

ORIGINAL RESEARCH PAPER

Definition and recognition of required factors for smartening cities in developing countries

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ABSTRACT: It has been over 20 years that emerging term “smart cities” has been used theoretically and practically and implemented in our built environments. Importance of smart cities is not ignorable due to the world crises such as energy issues which are threatening the future of mankind. Theories and strategies has been implemented in many major cities of developed countries but there are still major energy consumption and other critical issues in developing countries due to strategies, technological systems background and infrastructures on their way toward an industrialized country. Thus it is quite tangible that developing countries and their cities have to come up with strategies that will improve general sustainability of them. One way to achieve this goal is study of successful examples in the world. The aim of this research is to study successful smart cities around the world that received ICF (Intelligent Community Forum) awards to find successful and practical strategies that can be implemented in developing countries. We will first go through world top leading cities, extracting their strategies and technological systems, later coming up with infrastructures in developing countries and in our case, Tehran city in Iran and finally showing strategies and technological facilities and approaches that can be implemented in this city.

Keywords: Smart city, Policy, Open Data, Technique, Iran.

INTRODUCTION

Emerging term “smart city” has been used back in 1990s(Albino, *et al.*, 2015) but it has gained its popularity in recent years when governors and authorities recognized the importance of creating future spaces for the world urbanization prospects which has been published by UN in 2007(Komninos, 2002). In 2010 urban areas hosted 50% of the world’s population, this number has been predicted to raise to 75% in 2050 by UN(UN, 2008).

On the other hand current economics leading force is mainly targeting Information and communication technologies (ICT) despite all arguments about its accurate influence(Resnick, 2002). These 2 main fac-

tors are leading policymakers and authorities to aim building strong infrastructures for their future cities. (Caragliu, *et al.*, 2011)(Attention to Fig. 1).

Tehran as the capital of Iran and the most powerful economical pole of Iran has attracted an enormous number of people in recent years resulting in rapid haphazard growth of the city(Mansoorian, *et al.*, 2015)). Despite all policymakers’ efforts Tehran is still suffering from major problems including infrastructure and technology systems.(Nations, 2012) In this research we are going to study leading smart cities to extract their practical approaches in terms of building a smart city since it has been always a proper way to develop policies and strategies that their results has come up with success.(Yin, 2013)

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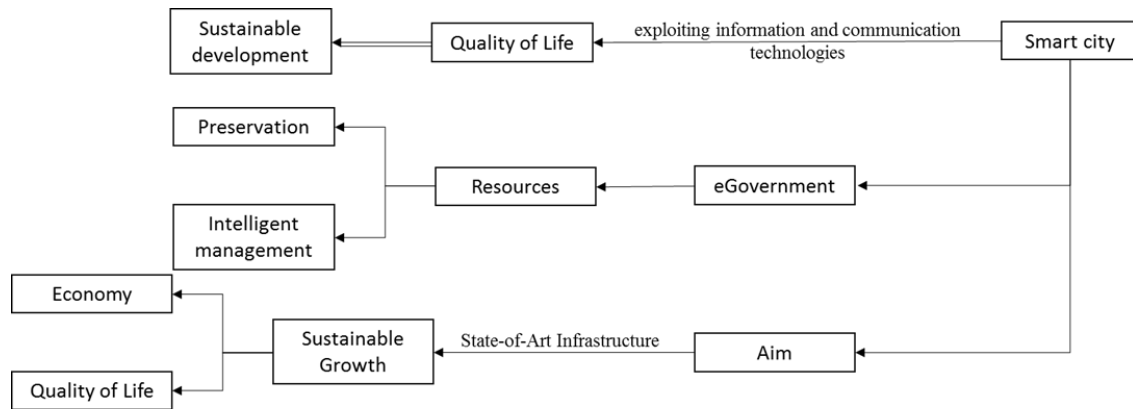


Fig. 1: Big picture of smart cities

MATERIALS AND METHODS

The term “smart city” is under debate among researchers across the globe and it has not been defined in an accurate definition but its characteristics can be distinguished from current definitions as a city which its occupants’ quality of life is supposed to be increased by exploiting information and communication technologies resulting in sustainable development of the city. eGovernment is another term which is derived from smart cities leading in preserving and intelligent management of city resources. On the other hand the term “smart city” is aiming sustainable growth in economics and occupants’ quality of life by implementing state-of-art infrastructures in urban centers (Bowerman, *et al.*, 2000; Caragliu, *et al.*, 2009)(Shows in Fig. 1). According to Hollands, economy, social participation and government efficiency are 3 main factors that a smart city aims to improve for its social and urban growth by using information and communication

technologies. (Hollands, 2008)(Shows in Fig. 2) ICF (intelligent community forum) has been selecting leading smart cities around the world since 1999(“Intelligent Community Forum,” n.d.). In this research we select top leading smart cities based on the years, then coming up with a thorough compilation of policies and technologies that have been implemented by the cities authorities through researches conducted on the cities or using official websites of the cities. In addition, Barcelona is considered as one of the leading cities with historical background. Uniqueness of Barcelona is due to its housing (García-López and Muñiz, 2010)(José Mascaró, 2002), urban policy (García, 2004; González, 2011; Leon, 2008; Majoor, 2009; Marshall, 2000, 2006; McCrone, 2000), environment(Domènech and Saurí, 2011; Villalba and Gemechu, 2011), employment(García-López and Muñiz, 2010) and knowledge economy(Hospers, 2003).

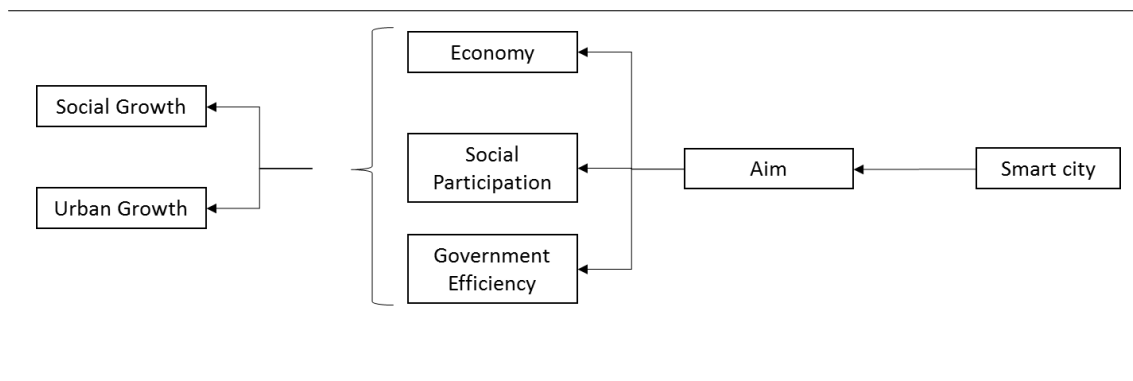


Fig. 2: Big picture of smart cities

RESULTS AND DISCUSSION

Infrastructures

In case of infrastructures, Barcelona as a successful smart city transformed into a knowledge-based economy with higher efficiency and profitably and its citizens' quality of life as well. This goal has been achieved through redesigning current infrastructures not by complete replacement of it. This redesigning of infrastructures led the city toward an improved system of transportation, public services access such as access to education and healthcare system. The redesign of Barcelona's first aim was to ease integration of information and communication technologies resulting in minor to complete transformation of major districts. Major transformation of districts was not cleaving the historical area but to implement technologies such as Wi-Fi, optic fibers or new mobility plans, new heating and cooling systems and new energy networks. In case of minor changes of the city projects such as renewal of old roads and streets had been implemented. (Bakici, et al., 2013) (Based on Fig.3 and Fig.4)

In Tehran these policies had been considered (Madanipour, 1998) but there is still a long way to overcome its obstacles, for instance Oudlajan in Tehran district which its buildings are suffering due to their age and lack of authorities attention leading to a decrease of 71 percent residential occupants. (Hanachee and Rezaei, 2015)

One of the most prominent outcomes of strategies which will be discussed later on this article is services created by public sector and private sector resulting in three types of connections including public-public, public-private, private-private which first type services employees of government, the second services offered by public sector to citizens to ease their daily life and the third which expands civil lifestyle and social connections.

Open Data

This concept has been used to create a platform which stores all necessary data and act as an encyclopedia as well, for citizens and other public sectors which is provided for free usage and republishing without copyright considerations. (Auer, et al., 2007) Importance of Open Data comes to mind when policymakers set goals and turn these goals into policies. At the very beginning of the process of setting goals, first a problem is observed and monitored but to set policies it should be measured in many cases. Mea-

surement provide more controlling ability and enables policymakers to set policies to improve some certain aspects of built environment. (Kulesa, 2009)

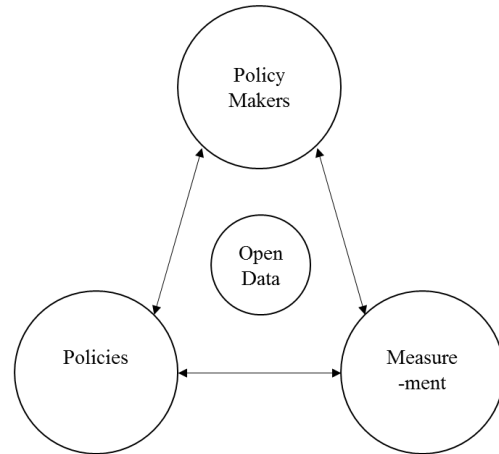


Fig. 3: Understanding the concept of Open Data

For achieving a true open data system, there should be certain strategies. Policymakers have to create a platform for sensor data and network management. They have to keep in mind that the platform should be open to integration of other forms of communication. Second in designing the platform, there should be a coordination between existing sensors and new developed sensors. (Bakici, et al., 2013) Shows in Fig. 3.

All these strategies can be only achieved through a collaboration of private and public organization to achieve an implementable strategy for instance there are 5 organizations involved in Barcelona smart city project including the 22@Barcelona agency, "Promoció Econòmica" (Economic Promotion), the mobility department of government, the control and environment department of government, "Institut Municipal d'Informàtica" (Municipal Institute of Information Technologies). In this case a successful strategy to build up a collaboration was to devolve economic capital gain, urban planning, building new infrastructures and refurbishing of existed infrastructures, IT services to private sector and transportation mobility including private and public transportation and environmental controlling to public sector. However, Barcelona is leading itself toward smart cities leadership in European Union but social interaction as an important criterion might be missing while we are going through these succeeded strategies. If we want to implement localized strategies, we have to consider social interaction which is called people system. People and businesses of a city play a key

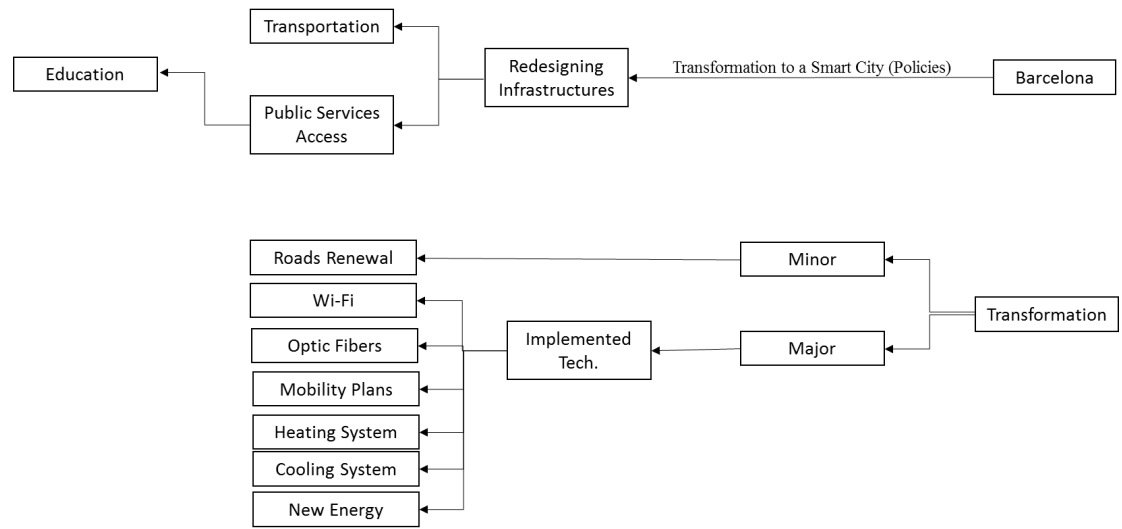


Fig. 4: Big picture of Barcelona

role in sustainable development.(Haughton, 1997)

Strategies

According to the Fig.4, two main elements about developing Barcelona toward being a smart city has been discussed, hereby this paper will go through more practical and tangible strategies which were implemented by cities like Amsterdam, these strategies are reported mostly by governmental body of these cities which its roots are originated from Open Data system that reveals these cities smartness level and open their statistics to public and researchers as well. In case of Amsterdam, ASC (Amsterdam Smart City) has created strategies for reduction of CO2. In designing a scheme, first ASC developed a vision for the city coming up with consultations with principals and technical architects, later determined an approach to implement strategies. In the second phase of ASC program, CO2 reduction potential had been determined coming up with determining partners for program and later developing program plan and setting a legal framework. In the third phase of program, funds had been secured from partners and projects had been started. In the fourth phase of ASC program evaluation of the executed program had been conducted, next results were discussed with respected governmental bodies, coming up with a full implementation of the project. (Shows in Fig. 5) Participants were managers of their own subproject and financially responsible. Each partner (partici-

part) delivered reports on progress and ensured that information they provided are scientific.

In West Orange district (residential), Strategy that had been followed was simple, installing smart meters to improve consumers' behavior. This simple strategy saved 9% in power and 14% in gas on average coincide with household devices efficient usage and lowering heating and replacing some of devices. In ITO tower which is an office tower, occupants were informed about sustainability and energy saving resulting in their awareness increase and implementation of energy saving scheme. Procedure was mostly same but in this case smart plugs that record energy usage were implemented, coming up with an energy efficient lighting plan and increasing employees' awareness had been implemented. Savings were almost same as residential projects.

In Climate Street as a pilot project for sustainable public space targeting urban shopping streets, central logistics had been used in order to diminish traffic, dimming of public lighting and sustainable tram stops, smart plugs and energy meters plus an electrical vehicles system for waste collection had been used. All these efforts resulted in moving almost 50% of all enterprises to sustainable waste system, successful installation of smart plugs to monitor their energy consumption. Public lights dimming resulted in 10%energy saving and the important issue to consider is that people on the street did not

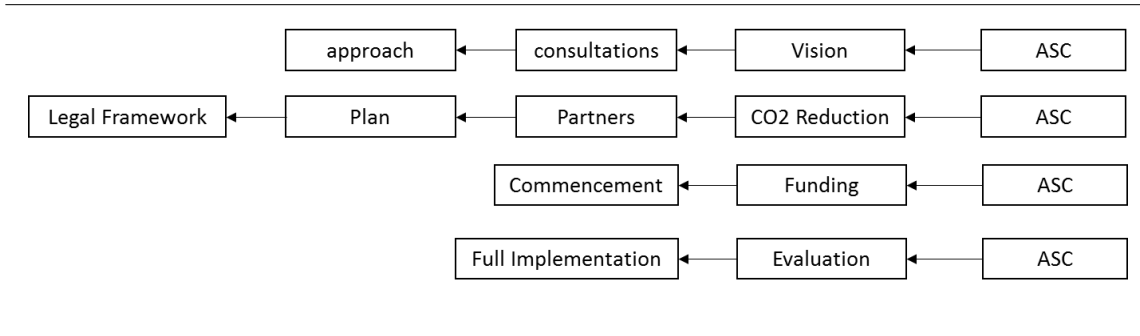


Fig. 5: How ASC managed to transform Amsterdam to a smart city

notice the difference of dimming.(Baron, 2010)As shown in Fig. 6.

Despite of all committees and public sectors efforts in Tehran toward creating a smarter city such as smart schools according to www.tehransmart-schools.ir and etc. there are still major obstacles toward smartening such as major deficits in Open Data section. By our search many public sectors are not providing their data online and traditional way is still exerted. (Nations, 2012)

To sum up an approach toward smartening cities and in our case Tehran, there should be a big picture for policy makers and authorities in charge. To the moment we have gone through major tested policies and tactics by other cities and we will come up with factors and elements that these strategies went through them. In examples that were provided government and their policies that resulted in regu-

lations played an important role toward a smarter community.

The smarter community leads toward smart growth; in case of Amsterdam it has been noted through SMEs. Hence Tehran policy makers have to facilitate rules and regulations for other sectors for smartening the city. On the other hand, technologies required for smartening a city shall exist and be funded that it can be done by private or public sector. In case of Tehran, technology-based improvement such as wired city is on its way to make to the city smarter. However, there are major deficits in sections such as Open Data and ongoing ICT developments such as hybrid city. Hybrid city is attributed to an international biennial event that explores influence of ICT on urban condition transformative shift and the city. (http://uranus.media.uoa.gr/hc3/?page_id=41, uranus, n.d.)

The most important factor is Open Data improve-

Table of Policies & Techniques

Area		Open Data						
Section	Legal Framework	Operative Characteristics of Data	National Data Portal	Language of Data & Portal		Data User Feedback	Data Quality	Designing an Special Sector
Policies	Required Improvements	CSV, RDF, XML Machine Readable Interpretation	Shall be Established	Persian (Farsi)	English	Required		Required
Area		Consumers` Behavior			Infrastructure of Services			
Section	Techniques	Smart Meters		Power Saving		Logistics		
	Devices	Examined Energy Saving		Devices	Examined Energy Saving	Devices	Examined Energy Saving	Examined Energy Saving
	Smart Plugs	10-14%		Public Lights Dimming	10%	Team Stops + Central Logistics		CO2 General Reduction
		Power 9%	Gas 14%		Power 0%			

Table 1. Policies and Techniques for Iran and their tested results

ments in Tehran, require public sectors to release their data and information online. The tested path to achieve this goal is collaboration of public and private sectors. Devolving economic capital gain, urban planning, building new infrastructures and refurbishing of existed infrastructures, IT services to private sector and transportation mobility including private and public transportation and environmental controlling to public sector. (Nations, 2012)(Shows in Fig. 7)

Open Data Strategies

- Establishing richer legal framework

According to Iranian Parliament (Majlis) FOI (Freedom of Information) rules has been passed in 2009 but it was not so effective till 2014. The law still suffers major deficits. (<http://www.rnk.ir/>)([Http://www.rnk.ir, n.d.](http://www.rnk.ir/))

- Operative characteristics of data
- Data provided shall be machine readable
- Current formats mostly include: CSV, RDF and XML
- Data shall be accompanied by satisfactory interpretation
- National Data Portal

It is highly advisable to publish data through a national data portal

- Language of Data and Portal

It is highly advisable that data provided be not only in domestic language (Persian) but also includes an English version as well.

- Data users feedback

Asking for feedback in different ways such as asking by mails, survey or even commenting below Data pages is very important to improve quality of Data

- Data Quality

This section is a bit under argumentation due to lack of any law on Data quality in Iran however the U.S. has passed a bill called “Data Quality Act” in which there is a thorough procedure on how to evaluate data. (https://www.whitehouse.gov/omb/inforeg_agency_info_quality_links)(“Office of Management and Budget of the U.S.,” n.d.)

- Designating a Special Sector

This will be credible for understanding which agency operates the Open Data.

Infrastructures and people

- Consumers’ Behavior

More specified strategies to target is to alter consumers’ behavior. As we know citizen participation plays a crucial role toward smartening a city. This issue can be achieved through informing them on their usage. The best devices in the market are smart meters. Smart meters can show consumers their usage. Hence consumption behavior is subjected to change voluntary if and only if consumers are aware of their consumption behavior.

- A. Understanding Smart Meters

Fig. 6: Amsterdam Policies

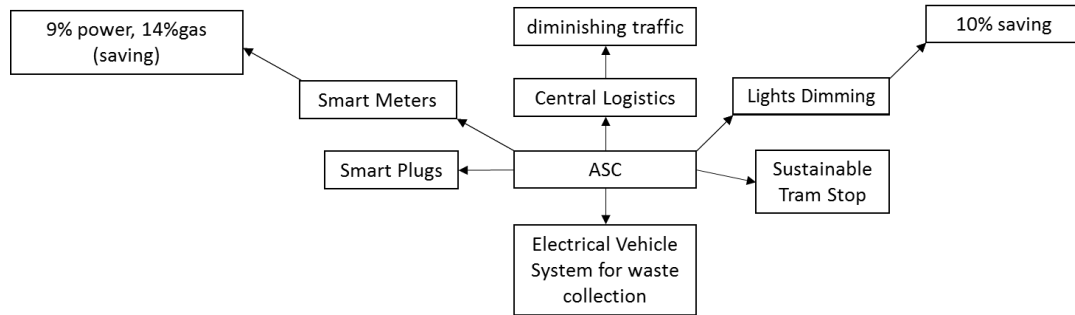
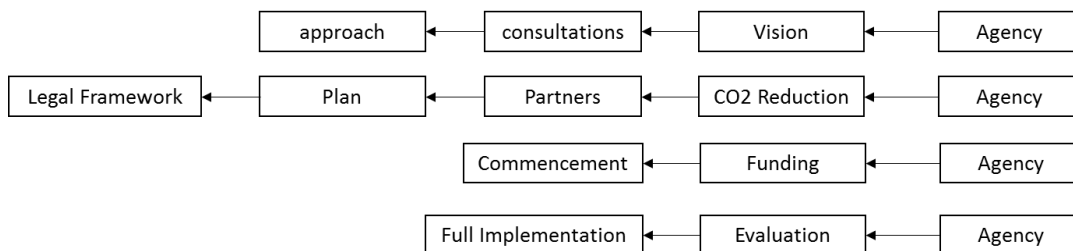


Fig. 7: Implementable scheme of Amsterdam for Iran



Smart meters and smart devices such as smart plugs which measure and monitor energy usage at the same time shall be distributed among consumers to alter their behavior and result in energy saving and reduction in CO2 production to achieve a smart city in Tehran.

▪ Infrastructures of Services

A. Logistics

In commercial urban areas such as Bazar, tram stops and central logistics should be used in order to diminish traffic.

B. Energy Saving by Public Sector

On the other hand dimming for lights is a proper way of controlling energy. (See diagram 8)

Scheme of Implementation

To plan all the above there shall be a 4 phase scheme to follow. First developing visions, determining implementation approach, second defining partners, detailed plan and Legal framework, third funding the project and the fourth phase is evaluation and later decisions. (Shows in Fig. 7)

Limitations and Barriers

Two major barriers toward the mention strategies and techniques are funding and people’s tendency.

▪ Funding

Funding plays a major role in implementation of Open Data and Infrastructure that this will significantly decrease by strengthening the laws to enforce companies provide their Data.

▪ People’s Tendency

This issue can be solved by placing initiatives by governors but its funding should be considered as well.

To conclude the aim of this study was to determine strategies and tactics exerted by 2 cities with historical background similar to Tehran’s condition coming up with extracting the big picture behind smart cities, searching for their programs and approaches and in which areas policy makers should put all their efforts which are government body to ease regulations, technologies including information and communication technologies and cities’ citizens. The findings that we have presented suggest that policymakers have to focus on open data as an important phase toward smartening our cities. Open data can be achieved through 6 steps. We distinguish establishing richer legal framework as the first step toward

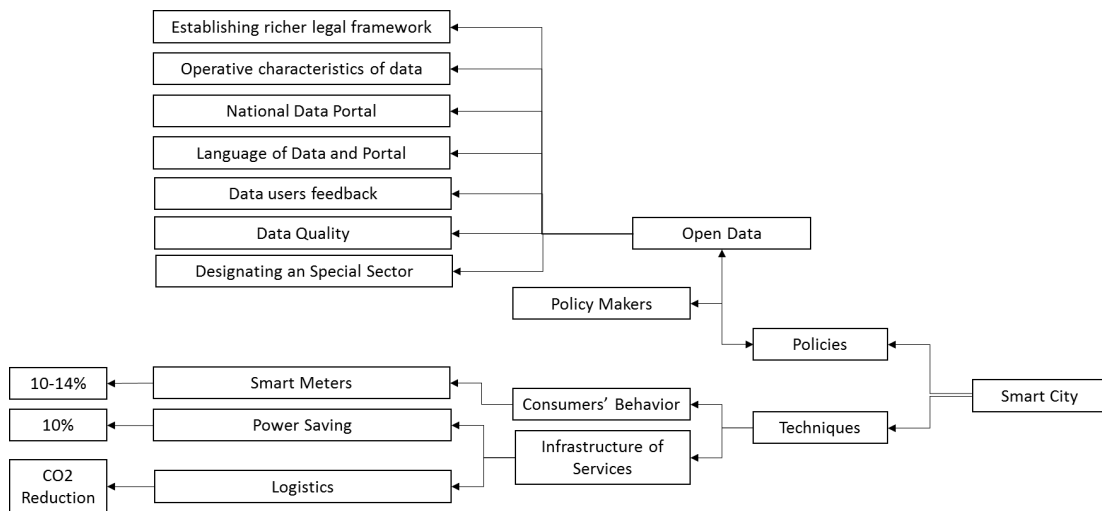


Fig. 8: Policies and techniques for Iran and their tested results

☑: Applicable

✗: Not applicable at the moment

*All Data provided requires sufficient interpretation and data needs to be machine readable.

**Data Quality is still under debate. It requires establishing legal framework on the issue.

achieving open data as the most important phase which shall be accomplished. Remaining 5 steps are considering operative characteristics of data, establishing national data portal, presenting the national data portal in both domestic and international language, asking for users' feedbacks, establishing rules to check data quality and at the end, designating a sector to implement open data project. On the other hand, there techniques that shall be considered. One is aiming consumers' behavior and altering it by using smart meters such as smart meters that can measure energy consumption and turn on/off devices online or automatically. Public lights dimming is another issue to consider as it can save up to 10 percent of power and the pros is that users won't notice the light difference. Reducing CO₂ production can be achieved through tram stops and central logistics in populated urban areas. (Attention to [Table 1](#)) These results are preliminary steps to smarten Tehran as the leading city of Iran.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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