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Effective policies to overcome barriers in the development of smart cities

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

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

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

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

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

63 **1.1. Global approach: Background and literature review**

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

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

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

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

86 Kim et al. investigated a systematic review from smart homes to sustainable smart cities
87 related to smart energy conservation systems. In this paper, through a quantitative review, the
88 authors showed remarkable solutions for advanced energy conservation systems in
89 sustainable smart cities. Among these, the adoption of a new strategy for energy trading in
90 distributed energy systems; implementation of integrated energy network technologies at the
91 city level; construction of infrastructure for advanced energy conservation systems;
92 development of real-time energy monitoring, diagnostics, and controlling technologies; and
93 application of intelligent energy management technologies are the most important solutions
94 [12].

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

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

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

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

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

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

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

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

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

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

139 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 existing 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]

140

141 **2. Motivation and objective of the study**

142 A smart city is a sustainable and efficient urban center that provides a high quality of life to
143 its inhabitants through optimal management of its resources. Therefore, attention to all
144 sections of a smart city leads to the development and reduction of global criticals, especially
145 in environmental and energy sectors. With rapid population growth, especially in urban areas,
146 and critical issues such as increase in energy demand and costs, internet accessibility
147 problems, and CO₂ emission, the adoption of smart cities is an essential and appropriate
148 solution for every country.

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

154 scale adoption of low-carbon transportation in the future using clean energy in order to
155 reduce CO₂ footprint, developing green spaces for inhabitants; enhancement of security
156 especially in information technology; and more attention to public participation in policy,
157 policymaking, and development programs.

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

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

168 **3. Methodology**

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

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

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

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

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

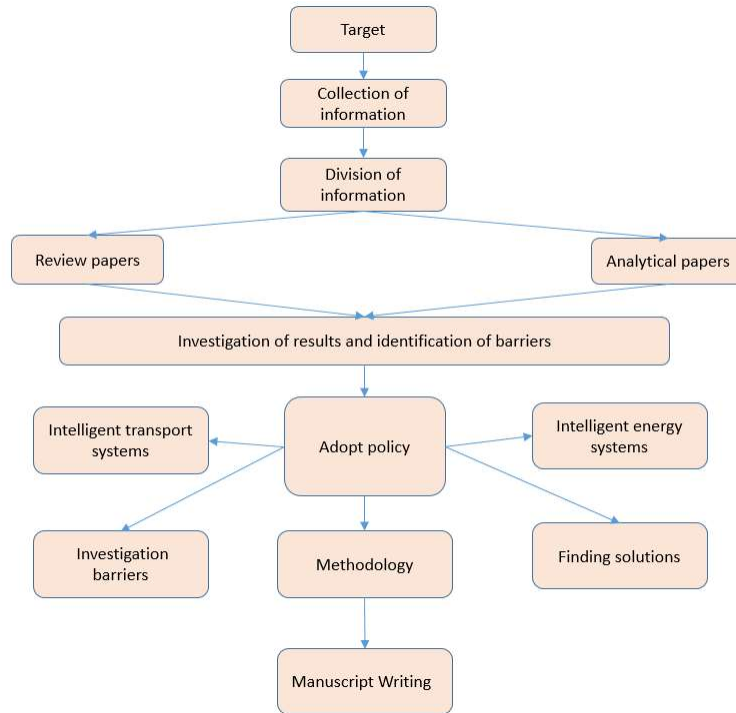
193 After this stage, we assessed a journal based on titles, abstracts, and introductions, selected
194 the appropriate articles to form a collection of 97 articles. Next, a literature review was
195 carried out on two categories of articles:

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

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

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

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



208

209

Fig 1. Study flowchart.

210

211

212

213 4. Importance of intelligent systems for smart cities

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

217 4.1. Importance of intelligent transport systems for smart cities

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

224 transportation powered by fossil fuels is also a major contributor to CO₂ emissions. As
225 mentioned earlier, CO₂ emissions are the major problems of smart cities. Sustainable
226 transport systems to reduce CO₂ emissions are significant challenges for policymakers
227 worldwide.

228 One of the best alternative vehicle technology for smart cities are electric vehicles (EVs)
229 [32]. The development of new sustainable modes of transportation systems has become one
230 of the priorities for all countries around the globe because there are innumerable successful
231 examples of sustainable, smart transport systems across the world like Paris, Boston,
232 Singapore, and Germany. Also, the development of a sustainable transport system is
233 beneficial for all aspects of a smart city, especially economic growth and CO₂ emission
234 reduction [33].

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

244 **4.2. Importance of intelligent energy systems for smart cities**

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

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

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

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

276 **5. Result and discussion**

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

283 **5.1. The key role of policy in creating and developing a smart city and implementation**
284 **of specific goals**

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

292 As mentioned above, implementing a policy requires public acceptance and support which is
293 not easy to achieve. In fact, the diversity of stakeholders' rationales to implementing
294 participatory processes should be investigated, and in addition, appropriate methods and
295 instruments should be used to engage the community in the process [47]. Therefore, to
296 succeed in implementing their policies, policymakers should integrate stakeholder
297 perceptions in the decision-making process, which leads to improving the policy design to
298 implement appropriate policies and prevent public opposition. For instance, providing energy
299 for the present and future generations is a big challenge that needs an appropriate strategy
300 [48].

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

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

313 **5.2. The key role of policy in developing information technology sector for smart city**
314 **citizens**

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

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

330 **5.3. Investigation of important barriers categories for smart cities**

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

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

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

- 343 • governance (G),
- 344 • social (S),
- 345 • technology (T),
- 346 • environmental (ENV) and
- 347 • economic (EC).

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

351 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 governments 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)

352

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

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

361 Table 3. Relevant references for the selected indicators.

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

368

369 5.4. Correct and incorrect policies of countries for developing smart cities

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

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

380

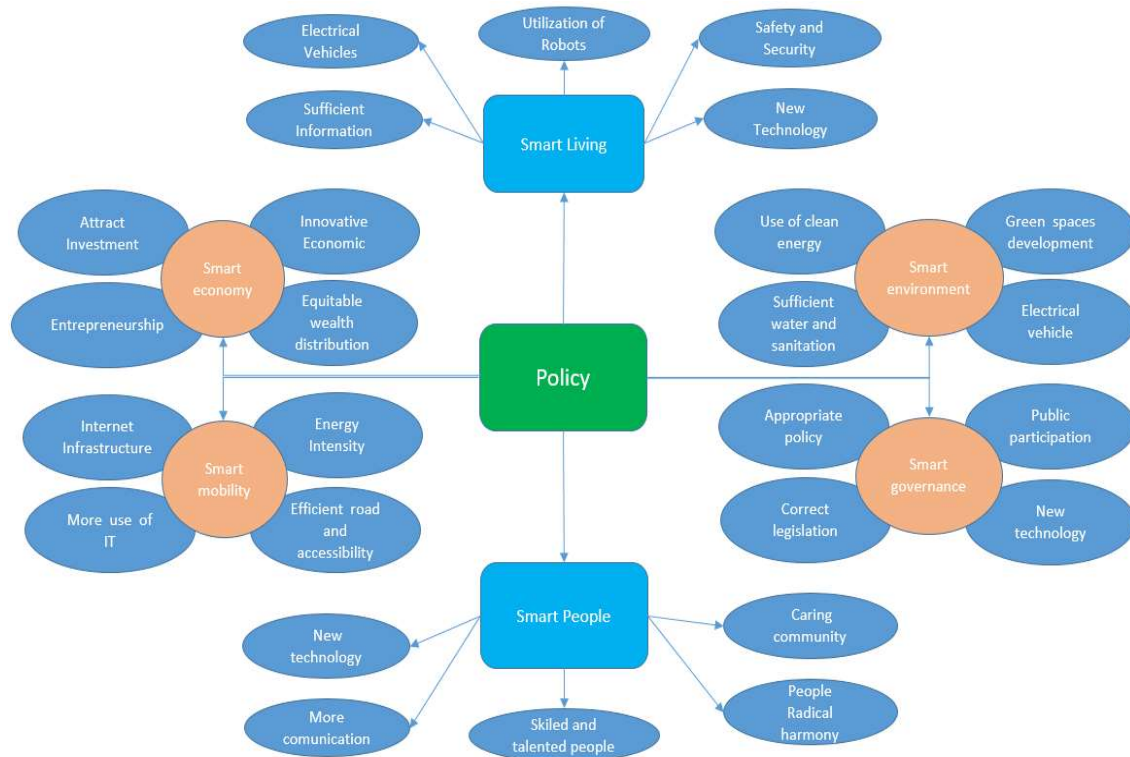
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382 Table 4. Barriers and solutions of smart cities based on governance (G), social (S),
383 technology (T), environmental (ENV) and economic (EC).

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

384

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



389

390

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

391

392 **5.5. Important findings of this study and suggestions for improving the existing**
 393 **obstacles in the development of smart cities**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

485 **6. Conclusion**

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

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

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

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

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

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

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

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