing obstacles and suggest potential solutions. Regarding the increasing urban population and the need to improve the service quality based on demand, policymakers and researchers should acquire a deeper and

more informed understanding to recognize relevant barriers to smart city development. To tackle these challenges and remove these barriers, innovative planning tools are required.

We also showed that for the successful implementation of the correct policy, smart technology plays a key role in smart city development. Without a doubt, smart technology can help reduce costs; maximize efficiency; and improve education, administrative procedures, urban security, and municipal maintenance. As smart cities use technology and big data to improve sustainability, enhance the quality of life, improve efficiency, and foster economic development, most problems related to smart cities development are solvable through electric energy companies, technology companies, city local authorities, and some other bodies as they are considered to be the main players in the development of smart cities.

On the other hand, to attract investments in a smart city, one needs to present strict control and monitoring on all sectors like electric energy companies that are private entities to investors. Smart grids is another significant innovation technology that should be supported by policymakers as these grids can help with distribution systems in smart cities in order to better integrate intermittent renewable energy sourcess.

Also, conversion of decommissioned coal-based stations into clean energy power plants such as solar or others, conversion of waste sludge to energy, customer-use management technology, and distributed energy resources. In addition, the utilization of smart LED streetlights in major metropolises is an effective contribution to smart city development because these are able to significantly reduce energy consumption of the city, especially modern cities. In fact, local governments are interested in E-government that interacts more closely with citizens and solve their issues. Improvement of urban services such as waste management, street lighting, water resource systems, and drainage systems, are other positive actions that can be taken by policymakers for the stakeholders. Utilization of new smart technology (e.g. smart sensors), for instance, to reduce traffic congestion and improve signal control; blockchains to enhance the security for the IoT; sensors to report water, stormwater, and sewage maintenance issues (e.g., leakage detection, and management of consumption and non-revenue water); 5G systems to provide a better communication, operate more efficiently and enhance security; and 5G technology to expand surveillance networks, video transmissions, and autonomous vehicle success.

Overall, it can be said that the results of this study demonstrated that awareness of technology, politics, economics, collaboration, and governance are the major challenges for developing smart cities.

Firstly, it is necessary to find new approaches to change the mentality. This is because, in some areas, change in the governance model will require redefinition of proper politics and rethinking of the city in order to enhance justice, and improve human rights. Without a doubt, the role of ICT is important for advancing knowledge transfer and improving innovation networks and the functionality of urban systems. In addition, utilization of the most advanced technologies such as AI, IoT, and autonomous vehicle technology will also have a positive impact. Due to some problems such as inadequate security and issues of privacy, however, it is possible that most strategies may not be appropriate to accommodate the local needs of related areas.

Second, the proper integration of plans can better support local innovation and effective urban transformation.

Third, the identification of strategic drivers can help policymakers and municipal executives to issue appropriate to engage people in the achievement of sustainable development. In this regard, it is imperative to validate business models to further attract investments, as the lack of validated business models will result in cities not having enough confidence to fund smart city initiatives. Therefore, in order to achieve the goals and integrate them, populist, short-term politics that are major roadblocks should be changed to convince the general public and authorities before it is too late.

Finally, cities governed by women and those cities located in the western region tend to have better smart cities scores. Therefore, gender discrimination should be forgotten to achieve smart city development.

In addition, for city management and policymaking in smart cities, special attention should be given to the needs of stakeholders such as enhancement of educational grade to create a good relationship between citizens and the city government administration, and to improve their public participation in decisions, use of new channels of communication between the government and citizens, using e-governance or e-democracy, attention of the government to local civic participation and resident consultations for designs of EV ramps and installation sites; also, creation of amenities and urban green spaces development can create social

cohesion and good confidence between government and citizens. Therefore, paying attention to people as social capital, and coordinating with them for policymaking leads to the transparency of effective smart cities plans and active participation of all the stakeholders. In additon, the essential role of local leaders should be investigated in smart city development.

Without a doubt, involvement of local government, like council members, in the progress of smart cities is undeniable and significant to the success and implementation of a smart-city strategy. Also, the role of local government is critical to educate the smart city residents in order to increase efficiency, decrease data security concerns, technological benefits, temporary disruptions. Local leaders should be open with its citizenry, and have frank dialogue with them through more engagement, especially in selection of technologies, showcasing successes, and acknowledging failures. In addition, the role of local leaders is most significant in changing regulatory structures, from local zoning ordinances and permitting rules to state laws, investment, privatization of municipal services as they are close to both citzens and businesses, and can better see the city problems and solve them. In fact, the most important aim of city councilmembers is to reduce the cost of services and increase productivity, especially in energy/utilities, public safety, information technology, and transportation system throgh strategic plans and public view survey. Thereby, to upgrade the situation of the smart city, selected officials must vigorously strive to provide the best living, working, and environmental conditions in the cities for its citizens.

## 6. Conclusion

In this paper, we have investigated the smart cities' concept, the potential sectors for the development of smart cities, the role of policy in smart cities development, existing barriers against development of smart cities, and have presented appropriate solutions for each of these barriers. After a comprehensive overview of smart cities, the vital role of information technology in two important sectors such as transport and energy were investigated.

These sectors have a large impact on the development of smart cities and the most important problems emerge from these sectors. For example, the lack of proper technology, poor private-public participation, utilization of fossil fuels, and air pollution are some of the major problems in the transport sector.

These problems can be overcome by improving public transport with modern technologies, large-scale adoption of EVs, and reduction of private cars. In the energy sector, the main

problems are lack of energy security, expensive fuel price, and nonrenewable fuels and to cope with these problems, clean, affordable and accessible energy are suggested.

Suggestions to overcome these problems include improving public transport with modern technologies, large-scale adoption of EVs, and reduction of private cars. Therefore, the utilization of modern technology to reduce these problems and improve these sectors is of paramount importance, and should be investigated by policymakers.

The smart cities concept includes smart people, smart governance, smart economy, smart mobility, smart environment, and smart living. To reach this concept truly, the barriers of these six important sectors should be mitigated and eliminated. The barriers of smart cities with respect to these six important sectors and the solutions to these barriers have been discussed. Barriers such as lack of knowledge, weak transport, lack of internet access, fossil fuels utilization tendency, old technology etc, should be mitigated by improving public transport, enhancing public knowdlege, improving access to the internet, using new technology, clean energy, and adopting EVs.

In addition, the role of local government is critical to educate the smart city residents to increase efficiency, decrease data security concerns, technological benefits, temporary disruptions. Local leaders should be open and have frank dialogue with its citizenry through more engagement, especially in the selection of technologies, showcasing successes, and acknowledging failures. In addition, the key role of local leaders is most significant in changing regulatory structures, from local zoning ordinances and permitting rules to state laws, investment, and privatization of municipal services, as they are close to both citizens and businesses, and can better see the problems of cities and solve them.

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