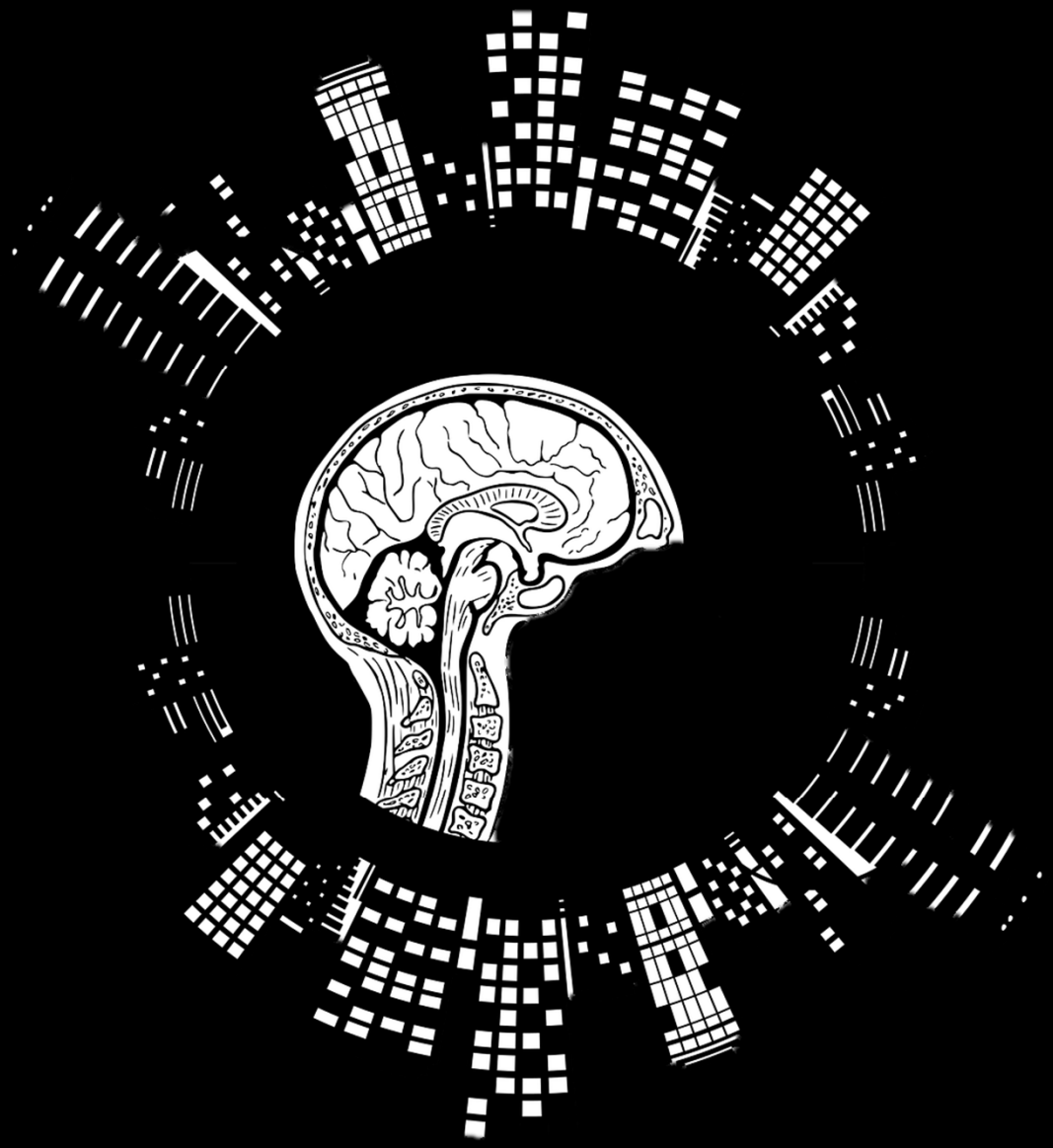
NEGAR NOORI

POLICY TRANSPLANTATION FOR SMART CITY INITIATIVES



ERASMUS UNIVERSITY OF ROTTERDAM

POLICY TRANSPLANTATION
FOR
SMART CITY INITIATIVES

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BELEIDSTRANSPLANTATIE
VOOR
SLIMME STADSINITIATIEVEN

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Negar Noori

Born in Ahvaz, Iran

Erasmus University Rotterdam

This dissertation has been approved by the promotors.

Composition of the doctoral committee:

Prof. dr. W. M de Jong	Promotor
Prof. dr. E. Stamhuis	Promotor

Other member:

Prof. dr. M. Janssen
Prof. dr. A. Meijer
Prof. dr. A. Arcuri

Co-promotor:

Dr. T. Hoppe

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To

My family

CONTENTS

SUMMARY

City branding is increasingly practiced in cities with a strong drive to engage in urban (re)development in the post-oil era through enhancing 'ecological modernization'. One of the most popular brands among them is 'Smart City', however, some of the adopted city branding strategies lack sophistication. The first challenge ahead for those cities aiming to profile themselves as 'Smart' is to credibly brand themselves and let this brand become the cornerstone for a transition towards a future city. Although there are an infinite number of city brands and at least thirty-five city labels distinguished in the literature (Schraven et al. 2021), still there is no framework to examine city brand credibility.

In the past decade, the popularity of using Smart City labels for sustainable techno-driven urbanization has increased dramatically. Several generations of Smart City constructs have emerged so far, and the concept has evolved and broadened in meaning. Although this broader scope has allowed for proper response to many criticisms of the Smart City, including the over-emphasis on technology, it has added to the complexity of the concept. The most significant consequence of this vagueness is that the policy implication underlying Smart City development have become puzzling for both policymakers and practitioners. Despite the fact that no model can cover all different aspects of Smart City development, models can simplify reality constructively and allow for better understanding of its various facets. Although there are numerous analytical models of the Smart City in areas such as the engineering and management of IoT platforms, no such model exists looking at Smart City development as a process with viable policy design choices that can be used as an intermediary tool between policymakers and practitioners.

Recently in numerous countries around the world, policy makers in urban areas pay a lot of attention to the programs associated with the development of Smart Cities. Many urban managers, however, are now just beginning to learn how to 'do' Smart City development. Nevertheless, building such an advanced techno-driven city seems very expensive and cities that are just getting started can potentially make it cost-effective through a learning process by technology, policy and experiences transfer and avoid having to reinvent the wheel. In the quest for smart city development, numerous examples of 'best practices' have been created and circulated in national and international arenas. Learning from good practices is a perennial aspect of human development. It is adopted in the Smart City realm aligned with the wider

stream of political science and urban policy studies. There are abundant indices to rank Smart City good practices, and extensive studies on lessons that can be learned from them have been conducted. Nonetheless, a comprehensive framework for analyzing lessons from Smart City good practices in a systematic way is missing.

Cities running Smart City programs seem to want a lot, but do not always know how to do it, and intend to learn from leading Smart Cities running good practices projects. The assumption underlying this research is that they can do so, but must realize that first, the readiness for becoming Smart is crucial and second, the political, legal, institutional and cultural context in donor countries are different. Context plays an important role and transferring lessons and policies is not something that occurs in a vacuum. First of all, transforming a city into a Smart City requires consideration of the readiness of a city for the change. The existing studies on Smart City readiness are mostly focused on technological readiness. Whereas the evidence shows social and political readiness are just as crucial as technological readiness, if not more so. Furthermore, taking steps in the complicated process of travelling policies (from donor countries to the recipient) requires a comprehensive framework to show pathways, and/or roadmaps.

To address these challenges and gaps the author first examines what indicators can be used for evaluating the credibility of city brands and apply these to the 'Smart City' brand. The proposed 'brand credibility evaluation' framework applies to Iranian large cities which are our candidate recipients for adopting Smart City policies from good practices in this research. The results indicate that four large Iranian cities have a credible 'Smart City brand' that justifies their use as illustrative examples for Smart City policy transplantation. Then an Input-Output (IO) model of the Smart City development process helping policy makers and analysts make informed design choices is developed. The IO model translates required key resources, the capabilities of transforming resources to intended applications, and the desired application of this development process into inputs, throughputs, and outputs. In the next step the (IO) model is used to retrieve which design variables are at play and lead to which output in the following Smart City projects: Smart Dubai, Masdar City, Barcelona Smart City, and Amsterdam Smart City. In fact, a Smart City design framework is developed based on the (IO) model which is used as a tool to analyze Smart City good practices. The results of analyzing the four cases (Amsterdam, Barcelona, Masdar, and Dubai) indicate in which ways their Smart City development pathways are different. In the next step, a framework for assessing Smart City readiness is presented to develop a Theory of Change for recipient cities to be ready for becoming 'Smart'. The framework is applied to the examples of the recipient cities (four large Iranian cities with a credible brand of 'Smart') to examine their readiness for becoming Smart. Here, I find that political readiness is the main challenge for Iranian cities.

And finally, all the conceptual and theoretical frameworks mentioned enabled the author to propose a comprehensive framework to analyze 'travelling' Smart City policy from donor countries to recipients; i.e. the so-called '**Smart City Policy Transplantation**' framework. This framework is the first comprehensive one for Smart City policy travelling that uses the term 'Transplantation' inspired by comparative law (legal transplantation) and political science (institutional transplantation). The main idea behind using this terminology is that 'The Smart City Policy Transplantation' framework is not only about the policy traveling but also accommodating of the policy travel.

Chapter 1 (Introduction) introduces the reader to the general concepts, theories and approaches associated with the Smart City development policy. It introduces the theory of Ecological Modernization as the source of the emergence of the concept of future cities' brands and the most popular one among them; Smart City development policy with the issue of vagueness in its implementation.

Chapter 2 (Towards credible city branding practices) examines the credibility of cities' brands facing ecological modernization. It also deals with recognizing the credible brand of 'Smart' among those cities that profile themselves as 'Smart'. Much of the future-proof city policies have started from branding practices, and as such represents an important chapter.

Chapter 3 (Input-output modeling of Smart City) deals especially with the Smart City development process and applies a system thinking to map the process. It first provides an overview of the Smart City's various definitions, classifications, and domains. Then translates various facets of its development process into inputs, throughputs, and outputs helping its implementation.

Chapter 4 (Classifying pathways for Smart City development) presents an integrated framework for the Smart City design choices based on the IO model as a tool to analyze and compare various Smart City good practices and their development pathways.

Chapter 5 (Towards an integrated framework for Smart City readiness) classifies indicators, factors, and practices for Smart City readiness into technological, socio-economic, and political readiness parameters. It also deals with how to develop a theory of change for cities to become ready to be 'Smart'.

Chapter 6 (A conceptual framework for Smart City policy transplantation) describes the mechanism of policy transplantation from good practices to a Smart City initiative that is the main ambition of the present study to help them initiate their Smart City program.

Chapter 7 (Conclusion) covers the responses to the research questions and some policy recommendations for the Smart City initiatives and those cities that are just started their Smart City program.

SAMENVATTING

City branding wordt steeds meer toegepast in steden met een sterke drive om deel te nemen aan stedelijke (her)ontwikkeling in het post-olietijdperk door het versterken van 'ecologische modernisering'. Een van de meest populaire merken daarvan is 'Slim'(smart). Maar sommige van de gebruikte city branding-strategieën zijn weinig verfijnd. De eerste uitdaging voor die steden die zich willen prositioneren als 'Smart' is om zichzelf geloofwaardig te profileren en zo het fundament onder de transitie naar een toekomstige stad te bouwen. Hoewel er meer dan twintig stadsmerken in de literatuur zijn, is er nog steeds geen raamwerk om de geloofwaardigheid van stadsmerken te onderzoeken en hoe een stad zichzelf geloofwaardig kan etiketteren als 'smart'.

In het afgelopen decennium is de populariteit van het gebruik van Slimme steden-labels voor duurzame, technologie-gestuurde verstedelijking fors toegenomen. Er zijn tot nu toe verschillende generaties Smart City-constructies ontstaan en het concept is geëvolueerd en breder geworden. Hoewel deze bredere reikwijdte een reactie was op kritiek op de Smart City, waaronder de te grote nadruk op technologie, heeft het de complexiteit van het concept vergroot. Het belangrijkste gevolg van deze vaagheid is dat de implementatie van het Smart City-ontwikkelingsbeleid een raadsel wordt voor zowel beleidsmakers als praktijkmensen. Ondanks het feit dat geen enkel model alle verschillende aspecten van de Smart City-ontwikkeling kan dekken, kunnen modellen de realiteit vereenvoudigen om de verschillende facetten ervan beter te begrijpen. Er zijn weliswaartalloze modellen in de hoofdcategorieen van de Smart City, maarer ontbreekt een model dat kijkt naar het proces van de Smart City-ontwikkeling. Zo een model kan met een pragmatische benadering een rol spelen als intermediair tussen beleidsmakers en praktijkmensen.

Tegenwoordig besteden beleidsmakers in stedelijke gebieden in tal van landen over de hele wereld veel aandacht aan de programma's rond de ontwikkeling van zogenaamde 'slimme steden'. Veel stedelijke managers en planologen beginnen echter nu pas te leren hoe ze slimme stadsontwikkeling kunnen aanpakken en uitvoeren'. Het bouwen van zo'n geavanceerde technologie gedreven stad lijkt erg duur, om welke reden efficiency wenselijk is. Steden die past zijn begonnen, kunnen effectief te werk gaan wanneer zij een leerproces doormaken, waarbij technologie, beleid en ervaringsoverdracht centraal staan, en zo vermijden dat ze het wiel

opnieuw moeten uitvinden. In de zoektocht naar de ontwikkeling van slimme steden zijn talloze voorbeelden van 'best practices' gecreëerd en verspreid in nationale en internationale arena's. Leren van goede praktijken is altijd een element dat in de menselijke ontwikkeling wordt aangetroffen, met verschillende betekenissen en consequenties in de verschillende contexten. In lijn met de bredere stroom in de politieke wetenschappen en stedelijk beleidsonderzoek wordt het leren van anderen ook in Smart City beleidsontwikkeling aangenomen. Er zijn veel rangen en indexen om de goede praktijken van Smart City te bepalen, en er zijn uitgebreide studies uitgevoerd naar de lessen die eruit kunnen worden getrokken. Niettemin ontbreekt een alomvattend kader om lessen uit de goede praktijken van Smart City op een systematische manier te analyseren.

Het lijkt erop dat steden die net begonnen zijn met Slimme steden-programmas wel veel willen, maar niet precies weten hoe ze het moeten doen en hoe te leren van toonaangevende Slimme steden elders die voorbeeldprojecten uitvoeren. De aanname die aan dit onderzoek ten grondslag ligt, is dat ze dat kunnen, maar wel moeten beseffen dat ten eerste de bereidheid om slim te worden cruciaal is en ten tweede, dat de politieke, juridische, institutionele en culturele context in die donorlanden anders is dan in de eigen stad. Ergo, context speelt een belangrijke rol en het overdragen van lessen en beleid kan daarvan niet worden geïsoleerd. Allereerst vereist het transformeren van een stad in een slimme stad dat rekening wordt gehouden met de bereidheid van een stad voor de verandering. De bestaande onderzoeken naar de gereedheid van Smart City zijn vooral gericht op technologische aspecten, terwijl het bewijs aantoont dat sociale en politieke bereidheid net zo cruciaal is als technologische gereedheid, zo niet meer. Bovendien vereist het zetten van stappen vooruit in het gecompliceerde proces van 'beleidtransfer' (van steden in donorlanden naar ontvangende steden) het gebruik van een alomvattend kader.

Om deze uitdagingen en hiaten aan te pakken begint de auteur met na te gaan welke indicatoren kunnen worden gebruikt om de geloofwaardigheid van 'stadsmerken' te evalueren en deze toe te passen op het merk 'Slim'. Het voorgestelde kader voor de beoordeling van de geloofwaardigheid van het merk wordt toegepast op Iraanse grote steden die kandidaten zijn om Smart City-beleid als ontvanger over te nemen op basis van goede praktijken in dit onderzoek. De resultaten geven aan dat vier grote Iraanse steden een geloofwaardige merk 'Smart' hebben, wat rechtvaardigt dat zij illustratieve voorbeelden zijn als de ontvangers van het Smart City-beleid. Vervolgens wordt een Input-Output (IO)-model geïntroduceerd dat beleidsmakers en analisten kunnen gebruiken bij het maken van geïnformeerde ontwerpkeuzes. Het (IO)-model wordt vervolgens gebruikt om te achterhalen welke ontwerpvariabelen van belang zijn en tot welke output deze variabelen leiden in de volgende Slimme steden-projecten: Smart Dubai, Masdar City, Barcelona Smart City

en Amsterdam Smart City. Dit model kan worden gebruikt als een hulpmiddel om de goede praktijken van Smart City te analyseren. Het resultaat van de analyse van de vier cases (Amsterdam, Barcelona, Masdar en Dubai) geeft aan hoe hun Smart City-ontwikkelingstrajecten verschillen. In de volgende stap wordt een raamwerk gepresenteerd voor het beoordelen van de gereedheid van een stad om zo een Theory of Change te ontwikkelen voor ontvangende steden die klaar willen zijn om 'Smart' te worden. Het raamwerk wordt toegepast op de voorbeelden van de ontvangende steden (vier grote Iraanse steden met een geloofwaardig merk 'Smart') om te onderzoeken of ze er klaar voor zijn om Smart te worden. Het resultaat is dat politieke geschiktheid de grootste uitdaging is voor Iraanse steden. Tot slot hebben al deze conceptuele en theoretische kaders de auteur in staat gesteld een alomvattend raamwerk te ontwerpen voor transplantatie van smart city-beleid. Dit raamwerk is het eerste alomvattende raamwerk voor Smart City-beleidstransities dat de terminologie van 'Transplantatie' gebruikt, geïnspireerd door rechtsvergelijking (juridische transplantatie) en politieke wetenschappen (institutionele transplantatie). Het belangrijkste idee achter het gebruik van deze terminologie is dat het raamwerk van 'The Smart City Policy Transplantation' niet alleen gaat over het reizen van het beleid in isolement, maar ook over de accommodatie van het reizen met het beleid van de ene naar de andere context.

Hoofdstuk 1 (Inleiding) laat de lezer kennismaken met de algemene concepten, theorieën en benaderingen die verband houden met het Smart City-ontwikkelingsbeleid. Het introduceert de theorie van ecologische modernisering als de bron van de opkomst van het concept van de merken van toekomstige steden en de meest populaire onder hen; Smart City-ontwikkelingsbeleid. Aan de kwestie van vaagheid bij de uitvoering ervan wordt in dat hoofdstuk aandacht besteed.

Hoofdstuk 2 (Towards credible city branding practices) onderzoekt de geloofwaardigheid van stedenmerken die worden geconfronteerd met ecologische modernisering. Het behandelt ook de erkenning van het geloofwaardige merk 'Smart' in steden die zichzelf profileren als 'Smart'. Veel van het toekomstbestendige stadsbeleid is uitgegaan van merkpraktijken en daarom vormt hoofdstuk 2 als zodanig een belangrijk onderdeel van deze studie.

Hoofdstuk 3 (Input-output modellering van Smart City) behandelt in het bijzonder het Smart City-ontwikkelingsproces waarbij een systeemdenken wordt toegepast om het proces in kaart te brengen. Het geeft eerst een overzicht van de verschillende definities, classificaties en domeinen van de Smart City. Vervolgens worden verschillende facetten van het ontwikkelingsproces vertaald in inputs, throughputs en outputs die de implementatie helpen.

Hoofdstuk 4 (Op weg naar een classificatie van Smart City-ontwikkelingstraject) presenteert een geïntegreerd raamwerk voor de Smart City-ontwerpkeuzes op

basis van het IO-model als een hulpmiddel om verschillende Smart City-good practices en hun ontwikkelingstrajecten te analyseren en te vergelijken.

Hoofdstuk 5 (Naar een geïntegreerd raamwerk voor Smart City-gereedheid) classificeert indicatoren, factoren en praktijken voor Smart City-gereedheid in technologische, sociaaleconomische en politieke gereedheidsparameters. Het behandelt ook hoe een veranderingstheorie ontwikkeld kan worden zodat steden klaar worden om 'slim' te zijn.

Hoofdstuk 6 (Een conceptueel raamwerk voor Smart City-beleidstransplantatie) beschrijft het mechanisme van beleidstransplantatie van goede praktijken naar een Smart City-initiatief, dat de belangrijkste ambitie is van de huidige studie om de beleidspraktijk te helpen bij het opstarten van een Smart City-programma.

Hoofdstuk 7 (Conclusie) behandelt de antwoorden op de onderzoeksvragen en geeft enkele beleidsaanbevelingen voor de Smart City-initiatieven, in het bijzonder die steden die net begonnen zijn met hun Smart City-programma.

1

INTRODUCTION

1

1.1. RESEARCH MOTIVATION

'***The Smart City concept is increasingly frequently used***'; this is a statement in which many authors express their motivation for researching and writing about the Smart City. Nevertheless, why the concept of a Smart City has been as broad as an umbrella? On the one hand, this inclusive incidence is due to the need to solve complex urban problems, and the other side is affected by technology push and technocracy (rules by technology companies). Therefore, from the standpoint of technological forecasting, smart urbanism is not only an urban development option or diplomacy but also an inevitable future reality. The experience of the COVID-19 pandemic has shown us how technology can be used to serve humans in vulnerable conditions. But is technology the core of designing our future cities? I started my journey on Smart City with this early assumption that 'technology is the core of our future cities and more specifically the Smart City'. My primary motivation was based on this assumption that I left my job as a Technology Manager in the ICT industry for new adventures on the fascinating and trendy subject of Smart Cities development. However, from the early steps of investigating the Smart City concept, I begun to change my assumption and my interest in the human factor grew for the further steps of this journey. I started my adventure on the topic of Smart Cities as a freelancer project coordinator to facilitate public-private partnership for the 'Smart City and City Branding' projects. Then I realized that despite the growing demand for creating Smart Cities, it seems the understanding of how put the policies in action and implement them is still very limited for Smart City initiatives. The more the concept of the Smart City becomes extensive and the higher its ambiguity, the more difficult it will be to convince urban policymakers and managers to invest in Smart City initiatives to transform their cities into a real Smart City rather than just branding it as smart (Hollands, 2008). Another challenge for the Smart City initiatives is managing stakeholders from different disciplines with various approaches and expectations. Using a common language so that policymakers and practitioners can understand each other's expectations is crucial for implementing the Smart Cities policies.

Those challenges in the real world of the Smart City development drove me to research on the initiation phase when urban governments begin a new policy and then it is mainly about governance. So, the main purpose of this research is to discuss the governance of Smart Cities and how local and municipal government should run the city to be smart. It will be centered around the policy behind such governance and highlight the institutional and organizational features. Looking at the legal con-

text, for instance, legality is more important in some countries than in others. Politically, the way government organization are structured, and the level of collaborative governance based on interaction between public and private sectors, levels of hierarchy lead to different approaches in initiating a Smart City. Since still there is no best model or clear conceptual definition and defined domain of application for the Smart City, learning from good practices helps initiators to develop better Smart City policies based on their own objectives. On the other hand, it also helps those leading Smart Cities to improve their policies over time and make them more transparent. To clarify how we can learn from good practices, first an understanding of the Smart City development process, its required resources, intended outputs and expected outcomes is essential. Then applying it to the various Smart Cities cases reveals different Smart Cities development pathways. The process to investigate what lessons follower Smart Cities can learn from leading Smart Cities in terms of governance approaches and how can these be transplanted is the core of this study.

1.2. Conceptual Realm and Interdisciplinary

1.2.1. Ecological modernization and urban policies

Globalization, technological changes, urbanization, and climate change have emerged as important challenges of the twenty-first century. Ecological modernization (EM) Theory-originating from the early 1980s (Mol & Spaargaren, 2000) has been developed in need of solutions for these challenges in the early 1990s (Mastrangelo & Aguiar, 2019). In response to the 'Risk Society Theory', which criticized science and technology and promoted deindustrialization and de-modernization, EM as an approach was developed (Mol & Spaargaren, 1993, p.433). The main discussion of the theory concerns the connection between society and nature based on the evolution of socio-political institutions (Campos-Medina, 2019). It is argued that modernization brings technology that consumes energy and leads to issues such as air pollution and climate change. Ecological Modernization narratives basically are related to making the environmental improvements through the further advancement of technology, industrialization, and urbanization (Fisher & Freudenburg, 2001). In a simple word, EM seeks eco-efficient innovation and environmentally friendly technologies to increase resource productivity that means achieving higher outputs with consuming less resource (Huber, 2000). From an economic point of view, EM claims that a sustainable form of capitalism is possible by using modern and clean technologies (Fieldman, 2014). The common denominator of all these definitions is that economic development and environmental protection can proceed hand-in-hand bene-

fiting from technological development (Dryzek, 1997). There are also two major approaches to ecological modernization as a theory of the social transformation-continuity and ecological modernization as the political program (Mol & Spaargaren, 2000). The wave of ecological modernization has led to many environmental laws faced with the problem of climate change (Campos-Medina, 2019). Urban transformation and sustainable development using technological advances affect urban policies and governance (Midttun & Kamfjord, 1999; Smith & Kern, 2009; McGee & Wenta, 2014). In another study, Hajer (1995) introduces two distinct approaches to EM: the techno-corporatist version, and reflexive EM. The techno-corporatist form pertains to the technological-administrative approach and the reflexive EM is associated with social learning, democratic governance, institutional arrangement approaches democratic governance, institutional arrangement approaches (Hajer, 1995). In a follow-up study, Christoff (1996) divided all those approaches to EM up into weak and strong types of EM. The weak form is associated with technological solutions to environmental problems, technocratic style of policy making, exclusive to developed nations to centralize their global economic advantages, and a closed rigid framework on political and economic development. On the other hand, the strong form is set side by side with socio-economic change incorporating environmental concerns, democratic and participatory style of policy making, international developments, and a more open and flexible framework on political and economic development (Christoff, 1996). I will discuss the EM theory more in-depth in the next chapter.

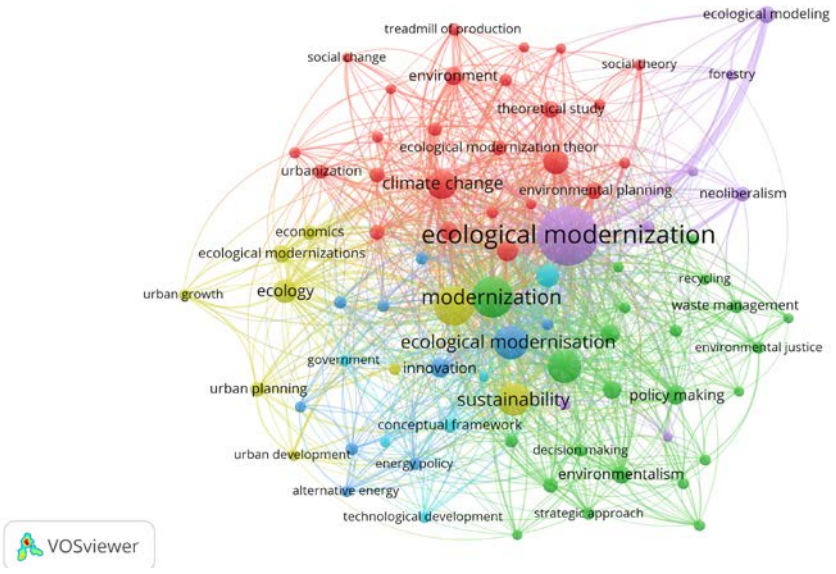


Figure 1- Structural linkages between keywords in the EM literature (Scopus: Publications between 1996 – 2020, N= 789 articles).

The interest in EM is also inspired many urban theories (Langhelle, 2000; Pepper, 1998), urban branding practices (Goes, de Jong & Meijers, 2016), and modern urbanization pathways (Szarka, 2012; Smink, Van Koppen & Spaargaren, 2003; Toke, 2011; Coles & Peters, 2003). Both academia and practice have introduced a myriad of terms and definitions related to face ecological modernization and building the cities of the future; smart, intelligent, ubiquitous, digital, knowledge, creative, innovative sustainable, eco, low carbon, and resilient (De Jong et al., 2015). Intelligent, digital and ubiquitous cities are mainly based on technological infrastructure and the state-of-the-art information and communication technologies (ICTs) are the core of these cities concept (Lee, 2009; Choi et al., 2005; Komninos, 2006). Knowledge, creative and innovative cities are looking for economic growth through creativity and knowledge-based society (Yigitcanlar, 2008). Eco, low carbon, and resilient cities are trying to (re)constructing cities in balance with nature with the aim of presenting a lifestyle in harmony with nature (Wong & Yuen, 2011; Sengers, 2016). Sustainable development balances ecological, socio-cultural, and economic values for development. And Smart Sustainable development aims to leverage technological developments for this balanced development (Tomor et al., 2019). Sustainable and Smart Cities are broader concepts than other cities. They are affected by more contextual aspects and also generate higher expectations than others. All of them are

introduced as answers to the set of issues related to urban agglomerations. Therefore, urban modernization inspiring by the EM theory certainly builds our future, But a question mark hangs over what kind of future city one can look forward to and how we can position the Smart City (at the center of our debate) among the various types? Are those cities that profile themselves really becoming Smart or they just are branded as Smart? Thus, to trace the emergence of the Smart City concept, this investigation takes EM theory as a point of departure and considers it the main root from which different urban labels and branding practices have emerged. Branding a city as 'Smart' is the first step of moving towards a 'Smart City' as having a policy in place to govern the city (De Jong et. al, 2015; De Jong et. al., 2018).

1.2.2. SMART CITY POLICY AS THE DOMINANT APPROACH

The use of the concept Smart City has grown tremendously over the past few years facing ecological modernization and has dominated the Sustainable city in the urban development stream (De Jong et. al, 2015; De Jong et. al., 2018; see also fig.2 in Chapter3). Nowadays it tends to be used like an umbrella concept and its meaning has become increasingly broad and hazy over time (Yigitcanlar et. al., 2018; Appio et. al., 2019; Chourabi et al., 2012; Hollands, 2008). Its rise can partly be explained by the need to solve complex urban problems that cross sectorial and disciplinary boundaries and partly by entrepreneurial technology push (Joss, 2016). Therefore, from a technological forecasting point of view, the Smart City tends to be seen as not just an urban development option or diplomatic tool for national or municipal self-promotion, but also a likely scenario for future urban and infrastructure investments. Traffic, air pollution, livelihood, employment, education and social and legal services are major concerns in metropolises in need of a solution. Apparently, nowadays, one of the solutions which urban planners, engineers and social scientists propose is Smart Cities, and the development of Smart Cities should be knowledge-based, sustainable and above all convincing to policymakers (Sabatini-Marques, et. al., 2020; Kumar et. al., 2020; Mora et. al., 2019; Yigitcanlar et. al., 2019; Yigitcanlar & Kamruzzaman, 2018; Trindade et. al., 2017). Nonetheless, the concept of a Smart City can seem elusive and vague, first of all because of the fact that there are many ways to be smart; secondly, because there is a tendency to use the concept as a tool for self-promotion, rather than a strategy for actually becoming smarter. Recently a geo-twitter analysis of Smart City concepts and technologies in Australia revealed that on Twitter the concepts perceived as the most trending are innovation, sustainability, and governance in the Smart City discourse. The result marks that the top three technologies in this discourse are Internet of Things (IoT), Artificial Intelligent (AI), and Autonomous Vehicle (Yigitcanlar et al., 2020). this study indicates that 8241 tweets with the keywords of 'Smart City' and 'Smart Cities' were circulated in 2018.

The result from searching scientific publications on Scopus with the same keyworks and the year of publication is 5402 articles which demonstrate the popularity of the Smart City discourse not only in the academic context but also on the social media.

Now that evidence shows (De Jong et. al., 2015; see also fig.2 in Chapter 3) that the most popular type of future cities is 'Smart', the question is: how can cities initiate (and later on evaluate) a Smart City development process?

1.2.3. Provisioning a Successful Smart City development process

The use of information and communication technology (ICT) and its new paradigm; Internet of Things (IoT) in the Smart City development has been extensively mentioned in the literature (Ahvenniemi et al., 2017). In this body of literature technology is considered as an enabler to improve the quality of life and bring prosperity for citizens (Angelidou, 2014; Gonzales & Rossi, 2011; Washburn et al., 2010). In the more sophisticated definitions, the role of technology as the key enabler is diminished and human capitals are given more attention (Neirotti et al., 2014; Giffinger et al., 2007; Hollands, 2008; Nam & Pardo, 2011). In the literature several generations of Smart City have emerged gradually along with the evolution of its concept. The early generations resemble the intelligent city more, and in fact with the arrival of new approaches such as 'digitally inclusion' (Deakin, 2007; Deakin, 2011) and 'socially inclusion' (Paskaleva, 2009) the transition from digital and intelligent cities toward the Smart City took shape (Deakin & Al Waer, 2011). Pascalova (2009) advocates a human-centered approach to Smart Cities using digital technologies not only to connect everything within the city, but also to use technology to strengthen good governance and provide services capable of improving the quality of life (ibid). Another example of strong critique of the concept of Smart City and its technology-centricity has been expressed by the governance center of University of Ottawa. It offers a governance-oriented approach with an emphasis on social capital Smart Cities development (Albino et al., 2015). To characterize good governance of the Smart City, several facets are expressed by various authors such as being collaborative, accountable, responsive, communicative, and transparent (Johnston & Hansen, 2011; Mooij, 2003; Odendaal, 2003) all of which pleasant qualities governments need to be capable of implementing the desired policies. However, the combination of technology and human infrastructure can be a powerful driver for smart city development but without government support for regulation, it will not be implemented (Mora, 2018). Meijer and Bolıvar (2016), identified four ideal-typical conceptualizations of smart city governance: (i) government of a smart city, (ii) smart decision-making, (iii) smart administration and (iv) smart urban collaboration (ibid). According to Joss (2016), Smart city innovation designates a transition from traditional forms of urban governance, to modern control rooms and centralized urban service

hubs, in which technology and engineering firms play a direct and effective role (ibid).

Looking at the Smart City as an urban development policy, needs to consider Smart City development as a process. Since still there is no best model or clear conceptual definition and defined domain of application for the Smart City, mapping the Smart City development process and its facets helps initiators to make better choices for Smart City policies and strategies implementation based on their own pathway and intended outcomes. Also, it helps those leading Smart Cities to overview and improve their policies over time through mapping the development process, its domains, outcomes and the way their policy works in practice more transparent. Through characterizing the domains of the Smart City more precisely and pinpointing structural factors and institutional and organizational features in the development process, the concept of governing a smart city can be pragmatized. Beyond that, this understanding and conceptualization of the Smart City can be used as a tool to analyze existing Smart City examples/practices to learn from them and provisioning a successful Smart City development process based on the experiences (both failures and successes). This is a common way in urban (re)development studies so-called 'Lesson Drawing'.

1.2.4. Cross city lesson drawing on Smart City development

Many cities, even in developing countries, have taken numerous steps to develop in that direction. They have started to use IoT (Internet of things) solutions to solve the problems of urban management (Zanella et al., 2014) through learning from strategic and technical approaches to developing 'Smart City' from good practices (Gascó-Hernandez, 2018). For instance, the UAE and Singapore are joining hands in develop the Smart City (Singapore, UAE embark on Smart City cooperation, 2015). Looking at a few significant Smart Cities around the world such as Amsterdam, Barcelona, Malmo, Copenhagen, Vienna, Helsinki, and so on, leads us to conclude that these cities have made great strides towards intelligent solutions, but this valuable experience comes at considerable effort and budget (Joss et al., 2017; Eden Strategy Institute and ONGandONG, 2019). It seems that cities that are just getting started Smart City programs want a lot, but do not know how to do it and intend to learn from mostly advanced countries (for instance the mayor of Tehran stating that: '*Our Smart City program is embarrassing*' when comparing the plans of Iranian cities with those of cities in other countries to Iran that are successful in this area and have provided a clear horizon). The assumption underlying this research is that, they can do so, but must realize that the political, legal, institutional and cultural context in those donor countries are different, so policy context plays an important role as well as technology in this case

Nevertheless, building such an advanced techno-driven city seems very expensive and cities that are just getting started can potentially make it cost-effective through a learning process by technology, policy and experiences transfer and avoid having to reinvent the wheel. They require policy and planning based on an analysis of the effects information technologies have on urban structures.

In the quest for Smart Cities development, numerous examples of best practice have been created and circulated in national and international arenas. But based on the contextual differences it is argued that the differences – cultural, political, ideological – are so great that public policy for cities should rightly be nation specific. However, I believe that notwithstanding the major differences between different societies there are significant possibilities for exchange. That is why I call this learning process and policy travel (as the policy donation and adoption): policy transplantation. Yet despite the vast array of examples, demonstration projects, case studies, and the like, little is known about the mechanism of policy transplantation, in which best practices are produced and used, and the policies are adopted by recipients.

1.2.5. WHERE TO LOOK FOR A LESSON: GOOD PRACTICES OF SMART CITIES

AND WHERE TO TRANSPLANT POLICIES: AN EXAMPLE OF SMART CITY INITIATIVES

I chose a list of European Smart Cities as the good practices looking for the lessons that illustrate us how the Smart City development process can be applied (Amsterdam, Barcelona, London, Paris, Malmo, Copenhagen, Oslo, Helsinki, Vienna, etc.) and also two special cases in Asia (Dubai and Masdar city). I also used desk research and content analysis that gave us an insight on the matter and provided us the opportunity to observe and point out the best practices and smartest cities in the world. In this case, the content analysis has been included the international rakings, rewards and competitions related to Smart City development.

Based on these data I made a long list of Smart City projects as good practices, and then a shorter list to visit and look for lessons considering their smart elements. To select the final cases from this list I consider some criteria; cases should have:

- Smart City development policy and programs in place
- International positioning of Smart City(ranking)
- Different governance patterns
- And, should be accessible for interview and visit.

Finally, based on these criteria I chose four cases which have been repeatedly considered among the top Smart City projects in the world, two European cases; Amsterdam and Barcelona and two Asian cases; Dubai and Masdar based on their

impact area to assess the policy they adopted, using a comprehensive framework that includes different pathways of Smart City development.

As for the policy transplantation, I needed to grasp the real cases for studying as the best practices for lesson drawing, I studied real life examples of cities that are in the early stages of transformation into Smart Cities to which I can transplant the policies. One of the countries where I find many adopting cities is Iran, which is promising due to familiarity with the context and data accessibility. Considering Iranian cities examples, I began this study by examining how they use 'Smart' label facing ecological modernization in practice to make sense of what Smart City initiatives are aimed at. It is known that urban planning failures can be costly and have serious consequences, so I examine of successful and failed cases to attain a clear vision for successful development of Smart Cities.

1.3. RESEARCH AIMS AND RESEARCH QUESTIONS

The main purpose of this study is to investigate the adoption and decision-making of Smart City policies through lesson-drawing from experiences obtained in leading Smart Cities to cities that are just getting started. This research focuses on the city level, and the initiation phase when urban governments begin a new policy and then it is mainly about governance. In the initiation phase, branding is the first sign that governments express their desire to become Smart and formulate their intended goals to achieve that. A credible Smart City brand is the first indicator that governments want to go beyond branding toward implementing their policies. In the implementation phase, governing a Smart City first requires that the development process and its various facets be well understood. To analyze the Smart City development process, I develop a conceptual model that can also be used by policy makers and practitioners in relevant decision-making processes. After understanding what the Smart City development process looks like, looking at the existing experiences and good practices can be a compass for newcomers to the pathway. To clarify how we can learn from good practices, I apply the model to compare the four cases (good practices) regarding their Smart City development process to investigate what lessons follower Smart Cities can learn from them. I previously argued that the lesson learnt from good practices cannot be copied and pasted into a new context. Adopting the lessons requires the recipient to prepare thoroughly before transferring the lessons. To systematically measure the recipient readiness for becoming Smart and being aware of what need to be done regarding that, I propose a readiness measurement system and a Theory of Change to get ready to be Smart. After ensuring readiness assessment, to theorize how these lessons can be transplanted I design a mechanism for policy transplantation that is the core of this study. Accordingly,

the main research question is: How to initiate and manage the process of transforming a city into a Smart City?

Thus, to answer the main question I need to respond to the following sub-questions:

Q1: How do cities engage city branding practices when facing ecological modernization? To what extent do they use 'smart' in their brands and how?

Q2: What does a conceptual model representing different domains of the Smart City development process look like?

Q3: How are Smart Cities different from each other by their resources and goals? What lessons can we draw from the good practices in Smart City development; how do their policy actors operate in governing a Smart City?

Q4: How to determine whether cities are ready to transition into Smart Cities? What does an indicator system measure to determine whether a city is ready to become smart? And to what extent do Iranian cities meet the minimum requirements for becoming smart?

Q5: How Smart City policies can be transplanted from those good practices to Smart City initiatives?

Finding the appropriate responses for these questions can offer us both positive and negative lessons to formulate them as a roadmap or policy guidelines for Smart City development at the initial phase.

1.4. Research Methodology

In order to answer the research questions, I conducted a systematic review of the core literature. I started the systematic literature review from one the important root of the Smart City debate as the 'Ecological Modernization' (EM) theory is. I looked at the EM theory to understand the reason behind emerging the concept of Smart City and I followed that root in the literature and through exploring different aspects of the Smart City, I arrived at theories of Implementing Smart City development policy. In this route, wherever the existing theories and models did not accurately address my research questions, I began to develop my own theoretical framework to fill the gaps in literature that I faced. For developing the theoretical framework, I mainly relied on the concept mapping and system thinking approaches. System thinking approach assisted me to integrate different components of Smart City and pinpoint them in a development process to reveal their interaction. Concept

mapping helped me to organize and structure various phases, stages, and activities regarding the Smart City policy transplantation mechanism in a comprehensive framework.

Considering the complexity of the study, I choose to use case study as a main method for data collection, which refers to the data that illustrate policies, institutional and organizational features of Smart City projects. The empirical analysis is based on desk research, site-visiting, interviews, and online survey pertaining to the Iranian case study. As for the policy transplantation, I needed to grasp the real cases for studying the best practices for lesson drawing as the Smart City policy donors. For the recipient side, I studied real life examples of Smart City initiatives that are in the early stages of transformation into Smart Cities to which I can transplant the policies. The research framework is shown in the Fig.1.

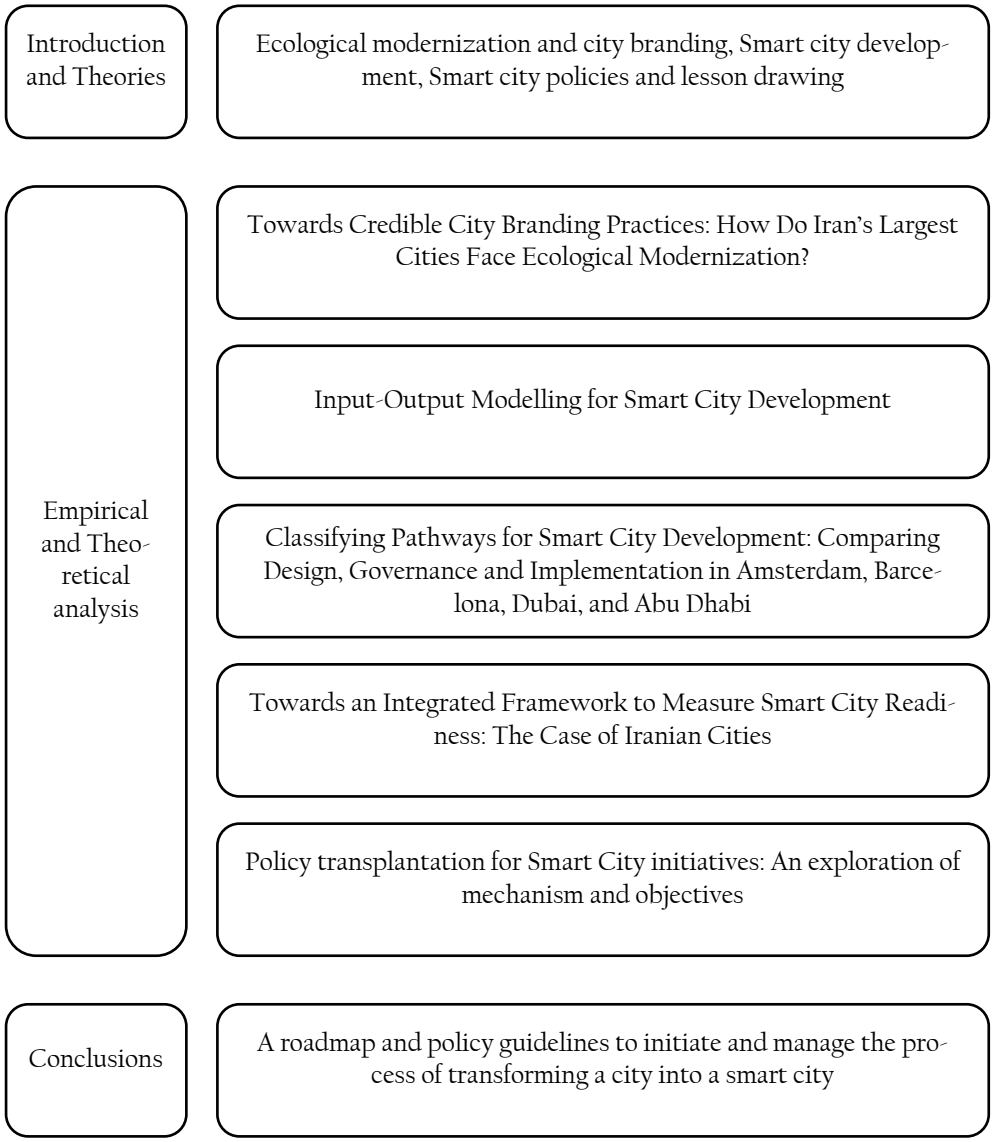


Figure 2-The research framework

1.5. The Innovative Aspects of The Study

This study provides insights and useful guidelines for those cities and governments who desire to initiate a Smart City development policy and take it towards its implementation. Therefore, the implementation aspect of the Smart City policy is an

important part of this study which has received less attention in the literature. In this study, I assume that one of the main challenges of involved governments is to find out how and from where to start the Smart City development, and it provides a comprehensive roadmap on a path to success. To do this, the present study starts from an early stage of this development pathway which is branding practices. Credible branding of a city as a Smart city indicates the intention for implementing the Smart City policy and a higher likelihood of achieving the goals of being Smart (Ohanian, 1990; Erdem & Swait, 2004). First, the study provides insights on how to credibly brand as 'Smart' to take its first step towards Smart City development. I develop a methodology and criteria to map and evaluate the credible city branding practices.

Second, inspired by system theory (Checkland, 1999) and input-output perspectives, a conceptual model of the Smart City is developed. The added value of using in-put-output (IO) model provides a realistic and dynamic analysis of various domains of the smart city and adds transparency as to how to engage in a smart city development process in practice. Thus, the second contribution is a novel pragmatic model of smart city applying in different cases to develop a taxonomy of smart city development pathways.

Third, a comprehensive framework of Smart City design choices is developed that can be used as a tool to compare various Smart City practices and determine how their development pathways are different from each other.

Fourth, a novel and comprehensive readiness assessment framework of Smart City covering technological, socio-economic, and political aspects is developed.

Fifth, for the first time the term 'policy transplantation' inspired by comparative law and public policy is applied to the Smart City context to develop a comprehensive framework for traveling Smart City policy from the donor(s) to a recipient wishing to adopt the policy.

1.6. Research Structure

The research is based on both a literature analysis and a large empirical survey of four good Smart City practices with different governance structures, and four Smart City initiatives. To achieve the ultimate goal of the research, several steps are taken (figure.1): Chapter 2 specifies which cities in Iran have Smart City credible brands to take them as the examples for Smart City initiatives for. Chapter3 construes an integrated conceptual Input-Output (IO) model of Smart City based on the system theory approach to apply in and analyze the good practices. Chapter 4 illustrates the lessons for beginners of a Smart City initiative, through comparing the four good practices on the basis of the goals, resources, policies, procedures, and design choices these cities have. Chapter 5 explains how the situation in Iranian

Smart City initiatives is as candidates for transplantation. Chapter 6 deals with policy transplantation theories to design a protocol for lesson drawing and shows how can we learn from successful examples, and what steps should be taken. And finally, Chapter 7 contains the conclusions of the study and policy guidelines for Smart City initiatives.

2

TOWARDS CREDIBLE CITY BRANDING PRACTICES: HOW DO IRAN'S LARGEST CITIES FACE ECOLOGICAL MODERNIZATION?

The contents of this chapter have been adapted from the following peer-reviewed article: Noori, N., & De Jong, M. (2018). Towards credible city branding practices: How do Iran's largest cities face ecological modernization? *Sustainability* (Switzerland), 10(5), 1–16. https://doi.org/10.3390/su10051354

2.1. INTRODUCTION

2

As noted at various places in the academic literature, city branding practices have grown in importance among ambitious municipal governments in recent decades (Braun, 2012; Dinnie, 2011; Vanolo, 2008; Kavaratzis & Ashworth, 2005). They are used as a tool to enhance a city's image in the competitive global arena to lure investors, corporations, a talented workforce, visitors, and residents into the city. In many cases, using labels, such as sustainable, low carbon, eco, resilient, knowledge, digital, or smart before 'city' aims to convey a particular impression among key stakeholders and enhances attractiveness (Joss, 2011; De Jong et al., 2015). Nonetheless, empirical evidence suggests that the malleability of a city's brand in the eyes of stakeholders, clients, and observers is limited: it depends on subjective perceptions, consists of multiple aspects that may not always point in the same direction, and is associated with ideas lingering on from the past that are difficult to erase (Anholt, 2007). Much of the literature deals primarily with city branding strategies, practices, and experiences collected in cities located in wealthy and developed nations, but knowledge of how this works in non-Western countries is less widespread, especially in those where opening up to market influence and global capitalism is a recent phenomenon. Nonetheless, there is a burgeoning literature and growing number of case studies on this topic (Morgan et al., 2012; Han et al., 2018; De Jong et al., 2018). Awareness is growing that international and national positioning, profiling, and imagineering of places is apparently also awakening in countries thus far relatively secluded from international influence. One of them is Iran.

Since the rise to power of President Rohani and the signing of the international treaty on nuclear power, economic sanctions have been lifted, curiosity for development 'out there' has increased, and cities are getting increasingly connected to global trends of which the need for credible self-branding is an important one. Iran is considered as being of strategic geopolitical importance due to its historical incorporation in the Silk Road, the presence of vast natural resources, the presence of a relatively highly-educated population, and the availability of comparatively advanced physical infrastructures (Iran Review). While the above suggests a very large fount of future economic opportunities, mounting environmental problems, in fact, cause a major headache. Implementing the construction of smart urban infrastructures and transforming outdated industrial structures have become developmental imperatives. As a consequence, urban master plans for Iranian cities frequently express attempts made by local governments to develop their urban environments into livable and pleasant places for their citizens, as well as promising locations for high-quality capital investments. Such efforts can be seen as dealing with the challenges of 'ecological modernization' (De Jong et al., 2018; Hajer, 1995; Mol & Spaargaren, 2000; Bayulken,& Huisingh, 2015): generating higher economic value-added with reduced

resource consumption and/or reduced emission of harmful substances. Often, a transition from manufacturing industries to services is involved, and/or the upgrading of production processes by making them higher in quality and lower in resource intensity. In the urban context, it is usually associated with the promotion of sustainable or Smart Cities.

The aim of this article is two-fold. It is first to distill from the academic literature on city branding key insights allowing us to establish a set of criteria to assess the credibility of city branding practices as developed by municipalities. This will allow us to have a critical look at the practices of any given municipality. In Section 2, therefore, I will examine what the state-of-the-art literature on city branding tells us about the criteria for credible city branding practices.

The second aim is to map and evaluate the city branding practices as engaged in by Iranian municipalities and obtain a valid impression of how they present themselves to the outside world, in terms of general positioning (city brand identities), as well as in the specific debate on sustainable and/or Smart City development (use of city labels). Section 3 will present the methodology as used in this contribution and explain how data was collected in Iran's 15 cities with over 500,000 inhabitants, nationally known as its 'megacities'. Section 4 will briefly introduce the main features of these 15 cities to the extent that these are relevant for assessing the credibility of their city branding choices. Section 5 presents the findings for the cities and a general assessment of the credibility of these choices is given. Specific attention is paid to the question of how issues of ecological modernization are addressed. Section 6 will conclude with an overview of the main takeaways from this article and some hints for future research on the Iranian cities with credible brand of 'smart'.

2.2. The Credibility of City Brands: Theory

This section will examine the existing literature on branding credibility and place branding with as a specific aim to identify factors contributing to the credibility of city brands.

The literature on product branding in the private sector has generated a number of insights on brand credibility with potential use for city branding. Ohanian (1990) argues that branding is tantamount to successful communication. It is essentially the manipulation of messages in such a way that these are received positively. Enhancing the credibility of both source and message can be helpful in reaching this goal. Erdem et al. (2004) identify three elements which contribute to communicated messages being received in a positive manner and, thus, provide a higher likelihood of being accepted: trustworthiness, expertise, and attractiveness. Trustworthiness is a quality related to the reliability of the source of the information on the brand, exper-

tise refers to the specific knowledge and skills of this source, and attractiveness involves the 'personality' features of this source. Unfortunately, the literature on credibility of product branding has more to say about the credibility of the messenger than about the credibility of the message or brand itself. Since, in this study, 15 municipal governments are the messenger in all cases, this can barely be considered a distinguishing factor.

As context for the credibility of city brands, their integration within the broader provincial and national (country) context of which cities are a part matter a great deal (Aitken & Campelo, 2011). In this sense, facilitating the national development of an overarching branding strategy or policy and inserting the city brand in it may eventually benefit both levels. A report commissioned by Heritage Counts (2016) demonstrates that, in the United Kingdom, cultural heritage is emphasized at both the national and local levels in place branding practices and that this combined approach promotes their credibility in terms of felt authenticity and distinctiveness. Credible brands use a unique voice to tell the story about promotional promises, the current situation, and the past heritage of the city. However relevant as a general insight, all cities under study here are located in the same nation; a reason why I do not include this factor in the analysis either.

Moving on to the literature on city branding (but without explicit attention paid to credibility issues), at face value, place branding shows resemblance to city marketing, a term much en vogue in the 1980 and 1990s. However, on closer inspection it appears that marketing essentially refers to a heightened sense awareness of what target groups or stakeholders wish, while branding has a strong aspect of loyalty and overarching policy strategy to it (Baker, 2012). In contradistinction, however, Lucarelli (2018) argues that place branding was driven by a more generic need in public policy where public authorities needed to profile themselves more strongly and, from there, place brands evolved into broader multi-dimensional socio-political constructs generated through multi-level interaction among a variety of different actors: this essentially makes city branding a co-development process of cities with various relevant stakeholders. Having these stakeholders on board is crucial for its translation into effective policy strategy and implementation. Vanolo (2008) has defined city branding as a complete set of activities aimed at establishing and maintaining a positive city image and conveying this information to different target groups via materials and events at various scales, all of this to gain competitive advantage over other cities. In other words, while city marketing can, for instance, support Isfahan in knowing more about its various stakeholders in and around the city and act on this knowledge, city branding can help it in letting these stakeholders grow aware of Isfahan's positive highlights that may be translated into a long-term commitment to engage in, and collaborate with, it. Dinnie (2011), emphasizing other

aspects in his definition, sees a city brand as a unique, multi-dimensional blend of elements, which provides the city with culturally-grounded differentiation and relevance for its target audiences. This implies that a chosen brand should be clearly distinct from others and, thus, the opposite of 'a great place to live and work' (Baker, 2012), while also able to attract a variety of audiences. Most authors in the field are in agreement that place branding, of which city branding is a specific subspecies, is more complex in nature than product branding, because cities are truly multi-dimensional entities evoking a great variety of impressions and associations depending on the people among whom, and circumstances under which, they are evoked (Braun et al., 2014). One general message addressed at different groups of stakeholders with potentially conflicting interests and expectations can lead to trouble, making it necessary to convey partially different (but not contradictory) messages to those various target groups (Kavaratzis& Kalandides, 2015; Merrilees et al., 2012; Henninger et al., 2016). In that sense, city branding has more in common with the corporate branding that large companies and holdings with many different product lines engage in (Kavaratzis& Hatch, 2013). Tourists and visitors seek the availability of exciting cultural centers and entertainment parks in a city, while wealthy residents, real estate companies, and project developers prefer quiet green neighborhoods and high-quality public facilities, such as schools and hospitals. They may, in fact, even be repelled by busy and noisy streets filled with hotels and exciting day-trippers. This demonstrates the importance of distinguishing between various target groups and stakeholders and addressing these in different ways; at their turn, they hopefully communicate the brand message in the same way with their own partners, a sign that they support it and act in accordance with it.

An additional aspect appearing in the literature on city branding relevant to urban transformation is the aspect of dealing with the tension between a city's current social, economic, and geographic features, and its profile (its existing brand) and self-image based on high-brow future ambitions (its desired brand). Generally speaking, one can say that cities have (i) a historically-based cultural, social, and economic inheritance or legacy which colors them; (ii) a present social and economic profile with a specific composition of the population and collection of dominant industries; and (iii) a set of policy ambitions, goals, and chosen policy measures aimed to realize these hopes for the future. If the present situation and future ambitions deviate from each other too strongly without stakeholders able to grasp how this gap can be closed, credibility of a brand severely suffers from this (perceived) inconsistency (Vanolo, 2008; Anholt, 2007; Kavaratzis, 2007; De Jong et al., 2018). On the other hand, if the realization of future ambitions can be seen as a continuation and enhancement of an evolving developmental path spiced up with a peculiar historical and cultural background the brand will appear both attractive and credible. It is all

about the potential to connect past, present, and future in one logical narrative. Therefore, local governments that are able to align their historical and current profile with future wishes, follow up with necessary implementation steps, and manage to convince relevant stakeholders to echo their brand in ways consistent with their own are likely to bridge the gap between the existing and desired brand and have a higher chance to realize their long-term goals for urban transition.

Based on the above reading of the literature, the list six factors that contribute to the credibility of city brands are listed that can be taken on board for the rest of the analysis. These are the potential to:

- Generate feelings of loyalty;
- Facilitate the development of an overarching strategy or policy;
- Evoke positive feelings;
- Demonstrate uniqueness or distinctness;
- Allow for different yet non-contradictory messages to various stakeholders; and
- Logically connect past heritage, current profile, and future ambitions.

2.3. The Credibility of City Brands: Method

This section will explain how data was collected and processed and, following, what procedures the credibility factors utilized to come to an assessment of the branding practices of the 15 Iranian mega cities under study.

We have examined the city branding practices among the fifteen most prominent cities in Iran, known as its 15 'megacities', each having more than 500,000 inhabitants. The question remains what city branding practices consist of and how they can be measured. Kavaratzis and Ashworth (2005) have identified three elements in city brands: brand identity, brand position, and brand image. Mayes (2008: 125) argues that identities derive 'from the intrinsic features and history of a given place and a shared (personalized) relationship to these elements'. Govers and Go (2009: 17) believe that 'place identities are constructed through historical, political, religious, and cultural discourses; through local knowledge, and influenced by power struggles'. In short, given that a city brand identity constitutes the essential actual or imagined core of a city's self-perception, it should definitely be examined here as an aspect that municipal governments deal with in their positioning and self-promotion activities. A brand position, on the other hand, is that part of value proposition communicated to a target group that demonstrates competitive advantages in particular fields (Kavaratzis& Ashworth, 2005). In this sense, a city's brand position is related to a specific economic market, niche, or policy area for which its spe-

cific plans and visions express both the status quo and expectations for future development based on future ambitions. I will also take this aspect into account in this study since it addresses the desired infrastructural development and industrial transformation of a city in the face of ecological modernization (De Jong et al., 2015; Han et al., 2018; De Jong et al., 2018; Goess et al., 2016). Finally, a brand image refers to how the brand is perceived by the outside world. In other words, identity is 'how we see ourselves', whereas image represents its mirror image and can be described as 'how others see us'. Since the focus of this article is on how local government practice city branding and not on how citizens, residents, and visitors perceive these cities, this study mapped the city brand identities and city brand positions for each city, but not the city images. The goal was to produce a table with the city brand identities and positions for each of the 15 cities and then assess the credibility for each cell in the table.

To compile this table, we collected the following data:

1. The city brand identity as shown in their most recent Urban Master Plan (UMP);
2. The city brand identity as found on their municipal government website;
3. The dominant use of city labels as found in their UMPs reflecting their brand position;
4. The dominant use of city labels on their internet websites reflecting their brand position; and

5. A city's adoption of and inclusion in national sustainable urban development programs, such as on environmental protection or Smart City development, but also the protection of cultural heritage and the preservation of Iranian-Islamic identity or the identity of city and countryside characteristics. These target 'ecological modernization' in Iran by promoting aspects of social, economic, and/or environmental sustainability. This reflects their efforts to flesh out the above brand position in terms of policy actions.

I assumed it to be more reliable to establish city brand identity on the basis of two indicators (1 and 2) and city brand position on three indicators (3, 4, and 5). While the brand identities were composed of essential self-descriptions and phrases these cities give of themselves in the UMPs and on their websites, the city labels in Table 5 had to be gathered in a more pre-structured manner. Inspired by earlier work where 10–12 key city labels were distinguished in the academic literature (De Jong et al., 2015), in the Randstad and Rhine-Ruhr areas (Goess et al., 2016), and in a variety of Chinese regions (Han et al., 2018; De Jong et al., 2018), I also found a number of recurrent city labels typical of the Iranian context. The labels were eventually used were Smart City, digital city (including E-City, ICT-city, and virtual city), innovation

city, manufacturing city, service city, knowledge city (including education city), creative city, resilient city, liveable city (including green city, garden city, juicy city, and smooth city), tourism city (including health city, natural eco city, religious city, and beautiful city), and sustainable city. I simply made counts of the appearance of each of these city labels in the UMPs and on official municipal websites and presented these counts in a table (Table 5). However, since the format, density, and size of UMPs and websites differed across cities, the numbers given in them cannot be easily be compared across cities. I decided to group similar variants under one label. As with the brand identities I gathered them from the cities' UMPs and websites, but I also analyzed which cities had successfully applied for, and had been accepted, in one of the national sustainable urbanization programs. This enables them to use the label or reputation associated with that particular high-brow program and is, thus, a valid third indicator of dominant use of city brand positions. Nevertheless, the consistency of visible labels choice is debatable. Since we can measure internal commitment to the labels mentioned in the website and UMPs, the assumption is that consistency of choice is a sign of commitment.

The original goal of this study had been to systematically apply the six criteria for credible city branding to the scores of the 15 cities as shown in Table 1:

Table 1- Criteria for credible city branding.

Credibility Aspect/City	Generating Feelings of Royalty	Facilitating Overarching Strategy	Evoking Positive Feelings	Demonstrating Unique-	Allowing different, Non-Contradictory Messages	Logically Connecting Past, Present and Future
City A						
City B						
…						
…						
Etc.						

However, when making the first tentative efforts to apply these credibility factors to the various data on the Iranian cities, it transpired that not all of them were amenable to measurement and/or unambiguous outcomes. This was specifically the case with 'generating feelings of loyalty' and 'evoking positive feelings' and mostly strongly with issues of religion, which would typically lead to bipolar outcomes (strongly positive or negative feelings about Iranian-Islamic identity). In this credibility assessment I restricted the analysis to the other four factors and applied these to the city branding practices of each city (an overall impression of the findings on

brand identity and use of city labels) with three possible scores: high, medium, and low.

2.4. THE MAIN FEATURES OF IRAN'S MEGACITIES IN BRIEF

Before analyzing and interpreting the branding practices in Iran's 15 megacities with over 500,000 inhabitants, it is important to have a general impression of their dominant demographic, economic, social, and cultural features. These features color the position from which cities brand themselves and determine the developmental options they have. The megacities are, in descending order of population numbers: Tehran, Mashhad, Isfahan, Karaj, Tabriz, Shiraz, Ahvaz, Qom, Kermanshah, Uremia, Rasht, Zahedan, Kerman, Arak, and Hamedan (see Figure 1 and Table 2). Figure 1 demonstrates the topographic position of the cities, Table 2 presents their population numbers and territorial size, while Table 3 at the end of the section summarizes all other relevant geographic data of the cities.

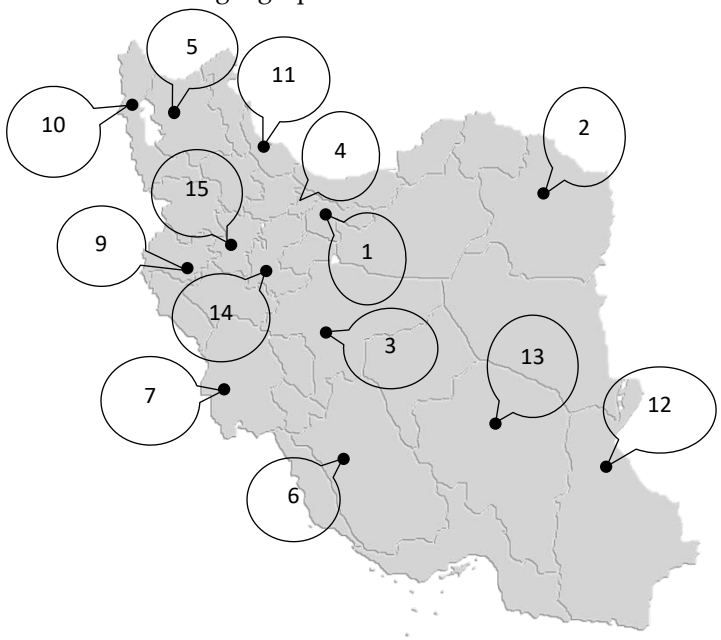


Figure 1- Fifteen Iranian megacities

Table 2- Population and space of Iran's megacities

	City	Population (2011)	Space (km^2)
1	Tehran	8,154,051	750
2	Mashhad	2,749,374	300
3	Isfahan	1,756,126	235
4	Karaj	1,614,626	165
5	Tabriz	1,494,988	190
6	Shiraz	1,460,665	225
7	Ahvaz	1,112,021	140
8	Qom	1,074,036	95
9	Kermanshah	851,405	90
10	Urmia	667,499	90
11	Rasht	639,951	60
12	Zahedan	560,725	75
13	Kerman	534,441	85
14	Arak	526,182	60
15	Hamedan	525,794	70

Tehran has been the nation's capital for more than 200 years and currently counts approximately 8 million regular inhabitants and an additional floating population of 4 million. It has 16.2% of Iran's entire population. In addition to being its political capital, Tehran is also an important administrative, economic, and cultural metropolis. Three dominant industries in Tehran province in terms of investment amount are food and beverages, rubber and plastics, and manufactured metal products (Statistical Center for Iran). Tehran is the focal point of Iran's transportation network and the area where more than 40% of the nation's economic activities take place. Tehran is a melting pot of ethnic groups, languages, and numerous Persian dialects and accents. Having a wide range of high-ranked universities, innovative businesses, and startups in comparison with others, their use of the term 'knowledge-based' is not far-fetched.

Mashhad (meaning 'place of martyrdom' in Arabic) is the capital of the central Khurasan province and the greatest religious metropolis in the country. It is home to about 8% of Iran's population. It is the site of the very large Imam Reza (the Shia imam murdered by Arabian Nights caliph Haroun al-Rashid) shrine that draws more than 20 million Shia pilgrims a year. The city's population numbers around 3 million in recent years and 55% of Iran's hotels are located in Mashhad. Mashhad is also the city of saffron. For this reason, agricultural and service sectors have an even greater share in its added economic value than manufacturing and mining. The three dominant industries in the central Khurasan province are; food and beverage, metal products and textile (Statistical Center for Iran).

Isfahan is Iran's third most populous city and the capital of Isfahan province. It has historically been among the most important urban centers on the Iranian plateau and counts a large number of historical monuments: bridges, caravanserais, minarets, and mosques, attracting a major share of the tourists in Iran. Petroleum products and nuclear fuels, fabricated metal products, and textile production are three dominant industries in Isfahan province (Statistical Center for Iran).

Located near Tehran, Karaj is one of the primary destinations for immigrants. Many believe that if Karaj did not exist, Tehran would have no room to breathe with all its immigrants, air pollution, and lack of green space. Karaj, due to massive immigration, is a microcosm of all cultures and ethnicities in Iran and has become one of Iran's economic and cultural pillars. Located near Tehran, it has accommodated many industrial towns around the city causing considerable environmental problems. The opening of Tehran-Karaj metro has added to the flourishing of Karaj. Food, equipment, and machine manufacturing and chemical products constitute the industrial core of Alborz province in which Karaj is located.

Tabriz city, one of the ancient Turkic cities has the world's largest historical indoor bazar and is known as a UNESCO world heritage site, of which hand-woven carpets are a key element. Ministers of tourism in Islamic countries selected Tabriz as the capital of Islamic tourism in 2018. Petroleum products and nuclear fuels, food and beverage products, and chemical products are the three dominant industries in East Azerbaijan province (Statistical Center for Iran).

Shiraz; the capital of Fars province, has been the city of poetry and Persian literature, philosophy, and ethics for a long time. Until the Islamic revolution, Iran had a tradition of wine-making which stretched back centuries. It centered on the ancient city of Shiraz. Different people have lived in the Fars province, such as the Aryans, the Samis, and the Turks, who worked together to form the Iranian culture (Iran Chamber Society). Shiraz is also the birthplace and resting place of the great Persian poets Hafez and Saadi. The most interesting buildings in Shiraz are located in the old part of the town. The largest share of value added in Fars province is related to agriculture; cultivation, and horticulture. With regard to industry, the three sectors with the highest value-added are food, the production of petroleum, and chemical products (Statistical Center for Iran).

Ahvaz is one of the key strategic metropolises of the country in that it contributes enormously to the nation's GDP (gross domestic product) with its oil production and refineries. Since much of its wealth is donated to the national coffers, while it is left with severe environmental problems itself, it has seen a large number of protests in recent years. It is said that 'Ahvazies get only pollution, disease, and death from the oil trade' (Ahvaz Monitor). According to a recent air quality survey by the World Health Organization, Ahvaz is one of the world's most polluted cities

with the highest count of small airborne particles out of 1100 urban areas around the world. As can be expected, the largest share of its the value added comes from petroleum products and chemical products (Statistical Center for Iran).

Iran's second pilgrimage center after Mashhad, Qom (Ghom), is home to the magnificent Massoumeh shrine and shrines for various other Shiite scholars; students come from around the world to study in its madrassas and browse in its famous religious bookshops. Receiving the pilgrims (providing accommodation, services, and facilities) and being the center of religious learning have, along with its proximity to Tehran, led to substantial population growth (Kiyani Haftlang, 2003).

Since Kermanshah is located in the middle of the Zagros Mountains, and between two cold and warm regions, it enjoys a moderate climate (Iran Chamber Society). Much of the industrial activity of the province is concentrated in its capital city. An early modern industrial enterprise, established in 1962, is the Bisotun sugar-refining factory. The most notable enterprise of all is Kermanshah's oil refinery, which was completed in 1971. There are also several operative factories of medium size that manufacture textiles for local consumption. Other industries include food processing, electrical and mechanical appliances, and cement and construction materials, as well as mining of marble and limestone throughout the province (Iran Review).

Urmia, another ancient Turkic city and the capital of West Azarbaijan province is located on vast green plains and surrounded by vineyards and apple orchards. Recently, Urmia's greatest challenge has been to preserve Lake Urmia. Lake Urmia was twice as large as Luxembourg and the largest salt-water lake in the Middle East. Since then it has shrunk substantially, and it was sliced in half in 2008, with consequences uncertain to this day, by a 15-km causeway designed to shorten the travel time between the cities of Urmia and Tabriz (Madani, 2016). The agricultural sector adds the largest share of economic value-added in West Azarbaijan province. Food production and non-metallic minerals manufacturing are the dominant industries in this province.

Rasht is located by the Caspian Sea where it was one of the cities along the Silk Road route. It joined the world's creative cities network under UNESCO as a creative city for gastronomy. Rasht and Hamedan are among the provincial centers of the country considered as great agricultural centers of the country. Surrounded by the fertile delta of the Sefīd-Rūd River, both the city and its gastronomy benefit from a rich variety of natural resources, especially various species of fish and in-season products. Above all, gastronomy in Rasht is synonymous with the protection and promotion of cultural heritage (Creative Cities Network). Thus, the highest value-added in industry is from food.

Zahedan is the capital of Baluchistan province in Iran. It is a border city connecting Iran with Pakistan. It is one of the largest regions in Iran, but it is less developed than much of the rest. Research carried out in this province and its cities indicate that on all four economic, environmental, social, and health aspects, Baluchistan ranks almost at the bottom of all Iranian provinces (Zahedan City Council).

Kerman is an ancient city located on the edge of the Lut Desert in the central south of Iran and the capital city of Kerman province. It has been famous for cumin and opium. Kerman and Zahedan are on the trade route opening Iran and Europe to the opium trade from Afghanistan. A large share of the GDP in agriculture in Kerman province is based on pistachios. Metal and steel manufacturing are the dominant manufacturing industries in Kerman.

As a major industrial city, Arak hosts several industrial factories inside and within a few kilometers outside of the city. As an industrial city in a developing country Arak is subject to serious pollution. This city, only 200 years old, officially became a megacity in 2014. The main agricultural products of the city are grain, barley, and fruits, including grape, apple, walnut, and almond. Arak also exports hand-knotted carpets which are generally referred to as Sarouk rugs. After Khuzestan (in which Ahvaz is located) and Tehran, Markazi province (with Arak in it) has the highest GDP per capita among Iranian megacities. Petroleum products, chemical products, and non-metallic minerals are the dominant industries (Iran Chamber Society).

Hamedan is a very historical city, since it was the capital of the empire of the Medes until they forged a union with the Persians. It also served as the summer capital of the Achaemenid Empire. Its modern version in Iran's mountainous region was designed by Karl Ferisch, a German engineer, as a city concentric in shape. Hamedan is famous for pottery and ceramics and it has an influential group of environmental advocates who use the power of the media to preserve the environment and the ancient city texture. Food production and the manufacturing of non-metallic minerals add the lion's share to its industrial value-added (Iran Chamber Society).

Table 3-Key economic data of Iranian megacities (Statistical Centre of Iran, 2017)

Province	Capital City	GDP			Value Added (%)		
		Value (Billion Rial)	**Share (%)**	**Per Capita**	**Agri-culture**	**Industry and Mining**	**Ser-vices**
Iran		6225.66	100	82.8	100	100	100
Tehran	Tehran	1436.432	23.1	117.9	3.9	11.8	36.4
Central Khurasan	Mashhad	331.292	5.3	55.3	6.7	3.3	6.9
Isfahan	Isfahan	416.864	6.7	85.4	4.1	7.9	6.0
Alborz	Karaj	157.793	3.5	65.4	1.7	1.5	3.6
East Azer-baijan	Tabriz	207.139	3.3	55.6	4.6	3.2	3.2
Fars	Shiraz	262.028	4.2	57	8.7	3.0	4.5
Khuzestan	Ahvaz	836.240	13.4	184.5	6.8	25.0	4.3
Qom	Qom	59.520	1.0	51.7	0.8	0.8	1.1
Kermanshah	Kerman-shah	106.086	1.7	54.5	2.4	1.2	2.1
West Azer-baijan	Urmia	125.717	2.0	40.8	4.6	1.0	2.5
Gilan	Rasht	126.891	2.0	51.1	3.0	1.3	2.6
Sistan	Zahedan	75.230	1.2	29.7	2.6	0.5	1.6
Kerman	Kerman	164.053	2.6	55.8	7.1	2.3	2.2
Markazi	Arak	125.424	2.0	88.7	2.2	2.3	1.7
Hamedan	Hame-dan	88.882	1.4	50.6	3.5	0.8	1.7

2.5. CITY BRANDING PRACTICES IN IRAN'S FIFTEEN MEGACITIES

Table 4 presents the city brand identities of all 15 megacities as expressed in their Urban Master Plans and as found on their official local government websites. It is important to realize that there is no common format in either UMP or local websites, so each city presents itself to the outside world in a different way. While some cities incorporate strategic visions others, such as Kermanshah and Zahedan, mainly display action plans.

Table 4- City brand identities in Urban Master Plan (UMP)s and on websites.

Brand Identity Indicator /City	City Brand Identity as in UMP	City Brand Identity as on Official Website
Tehran	Tehran is a world-class cultural, knowledge-based city, with authentic Persian and Islamic identity, beautiful, resilient, a benchmark for the Islamic world. Alive and prosperous, with a thriving economy based on cultural industries and higher education services. These features will make our city an 'educated city'.	Tehran, City of Hope, Partnership and Prosperity. Tehran; Smart, Innovative and Knowledge City.
Mashhad	Mashhad is a holy city with a unique religious-pilgrimage oriented identity on the national and global scale; lead in sustainable urban development at the national level with a global approach by relying on a knowledge-based economy, advanced industries and superior services, especially pilgrimage services, tourism and natural tourism.	Mashhad; A Smart City; City of Hope and Life
Isfahan	Isfahan Capital of Islamic Culture and Civilization; the cradle of elites, source of Inspiration and Embodiment of Islamic Civilization. A creative city with faithful, glad and knowledgeable people. A beautiful, green and Smart City with Iranian Islamic architecture. Professionally run city with a dynamic economy and a high quality of life. A productive city based on science, technology and tourism. An exciting city with prominent culture, art and tourism and the best city in Iran to live in.	Isfahan, the beautiful city of God, with turquoise domes, the Islamic Cultural Capital of Iran and a creative city.
Karaj	Karaj; A Sustainable city ensuring quality of life, providing superior services, with the economic opportunities of a metropolitan capital in terms of investment and employment, with relative self-sufficiency, favorable for tourism and leisure activities. A resilient and environmentally friendly city.	Karaj; a miniature Iran. "A city with an Iranian Islamic Identity", "A Sustainable City with Public, Lively, Succulent and Prosperous Spaces", A smart and Knowledge-based City. "A Justice-Driven City where Social and Economic

Brand Identity Indicator /City	City Brand Identity as in UMP	City Brand Identity as on Official Website
		Inequalities have been removed", "A creative and economically robust city with strong foundations to serve Iran as a while", A "sustainable city" residence, activity and leisure are well- integrated, " A city with prosperous, innovative, hopeful and joyful citizens ". A resilient city.
Tabriz	Tabriz, a city with a strong historical and cultural background. Tabriz is one of the most prominent faces of the Islamic city and is one of the most important academic centres of the country and the largest scientific pole of Northwest Iran. Turkish language symbolizes the local identity of the city. "Tabriz City of the Firsts"; the first printing house, the first school, the first school for deaf, the first machine produced coins, the first chamber of commerce, the first municipality and the first township.	Tabriz is the fourth largest city and one of the historical capitals of Iran. "City without beggars", "Iran's safest metropolis", "World of Carpet" and the cleanest city in Iran. The Capital of Tourism among Islamic Countries in 2018.
Shiraz	Shiraz the Religious and Cultural Capital of Islamic Iran. A smooth City for traffic, green and safe. A capable city in urban management and investment attraction. A city for life, work and leisure. Shiraz is a Centre for tourism (religion, sports, nature, health, history and culture) at the national and international levels. An ICT City for services on the Persian Gulf coast. A beautiful, coherent and shiny city.	Shiraz, the city of "Raz [means mystery]". The cultural capital of Iran and the second largest literary city in the world, the third religious city in Iran.
Ahwaz	Ahwaz is a clean, safe, commercial, industrial and tourism city with high social well-being based on continues cultural, social and managerial growth in Southern Iran. A tourism city in five years time.	Ahwaz has had many births throughout history, and what has been reminiscent of this glorious millennial treasure is a rich culture and small memorials left over from the last century.

Brand Identity Indicator /City	City Brand Identity as in UMP	City Brand Identity as on Official Website
Qom	Qom is the capital for the production and publication of religious thoughts and Shiite teachings, a world-wide pilgrimage city, a pattern of Islamic modernity. Qom is one of the main poles of religious tourism.	Qom, pilot city for religious diplomacy at the international level, a large workshop for construction projects, with efficient urban transportation; A Smart City. Qom is a desert that becomes green.
Kermanshah	n.a Only profiling actions mentioned	Kermanshah is a beautiful face and stout chest of Islamic Iran.
Urmia	Urmia is a cultural city, developed and citizen-oriented. One of the oldest Iranian cities on a lush flood surrounded by apple and grape gardens.	Urmia is the land of beauty; Land of Understanding and Peaceful Coexistence. The city of apple and grapes. Urmia is one of the oldest volleyball cities in Iran.
Rasht	Rasht is the most important centre for leisure and travel activities in terms of natural attractions. The industrial area in Rasht is one of the most important projects in the Caspian Sea region.	The beautiful city of Rasht is located in the most important region in the province of Gilan, no word can describe this lush and beautiful area and it should just be seen. Rasht is named the "city of silver frequent rains" due to rain and thunderstorm.
Zahedan	n.a Only profiling actions mentioned	Zahedan is the capital city of the Province of Sistan and Baluchestan and one of the youngest provincial capital cities in the country. Zahedan is connected to both Pakistan and Afghanistan via roads.
Kerman	Kerman; A city to live in with vitality and sustainable city development. The gateway to history and identity, the pole of tourism in the East and South-east for the ancient civilization of Islamic Iran. The historical civilization in Kerman is perpetuated in the academic and cultural activities.	Kerman has been usually one of the most important cities in tourism and every year has been host for many internal and external guests. It's the centre of Southeast and also

Brand Identity Indicator /City	City Brand Identity as in UMP	City Brand Identity as on Official Website
		its cultural economic, industrial, social and political reference point in the Southeast.
Arak	Arak, a city near the Zagros Mountains, Iran's Industrial Pole. Iran's central transportation hub.	Arak, a city on the central plateau of Iran, and its industrial capital.
Hamedan	Capital of Iranian History and Civilization.	Hamedan; an E-city and a Cradle of History. Hamadan is one of the most ancient cities in Iran and an emerald jewel in the western region of ancient Iran, One of the six historical and cultural cities of the country.

When comparing the style many of the above cities adopt in presenting themselves with those found in previous studies on Germany, the Netherlands (Goess et al., 2016), and China (Han et al., 2018; De Jong et al., 2018) it stands out that religious, cultural, and natural features are much more prominent in cities' self-images and that the focus on history is also stronger. This does not mean that a view of future economic development is absent, but it essentially only appears among the subset of cities that already economically do better. All taken together, a division can be made into five types of Iranian megacities based on their brand identity choices:

1. Cities eager to adopt the complete package of religious, cultural, and modern technological amenities. This implies they are proud of their natural and/or cultural treasures and Islamic significance, but they also want to share in high-tech development boosting the future economic profile of their city. This applies to Tehran, Mashhad, Isfahan, Shiraz, and Qom.
2. Cities adopting a modern, multi-cultural profile seeing themselves at the confluence of various migration and ethnic streams and deriving character and strength from diversity without leaning on tradition much. Karaj belongs to this category.
3. Cities with a strong industrial and manufacturing profile, based on petroleum and chemicals. Even though they may express a desire to diversify into tourism, the credibility of realizing this is limited for the moment. Ahwaz and Arak are in this industrial group.

4. Cities with abundant natural and agricultural treasures, and sometimes quite poetic ways of describing themselves, but with a comparatively low profile in industry and services. These cities are Tabriz, Urmia, Rasht, Kerman and Hamedan.
5. Cities with a weak economic profile and an essentially negative self-perception that mention only action points and features of transport accessibility in their brand identity. Their self-image seems neither strongly rooted in past heritage nor in future ambitions. Kermanshah and Zahedan are in this group.

It becomes apparent that there is a strong correlation between economic strength and professionalism in branding, with cities in groups 1 and 2 having both city brand identities that generate emotional appeal, are amenable to the development of an overarching strategy or policy, demonstrate a certain level of uniqueness and allow for different yet non-contradictory messages to various stakeholders, and connect past heritage, current profile, and future ambitions. Karaj is stronger in its multi-cultural uniqueness and leans less on the past, Tehran is special in its global ambitions, while the other cities in group 1 are strongest in connecting the past, present, and future. While cities in group 3 are strong in their industrial profile, the attractiveness of this profile as a city brand identity has obviously shrunk in the face of severe environmental deterioration. Cities in the fourth group, on the other hand, have attractive cultural identities in many ways: they demonstrate uniqueness and lean strongly on natural or cultural treasures. However, their messages are not future-oriented, allow for little economic variety, and cannot be seen as a strong starting point for an overarching policy strategy. This severely restricts their practical appeal for ecological modernization. The cities in the fifth group, finally, appear to be so fully absorbed in getting by to pay any attention to branding at all.

Table 5 presents the dominant city labels of all 15 megacities as expressed in their Urban Master Plans and as they are found on their official local government websites. In the final column, it also demonstrates into which national city programs each of them have been incorporated. Again, the website of Mashhad City proved unavailable.

In line with our findings in Table 4, we see that the economically more powerful cities also tend to adopt higher numbers and a greater variety of city labels; they are also included in more city programs, helping them boost their urban structure and profile. Tehran, for instance, is included in all of them, and so is Shiraz. It is also intriguing that exactly all cities identified before in group 1 are included in the national Smart City program, and that just Urmia from the fourth group has been added. Moreover, all cities in the first group with strong traditions in Islamic architecture (Mashhad, Isfahan, Shiraz, and Qom) also boost their tourist profile through

the use of the city label 'tourism city'. Karaj (group 2) is not a Smart City and also does not promote itself as such, but it has firmly placed its focus on sustainability, livability, and knowledge. Among the industrial cities (Ahvaz and Arak) choices of city labels and adoption in national programs is comparatively weak, but to the extent that these exist, they reveal a wish for increases in tourism, livability, and sustainability. Among the cities with weaker economic profiles, but potentially rich in natural and cultural treasures (fourth group), and generally weak economic structures (fifth group), Hamedan stands as being by far the most ambitious by using such terms as sustainable, tourism, digital, smart, livable, and resilient. Urmia is intriguing by focusing entirely on smart. Zahedan is significant at the very other extreme by not mentioning any term at all. Most others are in between these outcomes. More generally, however, consistency in the choices made in the various columns are a sign of commitments and focus rather than name-dropping. In that sense, Tehran, Isfahan, Karaj, Urmia, and Hamedan seem to stand mostly firmly behind the branding and policy choices made and, in that sense, the credibility of their use of labels and adoption of national city programs can be expected to be highest. Incorporation of their branding approach in an overarching policy strategy, therefore, seems most likely, making its transformative capacity towards ecological modernization highest. In most other cases, the use of labels appears more as a haphazard use of popular urban denominations than as actual reflected adoption and systematic application of city labels. A table offering a systematic assessment of the four credibility factors applied to the city brand identities and use of city labels is presented in Table 6. The findings are in line with the general impressions obtained in Tables 4 and 5 on city brand identities and the use of city labels, and can be used by individual cities to evaluate and monitor 'how well' they do in their city branding practices and what is open to improvement. We should add here that the factors with emotional appeal (generating loyalty and conveying positive feelings) were omitted from the analysis due to a lack of measurability (see Section 3).

Table 5-Use of city labels in UMPs and on websites, and the adoption in national programs.

City Brand Position/City	Dominant City Labels as in UMP	Dominant City Label as on Website	Visible Engagement in National City Programs
Tehran	Knowledge (8) [1] Global (7) Smart (4) Creative (3) Innovation (1)	Smart (7) Knowledge (3) Innovation (2)	Knowledge-based development Smart City program Preservation of Iranian-Islamic identity Identity of the city (global metropolis)
Mashhad	Livable (6) Global (6) Tourism (5) Sustainable (4) Knowledge (3) Digital (1)	Smart (8) Tourism (6) Livable (2) Sustainable (1)	Identity of the city (global metropolis) Smart City program
Isfahan	Tourism (6) Livable (5) Smart (4) Creative (1)	Tourism (3) Creative (1)	Iranian Islamic Culture Preservation of Iranian-Islamic identity Smart City program
Karaj	Sustainable (5) Resilient (3) Livable (2) Tourism (1) Digital (1) Manufacturing (1)	Sustainable (3) Smart (1) Knowledge (1) Resilient (1)	Sustainable development
Tabriz	Knowledge (1)	Tourism (15)	Knowledge-based development
Shiraz	Liveable (72) Tourism (34) Digital (15)	Smart (14) Digital (6)	Preservation of Iranian-Islamic identity Smart City program Sustainable development The identity of the city
Ahwaz	Tourism (1)	n.a	Identity of the city
Qom	Tourism (2)	Smart (3) Tourism (1) Digital (1)	Smart City program
Kermanshah	n.a	Livable (3)	n.a
Urmia	n.a	Smart (6)	Smart City program
Rasht	n.a.	Creative (2) Sustainable (1)	Sustainable development

City Brand Position/City	Dominant City Labels as in UMP	Dominant City Label as on Website	Visible Engagement in National City Programs
Zahedan	n.a	n.a	n.a
Kerman	Sustainable (3)	n.a	n.a
Arak	Sustainable (2) Manufacturing (1)	Livable (1)	Sustainable development
Hamedan	Sustainable (2) Tourism (2) Livable (1)	Sustainable (3) Digital (2) Smart (2) Livable (1) Resilient (1)	Sustainable development

[1] Frequency count.

Table 6- Evaluating city brand credibility of Iranian megacities.

Credibility Aspect/City	Facilitating Overarching Strategy	Demonstrating Uniqueness	Allowing Different, Non-Contradictory Messages	Logically Connecting Past, Present, and Future
Tehran	high	high	high	high
Mashhad	medium	high	High	high
Isfahan	high	high	High	high
Karaj	high	high	High	medium
Tabriz	high	medium	Medium	high
Shiraz	high	high	High	high
Ahvaz	low	low	Medium	medium
Qom	high	medium	Medium	medium
Kermanshah	low	low	Medium	medium
Urmia	medium	medium	Medium	medium
Rasht	medium	high	Medium	medium
Zahedan	low	low	Low	low
Kerman	high	low	Medium	medium
Arak	medium	high	Medium	medium
Hamedan	medium	low	High	high

When applying the four credibility factors in a systematic way we consider scoring each factor as below:

- facilitate the development of an overarching strategy or policy; high if alignment with a national program appears in both brand identity and position; medium if it aligns with one of them; and low if seen in neither;
- demonstrate uniqueness or distinctness; high if the unique highlight appears in both brand identity and position; medium if it appears in only one of them; and low if seen in neither;

- allow for different yet non-contradictory messages to various stakeholders; high if their profile covers all environmental, economic (technological and industrial), and cultural aspects; medium if they cover one or two aspects; and low if none is mentioned; and
- logically connect past heritage, current profile, and future ambitions; high if their brand shows promotional promises and current situation as well as past heritage; medium if two of them are seen; and low if only one or even none is mentioned.

As it can be seen, in two heads of the assessment spectrum the cities of Tehran, Isfahan, and Shiraz reflect top scores, and Zahedan has the lowest rank.

2.6. Conclusion

Like cities in other nations and regions around the world, Iranian cities have also increasingly engaged in city branding practices that are potentially conducive to industrial transformation and ecological modernization. The nuclear deal opening their economy to stronger international influence has made them more amenable to trends in global competition. Especially since it has become obvious that oil and gas, as non-renewable natural resources, have a limited future timespan and generate considerable ecological damage as a result of their exploration and exploitation, some of Iran's megacities have begun to engage in city branding practices. Adopting city brand identities and using various attractive city labels play crucial roles in their attraction of alternative investors, corporations, and other stakeholders that can contribute to the ecological modernization they aspire to. The question is, however, to what extent their branding choices can be assessed as being credible. In order to evaluate this, we identified six factors for credible city branding practices from the academic literature on the topic. These were found to be the potential to (i) generate feelings of loyalty; (ii) facilitate the development of an overarching strategy or policy; (iii) evoke positive feelings; (iv) demonstrate uniqueness or distinctness; (v) allow for different, yet non-contradictory, messages to various stakeholders; and (vi) to logically connect past heritage, current profile, and future ambitions. Four of these factors (2, 4, 5, and 6) proved fit for application to the branding practices in Iran's 15 megacities and led to an assessment table offering an impression of how well each city did on which factor.

This study has shown that compared to how city branding is deployed in the face of ecological modernization, Iranian large cities pay ample attention to aspects of past heritage and to cultural and religious identity, and (to a certain extent) natural beauty. It is obvious that all Iranian cities boasting religious shrines and monuments cherish these cultural aspects in their identity. Religion is undoubtedly the root aspect of their identity in Mashhad, Isfahan, Shiraz, and Qom and seen as an

important basis for tourism and pilgrimage. Science and technology also appear as relevant among Iranian megacities, but only among the economically-leading cities. The wish to transition from manufacturing to services is not nearly as prominent as in Europe (Goess et al., 2016) and China (De Jong et al., 2018; Hans et al., 2018).

Among all fifteen cities under study (all with over 500,000 inhabitants), we developed a classification of five types: (i) cities eager to adopt the complete package of religious, cultural, and modern technological amenities (Tehran, Mashhad, Isfahan, Shiraz and Qom); (ii) cities adopting a modern, multi-cultural profile, and deriving character and strength from diversity without leaning on tradition (Karaj); (iii) cities with a strong industrial and manufacturing profile, based on petroleum and chemicals; (iv) cities with abundant natural and agricultural treasures, and sometimes quite poetic ways of describing themselves, but with a comparatively weak profile in industry and services (Tabriz, Urmia, Rasht, Kerman, and Hamedan); and (v) cities with a weak economic profile and an essentially negative self-perception that mention only action points and features of transport accessibility in their brand identity (Kermanshah and Zahedan).

It appears that representatives in the first group tend to be sophisticated users of city branding practices and they meet most of the criteria for credible city branding. The picture is far more mixed among the cities in the third, fourth, and fifth groups. All the cities in the first group are adopted the national Smart City program and among them **Tehran**, **Isfahan**, **Shiraz**, and **Mashhad** have the most credible branding practices of 'Smart'.

The picture sketched above is confirmed in Table 6, where the four measurable factors influencing the credibility of city branding practices are systematically applied to all cities and from which individual cities can take clues as to which aspects in their branding may be improved.

The findings in this study add a few significant insights to the existing academic literature on the topic. They add knowledge on how cities in a nation that has recently opened up to global competition and where religious considerations play a vital role in information trends of economic development and urbanization, refract the drive towards ecological modernization. Some trends, such as the emphasis on sustainability and livability, tend to be generally shared, while others, such as knowledge-orientation, smartness, and digitality, have been adopted among the more developed cities. Chapter 5 will well introduce the four Iranian cities with the credible brand of 'smart' and examines their readiness for bringing the branding practices into action to become a Smart City. The follow-up researches in chapter 6 also indicate how these branding practices appear in the Smart City development process to make quite sophisticated use of branding to promote their ecological modernization.

3

INPUT-OUTPUT MODELLING FOR SMART CITY DEVELOPMENT

The contents of this chapter have been adapted from the following peer-reviewed article: Noori, N.; De Jong, M.; Janssen, M., Schraven, D.; and Hoppe, T. Input-Output Modelling for Smart City Development *Journal of Urban Technology* 2020.

3.1. INTRODUCTION

In the past decade, the popularity of using Smart City labels for sustainable techno-driven urbanization has increased dramatically (de Jong, Joss, Schraven, Changjie, and Weijnen, 2015; de Jong, et al., 2018). Smart City initiatives combine a variety of ambitions reflected in the precepts for smart growth and ecological modernization, which suggest that continued economic growth is possible alongside decreased environmentally harmful output. This is achieved by steering production and consumption more towards high-tech services. This list includes city concepts like 'sustainable cities,' 'eco cities,' 'low carbon cities,' 'knowledge cities,' 'information cities,' 'innovation cities,' 'intelligent cities,' 'digital cities,' and 'Smart Cities.' In particular, the popularity of the latter has skyrocketed in the past few years. The bibliometric study by De Jong et al. (2015) into different types of future cities indicated that the use of the Smart City label in the academic literature had already overtaken the previous champion and umbrella term of 'sustainable city' by 2012. The study counted the number of times that twelve city labels were mentioned (single and plural) in the abstract, title, or keywords of academic articles or reviews until 2013 in Scopus[1]. Using the same procedure used by De Jong et al. (ibid.) in their seminal work, I updated their study by including scientific articles and reviews that were published afterwards (until the end of 2018). The results are presented in Figure 1. This figure indicates that the dominant position of the 'Smart City' has taken on staggering proportions and has overtaken and completely eclipsed other terms. This may reflect the importance attached to it in the world of planning and policy-making.

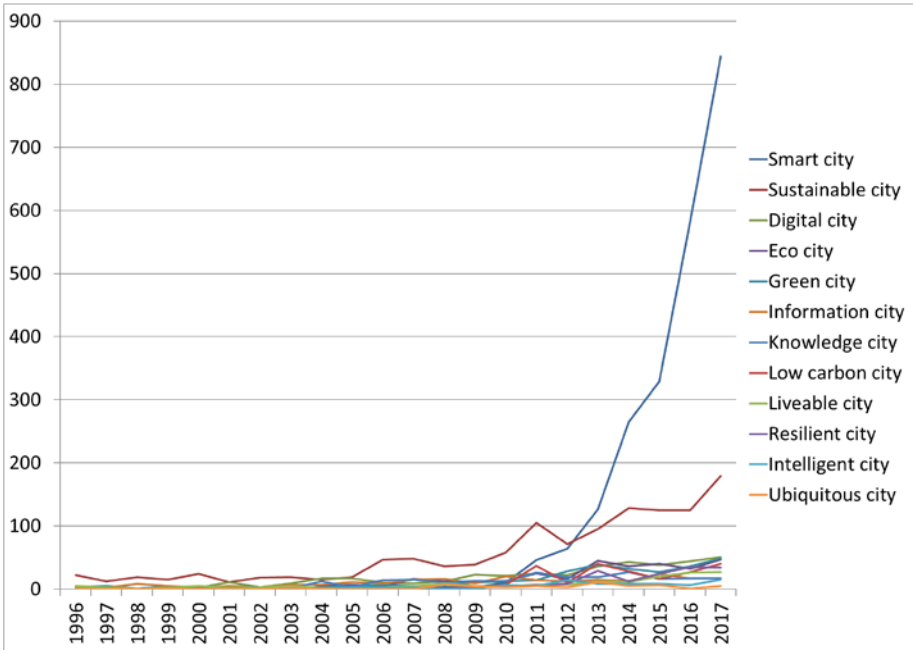
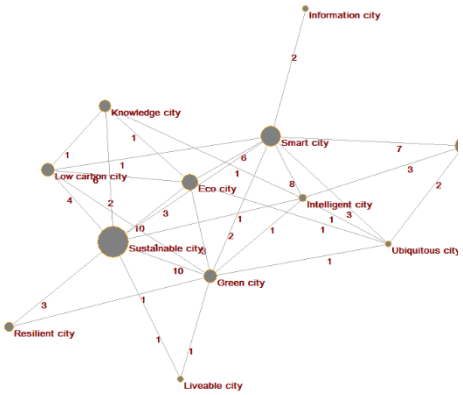


Figure 1- Frequency of appearance of different city labels over time in academic research articles (Scopus, N = 6475 articles).

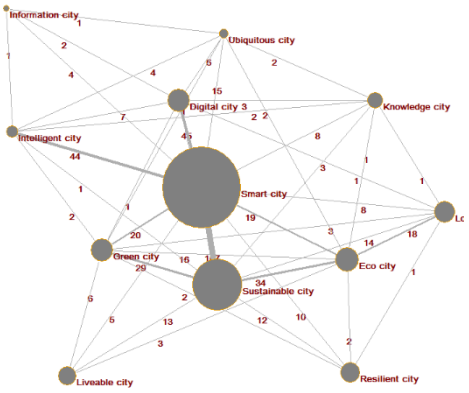
Equally significant is the shift of the 'Smart City' label in its relative position vis-à-vis other future city labels in terms of its conceptual co-occurrence, as shown in Figure 2. It clearly indicates that 'Smart City' has driven the 'sustainable city' out of the center as a city label with the highest centrality score, and has taken over its position, although smart and sustainable are still strongly interconnected.



Publications between 1996 – 2013

(N=1666 articles)

*(original figure obtained from De Jong et al. 2015).



Publications between 1996 – 2017

(N=6475 articles)

*(updated figure following the methodology procedure by De Jong et al. (2015), excluding the results from that particular study).

Figure 2- Network diagrams depicting co-occurrence of twelve city labels in title, abstract, and keywords in academic research articles (Scopus).

Although the 'Smart City' label has seen exponential growth in the number of publications (Komninos and Mora, 2018), and its meaning has shifted, thus far there are few indications that it has contributed in making cities 'smarter'. Despite the fact that the notion of Smart City development is increasingly popular[2], one should also notice that it has grown increasingly ambiguous for policy makers, city developers, and practitioners who are in need of more systematic and fine-grained conceptualization (Komninos and Mora, 2018). Various models (Chourabi, Nam, and Walker, 2012; Lee, Hancock, and Hu, 2013; Neirotti, Marco, Cagliano, Mangano, and Scorrano, 2014) have been developed to advance Smart City development, but all are primarily descriptive in nature and offer few clues on how to flesh out Smart Cities in practice.

The goal of the present chapter is, therefore, to map the various facets of the Smart City, transform these into an Input-Output (IO) model, and provide an overview of design variables that can be handled when developing a (specific type of) Smart City. The idea of IO modelling is to position and pinpoint key facets of the Smart City and dynamics of Smart City development (Batey and Rose, 1990). Cov-

ering all aspects of a Smart City is impossible and the aim is to develop a parsimonious model that can help in making the main design decisions. The contribution of the IO model is that it allows for conducting a dynamic analysis in various domains represented within Smart Cities. The model makes facets of Smart Cities tangible and transparent allowing decision-makers, city planners, developers, and engineers to envisage what the relevant design variables are, which choices they can make, and what their chosen type of Smart City may look like in practice. The main question addressed in this paper is: How to develop a conceptual model to analyze Smart City development that can also be used by policy makers and practitioners in relevant decision-making processes? In order to answer the main research question, the following sub-questions are used:

1. What are the key facets attributed to Smart City in the academic literature?
2. What are the key elements directly and indirectly related to Smart City development? And how can they be used to develop and elaborate an IO model on Smart City implementation?
3. How can this IO model for Smart City development be used?

To answer the first sub-question, I conducted a content analysis of the literature and presented our main findings in a table. To conduct a systematic literature review, first I started with identifying what has been written on the Smart City topic in scientific journals and making decisions about the suitability of material to be considered in the review (Cooper, 1988). Then I determined the relevant studies to which specific research reveals domains and facets of the Smart City which provides me a basis for including or excluding certain studies. And based on that, I extracted the different determined domains of the Smart City addressing the first research question (Cooper & Hedges, 2009). Besides, a bibliometric analysis was conducted to map the structural linkages between the keywords in the Smart City literature. To answer the second question, an IO modelling approach was used. This is presented in the third section of this paper. IO is founded in systems theory (See Figure 3) which translates sources (input) into policy deliverables (output) and identifies the main decisions that can be made to transform inputs into outputs (Checkland, 1999).

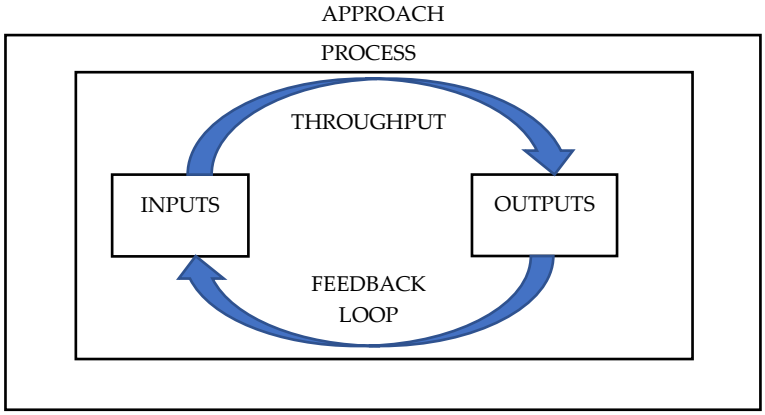


Figure 3- The IO model structure and its components (adapted from systems theory, Checkland, 1999).

In order to answer the third question, I analyzed the grey literature on Smart Cities and conducted interviews for the illustrative case of 'Smart Dubai' and translated these findings into terms that are used in the IO model. I thus examined how the IO model could be applied and what type of Smart City 'Smart Dubai' can be labeled as. In principle, I could have chosen any other case for our illustration purposes, since I also had usable data for Amsterdam Smart City, Barcelona Smart City, and Masdar City in Abu Dhabi, but Smart Dubai is less often described in the literature, yet it is highly innovative. Moreover, it involves comparatively high investments, shows progressive vision, recently appears in several international rankings (i.e., the Global Smart City issued by Juniper Research, 2017; the Smart City Index issued by Ernst and Young, 2017; or the global Smart City Discourse Network issued by Joss et al., 2017; Top 50 Smart City Government rankings issued by Eden Strategy Institute and ONGandONG, 2019), and has adopted an intriguing governance approach making it a good candidate of good practice and serving as an international benchmark (Yigitcanlar, et al., 2018). The data collection for the Smart Dubai case entailed conducting interviews, collecting text documents, and making site visits. Several interviews[3] were conducted with smart Dubai officials and experts from public and private organizations involved in the Smart Dubai program in 2018. I participated in a research trip to Dubai. Interviews were recorded on a digital audio recorder and transcribed using interpretative content analysis.

3.2. Positioning and Pinpointing Key Facets of the Smart City

Using the academic literature, key attributes of Smart Cities are identified in order to answer the first research question. Currently, there are multiple and various definitions of the Smart City concept (Chourabi, Nam, and Walker, 2012; Hollands, 2008; Caragliu, Bo, and Nijkamp, 2011; Yigitcalar, 2015). Table 1 shows that the variety of definitions and aspects attributed to it have increased substantially over the years. Moreover, the expectations that policymakers and analysts have of Smart Cities also vary, making the whereabouts of its implementation hazy.

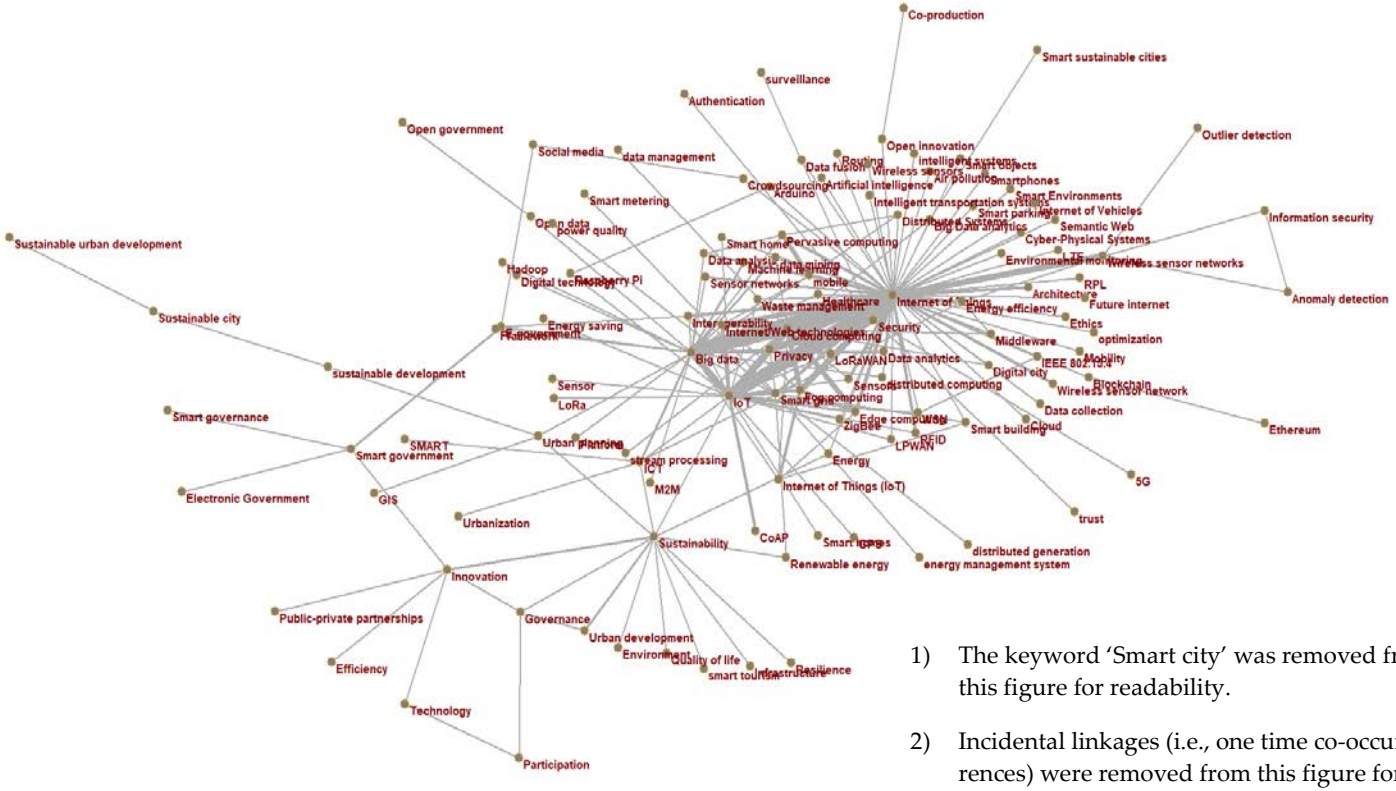
As one can see, ICT infrastructure plays a key role in some of them, but the meaning of 'smart' has broadened considerably and spread out to many urban infrastructures and services and aspects of livability and sustainability leading to a great variety of ways in which 'smart' can be implemented.

Table 1- Smart City meanings and domains as used in the academic literature.

Source	Meanings and Main Domains
Komninos (2008)	Use of networked infrastructures as a means to enable social, environmental, economic, and cultural development
Glaeser and Berry (2006)	Role of human capital and education in urban development
Hollands (2008)	High capacity for learning and innovation, creativity, institutions of knowledge production, and digital infrastructure for communication
Caragliu and Nijkamp (2011)	Considering the human and social capital, using ICT, sustainable economic growth, role of management
Paskaleva and Megliola (2011)	Better quality of life becoming a life-time outcome of urban functioning
Kuk and Janssen (2011)	Innovative information sharing technology, smart citizens, and businesses
Schaffers et al. (2012)	Advanced infrastructures, sustainability, economic growth, quality of life
Chourabi et al (2012)	Management and organization, technology, governance, policy, people and communities, the economy, built infrastructure, the natural environment
Anthopoulos (2015)	Resource, transportation, urban infrastructure, living, government, economy, coherency

Source	Meanings and Main Domains
Lee et al. (2013)	Urban openness, service innovation, partnership formations, urban proactiveness, Smart City infrastructure integration, Smart City governance
IBM	Planning and management services, infrastructure services, human services
ITU (2014)	Environmental sustainability, productivity, quality of life, equity, and social inclusion, infrastructure development
UN Habitat (2014)	Productivity and the prosperity of cities, urban infrastructure, quality of life and urban prosperity, equity and the prosperity of cities, environmental sustainability, and the prosperity of cities
ISO (2014)	Economy, education, energy, environment, finance, fire and emergency response, governance, health, recreation, safety, shelter, solid waste, telecommunication and innovation, transportation, urban planning, waste water, water, and sanitation
Neirotti et al. (2014)	Natural resources and energy, transport and mobility, buildings, living, government, economy and people
Joss (2015)	Urban governance, technology infrastructure
Negro et al (2015)	People, information, knowledge, and ICT
Yigitcanlar (2015)	Sustainability; wellbeing and livability, economy, governance
Joss et al (2019)	Governance, infrastructure, international, digital technology, society, economy, spatial planning, innovation, environment and sustainability
Kitchin (2019)	Smart citizens, neoliberalism, technological solutionism

Figure 4 shows the results of the bibliometric analysis on key words around the Smart City concept appearing in the academic literature. Internet of Things (IoT) is clearly at the center of the whole graph and tightly connected with data related concepts including big data, data analytics, security, and privacy. Yet, it is also linked with a wide selection of concepts ranging from cloud computing, energy (i.e., renewable, smart meter, energy efficiency), and healthcare to, mobility, and even ethics, trust, and social media. In the lower part of the graph, there are the governance and sustainability related concepts.



1) The keyword 'Smart city' was removed from this figure for readability.

2) Incidental linkages (i.e., one time co-occurrences) were removed from this figure for

Figure 4-Structural linkages between keywords in the Smart City literature, demonstrating the dominance of IoT (Publications between 1996 – 2018; N= 3573 articles).

Another extensive study (Anthopoulos, Janssen, and Weerakkody, 2015) concludes that there is broad agreement among experts that essentially six dimensions of the Smart City can be identified: people, governance, mobility, economy, environment, and quality of life. They propose these six dimensions as facets of the Smart City which can be included in developing an integrated conceptual model. However, a missing crucial element is technology. Similarly, Chourabi et al. (2012) developed an integrative framework to identify crucial factors of Smart City initiatives and examine how local governments imagine possible future Smart City initiatives. This framework includes eight factors: management and organization, technology, governance, policy context, people, economy infrastructure, and environment (Chourabi, Nam, and Walker, 2012). Overall, the previous models are mainly focused on Smart City facets. Inspired by these previous modelling exercises, in this study the goal is to determine where each facet is located in the Smart City development process by classifying them as inputs, throughputs, and outputs. The only model that adopted an input-process-output logic is Yigitcanlar's multidimensional Smart City framework (Yigitcanlar, et al., 2018). However, it still is too general for practitioners and policymakers to pinpoint Smart City facets in inputs, throughputs, and outputs.

More specifically, the proposed model in the present study consists of the following domains of the Smart City based on an extensive literature review:

- **Modern ICT infrastructures and data** (Hollands, 2008; Caragliu, Bo, and Nijkamp, 2011; Kuk and Janssen, 2011; Steventon and Wright, 2006; Lee, 2009; Negre, Rosenthal-Sabroux, and Gasco, 2015; Cianci, Grieco, Boggia, and Camarda, 2014; ISO, 2014; Joss, Sengers, Scheraven, Caprotti, and Dayot, 2019; Kitchin, 2014);

- **Financial resources** (ISO, 2014; Neirotti, De Marco, Cagliano, Mangano, and Scorrano, 2014; Chourabi, Nam, and Walker, 2012; Florida, 2005; Lu, Zhu, Li, and Wu, 2011; Yigitcanlar, 2014);

- **Governance** (Anthopoulos, 2015; (ISO), 2014; Neirotti, De Marco, Cagliano, Mangano, and Scorrano, 2014; Lee, Hancock, and Hu, 2013; Chourabi, Nam, and Walker, 2012; Hollands, 2008; Joss, 2015; Joss, Sengers, Scheraven, Caprotti, and Dayot, 2019);

- **Human infrastructure and entrepreneurial capital** (Chourabi, Nam, and Walker, 2012; Glaeser and Berry, 2006; Kuk and Janssen, 2011; Caragliu, Bo,

and Nijkamp, 2011; Yigitcanlar, 2015; Yigitcalar, 2015; Munier, 2007; Mortensen and Jonsbak Rohde, 2012);

- **Smart citizens and applications** (Neirotti, De Marco, Cagliano, Mangano, and Scorrano, 2014; Kuk and Janssen, 2011; Chourabi, Nam, and Walker, 2012; Mortensen and Jonsbak Rohde, 2012; Streitz, 2011);

- **Sustainability and high quality of life** (Caragliu, Bo, and Nijkamp, 2011; International Telecommunications Union, 2014; UN, 2014; Paskaleva and Megliola, 2011; Schaffers, et al., 2012; Yigitcanlar, 2015; Cianci, Grieco, Boggia, and Camarda, 2014; Munier, 2007; Yigitcanlar and Lee, 2014; Zhao, 2011).

The next step is to translate these into inputs and outputs to conceive of Smart City facets for the conceptual model. When portraying the Smart City as an object of urban development policy, I am convinced that it can be conceptualized as a process; I group the eight domains of the Smart City mentioned above in two categories to indicate how different facets are positioned vis-à-vis each other in the Smart City development process:

1. Source-based (or need-oriented) domains refer to the needs and resources for building a Smart City, such as modern ICT infrastructure, data, human infra-structure and entrepreneurial capital, governance, and financial infra-structure;

2. Target-based (or commitment-oriented) domains revolve around the results, the objects, and deliverables of Smart City promises. These include smart applications and externalities.

In the following section we apply these categorized key facets to map our conceptual model of the Smart City development process.

3.3. CONCEPTUAL MODEL

This section presents an IO model that has been developed for a city in an institutional environment in which a local government wishes to develop (itself into) a Smart City, and policy makers draft and implement Smart City development plans. The idea is that the various sorts of inputs of the Smart City vary and that there is no such thing as 'the' Smart City, but there are various conceivable types of it. The transformation from input to output and then back is determined by two arrows: (a) a transformation process from input through throughput to output, and (b) an evaluation pathway (feedback loop) from output back to input. This flow is presented in Figure 5.

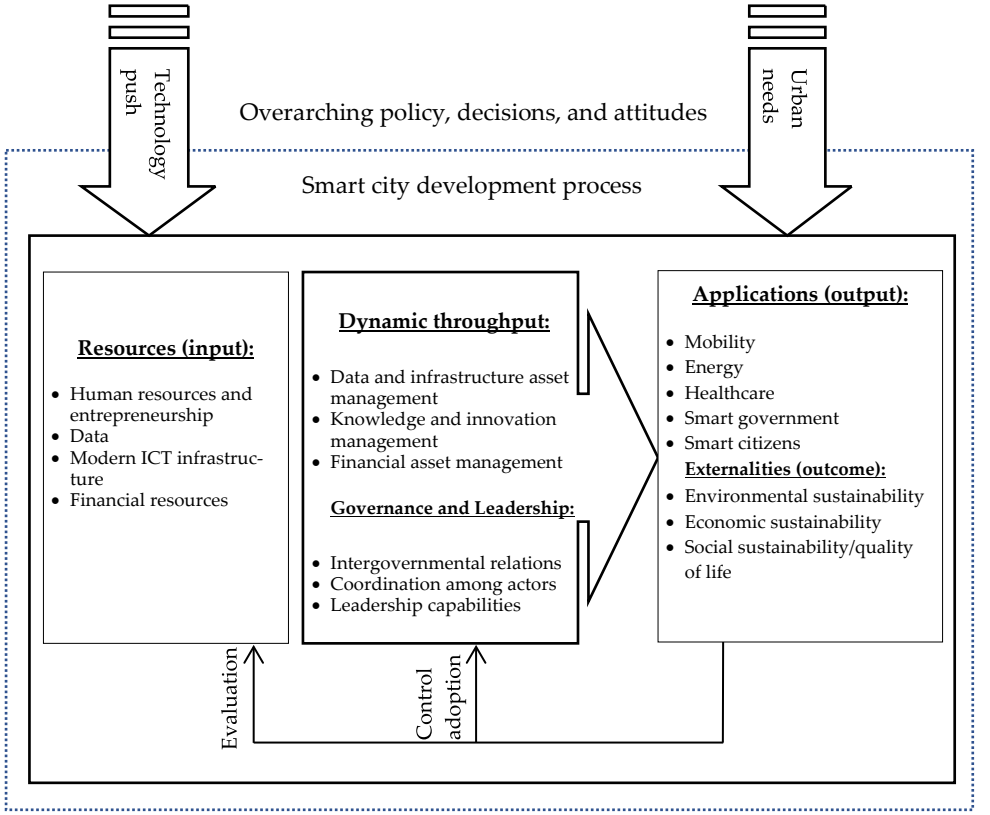


Figure 5-Graphical conceptualization of the IO model for Smart City development process (as compiled and drawn by the author).

3.3.1. INPUT

Input refers to the domains of the Smart City for which goals are formulated and re-sources made available. To characterize these resource-based domains, we first define them, then pinpoint their application in Smart Cities, and finally sketch what potential they offer for realizing the Smart City.

3.3.1.1 MODERN ICT INFRASTRUCTURE: INTERNET OF THINGS

From an engineering point of view, a Smart City is expected to deal with technology as well as the interconnection between technology and people (e.g., citizens, governments, and companies). On the one hand, there is a need for smart urbanism as an innovative solution for urban problems. On the other hand, the emergence of the IoT through technology push gives it an increasingly important role in fulfilling these expectations. As the Rothwell Innovation Model (1992) shows, the Smart City can be viewed as an innovation resulting from the need to resolve urban issues and the new technology push offered to deal with them (Rothwell, 1992). Accordingly, the availability and quality of ICT infrastructures have become some of the main resources for many cities aiding them to brand themselves as 'smart'. ICT infrastructures can achieve: (1) ICT-enabled information and knowledge sharing; (2) ICT-enabled forecasts; and (3) ICT-enabled integration (Gemma, 2014). State-of-the-art ICT infrastructures, often referred to as Internet of Things (IoT), play a crucial role in Smart City development since they act as a platform for the aggregation of information and data and enable an improved understanding of how a city functions in terms of resource consumption, services, and lifestyles. Janssen and Estevez (2013) define the platform as a focal point where various type of actors interconnect in a common area. There is a wide range of possibilities for Smart City development based on this state-of-the-art technology and IoT platforms. The IoT infrastructure for the Smart City refers to management of the city through connecting to physical objects (through sensors, camera, RFIDs, etc.), using a large amount of real-time data (energy and environment, transportation and traffic, healthcare, safety and. justice, and business), transforming data into trustworthy and reliable information and delivering the right information to the right person at the right time in the most appropriate way.

3.3.1.2 DATA

In the present era, the competitive advantage is directly related to the level of access to 'data and information'. The higher the level of access to data, the greater ability to control and enhance the future. But this is not valid for all data; data must

be processed, and made useful, reliable, and manageable. Provisioning aggregated data through embedded sensors from traffic and transportation systems, buildings, energy systems, and also people, products, and companies is crucial for developing an integrated platform to communicate within the Smart City. IoT provides a platform for sensors and actuator devices to communicate seamlessly within the Smart City environment and enables increasingly convenient information sharing across platforms. Furthermore, the physical infrastructure of the city must be integrated into the digital and communicative infrastructure in order to increase the mobility and effectiveness of the city and the administrative systems which connect its many stakeholders. To do this, data is the linkage for making this connection. Big data, sharing data, and open data platforms are required to have an IoT platform for real-time data accessibility. For these reasons data as an asset is another key resource in building a Smart City.

3.3.1.3 Human Resources and Entrepreneurship

Human resources and entrepreneurship refer to facilities honing human resources and taking advantage of their expertise as well as the provision of facilities for entrepreneurial initiatives. These should jointly promote the generation and implementation of creative ideas driving innovation towards smart solutions.

There are three main reasons for considering human and entrepreneurial resources as a source-oriented domain of the Smart City. First, although technology and particularly modern ICT are the key enablers of Smart City initiatives (Chourabi, Nam, and Walker, 2012), a Smart City requires human involvement to become effective. Second, entrepreneurship is one of the main drivers for a smart economy to stimulate creativity and innovation. Finally, as Nam and Pardo (2011) stress, community commitment to the enactment and use of technology is crucial in initiating Smart City initiatives (Nam and Pardo, 2011). Managerial and organizational factors are also considered as important factors in Smart City development (Chourabi, Nam, and Walker, 2012). Having research centers in place to foster creativity and innovation related to the Smart City, building support structures for start-ups and entrepreneurship, and establishing knowledge sharing programs are all potentially fruitful ways to develop human and entrepreneurial infrastructures.

3.3.1.4 Financial Resources

One of the important input facets for building such a techno-driven city is financial resources which a Smart City requires to build modern IoT infrastructures. Designing and equipping IoT platforms necessitates embedded sensors and actuator devices to aggregate data and then having a connectivity layer which is responsible

for transmitting aggregated data and an interface between embedded sensors and the network server. Besides these, for security purposes, IoT platforms need investment in cyber security which is conducive to privacy and safety of all data within the network through providing a secure and reliable substrate for data transmission and big data storage. However, the Smart City is not necessarily just ICT-based, but also deals with other aspects of innovation (Anthopoulos, Janssen, and Weerakkody, 2015). A Research and Development budget that is typically made available by local government would also allow for fostering innovation and inventing smart solutions (Hoppe, van der Vegt, and Stegmaier, 2016). In addition, some investment in branding and training practices would enable the Smart City to attract more actors (e.g., experts, citizens, investors, and business firms) to commit themselves. The possible funding sources for the Smart City can be funds provided exclusively by local, regional, or state governments, but may also be obtained from public and private co-funding arrangements, or even mainly private investment. Crowdfunding has also become increasingly popular among start-ups, for it offers additional financial resources (Carè, Trotta, Carè, and Rizzello, 2018).

3.3.2. THROUGHPUT

Throughput refers to managing and organizing of resources and assets and making decisions about how to transform them into the output to achieve intended goals and outcomes (Checkland, 1999). Throughput for Smart City development allows for the modification and alignment of resources and processes within various contexts (Gupta, Panagiotopoulos, and Bowen, 2015). Therefore, the process of transforming input to output (which in system theory is known as throughput) requires management, administration, and leadership skills and involves a variety of actors. Dynamic throughput refers to the ability to manage the resources and develop competencies in order to produce output (Teece, Pisano, and Shuen, 1997). One of the most important Smart City capabilities is the ability to turn data into value; providing reliable information in the context of Smart City (Gupta, Panagiotopoulos, and Bowen, 2015). The ability to use and maintain data and infrastructure assets has a significant impact on delivering sensed aggregated organized data as smart applications and data visualization. Knowledge and innovation management mainly address the question how benefits can be obtained from human involvement, which essentially represent the capacity to generate knowledge, and innovate to generate output. Another resource that needs to be managed to align goals with outcomes is financial assets. Since the IO model explains that one of the ultimate goals of developing the Smart City is sustainability, providing funding for it should also be sustainable. In this regard, there is a new approach for funding Smart Cities in the literature known as 'sustainable finance' which states that funding

should not only consider financial aspects of return on investment and profit or loss, but also non-financial aspects, such as responsibility for the future of the city, environmental protection, issues of climate change, and social obligations (Janssen, Charalabidis, and Zuiderwijk, 2012). Sustainable finance concerns long-term term value creation which considers employees, customers, suppliers, the environment, and society as a whole (Hauptmann, 2017).

Governance and leadership throughput refer to the question how the process of transforming a city into a Smart City, consisting of different domains, can be governed: i.e., intergovernmental relations, coordination among actors, and leadership capabilities (Hoppe, van der Vegt, and Stegmaier, 2016; Bressers, Bressers, Kuks, and Larrue, 2016) (See Table 2).

Table 2- Smart City development process throughput

Throughput domains	
Dynamic throughput	Data and infrastructure asset management
	Knowledge and innovation management
	Financial asset management
Governance and leadership	Intergovernmental relations
	Coordination among actors
	Leadership capabilities

Adapted from Gupta et al. (2015) and Bressers et al. (2016).

'Intergovernmental relations' refers to the interdependency of different organizational layers involved in governing the process and the way these are handled (Bress-ers, Bressers, Kuks, and Larrue, 2016). Since there are multiple actors, the interests they bring to the game also vary and the shape these interactions take depends on the political, legal, institutional, and cultural context in which they are embedded (Joss, 2015; Yigitcalar, 2015). 'Coordination among actors' elaborates on the question which actors are involved in the process, which interests and perspectives they bring to the table, what responsibilities they have for specific tasks (for instance data ownership), the legal authority granted to them and how key resources are exchanged among them (Bevir, 2012). Various leadership capabilities form the body of decision-making in different ways, in terms of how the process of transformation should be done and goals should be set. Different leadership styles form different ways of processing resources and transforming them to outputs. For instance, in participatory leadership styles leaders often make the final decision in alignment

with other stakeholders, so the process of decision making tends to be slower. Nonetheless in visionary leadership styles, leaders rely on their charisma and personality to make the final decision, in this way decision making can be fast but the level of acceptance by other stakeholders is based on the level of trust in the leader (Ibid.).

3.3.3. OUTPUT

Output refers to the deliverables of Smart City policies for which goals are formulated and for which reason the input resources are made available. To characterize these resource-based domains, we again first define them, then indicate how and where they appear when they are applied in the Smart City, and finally sketch what their potential is.

3.3.3.1 SMART APPLICATIONS

Giffinger et al. (2007) focus on the Smart City as a smart transportation system. This is often a key element in smart mobility. However, in the present study I define it in a broader sense as the innovative mobility capabilities in order to achieve more flexible urban services and benefits. Mobility in fact increases the level of utilization of facilities and services, and accessibility to them. Juniper Research on the top Smart City performance by index (2017) indicates that mobility saves considerable time and benefits Smart City inhabitants by allowing more time for family and friends, decreasing the risk of depression, and improving earning potential (Juniper Research, 2017). It includes all aspects of smart traffic systems, such as dynamic traffic light phasing and smart parking to reduce time spent in traffic, and open data platforms enabling citizens to choose the fastest option. The results also show that mobility winners have their own smart solutions for urban transportation challenges alongside long-term policies for new paradigms like autonomous vehicles. Some of them, other than focusing on smart solutions, contain strong policies regarding car ownership and reducing the number of vehicles on the road. So, there are different approaches to smart mobility ranging from smart traffic solutions, smart public transportation, and smart private transportation to smart mobile services like shipping packages by drones.

An important feature of the Smart City which distinguishes it from other types of techno-driven future cities is having 'smart citizens' in place (Cardullo and Kitchin, 2019). In the present study I define 'smart citizens' as interactive and even proactive citizens who are able to produce, share, and benefit from information within the city to accelerate smart and sustainable solutions. One of the main strategies to achieve the goal of Smart City development is its strategic use of innovative ICT-based solutions to connect the citizens and technologies of the city on a common

platform. Borgia (2014) in an analytical survey states that what most authors have in common is the focus on ICT as an enabler and as an opportunity to empower human capital; education, aware-ness, and proficiency of citizens in the use of ICT. This smart empowerment then becomes a primary goal of cities that brand themselves as 'smart'. Therefore, Smart Cities, in addition to creating smart solutions based on technology, are required to facilitate the communication between modern technologies and citizens through training and engaging them in the Smart City development process through living labs, organizing related events and workshops, and building spaces for idea sharing among citizens.

As Gil-Garcia, Pardo, and Burke (2010) argue, the use of ICT infrastructure and the potential of bringing various information streams together is clearly affected by acts of governance and institutional structures. They support the emergence and persistence of stable and trusted social networks (players having confidence in each other and collaborating) and facilitate information-sharing and the building of a platform for smart governance. We make a distinction between 'governing a city to become smart' (throughput) which includes making policies and regulatory regimes for Smart City development, and 'smart government' (output) where basically the application of ICT is basically utilized to transform traditional government and increase efficiency, effectiveness, transparency, and accountability of governance structures and operations through advanced use of information. This also promotes open data to empower citizens by making information more publicly accessible.

Smart energy systems seek to reduce energy consumption through the application of novel technological innovations while promoting energy conservation and material reuse, and thus support the environmental aspect of sustainability. As a result of the other achievements of the Smart City (smart mobility), Jeekel (2016) argues that, in response to the question 'is smart mobility socially sustainable?' new mobility services are considered to have positive effects on sustainability.

High quality of life is one of the ultimate goals of all human advancement and not exclusive to the Smart City. Access to high-quality healthcare services (including e-health or remote healthcare monitoring), electronic health records management, home automation, smart home and smart building services, and easier access—via the internet— to social services of all kinds are evidence of Smart City commitments for a high quality of life. Also, the smart use of new technologies by networks of actors makes cities safer (Meijera and Thaens, 2018).

3.3.3.2 EXTERNALITIES

Multiple authors have argued that Smart City development is intertwined with two aspects of externality: sustainability and high quality of life (Yigitcanlar, 2015;

Mortensen and Jonsbak Rohde, 2012; Gemma, 2014; Zhao, 2011). For instance, Yigitcanlar's definition of the Smart City focuses on sustainably to become an increasingly better place to live, work, and play which essentially covers both aspects (Yigitcalar, 2015). Although the issue of sustainability was initially debated by economists, later it was later also picked up by scholars from different academic domains like industrial ecology. The Smart City is believed to go hand in hand with sustainability, as it looks committed to contribute to sustainable growth. However, the effects of Smart Cities can differ; amongst others they can have social, environmental, and economic impact. According to McKenzie (2004), 'social sustainability occurs when the formal and informal processes and structures support the capacity of current and future generations to create healthy, liveable communities' (McKenzie, 2004). This largely coincides with quality of life. For Giessler (2005) in the social domain of sustainability, a more environmentally friendly way of life should be supported by Smart Cities. When economic sustainability is pursued, development is seen as a form of qualitative rather than quantitative growth (Basiago, 1999). Here social, economic, and potentially environmental sustainability coincide with quality of life.

Finally, from an environmental perspective, the Smart City should be supportive of reaching ecological sustainability which promises a thriving physical environment as expressed in biodiversity or in minimizing the city's ecological footprint. Mobilized urban services and the smartness of citizens - the two indicators of safety and livability - stand primarily for quality of life. Nonetheless, depending on the context, policies, and attitudes, there are different interpretations of what quality of life entails, and how it shows overlap with social and economic sustainability.

3.4. Illustrative Case Study: Smart Dubai; The Happiest City

This section presents the illustration of an iconic example of a well-branded international Smart City and shows how different aspects of a Smart City development process can be understood as input, throughput and output, and outcome in the application of the IO-model presented previously in this chapter (See Table 3).

Different cities in the world that brand themselves as 'smart' differ remarkably in the things they do. The history of the Smart City in Dubai returns to e-government which has evolved into a smart government program and, then Smart City development. In 2014 Sheikh Mohammad the Ruler of Dubai set up an executive office for Smart City development that would respond to his innovative ideas: 'Smart Dubai, the happiest city' (interview with Alazzawi, 2018). This is in line with his vision on happiness and positivity which states that positivity is a way of thinking, and happiness is a lifestyle (Al Maktoum, 2017). Smart Dubai is part of a transformational

mind-set steered by the visionary leadership of the Emirates (interview with Ali Rashid, 2018). Nonetheless the happiness policy influences all of the Emirates (Dubai is part of the UAE) as an overarching policy, but the idea and its fundamental attitude were created for Smart Dubai.

Table 3- Applying the IO model to the Smart Dubai case.

Elements/facets of the IO model		Application in the Smart Dubai case
Resources (Input)	Modern ICT infrastructure	Dubai Pulse IoT platform
	Human and entrepreneurial infrastructure	Dubai Pulse PPP, 'Happiness champion' Free zones
	Data	Presence of a shared data platform Dubai Data Establishment
	Financial infrastructures	Governmental funding, foreign investment
Throughput	Dynamic capabilities	Dubai Smart City Accelerator Expo 2020 Smart (AI) Lab Sustainable financing
	Governance	Administrative levels: The Ruler of Dubai, Smart Dubai Office
	Leadership	'Visionary' leadership by the Ruler of Dubai
Output	Mobility	Dubai-Abu Dhabi hyperloop, EV
	Smart government and citizens	'Happiness champions' 'Happiness meter' DubaiNow App Paper-free government
	Smart energy and health	Shams Dubai E-health program
Outcome	Sustainability	Increasing social, health economic, and environmental performance indicators; but predominantly focused on improving energy efficiency levels.
	High quality of life	Happiness in terms of increased satisfaction on public service delivery in a variety of policy areas

In 2015 Dubai and the International Telecommunication Union (ITU) signed an agreement on Dubai becoming the first city using key performance indicators (KPIs)

to assess smartness and sustainability of its urban services. To provide IoT infrastructure, 'Dubai Pulse', which is the digital backbone powering the Smart City, was made responsible for developing an IoT platform.

For data assets, there is a project called 'Dubai Data Establishment' (DDE), which oversees the Dubai Data Law; it prescribes that all data the government generates belong to DDE which is a government entity that ensures the presence of a shared data platform (interview with Alazzawi, 2018). The Dubai Pulse official website shows that there are two different categories of Dubai data: (1) open data published by the government or the private sector to be used or exchanged with individuals; and (2) shared data published under certain terms and conditions among the entities. However, there is no information to clarify what type of data is shared or made openly available. To manage data, disseminate information efficiently, and to deliver public services for citizens, 'DubaiNow' is supposed to be a single comprehensive application established in 2015 to put all the services in one place. It enables users through a single sign to access various kinds of public services. By the time of writing the present paper, the application was still under development (interview Alazzawi, 2018).

The supporting policy for entrepreneurship is to deploy free zones for attracting businesses where foreign ownership is allowed and zero personal or corporate income taxes are charged. Smart Dubai also has specific policies in place to support start-ups, (Smart Dubai Office, 2018).

In terms of providing financial resources, the Dubai Smart City program is a government program mainly funded by the Dubai government. Yet, private-sector partners and start-ups have started a wave of sustainable and green fund-raising activities supported by the Dubai Declaration on Sustainable Finance. On the other hand, financing a clean-tech business is not always easy as Daniel Zywietz founder and CEO of 'Enerwhere' states (a solar company with its headquarter located in Dubai). Crowdfunding is one of the solutions his company offers to counter financing problems start-ups encounter.

Looking at Smart Dubai's main governing body, the initiator is the Ruler of Dubai. The Dubai Smart City Office is the central implementation body which serves as an independent initiative, and is responsible for the development and implementation of smart programs and solutions while cooperating with other governmental and private-sector entities like the Dubai municipality, Du (a major integrated telecommunications services provider in UAE), DEWA (Dubai Electricity and Water Authority) RTA, (Road and Transport Authority), Dubai Pulse, and many other organizations. DEWA was launched in 2014 and started three smart initiatives to sup-

port Dubai's smart transformation including Shams Dubai (which pertains to a project regarding photovoltaic solar panel installation on rooftops), smart meters and grids, and the Green Charger for the construction of infrastructure and electric vehicles. Dubai Smart City Accelerator is another initiative within the Dubai Smart City office which also has joined the Dubai Future Accelerators (DFA) program to support innovations and start-ups in IoT and connectivity, smart applications, and sustainable living. Expo 2020 is one of the most extensive Dubai's programs to foster innovation for a sustainable future by engaging young people and promoting international cooperation. Branding aspects play a crucial role in generating worldwide attention to such events in Dubai.

While the countries with the highest ranking in smart mobility—like Singapore—are mainly focused on reducing the number of vehicles and car ownership, the UAE—considering its cultural context to change consumer behavior—is more focused on smart solutions like electric vehicles (EVs) and increasing the share of electrical vehicles on the roads of Dubai. There is a target of reaching an overall 10 percent share of electrical vehicles for government entities, and a 10 percent share for all vehicles of Dubai by 2030 (interview with Ali Rashid, 2018). In addition, Sypron Solutions, an IoT company, and the first hyperloop company in the Middle East, is to develop a project that constructs a hyperloop infrastructure from Dubai to Abu Dhabi using smart mobility technology (ENGIN, 2018).

In terms of smart energy, DEWA is Smart Dubai's main partner. It launched Shams Dubai as an initiative responsible for making Dubai greener with the installation of solar panels. Green building regulation is a supportive strategy promoted by Dubai's Supreme Council of Energy to create healthy, eco-friendly, and efficient buildings using smart applications.

Dubai Health Authority (DHA) is a public department that pursues the use of smart applications to ensure all hospitals in the Emirate of Dubai eventually adopt the electronic model which will facilitate the provision of better healthcare services to the community (DHA official website, 2018). The six month roadmap of Dubai Smart Health (2018-2019) contains four smart applications: (1) patient services: for medication, appointments, and lab results, (2) Dammi: for blood donation, (3) Salem: for medical fitness; and (4) live media and News: for health awareness (interview with Almazami , 2018).

Another dimension in the applications within the realm of Smart Dubai (as a form of Dubai smart government) is the 'Government of the Future' which operates 24/7 and 365 days a year. It considers any governmental body successful if it actively engages the citizens and does not passively await them in providing government services (Dubai Smart Office, 2018). There also is a paperless strategy used by the Dubai government. Smart Dubai office has been instructed to oversee this policy and

seeks to attain its goals by 2021 and enable this through three pillars: technology, legislation, and creating a culture to support achieving sustainability goals (Dubai Smart Office, 2018).

Sustainability has evolved into a key value of the Dubai Smart City Initiative. There is also a sustainable city district in Dubai, deploying new technologies to achieve social, economic, and environmental outcomes (SEE NEXUS Institute, 2018). Awareness is a key means for realizing the energy efficiency policy and sustainability goals in Dubai. Karim El-Jisr, the executive director of Dubai Sustainable City, states, '*What we offer here is not just sustainability, we create a lifestyle. So, if you appreciate this lifestyle you will begin to appreciate sustainability*' (interview with El-Jisr and Rogman, 2018). In order to achieve high quality of life and having smart citizens, the dominant concept is still related to happiness. Obviously, Smart Dubai operationalizes quality of life in happiness indicators.

When it comes to smart citizens, there is a Smart Dubai 'Happiness champion' in order to communicate with citizens and stakeholders and to involve them in coordinating, strategizing, and implementing programs and projects in line with the Happiness system instead of using living labs. 'Happiness champions' are considered part of value creation that seeks to have a shared language and shared understanding and make the co-creation of policies possible (interview with Alazzawi, 2018). Alazzawi adds, '*The main method to evaluate Smart Dubai's performance is to measure and monitor using the 'happiness meter' which demonstrates (increased) happiness of Dubai's citizens in terms of quality of life and satisfaction about the interaction with government bodies' (i.e., appreciating public service delivery).*

3.5. Discussion and Conclusion

This chapter set out with the question how to develop an IO model to support decision-making for developing a Smart City based on a conceptual interpretation of its key facets. The bibliometric analysis showed that the 'Smart City' has increasingly become a focal point in urban policy and planning practices. Moreover, technological innovation has widened the scope of the Smart City. Although the literature is already replete with contributions about various aspects and dimensions of the Smart City, thus far no attempt was made to synergize aspects and dimensions of Smart Cities into a comprehensive conceptual model that can be applied as an IO model to clarify how particular types of inputs and throughputs result in a given output. Having developed such a model enables academics, analysts, and policy makers to comprehend how design choices with regard to the Smart City development and translate these into a particular Smart City types or profiles. The content analysis based on the academic literature in the present study helped me to map the

various attributes of the Smart City. The subsequent IO modelling exercise based on system theory allowed me to position the key facets of the Smart City as found in the literature survey within the framework of an Input-Throughput-Output model and demonstrate the variety of design choices available to policy-makers and analysts when developing a Smart City. Finally, I applied the IO model to an illustrative case to show how it can be used to analyze Smart City development.

The IO model explains what the essential input and throughput resources for Smart City initiatives are, where and how they appear in making design choices during the Smart City development process, and what possible outcomes of the process are. Komninoa and Mora (2018) explored structural axes of the Smart City literature generated by a bibliometric analysis as technology-driven vs. human-driven approach, top-down vs. bottom-up planning, and collective intelligence vs. data-driven intelligence dichotomy. The results of applying the IO model to the illustrative case of Smart Dubai shows a specific type of Smart City development process, which can arguably be characterized as mainly a top-down process supported by visionary leadership and active branding strategies and actions, a focus on promoting happiness. This is very specifically defined as customer satisfaction about government services and the involvement of a variety of financial and technological applications to enhance the range of domains affected by Smart Dubai.

A look at the input to Smart Dubai's development process shows that the technology transfer strategy and the deployment of new technology-based smart solutions are important resources. However, the importance of the startups and the promotion of innovation was not overlooked. Creating an economic environment to attract innovative companies and start-ups is a strategy Dubai has used to boost the innovative atmosphere and strengthen the development of its human resources. Among the through-puts, the main arm of potency for the Smart Dubai development process is its visionary leadership style that determines the overarching policy. This overarching policy is the 'happiness' policy. Although this sounds as a very positive vision, the challenge is obviously to define and operationalize this elusive concept making Smart Dubai truly inclusive under the umbrella of this policy, and include all citizens including the migrant labor force. Smart Dubai, through designing a 'happiness meter' aims at operationalizing and measuring the happiness policy, has narrowed its actual meaning down in particular ways that may seem odd to people outside the region, but its approach has been embraced in other UAE members and widely acclaimed in the broader Gulf Region. Data management as a dynamic throughput is another aspect of Dubai's Smart City focus. Documentation, laws, and guidelines related to data indicate that this issue is of interest in Smart Dubai. What Smart Dubai is looking for as the output of this process, is covering different fields of application ranging from a main focus on energy (which is a major challenge for

countries in the region) to smart government and citizens, mobility, and health. Following the energy efficiency and carbon footprint challenges, the environmental sustainability issue is highlighted in many Smart Dubai statements. But to what extent Smart Dubai can live up to that expectation, remains to be seen and should be assessed in the future.

This raises the question how the Smart Dubai experience compares to those in other Smart Cities, and what the application of the IO model would look like for them? It also raises the question what crucially different design choices other cities around the world make that seek to become Smart Cities? Other questions pertain to how do other cities perform in terms of outputs and outcomes? And what can they learn from Dubai and each other to enhance their respective performance? The following chapter can throw light at these questions, further detail the use of this model and help policymakers and analysts make well-reasoned design choices by taking the various components and facets of a Smart City into account when developing one.

Notes

[1] See for more details in the methodology section on occurrences per category in the article by De Jong et al. (2015, p. 3).

[2] However some discussions have addressed potential negatives associated with the Smart City (Wiig, 2017; Attoh, Wells, and Cullen, 2019; Barns, 2016).

[3] In-depth interviews were held (during 15th -25th May 2018) with 10 Smart City stakeholders including: the City Experience advisor, the executive manager, the ideologist of Smart Dubai Office, a professor from Zayed University, the executive director of Sustainable City in Dubai, the executive director and the program manager of TAQATI, the executive director of DEWA, The of Dubai Supreme Council of Energy, and the managing director of a magazine called The *Sustainabilist*.

4

CLASSIFYING PATHWAYS FOR SMART CITY DEVELOPMENT: COMPARING DESIGN, GOVERNANCE AND IMPLEMENTATION IN AMSTERDAM, BARCELONA, DUBAI, AND ABU DHABI

The contents of this chapter have been adapted from the following peer-reviewed article: Noori, N.; Hoppe, T.; de Jong, M. Classifying Pathways for Smart City Development: Comparing Design, Governance and Implementation in Amsterdam, Barcelona, Dubai, and Abu Dhabi. *Sustainability* 2020, 12, 4030.

4.1. INTRODUCTION

Studies on the concept of the 'Smart City' have become an essential aspect of urban and environmental studies (Caprotti, 2019; Meijer & Thaens, 2018; Noori et al., 2019; Yigitcanlar, Kamruzzaman, et al., 2019). Whilst some believe that this is likely to be transient in terms of branding as a result of evolution (Cowley & Caprotti, 2019), there is no unique definition for the Smart City yet (Caprotti, 2019). This might be related to 'smart' having a strong connotation to (technological, organizational, and social) innovation (Anthopoulos et al., 2015; Giffinger, Rudolf; Lu, 2015; Meijer & Thaens, 2018).

Looking at cities that profile themselves as smart, one can conclude that not only do they contribute a variety of meanings to the Smart City but also that they deploy vastly different approaches to becoming a Smart City. For instance, the comparative studies of Amsterdam, Ningbo, and Hamburg by Raven et al. (2019), and Glasgow, Bristol, Barcelona, and Bilbao by Calzada (2017) demonstrate how these Smart Cities vary in their institutional arrangements.

The present chapter taps into these findings and seeks to systematically explore what different approaches are used to establish Smart Cities and reveals commonalities and differences in the patterns of coming into existence and the principles for design and governance that are used. Looking at the recent dominant approach from a perspective of social innovation (Calzada & Cobo, 2015; Giffinger, Rudolf; Lu, 2015), I consider this necessary given the complexity of Smart City planning and development. Meijer et al. (2018) even call Smart City development a socio-technological system innovation process (Meijer & Thaens, 2018).

To reach the ambition level formulated above, first I developed a systematic, conceptual Input-Output model (IO model) in pervious chapter to shed light on different facets of Smart City development, classifying them into the inputs, throughputs, and outputs. The main idea addressed in the present chapter is to test key propositions from the IO model, in general, and more specifically, to systematically convey the design choices city planners and policy makers make in developing Smart Cities. In fact, the IO model does not propose a prescriptive procedure but rather the ideal type of a Smart City development process as a framework for thinking about, making sense of, and finding ways to improve aspects in the implementation of Smart City policies that are perceived as problematic. Weber's definition of an ideal type highlights that an ideal type is a conception derived from observable reality and constructed in a particular way. It is not exactly similar to the reality and not conforming to it in detail because of deliberate simplification, and it represents the simplified reality in its highest perfection because of deliberate exaggeration (Encyclopaedia Britannica, 2002).

In this chapter, four Smart City planning and development projects will be systematically studied and compared, i.e., Amsterdam, Barcelona, Dubai, and Masdar. Thus far, multiple studies have addressed these cases (also comparative studies), e.g., (Margarita Angelidou, 2016; Badran, 2019; Baron et al., 2012; Breslow, 2020; Calzada, 2017; Capra, 2016; Caprotti & Cowley, 2019; Confer & Madeira, 2014; Cowley et al., 2018; Gascó et al., 2016; Griffiths & Sovacool, 2020; Mancebo, 2019; Mora et al., 2019; Mora L., 2017; Niederer & Priester, 2016; Raven et al., 2019; Tok et al., 2015; van Winden & van den Buuse, 2017; Virtudes et al., 2017; Yigitcanlar, Han, et al., 2019), but none of them focuses on design choices made, or reveals and classifies developmental pathways. The Smart City planning and development projects this study seeks to analyze pertain to two different geographical regions in the world (Europe and the Middle East), where it is expected that different institutions and different attitudes exist, each of them influencing the style of policy making and Smart City planning. Other relevant factors pertain to differences in cultural background and political system (De Jong et al., 2019).

Consequently, this chapter seeks to compare these Smart City cases on the basis of the goals, policies, procedures, and resources used in their Smart City development process. A comparison across cities seen from this angle has not been made yet in other studies. Whereas several studies were conducted to compare Smart City practices (Caprotti & Cowley, 2019; Cowley et al., 2018; Joss et al., 2019; Raven et al., 2019), the innovation in this contribution is the focus on design choices made, and revealing and classifying developmental pathways. Therefore, the main research question in the present study is: When comparing selected Smart City projects, how can pathways for their implementation be classified?

The chapter is structured as follows. The next section introduces the key design variables of the IO model classified under inputs, throughputs, and output variables. Section 3 specifies the research design and methodology. Section 4 presents the four Smart City cases. Section 5 provides the results of the comparative analysis of the four cases. Section 6 then discusses the results and presents a classification of Smart City development pathways. Finally, in Section 7, the conclusions and recommendations are presented.

4.2. Research Background

4.2.1. Design Choices for the Resources of Smart City Development

An overview of different rankings for the Smart Cities around the world (Bay, 2018; Berrone & Ricart, 2018; Eden Strategy Institute, 2018; Juniper Research, 2017)

that considers different criteria provides evidence for the existence of different approaches to Smart City development. Whereas Smart City development policy can be considered as a dominant approach in urban policy formulation, the challenging part of this dominant approach is in design and implementation. This section expands the IO model to a framework for Smart City design variables. As mentioned in chapter 3, the IO model was constructed based on systems theory. General System Theory is aimed at developing a language in which the problems of many disciplines can be expressed and shared (Checkland & Haynes, 1994). In this sense, system theory can be applied to many different fields and in many ways. Checkland and Haynes (1994) classified these varieties. Based on their classification IO model uses systems theory for 'problem solving in a real-world situation'. This problem-solving category used as decision-making support is divided into 'hard' systems and 'soft' systems sub-varieties. Since the goal is to model a human activity system (Smart City development process), it can be located within the realm of the (largely qualitative) soft systems approach. One could also claim that David Easton's famous portrayal of political systems (1957) was conceptual IO modeling ante datum (Easton, 1957).

There are still other IO models in existence for the analysis of Smart Cities, as, for instance, the one developed by Yigitcanlar (2018). His model stresses the interconnection between 'assets' as the inputs or resources of a city, 'drivers' as processes or opportunities for the Smart City formation, and 'outcomes' as the results that transform a city into a Smart City (Yigitcanlar, Kamruzzaman, et al., 2019). The special feature of the IO model is that it sheds light on those facets of the Smart City development process where intervention becomes possible through design variables.

In optimization theory, design variables are defined as the entities that can change the shape or properties of the model within a specified set of choices (Terlaky & Curtis, 2012; Arora, 2004). An overview of relevant indicators for the design variables as they can be found in academic and grey literature was conducted. In order to specify the Smart City design choices, first the determinant variables of each of these key facets need to be identified and defined. For human facet as design choices, Nam and Pardo (2011) highlight social learning, creativity, and education (which simply means becoming knowledgeable). Social learning concerns creativity for smart solutions and education to develop IT skills and knowledge-based human resources (Nam & Pardo, 2011; Appio et al., 2018; Borri et al., 2011).

Another source of knowledge is data flows and information sharing (Negre et al., 2015; Gil-Garcia et al., 2019). Data assets are becoming increasingly important because of the emergence of the Internet of Things (IoT) (Appio et al., 2018). The primary goal of the IoT is to connect to the 'things' to aggregate data (Abbate et al., 2019), then to process data, and finally to analyze the aggregated data and provide

services, applications, and information (for decision-making). The real-time analysis of city life can be used to model it, to predict and simulate urban processes, and/or to monitor, regulate and manage cities (Kitchin, 2014) for better delivery of utility services to citizens (Meijer,& Bolívar, 2016; Fistola & La Rocca, 2013).

For a high-tech driven urban development, financial requirements have a pivotal role in determining roadmaps. Collaboration between the public and private sectors for investment in smart urban development projects is always supported as a desirable fiscal mechanism (Pattberg & Widerberg, 2018). In practice, this collaboration is complicated due to different interests and attitudes stakeholders have vis-à-vis return on investment. Whereas private sector actors invest in urban commercial projects with a decent fiscal return, public sector actors focus on social improvements such as happiness, prosperity, and safety (Huston et al., 2015). Public sector funding can be allocated by different governmental bodies, located in different levels of government, for instance, via municipal outlay, via national investment or supra-national budgets such as European (EU) funding (e.g., via EU framework programs like Horizon 2020, FP7, or Interreg) (Engelbert et al., 2019).

4.2.2. Design Choices for the Throughputs

Under the throughput category, three levels are discerned: leadership, governance, and management.

Government roles in Smart City governance pertain to 'initiator' (Alkandari et al., 2019), 'facilitator' (Winters, 2011), 'regulator', or 'funder' (Gil-Garcia et al., 2015). Considering how the government interacts with other actors, there are different modes of governing Smart Cities, such as technocratic governance, citizen-centric governance, socio-technical governance, or hierarchical governance (Zygiaris, 2013). In order to determine governance structures, there is a need to specify the roles of the government, the decision-making process of formulating Smart City policies, the actors who are involved, and means for engaging actors (Dameri & Benevolo, 2016; Meijer & Bolívar, 2016).

Knowledge and innovation management as a dynamic throughput refers to the ways of adding value to the city by tangible and intangible sources of knowledge (Polanyi, 1967; Fernandez-Anez et al., 2017). Fostering and managing innovation towards propelling Smart Cities may involve establishing innovation centers and living labs, and 'champions' available to share promising innovative ideas.

Big data management aims to ensure the quality of data and transform data into knowledge (Watts et al., 2009) and to prevent the misuse of data. Issues like data theft, data ownership, data accessibility, and privacy issues call for proper management (Dijkers, 2019; Chierici et al., 2019).

Meijer and Bolivar (2016) argue that a Smart City requires a focus on both economic gains and other public values. Financial management as a dynamic throughput is about increasing public and private fiscal viability to provide funding for Smart City projects (Huston et al., 2015). In terms of public funding, as Floater et al. (2014) argue, existing funding should be redirected away from inadequate and inefficient urban infrastructure development. In terms of private finance, the main issue is to provide a strong public–private alliance for raising private funds (Huston et al., 2015). The former needs alignment of all the urban infrastructure development with Smart City policies, whilst the latter requires a sound understanding of the complexity that goes along with public–private collaboration.

Leadership explicitly addresses the offices that lead the public administration of a Smart City (e.g., mayor, ruler of the city, Smart City office, city council, CTO (Chief Technology Officer of the city)). Leadership capabilities strongly depend on the leadership style of whoever is leading the Smart City program. Switching to another type of leadership may change the shape or properties of the Smart City. The ways leadership creates a vision, motivates and empowers people, collaborates with stakeholders and influences them are the indicators that determine leadership style (Samosudova, 2017).

4.2.3. Design Choices for the Applications of Smart City Development

The IO model presents the application domains for mobility, energy, health, governance, and citizens. Orlowskia and Romanowska (2019) developed an indicator to measure smart mobility. It contains four dimensions: (i) technical infrastructure, (ii) information infrastructure, (iii) mobility methods and vehicles used for this purpose, and (iv) legislation (Orlowski & Romanowska, 2019).

Walnuma et al. (2019) define 'smart energy' as the goal of achieving energy systems that are highly energy-efficient, increasingly powered by renewable and local energy sources enabled by new technologies, and less dependent on fossil fuels (Walnum et al., 2019). This vision of smart energy has spurred the development of new approaches to future sustainable energy systems such as smart grids, green buildings, smart meters, and solar photovoltaic panels (Lund et al., 2017; Koutitas, 2018).

Another domain to become smart in cities is healthcare. Here, 'smart healthcare' pertains to affordable and quality patient-centred health services enabled by healthcare technologies (e.g., ICT supported, smart sensors, devices, and systems) along with big data analytics (Hossain et al., 2017).

Taking advantage of these smart applications and solutions requires citizens to share data (Bayar, 2017). From a participation perspective, it is one-way communication between citizens and the Smart City. In need of innovation, Smart Cities strive

to reach higher levels of citizen participation for sharing ideas (Appio et al., 2019). Doody (2013) states that smart citizens need smart governance (Doody, 2013). Smart governance then refers to the use data and ICT to produce effective, responsive, and transparent modes of governance (Goldsmith & Crawford, 2014). Wilke (2007, p. 165) argues that smart governance needs the 'redesigning' of formal democratic governance structures. Main areas of smart governance pertain to smart administration, smart interaction with stakeholders, smart security and safety, and smart infrastructures (Scholl & Scholl, 2014).

4.3. Research Design and Methodology

In this research, I used a cross-case research design to which I applied the analytical framework (IO model) presented in the previous chapter. The cross-case comparison of the specific cases was made in four steps. First, applying systems theory (and more specifically, the soft system variety) in order to tackle the research problem (implementation of Smart City development policy), I used the Input-throughput-Output model to map the facets and relevant purposeful activities that I named Smart City design variables. Then we applied the design variables framework (Table 1) to the different cases as a tool to describe their design choices in the real world. The third step was to scale their design choices in order to verify their common and unique choices. The next step was to analyze the design choice. For this purpose, I adopted the qualitative techniques of pattern matching and explanation building to generate descriptive analyses of the cases (Yigitcanlar, Kamruzzaman, et al., 2019). In this regard, pattern matching refers to scanning for similarities, dissimilarities, and patterns pertaining to design variables that influence Smart City development pathways. This helped me realize the main goal, which is to classify different Smart City pathways and generate insight regarding promising policy actions and interventions.

Table 1 provides an overview of Smart City design variables based on the IO model presented in chapter 3 with available indicators for each of the facets mentioned.

Table1- The design variables and indicators of the Smart City development process.

	Smart City Attributes	Design Variables	Indicators (Presence of)
Inputs	HR and Entrepreneurship	Educating and training people	Supporting and strengthening universities and research centres (HR1)
		Transferring (attracting) educated and skilled people	Launching knowledge transfer projects (e.g., scholarships, sabbaticals) (HR2)
		Nurturing the innovation environment	Specific policy in place to promote innovation (HR3)
		Attracting innovative companies	Supporting and encouraging programs for innovative companies (Science and technology parks, free zones) (HR4)
	Information and Communication Technology (ICT) and Data	Data aggregation	Big data establishment (D1)
		Data processing	Data science centres (D2)
		Data real-time analysis	Data visualization (D3)
	Financial resources	Supra-national and national investment	Supra-national and national Smart City development policy and budget (F1)
		Local government investment	Smart City profile and allocated budget (F2)
		Public–private investment	Collaboration with the private sector (F3)
		Foreign investment	International brand and investors
Throughputs	Governance	Governance structures; technocratic, citizen-centric, socio-technical, hierarchical, surveillance	Role of the government and decision-making process (G1)
			Actors are involved and engaged (G2)
	Knowledge and Innovation management	Open innovation	Living Labs, idea-sharing champions (KI1)
		In-house R&D	Innovation Centres, Smart City R&D department (KI2)
	Data management	Establishing a data authorization	Data Laws (DM1)
		Open/closed/ or shared data platform	Data accessibility (DM2)
	Financial management	Redirecting funds away from inadequate, inefficient urban infrastructure development	Alignment of the urban master plan with Smart City policies (FM1)

		Raising private funds	Having a collaboration platform (FM2)
	Leadership	Leadership styles	Vision creation and the bigger image (L1) Motivating and empowering people (L2) Collaborating with people and influencing them (L3)
Outputs	Smart Mobility	Smart transportation infrastructures	Smart (sensor and actuator equipped) roads and traffic lights, smart parking, bicycle routes (SM1)
		Smart public transportation	Interconnected public transportation, smart vehicles, information application (SM2)
		Smart private transportation	EVs (Electric Vehicles), autonomous driving, car-sharing (SM3)
	Smart energy	Renewable energy	Stationary energy use to be supplied from renewable energy sources (SE1)
		Energy-efficient buildings	Building regulations, energy certificates (SE2)
		New technology for utilities	Smart grids, smart meters (SE3)
	Smart health	Smart health monitoring systems	Remote health monitoring, mobile health monitoring, or wearable health monitoring (SH1)
		Smart health management and information applications	Mobile applications for medication information, weight management, information regarding hospitals and clinics (SH2)
	Smart citizens	One-way communication	A participation platform for data sharing (SC1)
		Two-way communication	A participation platform for idea sharing (SC2)
		Co-creating and co-designing	A participation platform for cooperative policies (SC3)
	Smart governance	Smart administration	Redesigning norms based on smart solutions (technologies) (SG1)
		Smart interaction	Participation and collaboration via social media and social networking (SG2)
		Smart security and safety	Using smart devices and data analytics for surveillance (SG3)

	Smart policies	Using big data analytics for decision-making (SG4)

4.3.1. Case Selection

The present study used a small-N comparative analysis research approach. Small-N case comparisons, also known as 'case-oriented comparative methods' (Ragin, 1987, pp. 34–52), are systematic comparative illustrations for insight-generating and in-depth studies of cases as a whole (Lor, 2019).

Four cases were compared: Amsterdam Smart City, Barcelona Smart City, Smart Dubai, and Masdar City. All four were well-known, did well on international rankings (e.g., the Global Smart City ranking issued by Juniper Research in 2016; the Smart City Index issued by Ernst and Young, in 2017; the global Smart City Discourse Network issued by Joss et al. in 2017). These four may not necessarily have been known as the four 'best practices' globally, but they were known for having very different governance styles and Smart City discourses and showing various types of Smart City applications in place, and were therefore intriguing to compare. Joss et al. (2019) presented a list of 27 cities based on a systematic webometric investigation of the Smart City global discourse network (Joss et al., 2019). Their study showed that Barcelona and Amsterdam are seen as pioneers (third and fourth place after London and Singapore). These two cities are located in Europe, having democratically governed cities. In contrast, Dubai and Masdar City are located in the Middle East and are governed by sheikhs. Masdar City in Abu Dhabi and Dubai are well-branded Smart Cities in the world (Yigitcanlar, 2019; Abdulla, 2019).

4.3.2. Data Collection

Data were collected between 2017 and 2019 by means of site visits and fieldwork in all four cases, participatory observation in Smart City workshops and meetings, including the Barcelona Smart City World Congress 2018 and 2019 editions, and the Amsterdam Smart City Open House meetings in 2017 and 2019. Data collection also involved in-depth interviews with 32 stakeholders who were involved in Smart City project development[1]. Finally, much information was collected from official documents and websites.

4.3.3. Data Analysis and Operationalization

The cases were compared by descriptions of the current situations and their design choices, using the operationalized indicators (See Table 2). In order to derive a classification of Smart City development pathways, I used a multi-method approach to identify patterns in the data that would provide more insight into the pathways, enable us to discern between them, and develop a classification. First, I analysed the case narratives for the four different cases and reflected on key events occurring that spurred smart policy development and implementation. Because this was a complex task with rich data available for each case, I decided to treat these mostly qualitative data in a way to make them apt for structured analysis. Toward that end, (qualitative) scores were assigned for each case using a four-point scale ranging from '0' for absence, '+' for having a plan without implementation, and '++' for a plan that has begun, to '+++' for implementation completed because ordinal scales were used. For the throughput indicators, which used a nominal scale, I tried to label the design choices and then compare them. In addition, the cases were compared through the interpretation of the commonalities, differences, and the patterns these revealed.

Table 2-The input and output indicators.

Indicators	Absence (0)	Plan without Implementation (+)	Plan has Begun (++)	Implementation Completed (+++)
HR1				
HR2				
HR3				
.				
.				
Etc.				

This led me to measure the data and to create a data matrix that included these data for each city measured against all indicators as presented in Table 1. I used this table to analyse development more structurally, using two approaches. First, I conducted an explorative statistical analysis focusing on bivariate correlations, focusing foremost on assumed relations between input and output indicators (See Appendix, Table A1). This would inform me about potential covariation but would offer too little evidence to confirm any causal relationship. This led me to seek confirmation using the rich qualitative data of the four cases, break them down into items pertaining to input, throughput, and output of the cases, fill them out with qualitative information, and interpret and attach meaning to how the development pathways played out for each of the four cases (See Supplementary Material). This also included a comparison of commonalities and differences between the four cases.

Based on triangulation between the three types of data analysis used—i.e., (i) interpretation of the four case narratives, (ii) statistical analysis, and (iii) qualitative comparative analysis of the qualitative comparative data matrix—we conceived development pathways for Smart City project implementation of the four cases and created insights on key commonalities and differences between them. Having more information available on case study storylines, narratives, and information on input, throughput, and output, I was able to interpret and further understand the case studies at a higher level of abstraction, which made it possible to discern key values used by policy makers that support key decisions and the ways they play out in the development pathways used in the four cases. Finally, following the next step of interpretation of the four cases, I discerned fundamental values as drivers and classification of development pathways to emerge from the data.

4.4. A Brief Description of the Cases

This section presents the four cases and show how each of them can be understood in terms of the concepts of the IO model. The origin of the Smart City concept in the four cases is also explored.

4.4.1. Masdar City

In 2006, the Masdar City project was launched in order to develop the world's most sustainable eco-city with the vision of making Abu Dhabi a reference for knowledge and collaboration on the advancement of renewable energy, clean technologies, and sustainable development (Griffiths & Sovacool, 2020; Yigitcanlar et al., 2019; Cugurullo, 2013). The mission of the project was not only to address the sustainability challenges of the United Arab Emirates (UAE) but also to develop commercially viable solutions in renewable energy and sustainable real estate. However, after more than ten years, the number of residents is around 1300 (McArdle, 2018), whilst it was initially planned to house 40,000 permanent residents with an additional 50,000 commuting to work and study in Masdar City (Abdulla, 2019). With the emergence of Smart Cities as a trendy competitive urban policy, it was transformed from an eco-centered project into a Smart City project. The Smart City project was then based on four pillars: (i) research and academics; (ii) sustainable real estate; (iii) clean energy deployment; and (iv) clean-tech innovation. Since Masdar City entails the construction of an entirely new city, it can be seen as a living lab for developing and testing new technologies to evaluate how they can integrate into the unified platform for developing a Smart City (Solomon, 2017).

4.4.2. Amsterdam Smart City

Two years later, in Amsterdam, the Amsterdam Smart City program set out with the primary goal of reducing CO2 emissions (Zygiaris, 2013). The program was started with the focus on smart energy and smart grids by the City of Amsterdam and Alliander through a three-year project funded by the EU (Mora, 2017). When the project was finalized a discussion started on how the program could continue and stand on its own feet. This was followed by the Amsterdam Economic Board, which decided to take over the program as the coordinator and to govern and fund it, using a collaborative platform. The first driver for moving toward implementing a Smart City policy was based on the results of climate change discussions (Mora, 2017). More recently, the scope of the Smart City was broadened to include areas that can improve the quality of life of citizens (Baron et al., 2012; Vermast, 2019). Amsterdam also developed a circular economy and sustainable structural vision that sketches an image of Amsterdam as a future-proof, innovative, data (evidence) driven, and collaborative city by 2040.

4.4.3. Barcelona Digital (Smart) City

In 2011, Barcelona also launched a Smart City policy of its own aligned with the European Union's strategy to create a more sustainable, smart, and inclusive path for development. Following that, a national plan for Smart Cities was launched in Spain called the 'Digital Agenda for Spain', which allocated EUR 170 million for actions related to city objectives, 5G technology, interoperable virtual labs, smart tourism, public services platforms, and rural territory. Currently, Barcelona's approach to becoming a Smart City derives from the digital city. Its profile pertains to 'Barcelona Digital City: the right to the (smart) city'. The Mayor of Barcelona Colau (2018) states, 'Our goal is to exploit digitization and achieve a city that is more open, fair, circular and democratic by putting technology at the service of people' (Colau, 2018). In this sense, Barcelona's Smart City foundation is based on digital transformation, digital innovation, and citizen empowerment.

4.4.4. Smart Dubai

For Dubai, the Smart City journey developed from the concept of smart government. In 2014, an executive office for the Smart Dubai program was established to expand the concept to different areas based on the vision of the Ruler of Dubai [1,49]. The vision was to make Dubai the happiest city on the earth (Al-Azzawi, 2019). This is pursued by using smart technology innovation as one of the main tools

contributing to creating happiness. Next to spurring technological innovation, a cornerstone of the approach of the Smart Dubai strategy pertains to having all city stakeholders on board (Smart Dubai Officie, 2018).

4.5. RESULTS

4.5.1. DESIGN INPUT CHOICES

4.5.1.1 MASDAR

To provide the human and entrepreneurship resource for the Masdar City development, Abu Dhabi's main funding project in research and education development is allocated to the Masdar Institute of Science and Technology (MIST), which is located within Masdar City. MIST, in collaboration with the Massachusetts Institute of Technology, aims to foster energy and sustainability innovations. In 2017, it merged with Khalifa University (interview, 2018). When it comes to innovation policy, Abu Dhabi follows the national strategy for advanced innovation (2018), which targets the establishment of an innovation platform and led to initiation of the 'UAE Innovation Month' festival. In order to attract innovative companies, Abu Dhabi established a policy for developing several free zones at a large scale per unit around Masdar and provided companies with high-profile locations inside Masdar City (De jong et al., 2019; Cugurullo, 2013). In terms of data and ICT infrastructure assets, the Mubadala Company made substantial investments in building ICT infrastructures. Mubadala, which is a regional government investment company, is responsible for funding and provisioning infrastructure by either its institutions or outsourcing. It also founded Khazna Data Centers (in Masdar City and Meydan Dubai) to deliver a combined 18+ MegaWatt (MW) of IT load in 2012. Therefore, Masdar City is majority-owned by the Mubadala Investment Company, which belongs to the Abu Dhabi Government in collaboration with the International Renewable Energy Agency (IRENA). The Mubadala Company announced that $20 million would be allocated to the Masdar project, but after spending a few million, the remaining budget was invested in other projects, mostly international projects.

4.5.1.2 AMSTERDAM

To make the potential human capital available for Amsterdam Smart City, the Smart City Academy and Amsterdam Institute for Advanced Metropolitan Solutions (AMS) were established as the knowledge-sharing programs for Smart City development, aiming to support knowledge and build a human infrastructure (interview, 2019). Amsterdam has a specific policy in place to promote innovation in

coordination with national and European policies, such as Innovation Union, Horizon 2020, and the Digital Agenda (Policy framework: European Strategy for Amsterdam, 2019). To support start-ups and emerging tech companies, Amsterdam Science Park and the startup village inside it offer an ecosystem for innovation. Moreover, in 2015, the City of Amsterdam initiated a public–private action program called 'Startup Amsterdam'. It aims to assist startups and innovative companies so they can accelerate their growth sustainably (Iamsterdam, 2019). Apart from the benefits of an established start-up hub, a talented workforce, and the spirit of innovation, Amsterdam offers skilled workers at start-ups and innovative companies a 30% personal income tax advantage (Iamsterdam, 2019).

Amsterdam has the second-largest Internet exchange point in the world and is considered the second top city in the world in terms of technology readiness (PWC, 2014). As such, it benefits from modern technology infrastructures to make the city smarter. There is a single portal for the data in Amsterdam ('City Data') established by the City of Amsterdam in 2015. City Data uses big data collections and tries to share as much data as possible, which is open to anyone who wants to use the data. This includes the collected data from eight policy domains: traffic and infrastructure, tourism, geography, population, public space and green, urban development, welfare, and energy. At the time of writing this article, the portal was under development. In terms of making the financial resources available, Amsterdam Smart City initially used EU framework project funding (i.e., Horizon2020) (Söderström et al., 2014). Later on, Amsterdam Smart City (ASC) established a public–private partnership portal to provide a favorable platform for collecting co-funding from the private sector (interview, 2018).

4.5.1.3 BARCELONA

For human resource development in Barcelona Smart City, the Institute for Advanced Architecture of Catalonia (IAAC) is one of the main research centers in collaboration with the city council of Barcelona. One of its departments, the so-called 'Fab lab', is currently developing projects in smart devices for data collection among citizens in collaboration with the Smart City Expo and World Congress in Barcelona. Barcelona's innovation policy is mainly based on the real open innovation approach (Gascó et al., 2016). It prefers to have open innovation centers for anyone to contribute rather than doing mere researches inside the universities. That is why the city council's cooperation with research centers and universities is generally carried out through the research labs (interview, 2018). The director of Barcelona's Smart City Program stressed that the strength of Barcelona's Smart City strategy relies on its cyclic and cross-cutting innovation model (Ferrer, 2017). Apart from fostering innovation in a collective collaborative way, the city council of Barcelona pays special

attention to promoting entrepreneurship (interview, 2018). This process is supported by Barcelona Activa, which is a local development agency belonging to the Barcelona City Council encouraging entrepreneurship and offering support to companies and startups (interview, 2018).

The Barcelona City Council established the municipal data office for public data sovereignty. Currently, it is promoting three projects: CityOS, Open Data Bcn, and Monitoring Gentrification, to aggregate data from the various sensors distributed throughout the city and numerous sources. CityOS is an advanced data analysis platform that offers comprehensive and transversal connectivity to serve citizens and the city. The platform is based on the main idea of using data to enable the foresight and the ability to predict situations in order to make better decisions and reactions. It is an open-code IoT platform that everybody can download and develop or modify.

In both Amsterdam and Barcelona Smart City initiatives are linked to projects that use EU framework funding (i.e., Horizon 2020). Apart from that, Barcelona City Council is the responsible entity for the majority of funding (interview, 2018). In terms of foreign investment, according to the Global Cities Investment Monitor 2019, Barcelona is the seventh most popular global destination attracting international investments (KPMG, 2013).

4.5.1.4 DUBAI

The most significant supporting programs for universities and research centers are focused on three districts: Dubai International Academic City (DIAC), Dubai Knowledge Village, and Dubai Internet City. DIAC lists middle-of-the-road colleges, schools, and universities from around the world (De Jong et al., 2019) established by TECOM Group (a governmental entity) as a free zone dedicated to higher education and the pursuit of intellectual growth. Apart from Dubai's main higher education project in DIAC, major training programs to develop human resources target civil servants (Smart Dubai Officie, 2019).

However, skilled and educated workers have always been welcomed to work in Dubai, and there is momentum in the Emirates to increase the number of highly skilled and educated local workforces' so-called 'Emiratization' (Ministry of Cabinet Affairs and the Future, 2014). According to the Ministry of Education's Strategic Plan for 2017–2021, Dubai's innovation policy was formulated to establish a culture of innovation in the institutional and working environment. To encourage start-ups and innovative companies to come, Dubai's government established a significant number of high-tech free zones and science parks. In parallel, the Smart Dubai startup initiative was launched, having three programs in place to support emerging technologies and entrepreneurs. These are: (i) the Global Blockchain Challenge; (ii)

the Dubai Smart City Accelerator; and (iii) the Dubai Future Accelerators. In terms of ICT infrastructure assets, The Network Society Index indicates that Dubai is 26th in performance in sustainable urban development and ICT maturity (interview, 2018).

For data assets as an essential resource for the Smart City, Dubai Data Establishment is the governing body with authority to push this strategy whilst seeking to implement the roadmap for Dubai Data (interview, 2018). In order to process and utilize data, 'Dubai Pulse' is the central platform that provides and computes, stores, and analyses services for the categorical use of various entities (interview, 2018). Currently, Smart Dubai office serves the analytical data as a single mobile application, 'Dubai Now', which helps citizens to manage bills, track their visas, renew the trade licenses, register cars, plan journeys by public transportations, and monitor health (interview, 2018).

In both Dubai and Abu Dhabi, the Smart City program is considered to be part of the National Happiness policy (interview, 2019). Therefore, the Smart Dubai initiative is established and funded by the ruler of Dubai. However, enjoying a positive global image, Dubai has ample ability to attract foreign investment. An overview of how the four Smart Cities perform against Smart City resources is presented in Table 3, which is constructed based on the scaling method defined in the data operationalization section (Table 2).

Table 3-Smart City development in Amsterdam, Barcelona, Dubai, and Masdar.

Design Choices/Cases	Amsterdam	Barcelona	Dubai	Masdar
Educating and training people	+++	+++	++	+
Transferring (attracting) educated and skilled people	+++	+++	++	+
Nurturing the innovation environment	+++	+++	+	+
Attracting innovative companies	+++	+++	+++	++
Data aggregation	++	++	+++	+++
Data processing	++	++	++	++
Data real-time analysis	+	++	++	++
Supra-national and national investment	+++	+++	++	++
Local government investment	++	++	+++	+++
Public–private investment	+++	++	++	++
Foreign investment	++	+++	+++	+

4.5.2. Design Throughput Choices

4.5.2.1 Masdar

The governance structure of Masdar is mainly based on a holistic approach to developing renewable energy and sustainability by creating a value chain from research to investment. Dubai and Masdar City share common governance features, such as the monarchical rule and central authority, that make their decision-making process fast and flexible; the idea is initiated by the rulers, policies are formulated and then adopted by citizens with high levels of trust. However, Abu Dhabi, having abundant financial wealth because of its oil and gas resources, is much stronger than Dubai. With a global approach, Masdar City launched the 'sustainability week' as a platform for accelerating the world's sustainable development. It brings together policy makers, industry specialists, technology pioneers, and the young generation of citizens for sharing knowledge, implementing strategies, and delivering solutions for the world's sustainable development (Masdar City, 2018). In terms of the Smart City in-house R&D, Masdar recently established the Honeywell Masdar Innovation Center of cutting-edge solutions for smart applications.

4.5.2.2 AMSTERDAM

Situated in a totally different political and government system from the Emirates, in the case of Amsterdam the ASC platform is an innovative platform for connecting ideas and challenges between municipalities, partners, and companies to accelerate doing/learning in order to strengthen smart solutions, market development, business models and replication (Baron et al., 2012; Dameri, 2014). In 2011, the municipality of Amsterdam governed ASC with more than 70 public and private partners (Mora, 2017). Within the ASC platform, the city administration has different roles apart from being the initiator, to a facilitator and from financer to customer (van Windenet al., 2016). At present, the dominant approach to managing innovation within the Smart City is to develop and test smart urban solutions in a real-life context (urban living labs) (Zygiaris, 2013). For ASC, the living labs are mapped in the middle of the stakeholder's collaboration (Figure 1).

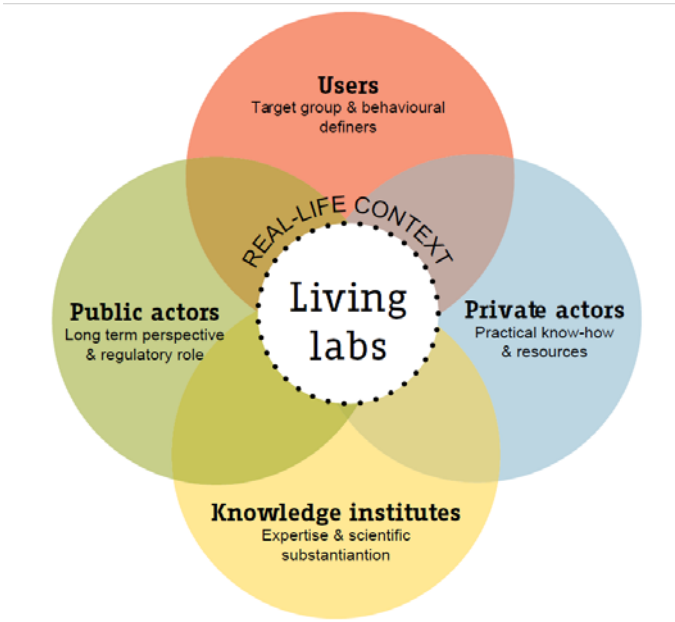


Figure1- Overview of the stakeholders involved in the Amsterdam Smart City (ASC) living lab (Steen & Van Bueren, 2017).

The Amsterdam Institute for Advanced Metropolitan Solutions (AMS) is responsible for ASC living labs working on six different themes: i.e., circularity, food, resilience, energy, mobility, and data. In addition, ASC uses open-house programs and open meet-ups for communicating and empowering citizens (interview, 2019). Within the Smart City context, knowledge and innovation management is closely connected to data management driving innovative solutions. For data-related decision-making, the IO model focuses on two crucial aspects: data laws and data accessibility (interview, 2019). Amsterdam and Barcelona are part of the European Union's DECODE project aiming to return data sovereignty to the citizens. Currently, four DECODE pilots are running in Amsterdam and Barcelona to test the technology and approach. Amsterdam City Data is openly accessible through the Internet, and data that are public can be freely used by anyone. However, some of the data are available for authorized city employees only (interview, 2019).

4.5.2.3 BARCELONA

To govern Barcelona Smart City, following the formulated smart policy in 2011, Barcelona City Council launched the project 'Barcelona Smart City Strategy, Planning and Implementation' in collaboration with DOXA. DOXA is a consulting company that assisted and coordinated Barcelona's Smart City strategy by supporting planning, execution, and monitoring actions. In 2015, the project outcomes pertained to the smart strategy development and implementation, the definition of a governance model (See Figure 3), storytelling and communication framework (Ferrer, 2017). The main governmental entities of Barcelona Smart City are the City Council, the Barcelona Provincial Council, and Area Metropolitana de Barcelona (AMB) (interview, 2018).

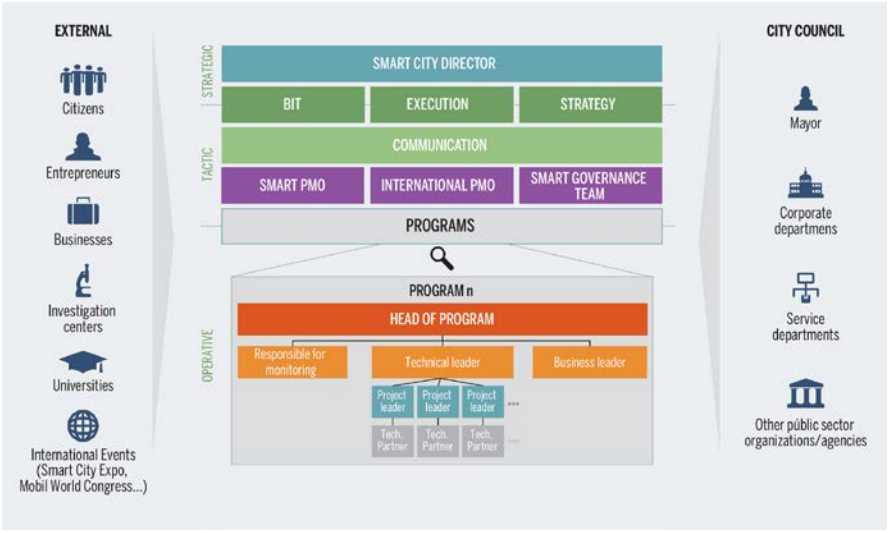


Figure 2-The Barcelona Smart City governance model (Ferrer, 2017).

One of the key points of Barcelona Smart City programs at the early stage was the development of a community of citizens and developers, and installations for Small to Medium Enterprises' (SMEs) experimentation with the Living Labs. Barcelona's 22@ innovation district was initiated by the City Council in need of an urban renovation strategy for the transformation of the industrial area to the knowledge economy area (Zygiaris, 2013). It brings universities, research centers, start-ups, and emerging tech companies together to create synergies and foster innovation (interview, 2018). The whole district operates as an urban lab that offers opportunities for

technology companies to move to the district, run pilot programs, and test new technologies (Ajuntament de Barcelona, 2012). There is a European Union (EU) General Data Protection Regulation (GDPR) for European city authorities in digital ethics and rights concerning citizens' empowerment (Calzada, 2018). Barcelona's Digital Plan 2017–2020 is the main agenda for data policies and strategies aligned with GDPR (Calzada, 2018). According to Calzada (2018), the three strategic initiatives regarding data protection and regulation are: 'Data Commons Barcelona', 'City Data Analytics Office', and 'Decode' (the EU's scientific) project (Calzada, 2018). Data Commons Barcelona offers an open-source policy toolkit regarding ethical digital standards 'for cities to develop digital policies that put citizens at the center and make governments more open, transparent, and collaborative' (Ajuntament de Barcelona). The city council of Barcelona also presented 'Decidim Barcelona', a participatory democracy (digital) platform for communicating and empowering citizens. Barcelona Municipal data office is currently working on the Open Data Bcn project to develop a platform for sharing the information generated or stored by public bodies with individuals and organizations (interview, 2018).

4.5.2.4 Dubai

The Smart Dubai governance structure is based mainly on visionary leadership and a positive approach to developing happiness. Setting up a 'champion' in line with the overarching policy of developing the Smart City is Dubai's unique pathway to engage citizens for coordinating, strategizing, and implementing programs and projects (interview, 2019). Smart Dubai points to the happiness champion as an essential component of Dubai's Smart City transformation where all the partners can work in close collaboration with the Smart Dubai Office (Smart Dubai, 2019). Dubai is also developing its first Artificial Intelligence (AI) Lab in partnership with IBM to support Dubai's AI roadmap (interview, 2018). The AI Lab's first strategy is to transform citizen engagement by infusing AI into services and operations, and disrupting business processes (Lootah & Miailhe, 2017). In terms of the Smart City in-house R&D, Dubai already has several innovation centers. Dubai has a set of comprehensive documents on data authorization, including Dubai data law, Dubai data policy, Dubai data manual, and the Dubai data model, which are all accessible online (interview, 2018).

Last but not least, as a dynamic throughput, leadership style plays an important role in the Emirati cases, where the initiators of the Smart City programs are the rulers of Dubai and Abu Dhabi (interview, 2018). In European cases, the initiators are institutions affiliated with either municipality or city council. So, the way of mo-

tivating and empowering citizens in Dubai and Masdar is based on getting inspiration from the vision of leader, whilst in Amsterdam and Barcelona Smart Cities are based mainly on two-way communication.

4.5.3. Applications and Externalities

All efforts to mobilize and manage resources are to provide solutions and then transform them into smart applications. A common classification many studies agree on pertains to five clusters, i.e., those of mobility, energy, health, governance, and citizen contributions to the different aspects of sustainability (externalities) (Anthopoulos et al., 2015; Neirotti et al., 2014; Chourabi et al., 2012).

4.5.3.1 Masdar

Smart transportation policies in Masdar City are based on the elimination of car use. They deploy cutting-edge technology solutions like the personal rapid transport (PRT) system. This pertains to a driverless automated transport system that can carry four passengers. Although it is mentioned on the official website of Masdar City that the system was implemented, in practice, it only turns around the building for a few minutes and it is clearly not as well-developed or functional as marketed through its branding media.

Deploying clean energy worldwide is Masdar City's core objective to make Abu Dhabi a hub for sustainability and renewable energy. Green building prototypes (Masdar Eco-villa), Solar PV Plant, and the Wind Tower are launched projects in Masdar City (interview, 2018).

In early 2017, Masdar City and Huawei signed an agreement to use Huawei's IoT platform to develop applications for increased health, productivity, and sustainability. The ultimate goal is to empower Masdar City residents in making better health decisions. Citizen participation seems not to be at the core of the Masdar City concept; in Masdar official documents and on the website (Masdar corporate brochure), the words 'citizens', 'residents', and 'people' are mentioned only once to address Abu Dhabi Sustainability Week. The Abu Dhabi Sustainability Week is a knowledge platform for the global sustainability community and the largest sustainability gathering in the Middle East to discuss viable and effective strategies to mitigate climate change.

Since automation through the cutting-edge technologies is the main facet of Masdar City, there is a unified service desk called 'one-stop shop' where people and companies can access a wide variety of government and business services, including registration and licensing, visa and medical checks, ID card processing, document

authentication, and so on. It refers to the key facet of Masdar's social attitude as 'customer satisfaction' (Cugurullo, 2013).

4.5.3.2 AMSTERDAM

Amsterdam has been at the forefront of smart mobility for many years (Vermast, 2019). What makes ASC different is that smart solutions and strategies are not only based on modern technologies but also help to develop simple solutions that are supported by cultural capacities. Amsterdam as 'the world capital of cycling' developed smart mobility solutions through smart bicycling, along with the electric car (Wagner et al., 2014) and car sharing in terms of private transportation (Sengers, 2016). ASC also provides a network platform for public transport, which is easily accessible to visitors and residents via smartphone applications (interview, 2018).

One of the crucial partners of ASC is the Chief Technology Officer (CTO), who has many initiatives on innovative mobility (interview, 2019). ASC also uses the smart traffic management system to optimize the traffic flow and works on a project (Amsterdam Practical Trail), creating a future where cars, navigation systems, traffic lights, and information signs are connected and working on an automated basis. The urban energy transition was the starting point and primary goal of the ASC program (Baron et al., 2012). City-Zen is an international consortium project on urban energy transition in Grenoble and Amsterdam to integrate new energy solutions in existing buildings and systems. A Virtual Power Plant (for storage and trade of surplus wind or solar-PV energy), Smart grid, The District Heating and Comfort Cooling network, Smart cooling, and Retrofitting homes are part of City-Zen project. 'Healthcare has less attention in our smart program so far, we just started to have strategic partners to develop the smart healthcare theme,' states Ger Baron, the chief technology officer of Amsterdam (interview, 2019).

The main product that the ASC team developed is an online platform for people to share their projects and initiatives and look for collaboration (interview, 2018). Collaboration with citizens is a clear goal of Amsterdam Smart City to keep the city livable, but currently it is more focused on collaboration with businesses and entrepreneurs (Capra, 2016). Amsterdam Smart Citizens Lab is a bottom-up way to explore smart solutions from citizen-driven innovations as well as to help citizens to become aware of smart lifestyles and ecosystems whilst it has early adopter citizens receptive to new technologies and sustainable solutions (van Winden et al., 2016). Considering the smart governance domain, administrative affairs in Amsterdam, like registration, payment lay-out, and taxes, are mostly paper-based. Amsterdam, however, is one of the first cities that has a Chief Technology Officer (CTO) in its governance body contributing to e-health, circular economy, and mobility themes of ASC.

4.5.3.3 BARCELONA

Barcelona's smart mobility policy began with raising public awareness through a research and innovation project ('Mobility Urban Value') aiming to encourage behavioral change in mobility by using new technologies. Connected mobility, safe and smart mobility for pedestrians and cyclists, clean, affordable, and efficient public transport, and integrating electric vehicles (EVs) into the transport system are the main aspects of Barcelona smart mobility that calls itself 'the right to smart mobility'(interview, 2018).

Barcelona Energia's (the public electricity distributor) energy transition model incorporates smart energy with the mission of producing a 100% certified renewable energy supply plan that began in July 2016 and is supported by the City Council with a budget of EUR 130 million (Barcelona Self-sufficient Energy Plan 2014–2024). For this purpose, Barcelona adopted encouraging plans like subsidies for the installation of photovoltaic panels and thermal solar panels, energy renovation, and energy improvements. Barcelona Energia (2018) also reported that 87 solar energy installations are already distributed around the city and the Program for Promoting Solar-Energy Generation has been established, which includes 73 projects for installing more solar energy panels on rooftops, party walls, facades, and pergolas (Ajuntament de Barcelona, 2018).

In the same way as ASC, Barcelona seeks two-way communication and co-creation of solutions and policies with citizens. For that purpose, there are several so-called democratic Barcelona projects. One of them is 'Decidim Barcelona', which aims to provide a portal for participation processes (interview, 2019). The 'Smart City Week' program is also an initiative to bring citizens closer to the notion of Barcelona Smart City, which is 'a city that uses its accumulated knowledge and technologies to achieve a more sustainable, fair, and inclusive urban setting' (Ajuntament de Barcelona, 2019).

As a collaborative governance platform, the 'City Protocol' project is another common project between Amsterdam and Barcelona that offers an 'Internet of Cities' platform to communicate, share solutions across diverse cities, and learn from each other (interview, 2018).

4.5.3.4 DUBAI

In Dubai, due to the Emirati preference for luxury and private transportation, smart mobility projects are mostly related to smart lights, smart parking, traffic control management, and increasing the share of electric vehicles (a smart initiative by Dubai Electricity and Water Authority) on the roads (Virtudes et al., 2017). Since the

UAE is always interested in using the title of 'the first', the Abu Dhabi–Dubai hyperloop is the world's first commercial hyperloop set to open in 2020 for the Expo 2020 (De Jong et al., 2019).

Shams Dubai is the main smart energy initiative by Dubai Electricity and Water Authority (DEWA), which is the key partner of Smart Dubai in this field. Shams is focused on expanding the solar panel installations on buildings to generate electricity and connect them to DEWA's grid (interview, 2018). The program was started on governmental buildings and aims to expand among household and private building owners (Dubai Electricity and Water Authority, 2016). The Green Building Regulations establishment is another major plan for energy efficiency launched by Dubai Supreme Council of Energy and DEWA for all new buildings to ensure the efficient use of electricity, water, and renewable energy (Virtudes et al., 2017).

In contrast to Amsterdam, Dubai pays a lot of attention to the health domain of its smart program. Dubai Health Authority's (DHA) smart applications are available to use for different purposes such as Patient Services (for medications, appointments, and lab results), Dammi (for blood donation), Salem (for medical fitness and occupational health screening), and Sheryan (for health licensing)(interview, 2018).

Smart Dubai tries to interact with citizens through different mobile applications. If the energy domain is the primary goal of Smart City development in Amsterdam, for Dubai it began in the governance domain (Badran, 2019). Paperless government policy is the goal for Dubai's smart administration (interview, 2018).

Table 4 presents an overview of how the four Smart City cases perform against Smart City output indicators.

Table 4- Applications of Smart City development in Amsterdam, Barcelona, Dubai and Masdar.

Design Choices/Cases	Amsterdam	Barcelona	Dubai	Masdar
Smart transportation infrastructures	+++	+++	++	+
Smart public transportation	+++	+++	+	+
Smart private transportation	+++	++	++	+
Renewable energy	++	++	+	+
Building energy efficiency	++	++	+++	++
New technologies for utilities	+	++	+	++
Smart health monitoring systems	+	+	++	0
Smart health management and information applications	+	+	++	+
One-way communication	++	++	++	+
Two-way communication	+++	++	+	+
Co-creating and co-designing	++	++	+	0
Smart administration	0	++	++	++

Design Choices/Cases	Amsterdam	Barcelona	Dubai	Masdar
Smart interaction	++	+++	+++	+++
Smart security and safety	n/a	n/a	n/a	n/a
Smart policies	++	++	++	+

Even though one obvious case of using big data collected from the environment is for surveillance objectives, in principle, governments do not publish information on this issue.

4.6. TOWARDS A CLASSIFICATION OF SMART CITY DEVELOPMENT PATHWAYS

In Sections 4 and 5 the results from the data collection and observations revealed the design choices for inputs, throughputs, and outputs. This led to several important analyses associated with Smart City development paths. The observed data for input and output indicators are shown in Tables 4 and 5. Subsequently, the qualitative and quantitative analyses of the observed data of the cases, through using pattern matching and explanation building techniques, led me to formulate their fundamental values as drivers for Smart City development. The results are presented in Table 5.

Table 5-Smart City development pathways (Amsterdam, Barcelona, Dubai, and Masdar).

Case	Main Driver (Core Element)	Development Path	Key Features
Amsterdam	Innovation	Innocratic (Startup and business-driven)	Competition, entrepreneurial Innovative, Bottom-up approach
Barcelona	Inclusion	Sociocratic (Participation-driven)	Democracy, Citizen empowerment through technology and citizens' data sovereignty Participatory, Co-creation
Dubai	Visionary-ambitious leadership	Aristocratic (State and service-driven)	Being first, being best, Top-down Happiness, government services, branding
Masdar	Technological optimism	Technocratic (Investment and branding-driven)	Visibility, lighthouse projects, branding

Significant results of the statistical analysis were found between 'nurturing of the innovation environment' and certain application domains such as smart transportation infrastructure, renewable energies, or smart mobility. Nurturing the innovation environment was also found to relate positively to investment from higher tiers of government (like Barcelona and Amsterdam getting EU-funded projects). In addition, nurturing the environment positively related to ways of bottom-up participatory innovation and decision-making, i.e., 'two-way communication', 'co-creation', and 'co-designing'. This, in turn, also showed a positive statistical relationship to indicators of the smart citizen domain. Other significant correlations were found between 'two-way communication' (of citizens and government) and 'educating and training of staff'. The 'data aggregation' and 'data processing' design variables turned out to be related in particular to the application domain of smart health, but also connected with 'smart private transportation' and 'building energy efficiency'. The analysis showed that there were remarkable interactions between 'smart policies', 'data processing', and 'one-way communication' (which points to sharing data from citizens).

These results in combination with the qualitative data analysis table (See Appendix, Table A2), enabled me to identify the pathways (See Table 5). The main drivers and the key values that were revealed from the process analysis (of Smart City development) informed us about the pathways Smart City development has taken in the four cases of the present study.

Looking at the origins of the Smart City program in each case showed that environmental issues, and eventually, the idea of making a city 'sustainable and future proof', formed the main motivations to start undertaking actions that would result in Smart City development plans, policies, and actions. However, the environmental issue alone did not suffice, as it was local leadership taking ownership of the latter to issue a vision and take the first steps in Smart City development, goal setting, and policy. The visionary scenario of Amsterdam was structured around sustainability (Gemeente Amsterdam, 2016). The ultimate goal of Amsterdam Smart City to increase the quality of life was making it a future-proof city based on a circular economy. This implied a city for the future, ready to respond to all kinds of disruptions and changes whilst remaining attractive and competitive in innovation, which is the core element of the process. Mora (2017) believes that the key to the success of Amsterdam Smart City is 'strategic planning' that is based on three main rules: strategic thinking, collaboration, and inclusion. In Masdar City, improving the quality of life was interpreted as taking advantage of the technologies of the day to provide environmental quality and better services to citizens (Han, et al., 2019; Masdar Mubadala Company, 2018). But taking advantage of technology with only the focus on technology sounds like technological optimism (Pontin, 2009). It was high-risk gamble

for Masdar, with a lot of confidence in technology and little space for the social aspect, that led Cugurullo (2013, p. 35) to end his study on the case of Masdar with the statement of 'We leave Masdar City hoping that Abu Dhabi's example will not cross the desert' (Cugurullo, 2013). For Dubai, a Smart City is the happiest city and that guarantees the quality of life, based on the vision and ambition of the Ruler of Dubai. This vision sounds utopian due to the difficulty of defining happiness and the variety of opinions people have of it. Another challenge for Dubai is that more than 80% of its population consists of migrant laborers (De Jong et al., 2019), for whom different criteria apply when compared with locals. Nonetheless, putting a lot of effort into the smart healthcare domain by Smart Dubai can be seen as a human-centric approach (especially in times of the COVID-19 pandemic) that ensures a higher quality of life for its citizens. Barcelona Smart City is a digital (smart) city with technological sovereignty of citizens that puts technology at the service of people, as Calzada (2018, p. 6) states: 'Barcelona is currently explicitly branding itself as an inclusive, democratic, and participative Smart City'. Barcelona is a leading Smart City in terms of digital ethics and citizen data sovereignty; however, the challenge ahead remains for citizens to become aware of their digital rights and duties (Calzada, 2018). Its experimental pathway in this regard can provide an answer to the question 'is the open-data era, and citizen data ownership realistic or will remain as a dream?'.

In sum, the results show that governance structures are a main determinant for successfully developing a Smart City. It involves local government, other (higher level) governments, private organizations, knowledge institutes, business enterprises, and citizens, and requires integrating technology (as the main enabler) with creativity (for entrepreneurship) and viable business models (the financial-economic driver). This leads to the emergence of smart applications (smart government, smart citizens, smart mobility, energy and healthcare) and sustainability. In all cases, it also requires outside investment to start Smart City initiatives and projects, not only from the private sector but also from higher levels of government such as the EU or national government. Once having secured a financial basis the first projects are set up to nurture the innovation environment and address how citizens can benefit or even participate in bottom-up Smart City development (except for the case of Masdar City). After the initial projects are set up, initiatives are taken to develop platforms that are embedded in local policies and supported by local political and administrative leadership, sometimes taking novel forms like in the Amsterdam Smart City case.

In parallel, action is taken to set up living labs and data-driven experiments in order to learn from e-innovations in practical, urban environments. Surrounding these labs is involvement of stakeholders from different sectors like industry,

knowledge institutes, government, and citizens. Local and state governments also use them as vehicles to attract more business investment. To support these innovation zones, other—often low taxation—measures are implemented by public authorities. Finally, in all of the cases local authorities—but in particular Masdar and Dubai—strive to have lighthouse projects in places they can show at international events (Yigitcanlar et al., 2019), like Expo Dubai 2020 or Barcelona hosting the Smart City World Congress 2019, or brand themselves with, in order to attract future investment and prolong their development paths of Smart City development.

Nonetheless, Amsterdam, Barcelona, Masdar, and Dubai still have quite different approaches to developing and governing a Smart City. Amsterdam and Barcelona are more focused on horizontal co-ordination with ample room for bottom-up decision-making, using participatory platforms (Zygiaris, 2013). In contrast, Dubai and Masdar use more vertically oriented, respectively aristocratic and technocratic government approaches (Angelidou, 2017; Yigitcanlar et al., 2019). How cases play out in terms of these dimensions and in which category they eventually end up in the matrix determines in the end how the development pathways take shape and differ from the more general pathway described earlier in this section.

4.7. Conclusion

This chapter examined different approaches to Smart City development that reflect different ways in which cities are governed, and different pathways urban governments take to become smart. The present study aimed to further understand how urban governments formulate and use policies by systematically analyzing and comparing four Smart City projects. The main research question was: When comparing a selection of Smart City projects, how can pathways for their implementation be classified? By using a comparative case study research design the present study mapped how different design choices of Smart Cities play out in their implementation and governance. The four cases were: Smart Dubai, Masdar City, Barcelona Smart City, and Amsterdam Smart City. We selected two Emirati/Arab and two EU cases (one in the North and the other in the South of Europe) to increase the variation in geographic location, culture, type of city, and government, polity, public leadership style, and institutions. To systematically analyze the four cases the Input-Output model for Smart City development was used and elaborated, containing indicators that are indicative for design choices and developmental pathways that influence their development.

The results of this study show that Smart City development in Amsterdam is based on a business-driven approach, which puts innovation at its core; Masdar's choices reflect technological optimism; social inclusion is the focus of the Barcelona Smart City pathway; and visionary-ambitious leadership is the main driver behind

Smart Dubai. This variety makes their Smart City development pathways different. Comparing Smart City development in the four cities reveals that they also have commonalities. In all cases, Smart City development took off in response to grand environmental challenges and the need to make the city future-proof. In addition, leadership is needed to adopt this vision and to start the process of initial policy making and planning. Next, in order to support capacity development, outside investment is needed, which concerns collecting a budget not only through private sector investment but also from higher levels of government. Once project budgets are secured, the first activities are embarked on to nurture the innovation environment and address how citizens can benefit from or even participate in bottom-up Smart City development. In parallel, initiatives are taken to develop platforms embedded in local policies and supported by local political and administrative leadership. Finally, local authorities strive to develop lighthouse projects that allow them to brand themselves in order to attract future investment and extend their developmental pathways for Smart City development. Although Amsterdam, Barcelona, Masdar, and Dubai were compared analytically one should not forget that they are located in contexts that vary a great deal.

The analysis of design choices made in the four cases also provides guidance for the following research on how to transfer lessons from developmental-pathway-supporting policies among various Smart City initiatives.

Finally, the concept and findings presented in this study for policy makers provide practical clues as well as policy lessons on how to develop a Smart City. Most of the time, confusion and contradictions appear when a comprehensive team that includes urban policy makers and planners, government officials, economists, environmental engineers, technology companies, and sometimes even citizens starts working on a Smart City development program. They have different expectations, which makes establishing a common language for Smart City development a challenge. For cities that have just gotten started with Smart City development programs, this is in fact the first challenge they face. With the broader question in mind of how best to govern one's Smart City development, an urban manager may look at a variety of examples, their practices, and outcomes.

Notes

[1] In-depth interviews were held (during 2018 -2019) with 32 Smart City stakeholders including: the City Experience advisor, the executive manager, the ideologist of Smart Dubai Office, a professor from Zayed University, the executive director of Sustainable City in Dubai, the executive director and the program manager of TAQATI, the executive director of DEWA, The of Dubai Supreme Council of Energy, and the managing director of a magazine called The *Sustainabilist*; Executive Director Erasmus Centre for Data Analytics, the Program Manager Urban Data & Intelligence - Amsterdam Institute for Advanced Metropolitan Solutions,

the Program Lead Living Labs - Amsterdam Institute for Advanced Metropolitan Solutions, Advisor Smart Cities, Netherlands Enterprise Agency, Ministry of Economic Affairs, CTO of Amsterdam, Delegations Lead - Amsterdam Smart City, Project manager Smart City Academy, Program Director Amsterdam Smart City at Amsterdam Smart City, and EVP Sales and Business Development at HAL24K; Direcció de Telecomunicacions i Infraestructures,Institut Municipal d'Informàtica, Ajuntament de Barcelona, Director of Digital Transformation and ICT International Relations, Commisisoner on Technology and Digital Innovation Office, Barcelona City Council; Professor of Practice at Masdar Institute of Science and Technology.

5

TOWARDS AN INTEGRATED FRAMEWORK TO MEASURE SMART CITY READINESS: THE CASE OF IRANIAN CITIES

The contents of this chapter have been adapted from the following peer-reviewed article: Noori, N.; de Jong, M.; Hoppe, T. Towards an Integrated Framework to Measure Smart City Readiness: The Case of Iranian Cities. *Smart Cities* 2020, 3, 676-704.

5.1. INTRODUCTION

Conferences, seminars, and statements of executives and government officials and academic articles around the Smart City topic reflect growing attention to starting programs associated with Smart City development in most of the countries around the world. Growing urbanization, economic competition, citizens' expectations, and environmental challenges, along with rapidly improving technological opportunities, are the main drivers (Smart Cities Council, 2015; Hollands, 2020; Wiig, 2018; Breslow, 2020). Some pioneering cities have gained valuable experience from which both positive and negative lessons can be drawn. Followers can learn from these and join in this emerging trend. The Iranian government, as one of these followers, has always mentioned globalization in its policy documents and visions and recently smart urban development amidst globalization appears in many policy documents drafted by Iran's largest cities. Tehran, Mashhad, Isfahan, Shiraz, Urmia, and Qom are the largest Iranian cities and are using a smart label in their profile. This is part of an overarching national Smart City program. Some of Iran's neighboring countries have taken considerable steps to develop Smart Cities of their own. They have used Internet of Things (IoT) solutions to solve urban management problems by learning from strategic and technical approaches to develop 'smart-city' capabilities, in particular based on good practice. For instance, in the UAE, Dubai has made significant progress in recent years (Harvey & Ponzini, 2019; Breslow, 2020).

In chapter 2, I examined the credibility of the city brands adopted by Iran's largest cities. The results revealed that, among the cities with a smart profile, only four cities (Tehran, Mashhad, Isfahan, and Shiraz) actually have credible brands. Credibility is defined in terms of six factors contributing to credibility of a city brand: (i) generate feelings of loyalty; (ii) facilitate the development of an overarching strategy or policy; (iii) evoke positive feelings; (iv) demonstrate uniqueness or distinctness; (v) allow for different, yet non-contradictory, messages to various stakeholders; and (vi) logically connect past heritage, current profile, and future ambitions. Still, the question remains on whether these cities are truly ready to become smart? In view of the fact that the formulation and implementation of a Smart City policy, like any other policy, needs to be tailored to the contextual conditions and would require infrastructures, assessment of the readiness of these cities to participate in this global trend is essential (Achmad et al., 2018). Therefore, the present study aimed to provide a systematic, integrated theoretical framework that can be used to measure Smart City readiness and, based on that, a Theory of Change which cities can consider when they prepare themselves for their transition to become 'smart'. Basically, they can learn from pioneers and good practice, and localize the policies and solutions since each city has its own unique features and challenges, as well as requires its very own set of solutions (Dameri et al., 2019).

Multiple studies have addressed the transition process cities engage into becoming smart (Chourabi et al., 2011; Lee et al., 2014; Neirotti et al., 2014; Ibrahim et al., 2018). But less attention has been awarded to the readiness of cities into becoming a Smart City (Berst et al., 2013). In their overview study, Ibrahim et al. (2018) assessed city readiness for change during the transition process into becoming smart sustainable cities by focusing on local assets. In another study, Achmad et al. (2018) evaluate city readiness considering technological, social, and political conditions for change. The study showed that the Smart City enablers are particularly brainware, hardware, and software. The authors hold that these are indicators that should be assessed for evaluating Smart City readiness. Although Ibrahim et al. (2018) discern different aspects of readiness, like the non-technical readiness, the study itself focuses predominantly on technical aspects, and, in particular, stresses the examination of readiness for Information and Communication Technology (ICT). The Smart Cities Council (2013) has investigated the barriers to Smart City development from working on Smart City projects all across the world. Their results show that a frequently emerging barrier is the lack of a system-wide view and integrated approach. Developing a Smart City requires integrating technological and non-technological contexts and create a holistic vision. This present study aims to add non-technological aspects to the readiness mix to enable urban governments in developing a more comprehensive ex ante assessment of their Smart City readiness.

The aim of this study is to examine the contextual conditions and readiness of cities to become smart. Consequently, our research questions (RQs) are the following:

How to determine whether cities are ready to transition into Smart Cities? What does an indicator system measure to determine whether a city is ready to become smart? And to what extent do Iranian cities meet the minimum requirements for becoming smart?

To address these questions, I conducted a qualitative study based on two theoretical frameworks: first, one presented by Dameri et al. (2019), which identifies a list of global and local Smart City features; and second, the framework for Smart City design variables (IO model) presented in chapter 4. I add social and institutional variables based on a literature study and my intention to compensate for the shortcomings of current theoretical frameworks and develop a more holistic integrated theoretical framework. I apply this to four cases in order to analyze their specifications in terms of being ready to become Smart Cities. The contribution of this study is in highlighting the role of technological, socio-economic, and political readiness of governing an urban transition process towards a Smart City with an indicator system to measure Smart City readiness.

The structure of this chapter is as follows. Section 2 maps the academic literature to explore more in-depth insights on cities' readiness for transition into smart urbanism and also presents the urban transition theory and the theory of change. Section 3 presents the research design, methodology, and data collection and shows our adjustment and elaboration of existing theoretical frameworks to develop an indicator system subsequently applied the case studies. Section 4 provides the analysis and exploratory insights on Iranian cities' readiness to become Smart Cities. In Section 5, the results of the study are presented and discussed. Finally, in Section 6, the conclusions and suggestions are presented. In addition, policy recommendations are provided for 'smart initiatives', particularly Iranian smart initiatives, to find out how they can prepare for their transformation.

5.2. Transition Towards a Smart City and Readiness for Change

5.2.1. Urban Transition

Transforming a city into a Smart City first of all requires consideration of the readiness of a city for change (Berst et al., 2013). The term 'change' refers to both technological and non-technological changes in the urban context. The transition discourse appears when a specific way of knowing long-term transitions is considered (Jhagroe, 2016). Frantzeskaki and De Haan (2009) view 'transition' as a societal process of fundamental change in culture, structure and practices. According to Geels and Schot (2007), transitions are changes from one socio-technical regime (which pertains to a network of actors and institutions, and cultural or social norms along with technological trajectories) to another. In the quest for an urban transition into Smart Cities, change is primarily described using insights on transitional change of socio-technical regimes in urban environments.

According to Jhagroe (2016), 'urban transition' can be defined as the creation and normalization of urban regimes and practices in the replacement and reforming of other urban regimes and practices. In this sense, it fits the more general definition of transition coined by Geels and Schot (2007) and applies it to the urban domain. To conceptualize the notion of urban transition, one needs to know how the transition process is initiated, guided, and how it evolves over time. Smith et al. (2005) point out that regime change is the result of internal or external pressures on the regime, which can range from political, economic, social, environmental, to technological pressures. They argue that the resources available inside and outside the regime should be coordinated to adjust to the pressures. By combining the availability of resources and the degree of coordination, Smith et al. (2005) developed a two-

dimensional framework for a typology of four transitions. They argue that system-level change requires coordination of different actors and resources. Stripple and Bulkeley (2019) also highlight the alliance between different actors in the process of a transition to promote certain transition pathways.

Over the past decade, the concept of urban transition has been used in a growing number of studies addressing ecological modernization of cities (Berst et al., 2013; Frantzeskaki & De Haan, 2009; Berkhout et al., 2009; Stripple & Bulkeley, 2019). A momentous discourse is the one on sustainable technology transitions, which is supposed to be one of the main contributions of Smart Cities development. Smith et al. (2005) understand sustainable technology transitions as changes mediated by the resources, interests, and expectations of institutionally embedded networks of actors. In an investigation of Asian development pathways and sustainable socio-technical regimes, Berkhout et al. (2009) stress the absence of linkages between different government levels (i.e., between the local, regional, and national levels) in socio-technical systems as an obstacle in sustainability transitions. All the studies mentioned above stress the importance of contextual factors, resources, and networks of actors in transition processes (Hoppe et al., 2016).

5.2.2. Technological Readiness

Several scholars argue that technological readiness is an essential condition for transition towards Smart Cities (Achmad et al., 2018; Berst et al., 2013; Calderon et al., 2018; Blut & Wang, 2019; Buyle et al., 2018; Madsen, 2018; Yu et al., 2019). In their study, Ibrahim et al. (2018) stress the importance of checking city readiness for change before planning a transition process. 'Technological change' is obviously part of this urban transitional change, including the adoption of emerging technologies and providing appropriate and adequate infrastructures. In the Smart Sustainable City transition roadmap, these authors propose to add two pre-phases that pertain to 'city vision' and 'city readiness'. In the 'city vision' phase, city priorities are identified through current city state analysis, vision and strategies, and identifying stakeholders. During the 'city readiness' phase, the readiness of ICT-based infrastructures, non-ICT-based infrastructures, and availability of any previous Smart Sustainable City initiatives are checked. In terms of ICT-based readiness, the authors propose to assess the hardware and software infrastructures, as well as ICT-related skills (Ibrahim et al., 2018). In 2009, the International Telecommunication Union (ITU) presented an ICT development index (IDI) that combines eleven indicators on ICT access, use, and skills, capturing key aspects of ICT development in one measure that allows for comparisons between countries and over time. Among many studies (Lee et al., 2014; Calderon et al., 2018; Ibrahim et al, 2018; Achmad et al., 2018), the

Smart City readiness guide presented by the Smart Cities Council (2015) appears to be the most comprehensive guide for assessing technological readiness.

The definition of the Smart City behind this Smart City readiness framework by the Smart Cities Council (2015; p. 6) is: a city that uses information and communications technology (ICT) to enhance livability, workability, and sustainability. The definition shows that the core enabler of Smart Cities is ICT, and the ultimate goal is to establish a better future city to live and work in, while preserving, the environment. The framework holds that all the city functions (including energy, transportation, telecommunication, health, human services, waste management, payments, and finance, as well as public safety) that Smart Cities promise to improve are enabled through the power of technology (Smart Cities Council, 2015). It proposes different technology enabling indicators to assess Smart City readiness to provide insights in where to start and where to end up for decision-makers.

In the present study, in order to assess the technological readiness based on urban transition concepts, I started with an analysis of the current situation of the available technological resources. For this purpose, I relied on an Input-Output (IO) model of Smart Cities that determined the key resources for Smart City development process. It proposes different design variables for ICT infrastructures as one of the key resources in the development process. For developing a Smart City technological readiness framework (see Table 1), I also deemed it necessary to pay attention to insights pertaining to the Smart City readiness guidelines presented by the Smart City Council (2015) and IDI issued by ITU (2017).

Table 1-Smart City technological readiness framework (adopted from the Input-Output (IO) model of Smart City and the Smart City readiness guidelines (Smart Cities Council, 2015)).

Smart City Attributes	Design Variables	Indicators (Presence of)
ICT and Data resources	Data aggregation	Big data establishment Sensors and actuator equipped devices, CCTVs & cameras
	Connectivity	ICT Development Index (IDI)
	Data processing	Data science centres
	Data real-time analysis	Data visualization platforms
Data management capabilities	Establishing a data authorization	Data Laws
	Security	Establishing a cyber security framework

The key purpose of developing ICT infrastructures for Smart City development concerns: (1) connection to things that facilitate collecting data; (2) connection to things for targeted information; and (3) connection to things for data serving in smart applications. The IO model emphasizes that, along with the required resources, there is also a need for dynamic capabilities to manage these resources. A vital resource for smart urbanism that needs to be managed is data. Watts et al. (2009) state that the complexity of managing data increases with increasing data volumes. The aim of big data management is to ensure the quality of data and transforming data into knowledge (Watts & Shankaranarayanan, 2009). But this is not the only purpose of data management; there also are concerns about the misuse of data and cybercrime. Issues like data theft, data ownership, data accessibility, and privacy issues can arguably be managed by establishing data authorization and cyber security platforms (Dijkers, 2019; Chierici et al., 2019).

5.2.3. Socio-economic Readiness

Urban transitions influence the societal system in several ways, but this is not to be considered one-way traffic. In fact, it is an interaction between the societal system and technology regimes governed through authorization. Change in urban transitions requires input of human resources to make the transition happen, and the new urban regimes and practices need to be supported by social networks (Smith et al., 2015). The central activities for Smart City readiness may be to provide human resources for the Smart City development process and to support formation of social networks around the Smart City development process. Context matters in this regard (Dameri et al., 2019). Using a knowledge-based conceptual vision of the Smart City is a fundamental requirement for improved decision-making (Geels, 2005). Providing the required knowledge for Smart City development can either be extracted from data flows (explicit knowledge) or from human capital (including tacit knowledge) (Geels, 2005). Nam and Pardo (2011) even argue that human factors form the core components of a Smart City, along-side technology and institutional factors. Human factors entail concepts like social learning, creativity, and education. However, knowledge alone is not sufficient. Knowledge and creativity can, rather, be viewed as two enabling wings of innovation fostering smart solutions (Negre et al., 2015). Based on these arguments, the IO model proposes resources to provide both human and entrepreneurial infrastructure as: educated and trained people, an innovation environment, and a supporting system for innovative companies and start-ups. The output in the IO model pertains to smart applications (in terms of energy, mobility, healthcare, governance, and citizens) (Hoppe et al., 2016).

In the context of Smart Cities, innovation studies provide insight into which type of citizens are most likely to support Smart City technologies and policies and

be involved in the development process. Sepasgozar et al. (2019) found that the culture and needs of urban citizens are important factors for acceptance of related urban service technology. Dameri et al. (2019) enumerate geographical localization, culture, mentality and values of people, educational level, different ideas of quality of life, national laws, and territorial governance models as characteristics that are specific to Smart Cities. In an extensive survey, Calderon et al. (2018) also mention the knowledge level citizens have about the Smart City concept and smart technologies for checking Smart City readiness in Latin American cities.

Insights taken from the previously mentioned literature led us to conceive the following framework for social readiness of city residents to Smart City transitions (Table 2).

Table 2- Smart City socio-economic readiness framework.

Factors	Definition and Operationalization
Education	Number of universities and research centres
	Knowledge transfer and knowledge sharing programs
Innovation	Specific policy in place to promote Smart City innovation
	Supporting and encouraging programs for innovative companies (science and technology parks, free zones, etc.)
Awareness	Level of citizens' awareness of the Smart City program in their city
	Level of citizens' awareness of the Smart City concept and technologies
Perceived usefulness	Level of perceived usefulness of the smart solutions for the city's challenges by citizens
Mentality and values	Citizens' opinion about a Smart City
	Citizens' image of their cities
	Citizens' different ideas of quality of life

5.2.4. Political Readiness

An important additional contextual factor affecting Smart City readiness is the policy environment, including national policies, legislation, and local governance arrangements. Smith and Stirling (2010), through highlighting the relation between 'policy institutions and political activities' on the one hand and the transition management processes on the other, stress the importance of political power to decide when and how to make the transition happen. When many actors are involved in a process and their interactions vary across time and policy issues, the process is complex in terms of policymaking and implementation (Sepasgozar et al., 2017). Smart City programs deal with this complexity, having to cope with different actors who

have divergent interests (Cairney, 2012; Joss, 2015; Yigitcanlar, 2016). Cairney (2012) believes that power diffusion makes public policy processes and outcomes different.

It is also important to consider governance models that are used in urban transitions. Governance model here refers to all the processes of governing the city, both formal and informal institutions, undertaken by a government or any other actors. Governance includes formal policy instruments, such as laws, rules, municipal ordinances, and territorial policies, and non-institutional mechanisms, such as public–private partnerships, subsidiaries, negotiations, and citizen participation (Bevir, 2012). Governance is not only about what governments do but also about the outcomes of interactions between all actors in the public domain (Scholl& Scholl, 2014; Dameri& Benevolo, 2016). Therefore, there are two characteristics in the political environment that have impact on Smart City development: the governance structure, and the interaction between government and other actors (see Table 3). Government also has a role to play in the interaction among actors. In Smart Cities known as good practice examples, like Dubai or Amsterdam, local government takes the initiative for Smart City transition and is responsible for coordinating joint action involving multiple local stakeholders. This includes alignment of visions and expectations, formulation of the Smart City vision, and alignment with the overarching policy, regional, and national programs, providing a platform to involve different actors, attracting funds, and eventually implementation of a Smart City transition policy. In addition, public leadership is necessary to support establishing a vision for policy making and implementation, while, at the same time, maintaining transparency and building trust among local stakeholders and residents (The Government Summit, 2015; Scholl& Scholl, 2014).

Table 3-Smart City political readiness framework.

Political Context	Definition and Practices
National policy and governance	National leadership
	Government structure, governance arrangements, policy networks
	Rules, laws, legal and regulatory reforms
	Legitimacy, transparency, and trust
Municipal policy and governance	Local leadership
	Partnerships with industry, academia, and citizens
	Providing a platform for multi-stakeholder partnership
	Smart City innovation clusters and networks

5.3. Research Design and Methods

The analytical framework used is based on the IO model of Smart City development and the Smart City readiness guide by Smart City Council (2015). I use the framework derived from a qualitative data analysis of scientific papers and existing frameworks for Smart Cities readiness (Appendix A, Table. A3). My approach applies the IO model and existing related frameworks to develop a framework for technological, socio-economic, and political readiness and uses the theory of urban transitions to understand how technological, social, and political features influence the cities' readiness to become smart. Then, I use the integrated framework on Smart City readiness based on Tables 1, 2, and 3 to identify indicators and collect and organize our data. The integrated framework is shown in Table A1. The next step is to apply this framework to the cases of Iranian cities. These cases pertain to four large-scale Iranian cities (with over 500,000 residents each) that have Smart City policies in place and have also adopted a Smart City brand that is considered credible as discussed in chapter 2. The four cities are: Tehran (the capital of Iran), Mashhad (the capital of the Khorasan-e Razavi Province), Isfahan (the capital of the Isfahan Province), and Shiraz (the capital of the Fars Province).

5.3.1. Data Collection

In order to collect data, I used both desk research and a survey. For assessing technological readiness, both qualitative and quantitative data were collected from the city websites, available statistical datasets, and policy documents, such as masterplans and policy reports. To collect data related to social readiness, I conducted a survey among citizens using a questionnaire. I conducted a survey in 2020 asking for citizens' views on the Smart City program in their city (whether respondents are

aware of it or not; whether respondents agree with or not; whether respondents find it useful to solve their urban issues or not; to what extent respondents are familiar with Smart City technologies, and the perceptions respondents have of a Smart City in general, the main issues playing in their city, respondents' perception image of the city; and their assessment of quality of life). I distributed the questionnaire through email and social media (i.e., via WhatsApp and Telegram groups) until I received responses from at least 20 participants in each city. The response rate varied per city: i.e., in Tehran (21/ 37), Isfahan (23/34), Mashhad (20/52), and Shiraz (20/78). All participants were citizens of one of the four cities and had lived there for at least three years. The sampling method was intended to be random. However, the final sample was biased because an online survey was used. For this reason, respondents are mostly citizens who are familiar with and use the internet, use smart phones, and, in this sense, already have some affiliation with the concept of the Smart City. For political readiness, we used qualitative data available on the international index rankings and reports on Iran's governance assessment (Bertelsmann Stiftung's Transformation Index (BTI) 2018), cities' official websites, governmental reports, and policy documents.

5.3.2. Data Analysis and Theory of Change

To analyse data, I applied the approach of the Theory of Change (ToC), which included a situational analysis as a form of empirical analysis, prior to designing a Theory of Change. Weiss (1995) introduced 'Theory of Change' (ToC) as a theory to clarify how and why a given (policy) intervention initiative works. It was mainly generated to support ex ante evaluation of a given intervention. Connell and Kubisch (1998) argue that there are three main reasons to develop a ToC for interventions: First, by sharpening the planning and implementation; second, by facilitating the measurement and data collection elements of the evaluation process; and third, by reducing problems associated with causal attribution of impact by articulating a roadmap for the change and making an agreement between different stakeholders. The United Nations Children's Fund (UNICEF) defines ToC as follows (Rogers, 2014 p. 3):

'*A ToC explains how activities are understood to produce a series of results that contribute to achieving the final intended impacts. It can be developed for any level of intervention – an event, a project, a program, a policy, a strategy or an organization*'.

Starting with the definition by UNICEF that stresses using the ToC for different levels, I associate the theory of change with Smart City policy planning to identify the current situation, the intended situation, and what needs to be done to transform a city into a Smart City. According to the UNICEF definition, the ToC deals with the

interventions. It makes the theory responsible for addressing three fundamental questions: (1) What are the interventions? (2) What is the current situation in terms of needs and opportunities for future development? And (3), what needs to be done to move from situation 'A' to situation 'B'? (Rogers, 2014; Connell& Kubisch, 1998). In the present study, the object for the ToC is 'the readiness of Iranian cities to become smart', the interventions refers to 'technological resources and capabilities', individuals and society', and 'national and municipal political systems, while 'situation' refers to the plans, projects and actions regarding technological, social, and political readiness to becoming a Smart City. The current situation analysis provides insights on available resources, current issues, and problems in need of solutions, as well as contextual conditions. Analysis of the desired situation clarifies what outcomes the initiative should reach with those interventions and available (or planned) resources in a certain context. The comparison between the current situation analysis and the intended outcomes reveals the gap between situation 'A' and situation 'B', and the challenges and opportunities for the transition from 'A' to 'B'. Generating a ToC -based on the gap analysis considering challenges and opportunities can guide decision-makers on how the gap can be bridged. They may either decide to plan for making necessary resources available and some contextual changes, or to adjust their intended goals.

In order to take the first step of generating a ToC in the present study I need to specify what the situation (both the current situation and the desired future situation) means in our intervention (or initiative), including technological, social, and political readiness. Based on the ToC, I take the following three steps for all four city cases data analysis: Step1: A situational analysis; Step 2: An analysis of the gap between current situation and intended situation, laying bare the challenges and opportunities; and Step 3: Mapping a ToC about how to get from the current situation to the desired situation.

To conduct a situational analysis (step 1), I rely on a qualitative analysis of data organized through the integrated framework for Smart City readiness in this study. To perform step 2 (determining the challenges and opportunities), I rely on qualitative data reflecting the cities' visions and goals of Smart City development, as well as statements of the officials about their Smart City programs. And, finally, based on the analysis, I provide policy recommendations for the change (being ready to transform into a Smart City).

5.4. Iranian Smart City Development: Smart City Readiness

Iran started promoting Smart City development in its third Five-Year Plan (2018–2022). It sought to deal with urban problems ahead and looked at new approaches in the development of future cities around the world. It selected five cities

(Isfahan, Uremia, Tabriz, Tehran, and Mashhad) for the development of Smart Cities. Later, the municipalities of Shiraz, Qom, and Kish Free Zone also joined to the national Smart City program and adopted a vision to profile themselves as 'smart'. In most cases, expressing the wish to become smart was a reaction to urban problems, such as traffic congestion, air pollution, energy crisis, or ideals for improving the general well-being of citizens. I examined the credibility of the Iranian mega cities brands in chapter 2 and found that four cities among them had the most credible Smart City brands, i.e., Tehran, Mashhad, Isfahan, and Shiraz.

In this section, the readiness framework presented in Section 2 is applied to the case of these cities to map their current technological, socio-economic, and political situation in terms of being ready for transition towards a Smart City.

5.4.1. Technological Readiness

Tehran, which is more engaged with urban issues, like traffic and air pollution, and has different urban policy layers, perhaps would be one of the most complex Smart City projects in Iran. Although all cities in the mainland operate in a multi-level government context, Tehran, as the political centre of the country, has always attracted more attention. This most important city of Iran, with a population of more than 8 million people, accounts for about 11% of the country's total population and ranks 28th among the world's most populous cities (Shabestar et al., 2017).

ITU ranks Tehran province 1st in Iran with an IDI value of 7.24 in 2017, while Shiraz (6.25), Isfahan (6.24), and Mashhad (5.35) ranked, respectively, 7th, 8th, and 18th. Most of Iran's datacentres are located in Tehran, to serve the entire country from the capital where the equipment and infrastructure is most advanced. Iran's IoT research centre launched 'The Things Network of Tehran' as a global open crowd-sourced IoT data network, which is the first of its kind in the Middle East. An integrated city data portal and application, so-called 'My Tehran', was established in 2018. Citizens of Tehran can access many services through this integrated portal with a citizen account in which city statistical data are openly available and visualized in eighteen categories. Yet, the portal is under development and a limited number of data (and not critical data) was accessible at the time of writing this article.

The ICT organization of Mashhad municipality is planning to launch a city portal, as well. The goal is that citizens can access all the smart applications through a single user account (ICT Organization of Mashhad Municipality). Isfahan launched the 'Network Real Time Kinematic', which aims to develop an integrated platform for spatial information so-called 'Sima' (Isfahan Municipality ICT Organization). Shiraz's financial and economic deputy announced setting up a data centre in the city of Shiraz in order to achieve smart features. The goal of the Shiraz Big Data Centre is to establish Smart City features through which services in terms of smart

governance and policies, smart economy, smart living and working environment, smart transportation, and smart citizen can be provided (City of Farda, 2020).

Iran's Minister of Communications and Information Technology (2015) claimed that the fiber-optic network expansion program in Isfahan that is in progress will in the near future provide appropriate infrastructure for Smart Isfahan. The 2019–2020 plan of Isfahan indicates the focus on expanding the fiber-optic network and data centre projects. The Geographical Information System projects based on developing a Geo-data base is also another focus of this one-year plan (IRNA, 2015). Sensors and actuator-equipped infrastructures can enrich big data establishments by providing real-time inputs. According to the ICT Director of Tehran Municipality (2019), importing needed sensors for the Smart City program will be expensive due to the rising exchange rate and sanctions, so that promoting domestic production will be a cost-effective solution to provide these sensors and actuators (ICTNA, 2019). In Mashhad, the municipal ICT organization has announced it will provision flood alert sensors, air quality sensors, and traffic sensors for the Smart City development program (ICT Organization of Mashhad Municipality). To improve traffic conditions, the ICT Organization has started to produce and operate the 'Traffic Image Analysis System' (Sobh Mashahd News, 2019).

Four main data centres are based in Tehran (Supreme Council of Cyberspace, ICT research institute, Iranian Institute of Information Science and Technology, and Iran's IoT Academy) and one in Mashhad (IT and Cyberspace Research Centre). In 2017, Iran's Supreme Council of Cyberspace established IoT laws and regulations for the whole country, which were approved and authorized by Iran's Leader (Supreme Council of Cyberspace, 2017). In terms of establishing a cyber security platform, Tehran has a cyber security research institute, and Mashhad's and Isfahan's master plans indicate specific budget allocation for cyber security projects.

5.4.2. Socio-economical Readiness

In examining whether a given society has a suitable platform for developing a Smart City, the educational status is a first indicator. There are 119 universities and academic centres in the city of Tehran, and 24% of its population is high educated. There were 1,382,515 students enrolled in Tehran universities in 2018, with 149,544 professors and faculty members. These figures for Isfahan are 67 universities and academic centres, with 140,374 enrolled students in 2018. These numbers for Shiraz and Mashhad are at 25 and 30, respectively, for universities and academic centres (Iran Universities Reference, 2018).

One of the main knowledges and experience sharing programs around Smart Cities was founded in 2008 following the proposal of Tehran Municipality to the Asian Parliamentary Assembly (APA), Asian Mayors Forum (AMF): the Asian

Smart Cities Committee. The Tehran Urban Innovation Center (TUIC) was founded in 2017, aiming to present new urban solutions influenced by the Smart City discourse. TUIC's innovation model is based on the network innovation approach, striving to build a foothold in the international network of knowledge generation and idea sharing in the field of urban innovation (TUIC, 2017).

Isfahan Urban Creativity and Innovation Centre was also established in 2017 as a bridge between the citizens' ideas and the municipality (Iran's Metropolises News Agency, 2017). In 2018, the Urban Innovation Centre in Mashhad was put into operation to establish a link between urban management and emerging technologies (IRNA, 2018). The City Council of Mashhad and Mashhad municipality have raised the issue of establishing an urban innovation centre to achieve the 20-year vision of city as a knowledge and Smart City (Mashhad Urban Innovation Centre, 2018). According to the ICT Director of Isfahan Municipality (2017), Isfahan has adopted the international standards and indicators as its Smart City model, issued by the Smart City World Council and the International Organization for Standardization (ISO 37120) (Isfahan Today, 2017). The head of the Centre for Strategic Technologies Development of the Scientific Deputy stated that the Shiraz Innovation Factory will be launched in 2020. Ghaderifar (2020) mentions that the innovation factory is a campaign for start-ups aimed to support ideas and train human resources and specialists to create knowledge-based companies and innovative solutions.

There are eight science and technology parks and incubators around Tehran to support innovative companies and start-ups by providing benefits to businesses based in the parks. These are based on: tax exemption, annual performance exemption, exemption of duty payments, commercial interests and export duties, and foreign exchange transactions, like free economic zones (Iran Academic Centre for Education, Culture, and Research, 2008). All science and technology parks in Iran are allowed to offer these advantages. In Mashhad, there is a science and technology park, and there are eleven incubators. Isfahan has three science and technology parks and 10 incubators, and Shiraz has one and five, respectively, science and technology parks, and incubators (EcoSystem).

The results from this four-city survey show that the level of citizen awareness of the Smart City program in their cities are almost similar, and citizens mainly have heard about it but have not received enough information. They also have an average level of awareness of the of the Smart City concept and technologies. The level of perceived usefulness of the smart solutions for the city's challenges by citizens (of all four cases) is significantly higher for traffic, pollution and environmental issues. However, in Isfahan, the usefulness of smart solutions for housing issues was also mentioned. In terms of citizens' opinion about a Smart City, our preliminary results

from a pilot survey indicate that, in Tehran and Mashhad, the most frequent statements by the survey respondents are related to 'green' and 'surveillance' city; in Isfahan, are linked to 'surveillance' and 'happy' city 'surrounded by technology'; and, in Shiraz, are associated with a 'safe' and 'green' city. Regarding the image of the respondents from Tehran of their city, the most frequent images are intertwined with a 'polluted city', 'over-crowded', and 'expensive', but still an 'alive' city. The images that appear most frequently by the respondents of Mashhad minds regarding their city are linked to a 'crowded' and 'polluted' city with deficiencies in public transportation. In Isfahan, in addition to crowds and pollution, the respondents have the image of a 'beautiful' and 'historical' city 'with a lot of potential'. The most frequent images of the city expressed by the respondents of Shiraz are 'happy' and 'beautiful' city. Regarding citizens' different ideas of quality of life, the most frequent statements in Tehran by the respondents are: 'safety', 'prosperity', 'happiness', 'peace', and 'citizen's (human) rights'; in Mashhad, they are: prosperity', and 'happiness'; in Isfahan, they are: 'health', 'safety', and 'happiness'; and in Shiraz, they are : 'safety', 'prosperity', and 'happiness'. However, these statements are not based on a large sample from among citizens but, given the internal variation, they still represent the opinions, images, and ideas of a relatively random group of citizens such that it can at least serve as a first approximation in this exploratory study.

5.4.3. Political Readiness

In terms of political readiness assessment, the BTI report in 2018, on the governance index, such as political participation; rule of law; stability of democratic institutions; socioeconomic development; economic transition; private property, ranks Iran 115th out of 129 nations (Figure 1) (Bertelsmann Stiftung, 2018). The report (p. 4) states that:

'Ideological and religious dogmas are basic principles of politics and the economy in Iran, often preventing the implementation of professional strategic plans, projects and expertise. The leadership style and the entire ideological-religious foundation of the Islamic Republic are the major constraints.'

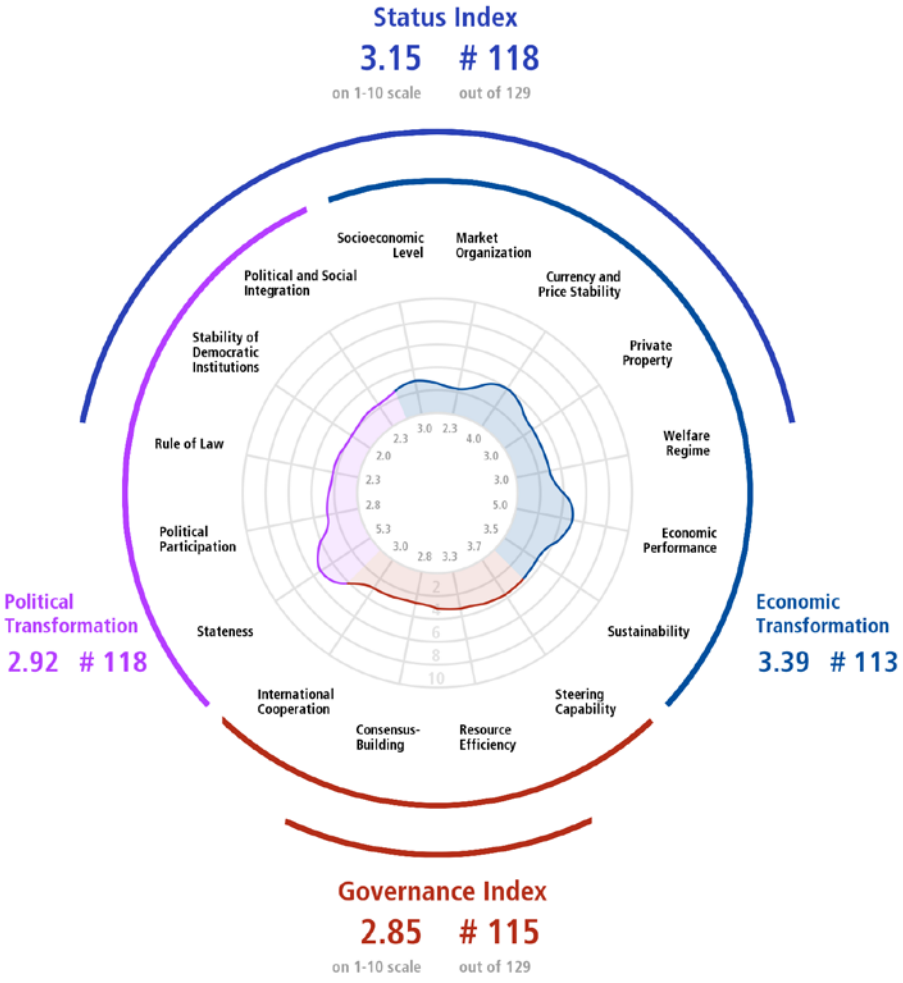


Figure 1- Bertelsmann Stiftung's Transformation Index (BTI) 2018 Iran Country Report.

Iran has a multi-level governance structure, governing cities through a centralized approach. Each city has a city council of which candidates should be examined by a central council overseeing the elections, and people will elect members of the city council from among them. Each city has a municipality and its own municipal laws and regulations that have to be aligned with the upstream policy documents under the overarching Islamic law (Shariah). One of the main trustees of the Smart City program in the Iranian cities is the ICT Organization of Municipality. It is responsible for directing and supervising the activities of the municipality and all its

affiliated organizations in the field of information and communication technology. Another highlight in the BTI report (2018) is its emphasis on the lack of transparency of the political system in their financing and administrative structures, which play a crucial role in Smart City governance. A poll conducted by the state-run Iran Students Polling Agency (ISPA) in 2019 confirmed that only 15 percent of the citizens of Tehran were satisfied with the government (Radio Farda, 2019). Moreover, in 2020, only 26 percent of Tehran's citizens participated in the parliamentary election. Political analysts believe that, based on recent events (such as suppression of public protests in November 2019 and the Ukrainian plane crash in Iran), the level of public trust in government institutions has declined even further (FINANCIAL TIMES, 2020; Behravesh, 2020; Von Hein, 2020). The results of the survey presented in this study, on the other hand, indicate that all respondents emphasize the importance of citizen participation in urban decision-making. Appendix A (Table. A3) summarizes the results and empirical observations from the four Iranian Smart Cities in addressing the research questions.

5.5. Iranian Smart City Development: Vision and Expectations

According to the analysis of about one million scientific articles, the topics around Smart City concepts, such as 'sustainability', 'information technology', 'quality of life', 'environment', 'data mining', 'knowledge management', and 'entrepreneurship', are among the top 20 research topics in Iran over the last 10 years (Iran Universities Reference, 2019). These themes are derived from academic channels. But what do urban managers and policy makers aim for? Tehran has clearly mentioned the 'smart' program in its third Five-Year Plan (2019–2023) (Ilna News, 2019). In both strategic documents of Isfahan 2021 and Isfahan 2026, the Smart City program is referred to in the vision, goals, and missions. The Five-Year Plan (2017–2021) of Mashhad Municipality has been compiled as the fourth operational plan, in which smartening is clearly one of the goals mentioned, in line with the 2026 vision document of Mashhad city. Shiraz's third Five-Year Plan stresses smartening of urban management, in particular by having an electronic municipality, i.e., making digital public service delivery facilities available. Iran's Minister of ICT, during the third Smart Cities Conference (Tehran, 2019), emphasized the duty of the government to provide infrastructures for Smart City projects and noted that '*…the activities carried out in the field of the Smart City over the past year show that we have moved beyond the infrastructure layer, and this year we need to focus on developing inter-sectoral collaboration*' (Tehran Nameh, 2019). There is a strong emphasis on preparing the infrastruc-

tures for Smart Cities in which the Ministry of ICT will be involved, and it also requires the involvement of other ministries. He added '*…apart from the above-mentioned investors, also universities, knowledge-based companies, Internet companies and mobile operators must be active in this sector to ensure Smart City development*'.

Vice President of Science and Technology, Sattari, during the third Tehran Smart Conference (2019), pointed out the necessity of Tehran's smartness. He stated that: '*The Smart City is a new operating system that will be installed on Tehran hardware and will change the city's usage; all the cities around the world are moving in this direction and Tehran must take important steps in this regard to achieve the intended goals*'(Tehran Nameh, 2019) . A deputy of the Technology and Innovation department at the Ministry of Communications during the recent Smart Cities Panel in Tehran (2019) stated that '*…we need a shared discourse to create Smart Cities*' (IRNA, 2019). Hashemi, head of the Tehran City Council during the third Smart Tehran Conference and Exhibition (2019), emphasized that data aggregation and management, open data platform, and big data establishment are Tehran's most important challenges in the path towards becoming smart (Tehran Nameh, 2019). Hanachi (2018), Tehran's Mayor, believes that Smart Tehran can make a profound difference in the lives of its citizens through the development of technological infrastructure and technological advances (The Online Version of the Iranian Daily Hamshahri, 2018). Regarding the current situation in Tehran, he reported that: '*In September 2017, in a poll conducted by Tehran municipality, citizens introduced the two problems of air pollution and traffic as the main problems of the city*'. In response to the question of what his plans to combat air pollution were, he said 'Reducing the share of private cars on the roads and developing the public transportation system are our main goals'. It is mentioned in the Tehran Smart program that '*…the Smart City approach does not just mean hiring urban information and communication technology (ICT) infrastructure, but six dimensions of smart economy, smart mobility, smart environment, smart infrastructure, smart governance and smart living will be noticed at the same time*' (The Official Website of Smart Tehran). The Tehran Mayor emphasizes that the supreme leader advised him to use experts in the city administration and preserve the cultural identity of Tehran (Tasnim News, 2018).

Mashhad puts its main focus on smart citizens. The Mashhad Smart City portal marks as its slogan 'Smart City, Smart Citizen'. Currently, Mashhad profiles itself as 'Mashhad; Smart City, city of hope and life' (Official Portal of Mashhad Municipality). Managing Director of ICT Organization in Mashhad Municipality (2019) in the annual report of 2018 states that in 2018, we witnessed positive developments towards the Smart City, which mostly related to smart applications and services for citizens. He also stresses smart mobility goals '*...the issue of traffic is still at the top of urban issues and is one of the most important concerns of citizens*' (Sobh Mashahd News,

2019). According to the city council announcement, the city of Mashhad also follows smart economic objectives, including the development of regional-global competition and access to business opportunities.

Isfahan, with its historical, cultural, and tourist attractions, has a distinctive look to be smart, sets its goal for smart citizen services, smart traffic and tourism, and smart buildings. Isfahan Municipality's Deputy Minister of Transportation and Traffic announced that Isfahan's smart traffic infrastructures were put into operation at a cost of more than 402 billion Rials (Ettelaat News). Nonetheless, the most important project currently is the integrated spatial information system. In Isfahan municipality, a headquarters was established for the Smart City under the direct supervision of the Mayor of Isfahan, whose task it is to implement a comprehensive plan for the Smart City with the cooperation of the city council research center (Hamshahri, 2017). The director of Isfahan Municipality's ICT Organization (2017) points out: 'Our movement is based on a 5-year plan, which is proposed as Isfahan's 1400 vision program and as the municipality's ICT representative'. According to this plan, it intends to achieve the indicators of the Smart City in the next three years. But certainly, what is planned in the 'Isfahan 1400' is still not what it takes to reach the ideal Smart City. Arbabshirani also mentioned that, comparing Isfahan with Tehran and Mashhad, it is clear that the former two were ahead of Isfahan in this field. However, it is hopeful that, by using their positive and negative experiences, trial and error in the Isfahan's Smart program can be reduced (Hamshahri, 2017). Recently, a member of Isfahan's City Council (2019) stated: '*Since 2016, Isfahan has established its Smart City program but unfortunately, despite the great emphasis of this council, the Smart City project in Isfahan is not going well and at present, Isfahan is not in a good position compared to Tehran, Mashhad, and Shiraz in terms of Smart City indicators*'(Isfahan City Council Official Website).

'*In Shiraz, we have tried to define our goals for the realization of the Smart City based on both scientific definitions, and the situation and problems of our city, in order to draw a better future for the city*', stated the managing director of Shiraz's ICT organization. He stressed that citizen welfare enabled by information technology was the highest goal of Shiraz's Smart City program, which was based on the sub-goals of having clean air, a smart economy, smart transportation, preserving gardens, and greenery of the city. He believed the lack of integrated urban management was the biggest hurdle in the pathway toward developing the Smart City and pointed to the scattered policies and activities of various organizations, such as healthcare and telecommunications, noting that the municipality has a pivotal role to play as coordinator and facilitator (Tamasha News). The head of the Smart and Information Technology Commission of Shiraz City Council (2020) emphasized the smart economy as one of the main goals of Shiraz's Smart City program. She declared that, in order to

achieve a smart economy, eliminating unnecessary regulations and facilitating administrative affairs for the private sector were important issues requiring serious implementation (Iran's Metropolices News Agancy, 2020).

Table 4 provides an overview of the current situation (A) based on the evidence and observations presented in Section 4, as well as the expectations and goals of the Iranian Smart Cities (situation B) to reveal the challenges and opportunities for a transition from 'A' to 'B'.

The challenges regarding technological readiness, however, are related to insufficient infrastructures and unavailability of cutting-edge technologies, but, at a macro level, these are intertwined with Iran's diplomatic status in the world. The issues of economic sanctions and exchange rates have reduced Iran's ability, both economically and in terms of trade, to transfer technology. Meanwhile, focusing on knowledge transfer instead of technology transfer to foster innovation, supporting start-ups, and focusing on the creativity-based solutions instead of high-tech solutions may present opportunities that can boost core competencies for Iran's Smart City program. Generating knowledge and innovative ideas is not sufficient, however. Commercialization of creative solutions and scaling-up innovations are key to success in developing smart solutions (El Abed et al., 2019). Providing a platform for multi-stakeholder partnerships, citizen involvement, and partnership with academia have a critical role in reaching these goals (Geels, 2005). The result analysis indicates that poor citizen participation is due to low trust and awareness levels. As several officials state, the main concern among citizens in these four cities relates to pollution and traffic congestion. The likelihood of changing the citizens' view in favor of the Smart City is thus connected with it solving traffic and pollution problems and may evoke an increase in participation.

The most significant difficulty in getting ready for becoming smart in Iran is associated with the political context. Iran's rigid political ideology and administrative structure do not meet the standards for governing a Smart City. Lack of a common language for the Smart City, lack of a clear vision and roadmap for the Smart City development, scattered policies and urban administration systems, and low levels of citizen trust are Iran's main challenges ahead to be politically ready for any transition towards the Smart City. Utilization of open data policies and data sharing, making reforms in government structures to achieve smart government, are sine qua non's to gain momentum for it. Smart Governance and developing Smart Government applications can be considered as alternative possibilities to raise the level of citizen satisfaction. Nonetheless, in my opinion, they should still consider that when the government uses smart solutions and applications for practical issues perceived as Smart City optimization of various goods and services, the likelihood of everybody using it, too, will increase. But I fathom that as soon as it is more about strategic

and high-level aspects of policy, trust will be missing among many, and its acceptance is bound to remain lower. In short, it will probably work for non-politically sensitive topics. As soon as people get the impression that this is tied up with promoting the interests of the ruling class, they may reject it.

Table 4-Challenges and opportunities of Iranian cities for transition towards the Smart City.

RQs	Empirical Evidence and Observations (Current situation 'A')	Expectations and Goals (Future situation 'B')	Challenges & Opportunities to a transition from 'A' to 'B'
To what extent are Iranian cities technologically ready for becoming smart?	Existence of big data establishment is considering in all four cities, Limited availability of sensors and actuator equipped devices, Notable improvements in terms of ICT Development Index (IDI) in 2017, IoT laws and regulations establishment for the whole country, Existence of data visualization platforms in Tehran & Mashhad, Establishing a cyber security framework is considering.	**General goals and expectations:** 'Sustainability, Higher quality of life Reducing air pollution and congestion, **Individual goals and expectations:** Tehran; smart economy, smart mobility, smart environment, smart infrastructure, smart governance and smart living. Isfahan: smart citizen services, smart traffic and tourism, and smart building. Mashhad; smart citizens, smart	**Challenges:** Insufficient infrastructures, Unavailability of some emerging technologies, Restrictions on buying and transferring technologies due to the sanctions and raising exchange rate. **Opportunities:** Focusing on knowledge transfer instead of technology transfer, fostering innovation and supporting start-ups, focusing on the creativity-based solutions instead of high-tech solutions through citizen participation.
To what extent are Iranian cities socio-economically ready for be-coming smart?	Proper status in knowledge generation, Organizing Smart City conferences and events, Existence of urban innovation centres in all four cities, Existence of science & technology parks and incubators in all four case, Low level of citizens' awareness of the Smart City program in all four cases, Perceived usefulness of the smart solutions for traffic and pollution issues by citizens,		**Challenges**: Poor citizen participation due to lack of trust and low level of awareness, commercialization of creative solutions, scaling-up the innovations. **Opportunities**: Increasing knowledge and innovation capacity, Expanding the positive view of citizens towards the Smart City by solving traffic and pollution problems and then attracting the participation of citizen.

RQs	Empirical Evidence and Observations (Current situation 'A')	Expectations and Goals (Future situation 'B')	Challenges & Opportunities to a transition from 'A' to 'B'
	Citizens' image of their cities are not commonly positive.	economy, changing the image of Mashhad into a city of hope & life. Shiraz; having clean air, smart economy, smart transportation, preserving gardens and greenery of the city.	
To what extent are Iranian cities politically ready for becoming smart?	Having a rigid and narrow vision due to the ideological and religious dogmas, Multi-Level Governance structure with a centralized approach, Lack of integrated urban management system The low level of citizens' sovereignty, The low level of Citizens' trust in the government, Lack of an integrated partnership platform,		**Challenges:** Lack of a common language for the Smart City, Lack of a clear vision and roadmap for the Smart City development, scattered policies and institutions, Gaining the trust of citizens. **Opportunities**: Utilization of open data policies and data sharing to gain the trust of citizens, making reforms in government structures to achieve smart government, considering the Smart City as a common ground to improve international communication and foreign relations.

In consequence, the ToC identifies technological, socio-economic, and political interventions, as well as output, outcomes, and impact in order to become smart (Figure 2).

In terms of technological resources, developing the infrastructures for smart mobility is crucial because of the main urban issues that they face traffic congestion and air pollution. Developing capabilities in cybersecurity, for which Iran already has fine knowledge capacities, can be considered an asset in trading knowledge transfer for technology transfer.

In the national political context, mapping a holistic vision for Smart City development programs is essential. This requires support from both leaders and citizens. At the same time, reforms in international relations and diplomacy are crucial role to acquire necessary technologies and make exchange and global harmonization possible. In the municipal context, changes from segregated urban management systems to more integrated ones based on decentralization and meritocracy are a must.

Last, but not least, making individuals and society at large ready to become smart makes raising awareness a key consideration. Iran may consider to, if technology transfer proves out of reach, promote knowledge transfer and innovation as its main drivers in Smart City programs.

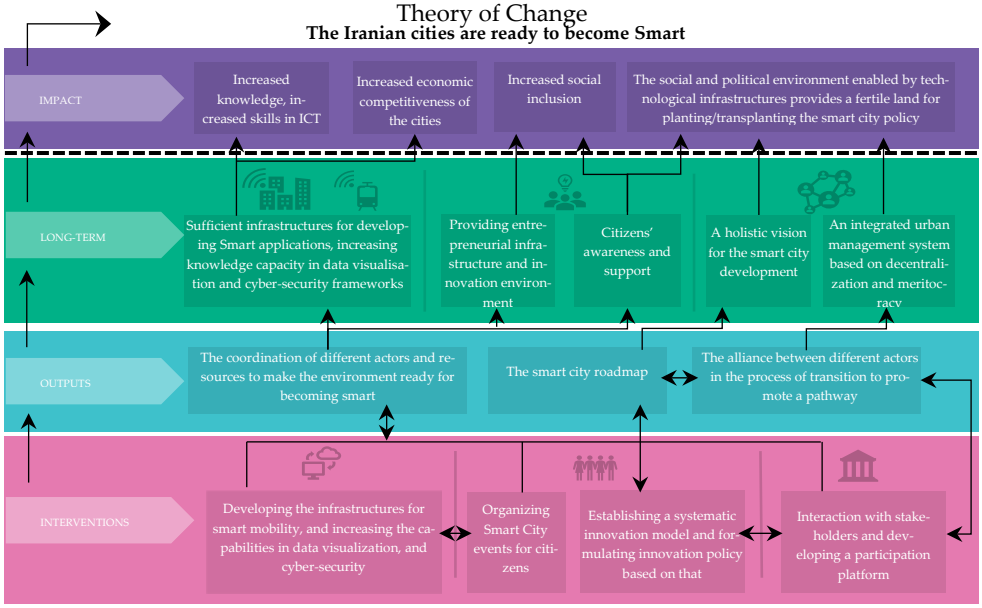


Figure 2-The infographic Theory of Change (ToC) for the readiness of Iranian cities to become smart (developed by the author)

5.6. CONCLUSION

Through a descriptive-analytical approach, the present study sought to address the following questions: How to determine whether cities are ready for a transition into Smart Cities? What does an indicator system measuring Smart City readiness look like? To what extent do Iranian cities meet the minimum requirements to become smart?

The academic merit of the present study was to develop a framework for cities' readiness to move toward a Smart City through an in-depth study of the existing literature, and by measuring it in four large Iranian cities, to reveal the challenges and opportunities ahead for them to become smart. In this study, I developed a Theory of Change (ToC) for the transition Iranian cities should go through.

The results of the analysis show that for several reasons the urban governance model is the most important factor and key bottleneck for Iranian Smart City readiness, making them miss vital opportunities. First, Iran shows significant advances in ICT development, but for proceeding on that road, it needs to overcome the negative consequences of international sanctions. Big data availability and competencies in cybersecurity are Iran's strengths in ICT infrastructures required for Smart City development. Second, as many studies stress the importance of citizen participation in transitions towards a Smart City, Iran needs its citizens' trust and support to be socially ready. My survey reveals that one of the most frequent ideas among citizens' conception of quality of life is connected to 'safety'. Lastly, fundamentalist religious considerations affect openness in policymaking negatively and lead to societal polarization. Rejection of political and religious opponents in governance bodies make the development of a common language and getting citizens on board difficult. Organizing citizen awareness programs, government openness, and adopting a bottom-up approach instead of imposing restrictions can be seen as potential solutions for increasing civic trust and participation. However, to enable a bottom-up approach for developing Smart Cities, Iran basically first needs reforms in its governance structure. Starting Smart City experiments, like urban living labs, virtual forums and meeting hubs, etc., also encourage citizens to participate in the Smart City development process.

Tehran, Mashhad, Isfahan, and Shiraz have planned to become smart, but it seems that their plans are neither comprehensive nor sufficiently systematic. They seem to satisfy neither policymakers nor engineers. Iran requires policy and planning based on knowledge regarding the effects of information technologies on urban structures. Compared to good practices of Smart Cities elsewhere (e.g., Amsterdam, Barcelona, and Dubai), the Iranian cities need to provide a clear horizon and systematic plans through taking into account the variety of different aspects involved in any Smart City program. Poorahmad et al. (2018), who conducted a study on the

necessities and requirements of Tehran to become smart, believe that many of the urban issues in Tehran reside in the way the city is governed and the attitude of its urban managers. They argue that the centralized and authoritarian planning style of the city administration is increasingly linked to the tastes and wishes of city managers. In their view, the formulation and implementation of integrated policies, legislation, and aligned vision have a significant role to play in Tehran's Smart City initiative. Kazemian and Mirabedini (2011) stress the need for an integrated urban management system and state that Tehran, with more than a hundred years of systematic urban management, due to the regime's centralized approach, still lacks sufficient autonomy in its decision-making process. Similarly, Isfahan and Shiraz have no clear vision for their Smart City programs. They, too, require an integrated urban management system, alongside the development of smart infrastructures (Taqvaei, 2015). Zarabi et al. (2019) mention the inequality in infrastructure development in different neighborhoods of Isfahan. The same holds true for other Iranian large cities, particularly Tehran. Unequal access to urban services in poor and wealthy neighborhoods is another characteristic of large Iranian cities which constitutes an obstacle to becoming a Smart City. Mashhad, in comparison, has adopted a more systematic approach. But none of the four cities use a comprehensive roadmap for developing their Smart City. The leadership style and chain of command in Iran present another challenge ahead in promoting systematic urban management. This challenge is more severe in Mashhad, which has conservative local rulers in place with extreme religious perspectives.

The present study adds a few significant insights to the existing frameworks for Smart City readiness in the academic body of knowledge. They contribute knowledge on how cities that are just getting started can be prepared for their transition and start the Smart City development process. In the following chapter I discuss the mechanism that the Smart City initiatives can go through for transplanting the good practices policy lessons in their own context.

6

CONCLUSIONS & FUTURE PERSPECTIVES

6.1. CONCLUSIONS

The evolution of the Smart City concept from the early phase (technology-driven by companies) until now shows that a lot of progress has been made in both research, development and implementation in practice (Ismagilova, Hughes, Dwivedi, & Raman, 2019). In 2008, a debate on the 'Smart City' evoked as urban planning built on high-tech ICT infrastructure for economic growth (Hollands, 2008). Furthermore, the Smart City concept has evolved from a predominantly techno-driven city profile (i.e. digital, intelligent, ubiquitous and information cities) to a more integrative profile that also also takes citizens and broader urban interests into account, while at the same time dealing with the criticism of merely being techno-centric (Huovila et al., 2019; De Jong et al., 2015).

In recent years there has been a lot of attention to the ambiguity of the Smart City concept, leading Komninos and Mora (2018) to conclude that it needs more clarification (Komninos and Mora, 2018). One of the main reasons is that there are multiple stakeholders involved in Smart City development processes with each of them having their own approach based on their interests and expectations (Anthopoulos et al., 2015; Dameri & Benevolo, 2016). Business firms expect financial benefits, whereas governmental organizations have broader political and social concerns. Moreover, environmentalists wish to minimize the ecological impact, and citizens are worried about their safety, privacy and well-being (Kuk & Janssen, 2011; Meijer & Bolívar, 2016; Yigitcanlar & Kamruzzaman, 2018).

More recently scholars have started modelling exercises in a more systematic way to cover different aspects of the Smart City concept (Chourabi et al., 2012; Lee et al., 2014; Neirotti et al., 2014). Most conceptual models of Smart City development reflect different dimensions of the Smart City and all are primarily descriptive in nature and offer few clues as to how to flesh out Smart Cities in practice. Besides, various conceptual models that have been developed mostly look at the Smart City as a phenomenon of urban policy or city branding rather than as an urban development process.

Since still there is no best model or clear conceptual definition and defined domain of application for 'Smart City', learning processes from good practices policies help initiators to make better choices for Smart City policies and strategies based on their own pathway and intended outcomes. Analyzing good practices to draw lesson also helps those Smart Cities good practices to improve their policies over time through making the Smart City concept, its domains, outcomes and the way their policy works in practice more transparent. But this learning process requires a tool to analyze, monitor and benchmark Smart City development process in good practices. Based on this, lessons can be drawn. Next, based on these lessons a learning process mechanism can be established and/or elaborated. Most importantly, during

the learning process the complexity of the context should be considered as well. To address this issue, the present dissertation investigates what local governments that are just getting started in developing and governing their own Smart City can do to reach their intended goal of becoming a Smart City? And how do they manage the process of achieving this, while taking into account their specific circumstances including the policy context? Given that one of the most important approaches in urban policy often is drawing lessons and transplanting concepts and policy from successful examples (i.e. good and 'best' practice), how can this approach help cities in this regard that seek to identify good practice and adopt their likely successful approaches locally? These fundamental questions lead to the main question of this research: '**How to initiate and manage the process of transforming a city into a Smart City?**'

This main question is answered step by step through five sub-questions, which are elaborated in previous chapters. Their answers are summarized in the following sections of this chapter.

6.1.1. Sub-question one: How do cities engage city branding practices when facing ecological modernization? To what extent do they use 'smart' in their brands and how?

City branding is an increasingly practiced in cities around the world with a strong drive to engage in urban (re)development through enhancing 'ecological modernization'. For example, largest cities of Iran have all begun to venture into making profiles of what they think they are or would like to be. However, some of the adopted city branding strategies lack sophistication. I examined what indicators can be used for evaluating the credibility of city brands and applied these to Iran's fifteen largest cities (Table 1). After offering brief descriptions of the generic features of each of these cities, I mapped the use of city brand identities and popular city labels related to ecological modernization and analyzed the credibility of their city branding practices.

Table 1-Criteria for credible city branding.

Credibility Aspect/City	Generating Feelings of Royalty	Facilitating Overarching Strategy	Evoking Positive Feelings	Demonstrating Uniqueness	Allowing different, Non-Contradictory Messages	Logically Connecting Past, Present and Future
City A City B … … Etc.						

Based on the findings, I distinguish five types of cities which the cities with credible brands belonging to the type of 'Cities eager to adopt the complete package of religious, cultural, and modern technological amenities, and want to share in high-tech development boosting the future economic profile of their city. This applies to the cities of Tehran, Mashhad, Isfahan, Shiraz and Qom'. I explained what makes this type of branding more credible in their use than alternatives. Generally speaking, the most credible branding practices facing ecological modernization pertains to 'Smart'. Tehran, Mashhad, Isfahan, Shiraz, Urmia, and Qom are the largest Iranian cities, and are using a 'Smart' label in their profile. The result from examining the brand credibility shows that Tehran, Mashhad, Isfahan, and Shiraz use the most credible brand of 'Smart' (Table 2). They facilitate the development of 'Smart' policy aligns with the national program which appears in both brand identity and position. As the results in Chapter 2 show, their brands of 'Smart' demonstrate their uniqueness and distinctness and their 'Smart' profile covers all environmental, economic (technological and industrial), and cultural aspects.

Table 2 - Evaluating city brand credibility of Iranian large cities.

Credibility Aspect/City	Facilitating Overarching Strategy	Demonstrating Uniqueness	Allowing Different, Non-Contradictory Messages	Logically Connecting Past, Present, and Future
Tehran	high	high	high	high
Mashhad	Medium	high	High	high
Isfahan	High	high	High	high
Shiraz	High	high	High	high

6.1.2. Sub-question two: What does a conceptual model representing different domains of the Smart City look like?

While many national and local governments in the world are placing their bets on Smart City development in countering challenges such as climate change, air pollution, and congestion, few know exactly how to develop them in practice. A high and rising number of publications has appeared addressing the concept of 'Smart City', but not many address its implementation. I developed an Input-Throughput-Output (IO) model (Fig. 1) that aims at increasing a conceptual understanding of the Smart City by describing its various facets and helping policy makers and analysts to make better informed design choices. The different domains of Smart City development process are categorized into resources (inputs), dynamics capabilities and governance (throughputs), and smart applications and externalities (outputs & outcomes). The IO model is developed focusing on a city in an institutional environment in which a local administration wishes to develop (itself into) a Smart City, and where policy makers draft and implement Smart City development plans.

The idea is that the various facets of the Smart City development process can be transformed into sorts of inputs, throughputs and outputs. Clearly, there are several factors that affect this development process, including: contextual factors, and drivers (technology push and needs to solve urban problems). For such a technologically driven city, technology push along with urban needs would be the main driver of innovation (Brem & Voigt, 2009). In fact, by promoting innovation in the urban context they can enable the Smart City development process. When many actors are involved in the process and their interactions vary across time and over policy issues, the process is complex in terms of decision and making policy implementation (Cairney, 2012). Smart City programs deal with different actors and various interests (Joss et al., 2017). Context obviously matters and political, legal, institutional and cultural contexts all affect the Smart City development process. The key throughputs of the process – i.e. Smart City capabilities - allow for the modification and alignment of resources (Gupta et al., 2015).

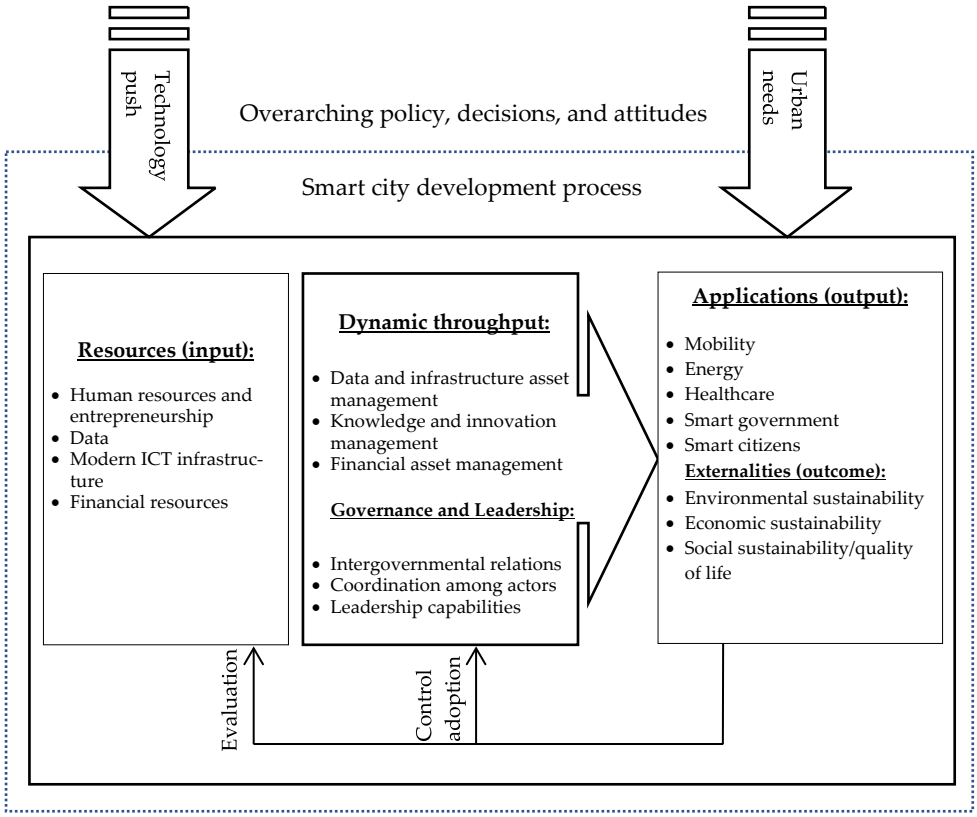


Figure 1- The IO model for the Smart City development process

However, covering all aspects of Smart City and generalizing the Smart City concept in one integral model is not possible. This systematic IO model can provide practitioners and policy makers the required know-how to implement it. Using this model allows them to further their conceptual understanding of Smart Cities, envisage design choices they will face during planning and implementation, and help them to understand the impact of these choices. Using the IO model is illustrated by introducing the case of 'Smart Dubai'. This illustrative case provides insight into how our IO model can be used to explain what the essential resources for Smart City initiatives are, and how Smart Dubai has provisioned them, which facets are at play in each stage of the Smart City development process, what key output facets of Smart Dubai are, and to what extent they were pursued in the Smart Dubai case. The results show that Dubai has a specific type of Smart City development process, which can arguably be characterized as mainly a top-down process supported by visionary

leadership and active branding strategy and actions. The case shows the importance of having a vision in place to support the development process. Overall, the IO model provides enhanced understanding of Smart City development processes. It can be used to analyse complex Smart City development or implementation processes. Alternatively, it can be used in decision making processes. Finally, I suggest to expand it, and use it to design choices for benchmarking Smart Cities development process.

6.1.3. SUB-QUESTION THREE: HOW DO SMART CITIES DIFFER FROM EACH OTHER IN TERMS OF THEIR RESOURCES GOALS AND DEVELOPMENT PATHWAY?

Policy makers, city planners, and practitioners appear to have quite different expectations from what Smart Cities can offer them. This has led to the emergence of different types of Smart Cities and pathways of development. In a follow-up study I expanded the IO model into a framework (Table 3) to introduce the Smart City design choices for each facet in the IO model as a benchmarking tool to identify different pathways of Smart City development.

Table 3-The design variables and indicators of the Smart City development process.

	Smart City Attributes	Design Variables	Indicators (Presence of)
Inputs	HR and Entrepreneurship	Educating and training people	Supporting and strengthening universities and research centres (HR1)
		Transferring (attracting) educated and skilled people	Launching knowledge transfer projects (e.g., scholarships, sabbaticals) (HR2)
		Nurturing the innovation environment	Specific policy in place to promote innovation (HR3)
		Attracting innovative companies	Supporting and encouraging programs for innovative companies (Science and technology parks, free zones) (HR4)
	Information and Communication Technology (ICT) and Data	Data aggregation	Big data establishment (D1)
		Data processing	Data science centres (D2)
		Data real-time analysis	Data visualization (D3)
	Financial resources	Supra-national and national investment	Supra-national and national Smart City development policy and budget (F1)
		Local government investment	Smart City profile and allocated budget (F2)

		Public–private investment	Collaboration with the private sector (F3)
		Foreign investment	International brand and investors
Throughputs	Governance	Governance structures; technocratic, citizen-centric, socio-technical, hierarchical, surveillance	Role of the government and decision-making process (G1) Actors are involved and engaged (G2)
	Knowledge and Innovation management	Open innovation	Living Labs, idea-sharing champions (KI1)
		In-house R&D	Innovation Centres, Smart City R&D department (KI2)
	Data management	Establishing a data authorization	Data Laws (DM1)
		Open/closed/ or shared data platform	Data accessibility (DM2)
	Financial management	Redirecting funds away from inadequate, inefficient urban infrastructure development	Alignment of the urban master plan with Smart City policies (FM1)
		Raising private funds	Having a collaboration platform (FM2)
	Leadership	Leadership styles	Vision creation and the bigger image (L1) Motivating and empowering people (L2) Collaborating with people and influencing them (L3)
Outputs	Smart Mobility	Smart transportation infrastructures	Smart (sensor and actuator equipped) roads and traffic lights, smart parking, bicycle routes (SM1)
		Smart public transportation	Interconnected public transportation, smart vehicles, information application (SM2)
		Smart private transportation	EVs (Electric Vehicles), autonomous driving, car-sharing (SM3)
	Smart energy	Renewable energy	Stationary energy use to be supplied from renewable energy sources (SE1)
		Energy-efficient buildings	Building regulations, energy certificates (SE2)
		New technology for utilities	Smart grids, smart meters (SE3)

Smart health	Smart health monitoring systems	Remote health monitoring, mobile health monitoring, or wearable health monitoring (SH1)
	Smart health management and information applications	Mobile applications for medication information, weight management, information regarding hospitals and clinics (SH2)
Smart citizens	One-way communication	A participation platform for data sharing (SC1)
	Two-way communication	A participation platform for idea sharing (SC2)
	Co-creating and co-designing	A participation platform for cooperative policies (SC3)
Smart governance	Smart administration	Redesigning norms based on smart solutions (technologies) (SG1)
	Smart interaction	Participation and collaboration via social media and social networking (SG2)
	Smart security and safety	Using smart devices and data analytics for surveillance (SG3)
	Smart policies	Using big data analytics for decision-making (SG4)

To answer the research question: When comparing a selection of Smart City projects, how can we classify pathways for their development? We do this by using a cross-case research design of four cities to explore commonalities and differences in development patterns. I used the IO model to retrieve which design variables are at play and lead to which output. The IO model is applied to four cases which are considered as good Smart City practice in this research. The four cases pertain to the following Smart City projects: Smart Dubai, Masdar City, Barcelona Smart City, and Amsterdam Smart City. The four cases have a number of commonalities while they are different in other like governance structures, political system, and culture. The analysis shows that the Smart City development pathway in Amsterdam is based on a business-driven approach that puts innovation at its core. For Masdar technological optimism is the main essence of the pathway, while social inclusion is the main focus of Barcelona Smart City. Finally, visionary ambitious leadership is considered the main driver for Smart Dubai. Based on these insights, a classification for Smart City development pathways is established (Table 4). Following the design choices made for each facet of the Smart City development process, the four cities have different fundamental values and drivers that influenced the pathways they took for Smart City development. This led me to formulate the lessons from their experiences

of choosing specific design variables which result in a specific pathway leading to achieving expected outcomes as well as unexpected outcomes (especially in the case of Masdar).

Table 4- Smart City development pathways (Amsterdam, Barcelona, Dubai, and Masdar).

Case	Main Driver (Core Element)	Development Path	Key Features
Amsterdam	Innovation	Innocratic (start-up and business-driven)	Competition, entrepreneurial Innovative, Bottom-up approach
Barcelona	Inclusion	Sociocratic (Participation-driven)	Democracy, Citizen empowerment through technology and citizens' data sovereignty Participatory, Co-creation
Dubai	Visionary-ambitious leadership	Aristocratic (State and service-driven)	Being first, being best, Top-down Happiness, government services, branding
Masdar	Technological optimism	Technocratic (Investment and branding-driven)	Visibility, lighthouse projects, branding

6.1.4. Sub-question four: How to determine whether cities are ready to transition into Smart Cities?

I answered these questions through introducing an indicator system to measure and assess Smart City readiness (Table 5).

Table 5- The Smart City Readiness framework.

	Smart City Attributes	Design Variables	Indicators (Presence of)
Technological Readiness	ICT and Data resources	Data aggregation	Big data establishment
			Sensors and actuator equipped devices, CCTVs & cameras
		Connectivity	ICT Development Index (IDI)
		Data processing	Data science centers

		Data real-time analysis	Data visualization platforms
	Data management capabilities	Establishing a data authorization	Data Laws
		Security	Establishing a cyber security framework
	Factors	**Definition and Operationalization**	
Socio-economic Readiness	Education	Number of universities and research centers	
		Knowledge transfer and knowledge sharing programs	
	Innovation	Specific policy in place to promote Smart City innovation	
		Supporting and encouraging programs for innovative companies (science and technology parks, free zones, etc.)	
	Awareness	Level of citizens' awareness of the Smart City program in their city	
		Level of citizens' awareness of the Smart City concept and technologies	
	Perceived usefulness	Level of perceived usefulness of the smart solutions for the city's challenges by citizens	
	Mentality and values	Citizens' opinion about a Smart City	
		Citizens' image of their cities	
		Citizens' different ideas of quality of life	
	Political Context	**Definition and Practices**	
Political Readiness	National policy and governance	National leadership	
		Government structure, governance arrangements, policy networks	
		Rules, laws, legal and regulatory reforms	
		Legitimacy, transparency, and trust	
	Municipal policy and governance	Local leadership	
		Partnerships with industry, academia, and citizens	
		Providing a platform for multi-stakeholder partnership	
		Smart City innovation clusters and networks	

I analysed Smart City initiatives in Iran as case studies and used the indicator system to do this. I present and reflect on how cities in Iran explore the possibility of becoming smart and prepare themselves to begin implementing to transition into Smart Cities. The findings of the analysis reveal that the most significant difficulty in Iran is associated with the political context. The changing urban governance model is the most important factor in Iranian Smart Cities' readiness. Utilization of open data policies and data sharing, as well as making reforms in government structures are all considered a sine qua non to gain momentum. Based on the results of the empirical analysis a Theory of Change is developed to address the cities' technological, socio-economic, and political readiness vis-à-vis the desired transition (Fig. 2). The framework for measuring Smart City readiness and the Theory of Change provide practical guidelines to developing systematic roadmaps for initiating implementation of the Smart City policies. The Theory of Change (ToC) is developed based on the interventions which result in the outputs and long-term outcomes that Iranian cities need to enhance for being ready to become smart. The long-term outcomes address impacts that relate to knowledge capacity related to ICT, economic competitiveness, social inclusion, and the organised social and political environment that influence Smart City policy implementation processes.

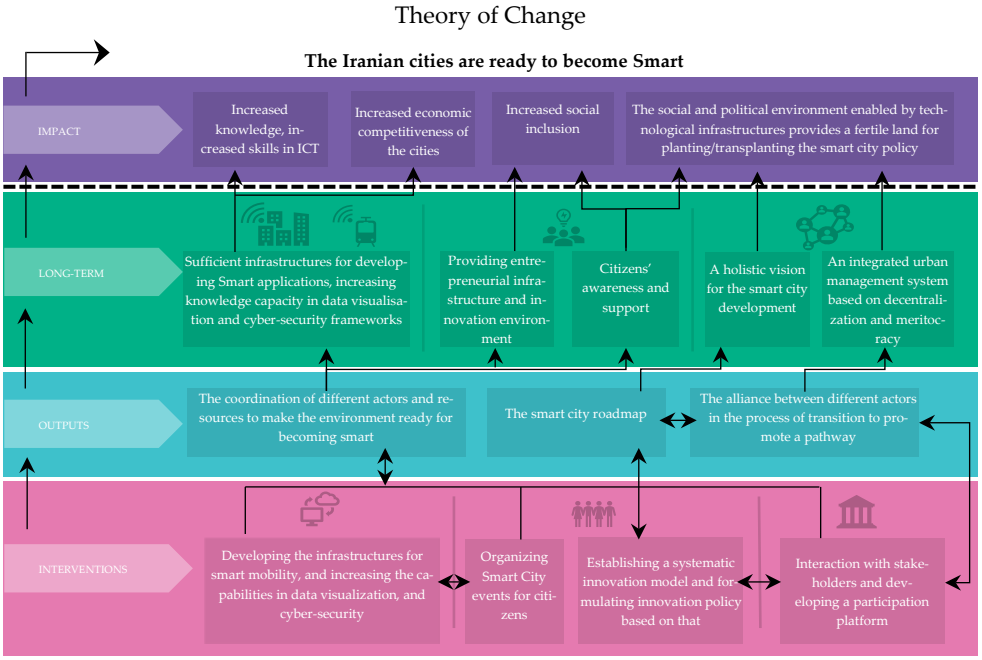


Figure 2-The Theory of Change (ToC) for the readiness of Iranian cities to become smart

6.1.5. Sub-question five: How can Smart City policies be transplanted from cities hosting good practices to cities where Smart City initiatives are to take place?

To address this question, I developed a theoretical framework using theoretical insights from a literature study and insights from empirical studies I conducted previously (see the previous chapters). What I have done so far for transplanting Smart City policies from good practice projects to smart initiatives includes studies on recipient preparation for Smart City transplantation and learning from good practices analysis. Adding insights from policy and issue networks (i.e. transnational networks that support policy transfer), transferring mechanisms, and transplanting approaches, at this step enabled me to sketch a comprehensive image of the comprehensive process of Smart City transplantation (Fig. 3). The greatest thing that the Smart City Transplantation framework can do is to show how the Smart City policy transplantation process can be implemented in a comprehensive conception as a

roadmap for Smart City initiatives to transplant the policy including knowledge on processes and the governance setting enabling Smart City policy implementation. The framework represents the initiation of the Smart City transplantation process, the activities are taken, and the expected outcomes. The roadmap of policy transplantation process in the presented framework also indicates that the various activities are intertwined within an issue network.

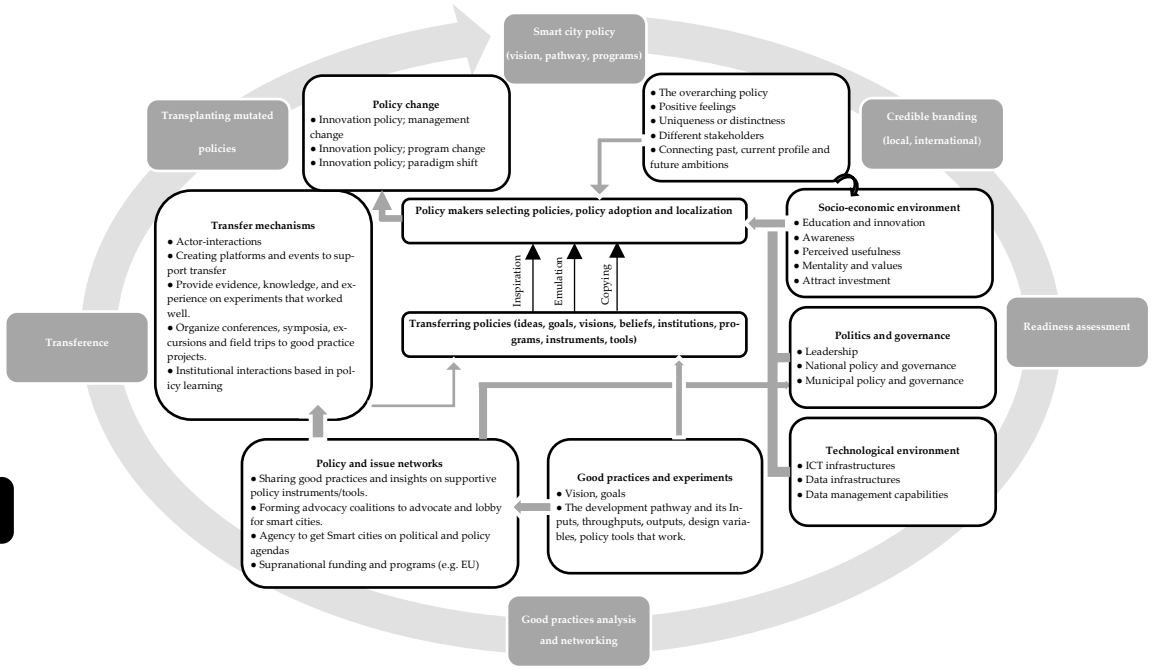


Figure 3- The Smart City Policy Transplantation framework.

It indicates that the transplantation process occurs when the cities begin to have a Smart City development policy in place and profile themselves as 'smart'. City branding practices can be seen as the motives for moving towards this sort of development process. When the brand is considered credible, the motives of becoming 'Smart' are transformed into being willing to develop towards a Smart City. Promoting a credible brand is the beginning of entering to the Smart City networks and communities. Interaction with other experienced and leading members (are known as good practices) and actors inspire the newcomers to learn from them. The Smart

City initiatives start to learn from different sources (e.g., from actor interactions, different sources of evidence, reports, or policy documents) and transfer the ideas, goals, vision, beliefs, institutions, programs, and instruments or tools in various ways (i.e. via copying, emulation, or inspiration). These transferred policies will be mutated in their local context under their overarching policy, and will affect their socio-economic, political, and technological environments. This mutation leads to either radical or incremental policy change that eventually contributes to the Smart City policy adjustment and modification. This also includes adaptation of multiple existing sectoral regulatory and policy frameworks.

In closing, all above responses provide frameworks, conceptual models and empirical findings that enabled the author to answer the main question of this research: '**How to initiate and manage the process of transforming a city into a Smart City?**'. The present study answers this question in two phases: initiating the Smart City policy and program, and then governing its further development process. In the first phase, the author considers the beginnings of a transition to becoming a Smart City based on the postulates of EM theory and the emerging policy direction based on it. In this regard, city branding practices can be seen as the earliest activity of initiating a developmental pathway towards a Smart City. The importance of considering this point as a starting point becomes even more apparent in light of the fact that many studies into urban branding suggest that governments sometimes seek short-term branding benefits rather than long-term development plans. Although this study does not contradict the merits of such short-term goals as such, its main focus is obviously on implementing the Smart City policies and actually realize the desired goals, including improving the quality of life and sustainable development of an urban area. This requires fruitful use of the concept of 'credible branding'. Therefore, through developing credible branding criteria, the way to initiate a transition to a Smart City with a higher likelihood of achieving its desired goals and promises is mapped.

In response to the other part of the main question, successful governance of a Smart City, given the current challenges governments face, achieving a clear and pragmatic understanding of this development process is in order before it can be implemented. A firm grasp of the various facets of the process and using those as a common language between policymakers and practitioners is then due. Choosing the appropriate policies and programs for each city able to meet its needs and be accepted given its circumstances is another factor conducive to a successful Smart City program. Learning, drawing inspiration and transferring lessons from existing good practices is a well-known academic field and governance method, which itself requires insight, creativity and sensitivity to context to be conducted successfully.

6.2. POLICY RECOMMENDATIONS

Targeting policymakers, in this section, I present some recommendations regarding Smart City development. Firstly, to those cities who are just getting started to become 'Smart' I suggest paying attention to their branding practices and consider the credibility factors proposed above to make a strong start in branding themselves in line with their long-term objectives. A credible Smart City branding practice introduces a city as a candidate for Smart City policy adoption based on proven good practices obtained from elsewhere and then flesh it out with full participation from among the policy actors and networks around the municipal government. This also influences the local environment by raising awareness among actors and encourage them to participate in transferring the Smart City policy from other polities (Ohanian, 1990). The brand credibility increases the likelihood of being accepted by the community and allowing the various actors access to the relevant information, policy instruments and tools, lobbies, funds, etc. (Erdem et al., 2004; Aitken & Campelo, 2011). In terms of citizen engagement, a credible brand which generates feelings of loyalty and logically connects past heritage, current situation and hopes for futures has a higher potential to attract citizens. In any kind of innovation, especially innovative policies, resisting acceptance is a major challenge. A credible brand through allowing for different yet non-contradictory messages given to various stakeholders, can target different interests and turn resistance into companionship and participation (Baker, 2012).

Secondly, for Smart City initiatives I recommend following orders to assess their readiness both technologically and non-technologically. Readiness assessment is very important from two angles; (1) it reveals the challenges and opportunities ahead in the transition pathway, and (2) defines a clear horizon of what needs to be done to succeed on this pathway. This can assist them to develop a Theory of Change and a roadmap for transition toward becoming ready to initiate their Smart City development process. Studies and available evidence show that the greatest attention of governments in assessing their own readiness so far has been on technological readiness (Berst et al., 2013). But the centrality of the human factor in the new generations of Smart Cities has become indisputable so that assessing the non-technological readiness obtains more and more attention (Achmad et al., 2018).

Thirdly, I suggest Smart City policymakers to start using the IO model both for implementing and evaluating their Smart City development process. The model can help policymakers (1) ensure that the required resources have been made available, (2) help determine priorities for developing smart applications based on their intended goals in meeting the needs and challenges aligned with the overarching policies, and (3) establish the capability of transforming resources into those applications while anticipating the emergent externalities. Adding a pragmatic view to

Smart City development enhances the likelihood of that the entire development process is indeed completed and diminishes chances of encountering unexpected complications along the way (Yigitcanlar, et al., 2018).

Fourthly, both policymakers and practitioners need to be aware of various design choices for each of the Smart City facets to make the right choices based on their respective needs, available resources, and visions. I suggest to use the design variables and indicators of the Smart City development process proposed in Chapter 4 of the present study. This can be done first for considering various design choices in planning their own Smart programs and second, as a tool to analyze relevant Smart City good practices and their developmental pathways.

Finally, to use experiences of success and failure from others, learn from good practices, access to the accumulated knowledge inside the issue network, transfer and adopt the Smart City policy, I propose to use the Smart City policy transplantation framework to avoid merely copy-pasting policies or isolated policy transfer. Entering the policy and issue networks is an essential requirement for Smart Cities initiatives for sharing good practices and insights through forming advocacy coalitions to advocate and lobby for Smart Cities, and Smart Cities agencies. Organizing conferences, symposia, excursions and field trips to good practice projects facilitate the policy transfer and creating platforms and events supports the transfer. Last but not least, I encourage policymakers to consider having a clear vision for the Smart City development as the central point that prevents them from unguided deviations and translate this vision into a common language for all stakeholders.

6.3. Scientific Contribution

The added scientific value of this research mostly concerns a contribution to the academic body of knowledge on Smart Cities in general and governance and policy of Smart Cities in particular (Hollands, 2008; Komninos & Mora, 2018; Chourabi, Nam, & Walker, 2012; Yigitcalar, 2015; Kuk & Janssen, 2011; Joss et al, 2019; Negro et al, 2015; Kitchin, 2019). Considering the Smart City discourse as one of the main city branding practices and the importance of brand credibility, this doctoral study has contributed to the emerging body of knowledge on city brand credibility by developing a methodology to measure this among cities. In this regard, the study first contributes to the body of knowledge on city branding practices to fill the knowledge gap in terms of a methodology and criteria to map and evaluate credible city branding practices. The proposed methodology provides new insights on how to credibly brand as 'Smart' as the first step towards a Smart City development.

The other piece of added value to the academic literature on Smart Cities (Yigitcalar, 2015; Yigitcalar, 2016; Anthopoulos, 2015; Negro et al, 2015) concerns clarification of the of Smart City concept, reducing ambiguities in it, and making it more

pragmatic by translating a number of its characteristics into inputs, outputs, and throughputs. This was done by modelling the Smart City development process as a specific application of soft system theory (Checkland, 1999). The proposed (IO) model of Smart City development (presented in Chapter 3) as proposed in this doctoral study aims to provide better understanding into the Smart City development process for researchers, policymakers, and practitioners. It does so by providing by providing a general model which helps communication between these user groups. Perceiving Smart City development as a process that needs to be governed (Anthopoulos, 2015; Neirotti et al., 2014; Lee et al., 2013; Chourabi et al., 2012; Hollands, 2008; Joss, 2015; Joss et al, 2019), the (IO)model elaborates existing concepts in the Smart City governance literature.

Developing the (IO) model into a framework for Smart City design offers a range of various choices for designing a Smart City development process according to the specific needs, resources, and intended goals of policy makers and city planners. On the one hand, this design framework can be used to analyse good practice development pathways and learn from them. On the other hand, this framework can be applied to the Smart City practices to assess or evaluate specific Smart City development pathways.

Another significant scientific achievement of this doctoral study concerns the development of a framework for readiness assessment of cities, and its application to a real-life case. This illustrates the use of the framework, and enabled development of a Theory of Change. To date there was no such comprehensive readiness assessment framework covering both technological and non-technological (pertaining to) aspects in the existing literature so far. The proposed Smart City readiness assessment framework classifies non-technological factors into socio-economic and political factors and operationalizes the indicators to measure them.

The final innovative contribution of this study to science is applying the terminology of 'policy transplantation' inspired by the stream of comparative law and policy transfer studies. Considering Smart City adoption and development in terms of urban policy, this doctoral study contributes to policy studies and political science by integrating insights on policy diffusion, transfer and transplantation (Benson & Jordan, 2011; Berry & Berry, 1990; Dolowitz & Marsh, 2000; Hettne, 2002; Sausman et al., 2016; Spicker, 2016) into a novel, integrative, comprehensive framework for Smart City policy transplantation. The Smart City policy transplantation framework in the present study maps the mechanism for traveling and accommodating policy ideas from the donors to recipients in the Smart City context. This study provides a comprehensive framework for municipal governments eager to initiate Smart City programs, learn from practices, transfer the lessons, make the context ready, and

finally adopt, adapt and adjust their Smart City policies to fit the local context and meet the specific local ambitions.

6.4. LIMITATIONS

An important limitation in examining brand credibility is that two more subjective and/or emotional factors determining credibility were not included in the study for lack of measurability. Future research may well introduce viable ways of including these factors in methodologically-sound ways and build connections with images of the city as held by outsiders.

In developing the IO model, there is a concern regarding the linearity of the model, which will be taken up in our future research as well by introducing a new version of the IO model using a neural network modeling approach that will shed light on the interconnections between different facets of the Smart City development process.

Limitations to the comparative study of good practice Smart City projects pertain to the case selection, which included only European and Arab countries, and excluded other ones, like pioneering Smart Cities in North America and East Asia. Because of this bias in the case selection, it is conceivable that potentially more pathways exist in other cities around the world.

Another important limitation is related to the Smart City readiness assessment study that the cultural factors affecting social readiness were not included for lack of measurability. Future research may cover the these and other relevant factors to make the framework even more encompassing. The path dependency in the Smart City transplantation framework can be seen as another limitation to this research. There are more ways for cities to adopt Smart City principles than only looking for good practice elsewhere and adopting the policies to transplant them in their own context. The alternative pathways can be also reflected in future research.

Lastly, language barriers are the other limitations to conduct a cross-national study since for this research I read some sources in the original languages i.e. Farsi, Arabic and translated them into English.

6.5. FUTURE PERSPECTIVES

The present study offers insights that can inform future research agendas on Smart City development. First, I suggest that future studies on different Smart City cases across the world (for instance, China and the United States of America) can provide further detail in the use of the Smart City design choices framework and discover more pathways. Investigating multiple Smart City cases with contextual differences—most importantly with variation in cultural and political systems - can

reveal new aspects of development pathways and their relative success and failure. Moreover, I would like to draw the attention to a current development in Smart City concepts and pathways; i.e., from a predominantly technology-driven approach towards the emerging approach pertaining to 'inclusive Smart Cities'. Taking this shift into account can provide more insight into forecasting and back-casting (Vergragt & Quist, 2011) as the next steps in Smart City development. This would eventually benefit local policy makers in developing local Smart City policy, roadmaps and projects.

Learning from the experiences of leading cities running good practice projects is a common way to formulate and implement Smart City policies in Smart City initiatives through drawing positive and negative lessons. I expect this trend to continue in the future and hope to contribute my share to improving this very practice. This aspect of urban development starts with the rise of Smart Cities as a bridge between economics and technology. The evolution path of Smart City development indicates that it will contain attention to both strong technological stimuli, but also to the human factor, which is arguably the core of its development.

Nowadays, many good practices such as Barcelona, Amsterdam, and Vienna highlight 'social inclusion' in their vision in Smart City development (Smart City World Congress, 2019). In a similar vein, the 'Open Innovation approach' is taking the place of technology push as the core enabler of the Smart City development process (Yun & Liu, 2019). As the results of this doctoral study revealed local governments have different foci that are central to their Smart City development pathways. Social inclusion is the focus of Barcelona Smart City, Amsterdam Smart City has its goal to be an inclusive city, and Dubai Smart City puts the vision as the happiest city for its citizens. This proves that cities that have leading Smart City projects running desire for a citizen-centric approach and becoming an inclusive city. The challenge ahead is that can an inclusive Smart City be realistic or will be a utopian Smart City that policymakers are dreaming for. To clarify, many aspects of a citizen-centric and inclusive Smart City such as citizens co-creation, citizens' participation in decision-making, open data policies and regulations, citizens' data ownership, their awareness and duties, privacy and transparency issues, need to be investigated.

A
Appendix

A

Table A1 -SPSS statically analysis_ correlation between input and output indicators

		Educating & training people	Transferring (attracting) educated and skilled people	Nurture the innovation environment	Attracting innovative companies	Data aggregation	Data processing	Data real-time analysis	Supra-national and national investment	Local government investment	Public-private investment	Foreign investment	Smart transportation infrastructures	Smart public transportation	Smart private transportation	Renewable energy	Buildings energy efficiency	New technologies for utilities	Smart Energy average	Smart health monitoring systems	Smart health management and information applications	Smart health average	One-way communication	Two-way communication	Co-creating and co-designing	Smart city average	Smart administration	Smart interaction	Smart security and safety	Smart policies	Smart governance average	Smart Mobility Average
Educating & training people	Pearson Correlation	1	0,818	0,577	0,577	-0,333	0,333	-0,577	0,577	-0,577	1,000**		0,522	0,577	0,816	0,577	-0,333	-0,577		0,000	-0,333	-0,333	0,333	0,866	0,522	0,577	-1,000**	-1,000**		0,333	-1,000**	0,522
	Sig. (1-tailed)		0,091	0,211	0,211	0,333	0,333	0,211	0,211	0,211	0,000		0,239	0,211	0,092	0,211	0,333	0,211		0,500	0,333	0,333	0,333	0,058	0,239	0,211	0,000	0,000		0,333	0,000	0,239
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4		4	4	4
Transferring (attracting) educated and skilled people	Pearson Correlation	0,816	1	0,000	0,707	0,000	0,000	-0,707	0,000	0,000	0,816		0,000	0,000	0,500	0,000	0,000	-0,707		0,000	0,000	0,000	0,000	0,000	0,424	0,000	0,000	-0,816	-0,816		0,000	-0,816	0,000
	Sig. (1-tailed)	0,092		0,500	0,146	0,500	0,500	0,146	0,500	0,500	0,092		0,500	0,500	0,250	0,500	0,500	0,146		0,500	0,500	0,500	0,500	0,287	0,576	0,500	0,500	0,092	0,092		0,500	0,092	0,500
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Nurture the innovation environment	Pearson Correlation	0,577	0,000	1	0,000	-0,577	0,577	0,000	1,000**	-1,000**	0,577		,905	1,000**	0,707	1,000**	-0,577	0,000		0,000	-0,577	-0,577	0,577	,905	,905	1,000**	-0,577	-0,577		0,577	-0,577	,905
	Sig. (1-tailed)	0,211	0,500		0,500	0,211	0,211	0,500	0,000	0,000	0,211		0,048	0,000	0,146	0,000	0,211	0,500		0,500	0,211	0,211	0,211	0,048	0,048	0,000	0,211	0,211		0,211	0,211	0,048
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Attracting innovative companies	Pearson Correlation	0,577	0,707	0,000	1	-0,577	0,577	0,000	0,000	0,000	0,577		0,302	0,000	0,707	0,000	0,577	-1,000**		0,707	0,577	0,577	0,577	0,302	0,302	0,000	-0,577	-0,577		0,577	-0,577	0,302
	Sig. (1-tailed)	0,211	0,146	0,500		0,211	0,211	0,500	0,500	0,500	0,211		0,349	0,500	0,146	0,500	0,211	0,000		0,146	0,211	0,211	0,211	0,349	0,349	0,500	0,211	0,211		0,211	0,211	0,349
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Data aggregation	Pearson Correlation	-0,333	0,000	-0,577	-0,577	1	0,333	0,577	-0,577	0,577	-0,333		-0,174	-0,577	-0,500	-0,577	1,000**	0,577		0,816	1,000**	1,000**	0,333	-0,522	-0,174	-0,577	0,333	0,333		0,333	0,333	-0,174
	Sig. (1-tailed)	0,333	0,500	0,211	0,211		0,333	0,211	0,211	0,211	0,333		0,413	0,211	0,250	0,211	0,000	0,211		0,092	0,000	0,000	0,333	0,239	0,413	0,211	0,333	0,333		0,333	0,333	0,413
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Data processing	Pearson Correlation	0,333	0,000	0,577	0,577	0,333	1	0,577	-0,577	0,577	0,333		0,870	0,577	0,816	0,577	0,333	-0,577		0,816	0,333	0,333	1,000**	0,522	0,870	0,577	-0,333	-0,333		1,000**	-0,333	0,870
	Sig. (1-tailed)	0,333	0,500	0,211	0,211	0,333		0,211	0,211	0,211	0,333		0,065	0,211	0,092	0,211	0,333	0,211		0,092	0,333	0,333	0,000	0,239	0,065	0,211	0,333	0,333		0,000	0,333	0,065
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Data real-time analysis	Pearson Correlation	-0,577	-0,707	0,000	0,000	0,577	0,577	1	0,000	0,000	-0,577		0,302	0,000	0,000	0,000	0,577	0,000		0,707	0,577	0,577	0,577	-0,302	0,302	0,000	0,577	0,577		0,577	0,577	0,302
	Sig. (1-tailed)	0,211	0,146	0,500	0,500	0,211	0,211		0,500	0,500	0,211		0,349	0,500	0,500	0,500	0,211	0,500		0,146	0,211	0,211	0,211	0,349	0,349	0,500	0,211	0,211		0,211	0,211	0,349
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Supra-national and national investment	Pearson Correlation	0,577	0,000	1,000**	0,000	-0,577	0,577	0,000		-1,000**	0,577		,905	1,000**	0,707	1,000**	-0,577	0,000		0,000	-0,577	-0,577	0,577	,905	,905	1,000**	-0,577	-0,577		0,577	-0,577	,905
	Sig. (1-tailed)	0,211	0,500	0,000	0,500	0,211	0,211	0,500		0,000	0,211		0,048	0,000	0,146	0,000	0,211	0,500		0,500	0,211	0,211	0,211	0,048	0,048	0,000	0,211	0,211		0,211	0,211	0,048
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Local government investment	Pearson Correlation	-0,577	0,000	-1,000**	0,000	0,577	-0,577	0,000	-1,000**		-0,577		,905	-1,000**	-0,707	-1,000**	0,577	0,000		0,000	0,577	0,577	-0,577	,905	,905	-1,000**	0,577	0,577		-0,577	0,577	,905
	Sig. (1-tailed)	0,211	0,500	0,000	0,500	0,211	0,211	0,500	0,000		0,211		0,048	0,000	0,146	0,000	0,211	0,500		0,500	0,211	0,211	0,211	0,048	0,048	0,000	0,211	0,211		0,211	0,211	0,048
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Public-private investment	Pearson Correlation	1,000**	0,816	0,577	0,577	-0,333	0,333	-0,577	0,577	-0,577	1		0,522	0,577	0,816	0,577	-0,333	-0,577		0,000	0,333	0,333	0,333	0,866	0,522	0,577	-1,000**	-1,000**		0,333	-1,000**	0,522
	Sig. (1-tailed)	0,000	0,092	0,211	0,211	0,333	0,333	0,211	0,211	0,211			0,239	0,211	0,092	0,211	0,333	0,211		0,500	0,333	0,333	0,333	0,058	0,239	0,211	0,000	0,000		0,333	0,000	0,239
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Foreign investment	Pearson Correlation																															
	Sig. (1-tailed)																															
	N	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0
Smart transportation infrastructures	Pearson Correlation	0,522	0,500	,905	0,302	-0,174	0,870	0,302	,905	,905	0,522		1	,905	0,654	,905	-0,174	-0,302		0,426	-0,174	-0,174	0,870	0,818	1,000**	,905	-0,522	-0,522		0,870	-0,522	1,000**
	Sig. (1-tailed)	0,239	0,500	0,048	0,349	0,413	0,065	0,349	0,048	0,048	0,239			0,048	0,077	0,048	0,413	0,349		0,287	0,413	0,413	0,065	0,091	0,000	0,048	0,239	0,239		0,065	0,239	0,000
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart public transportation	Pearson Correlation	0,577	0,000	-1,000**	0,000	-0,577	0,577	0,000	-1,000**	-1,000**	0,577		,905	1,000**	0,707	1,000**	-0,577	0,000		0,000	-0,577	-0,577	0,577	,905	,905	1,000**	-0,577	-0,577		0,577	-0,577	,905
	Sig. (1-tailed)	0,211	0,500	0,000	0,500	0,211	0,211	0,500	0,000	0,000	0,211		0,048		0,146	0,000	0,211	0,500		0,500	0,211	0,211	0,211	0,048	0,048	0,000	0,211	0,211		0,211	0,211	0,048
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart private transportation	Pearson Correlation	0,816	0,500	0,707	0,707	0,000	0,816	0,000	0,707	-0,707	0,816		0,654	0,707		0,707	0,000	-0,707		0,500	0,000	0,000	0,816	0,654	0,816	0,707	0,000	0,000		0,816	0,000	0,816
	Sig. (1-tailed)	0,092	0,250	0,146	0,146	0,500	0,092	0,500	0,146	0,146	0,092		0,077	0,146		0,146	0,500	0,146		0,250	0,500	0,500	0,092	0,077	0,074	0,146	0,500	0,500		0,092	0,500	0,092
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Renewable energy	Pearson Correlation	0,577	0,000	1,000**	0,000	-0,577	0,577	0,000	1,000**	-1,000**	0,577		,905	1,000**	0,707	1	-0,577	0,000		0,000	0,577	0,577	0,577	,905	,905	1,000**	-0,577	-0,577		0,577	-0,577	,905
	Sig. (1-tailed)	0,211	0,500	0,000	0,500	0,211	0,211	0,500	0,000	0,000	0,211		0,048	0,000	0,146		0,211	0,500		0,500	0,211	0,211	0,211	0,048	0,048	0,000	0,211	0,211		0,211	0,211	0,048
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Buildings energy efficiency	Pearson Correlation	-0,333	0,000	-0,577	0,577	1,000**	0,333	0,577	-0,577	0,577	-0,333		-0,174	-0,577	-0,500	-0,577	1	0,577		0,816	1,000**	1,000**	0,333	-0,522	-0,174	-0,577	0,333	0,333		0,333	0,333	-0,174
	Sig. (1-tailed)	0,333	0,500	0,211	0,211	0,000	0,333	0,211	0,211	0,211	0,333		0,413	0,211	0,250	0,211		0,211		0,092	0,000	0,000	0,333	0,239	0,413	0,211	0,333	0,333		0,333	0,333	0,413
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
New technologies for utilities	Pearson Correlation	-0,577	-0,707	0,000	-1,000**	-0,577	-0,577	0,000	0,000	0,000	-0,577		-0,302	0,000	-0,707	0,000	-0,577	1		-0,707	-0,577	-0,577	-0,577	-0,302	-0,302	0,000	0,577	0,577		-0,577	0,577	-0,302
	Sig. (1-tailed)	0,211	0,146	0,500	0,000	0,211	0,211	0,500	0,500	0,500	0,211		0,349	0,500	0,146	0,500	0,211			0,146	0,211	0,211	0,211	0,349	0,349	0,500	0,211	0,211		0,211	0,211	0,349
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart Energy average	Pearson Correlation																															
	Sig. (1-tailed)																															
	N	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0
Smart health monitoring systems	Pearson Correlation	0,000	0,000	0,000	0,707	0,816	0,816	0,707	0,000	0,000	0,000		0,426	0,000	0,500	0,000	0,816	-0,707		1	0,816	0,816	0,816	0,000	0,424	0,000	0,000	0,000		0,816	0,000	0,426
	Sig. (1-tailed)	0,500	0,500	0,500	0,146	0,092	0,092	0,146	0,500	0,500	0,500		0,287	0,500	0,250	0,500	0,092	0,146			0,092	0,092	0,092	0,500	0,287	0,500	0,500	0,500		0,092	0,500	0,287
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart health management and information applications	Pearson Correlation	-0,333	0,000	-0,577	0,577	1,000**	0,333	0,577	-0,577	0,577	-0,333		-0,174	-0,577	-0,500	-0,577	1,000**	0,577		0,816	1	1,000**	0,333	-0,522	-0,174	-0,577	0,333	0,333		0,333	0,333	-0,174
	Sig. (1-tailed)	0,333	0,500	0,211	0,211	0,000	0,333	0,211	0,211	0,211	0,333		0,413	0,211	0,250	0,211	0,000	0,211		0,092		0,000	0,333	0,239	0,413	0,211	0,333	0,333		0,333	0,333	0,413
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart health average	Pearson Correlation	-0,333	0,000	-0,577	0,577	1,000**	0,333	0,577	-0,577	0,577	-0,333		-0,174	-0,577	-0,500	-0,577	1,000**	0,577		0,816	1,000**	1	0,333	-0,522	-0,174	-0,577	0,333	0,333		0,333	0,333	-0,174
	Sig. (1-tailed)	0,333	0,500	0,211	0,211	0,000	0,333	0,211	0,211	0,211	0,333		0,413	0,211	0,250	0,211	0,000	0,211		0,092	0,000		0,333	0,239	0,413	0,211	0,333	0,333		0,333	0,333	0,413
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
One-way communication	Pearson Correlation	0,333	0,000	0,577	0,577	0,333	1,000**	0,577	-0,577	0,577	0,333		0,870	0,577	0,816	0,577	0,333	-0,577		0,816	0,333	0,333	1	0,522	0,870	0,577	-0,333	-0,333		1,000**	-0,333	0,870
	Sig. (1-tailed)	0,333	0,500	0,211	0,211	0,333	0,000	0,211	0,211	0,211	0,333		0,065	0,211	0,092	0,211	0,333	0,211		0,092	0,333	0,333		0,239	0,065	0,211	0,333	0,333		0,000	0,333	0,065
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Two-way communication	Pearson Correlation	0,870	0,436	,905	0,302	-0,522	0,522	-0,302	,905	,905	0,870		0,818	,905	0,654	,905	-0,522	-0,302		0,426	-0,522	-0,522	0,522	1	0,818	,905	-0,870	-0,870		0,522	-0,870	0,818
	Sig. (1-tailed)	0,065	0,282	0,048	0,349	0,239	0,239	0,349	0,048	0,048	0,065		0,091	0,048	0,077	0,048	0,239	0,349		0,287	0,239	0,239	0,239		0,091	0,048	0,065	0,065		0,239	0,065	0,091
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Co-creating and co-designing	Pearson Correlation	0,522	0,000	,905	0,302	-0,174	0,870	0,302	,905	,905	0,522		1,000**	,905	0,654	,905	-0,174	-0,302		0,426	-0,174	-0,174	0,870	0,818		,905	-0,522	-0,522		0,870	-0,522	1,000**
	Sig. (1-tailed)	0,239	0,500	0,048	0,349	0,413	0,065	0,349	0,048	0,048	0,239		0,000	0,048	0,077	0,048	0,413	0,349		0,287	0,413	0,413	0,065	0,091		0,048	0,239	0,239		0,065	0,239	0,000
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart city average	Pearson Correlation	0,577	0,000	1,000**	0,000	-0,577	0,577	0,000	1,000**	-1,000**	0,577		,905	1,000**	0,707	1,000**	-0,577	0,000		0,000	0,577	0,577	0,577	,905	,905	1	-0,577	-0,577		0,577	-0,577	,905
	Sig. (1-tailed)	0,211	0,500	0,000	0,500	0,211	0,211	0,500	0,000	0,000	0,211		0,048	0,000	0,146	0,000	0,211	0,500		0,500	0,211	0,211	0,211	0,048	0,048		0,211	0,211		0,211	0,211	0,048
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart administration	Pearson Correlation	-1,000**	-0,816	-0,577	-0,577	0,333	-0,333	0,577	-0,577	0,577	-1,000**		-0,522	-0,577	-0,816	-0,577	0,333	0,577		0,000	0,333	0,333	-0,333	-0,870	-0,522	-0,577	1	1,000**		-0,333	1,000**	-0,522
	Sig. (1-tailed)	0,000	0,092	0,211	0,211	0,333	0,333	0,211	0,211	0,211	0,000		0,239	0,211	0,092	0,211	0,333	0,211		0,500	0,333	0,333	0,333	0,065	0,239	0,211		0,000		0,333	0,000	0,239
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart interaction	Pearson Correlation	-1,000**	-0,816	-0,577	-0,577	0,333	-0,333	0,577	-0,577	0,577	-1,000**		-0,522	-0,577	-0,816	-0,577	0,333	0,577		0,000	0,333	0,333	-0,333	-0,870	-0,522	-0,577	1,000**	1		-0,333	1,000**	-0,522
	Sig. (1-tailed)	0,000	0,092	0,211	0,211	0,333	0,333	0,211	0,211	0,211	0,000		0,239	0,211	0,092	0,211	0,333	0,211		0,500	0,333	0,333	0,333	0,065	0,239	0,211	0,000			0,333	0,000	0,239
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart security and safety	Pearson Correlation																															
	Sig. (1-tailed)																															
	N	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0
Smart policies	Pearson Correlation	0,333	0,000	0,577	0,577	0,333	1,000**	0,577	0,577	-0,577	0,333		0,870	0,577	0,816	0,577	0,333	-0,577		0,816	0,333	0,333	1,000**	0,522	0,870	0,577	-0,333	-0,333		1	-0,333	0,870
	Sig. (1-tailed)	0,333	0,500	0,211	0,211	0,333	0,000	0,211	0,211	0,211	0,333		0,065	0,211	0,092	0,211	0,333	0,211		0,092	0,333	0,333	0,000	0,239	0,065	0,211	0,333	0,333			0,333	0,065
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4
Smart governance average	Pearson Correlation	-1,000**	-0,816	-0,577	-0,577	0,333	-0,333	0,577	-0,577	0,577	-1,000**		-0,522	-0,577	-0,816	-0,577	0,333	0,577		0,000	0,333	0,333	-0,333	-0,870	-0,522	-0,577	1,000**	1,000**		-0,333	1	-0,522
	Sig. (1-tailed)	0,000	0,092	0,211	0,211	0,333	0,333	0,211	0,211	0,211	0,000		0,239	0,211	0,092	0,211	0,333	0,211		0,500	0,333	0,333	0,333	0,065	0,239	0,211	0,000	0,000		0,333		0,239
	N	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4

**. Correlation is significant at the 0.01 level (1-tailed).
*. Correlation is significant at the 0.05 level (1-tailed).
b. Cannot be computed because at least one of the variables is constant.

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Table A2-Qualitative analysis of the design throughput choices

Pathways	**Origin (opportunity window)**	**Throughput**				
		Management of input resources	*Policy*	*Leadership*	*Knowledge & Innovation*	*Coordination of actors*
Amsterdam	City of A'dam and Alliander want to build Smart City to lower CO2 emissions. EU project funding and aligned with Horizon2020	Second largest internet exchange point in the world, High technology readiness level modern technology infrastructures City Data portal ASC platform (to generate ideas)	Structural vision 2040: economy and sustainability Specific policy in place to promote innovation in coordination with national and European policies StartupAmsterdam ASC has the open-house programs and open meeting ups to empower citizens	Economic Board AMS	Smart City Academy and AMS. Smart Entrepreneurial Lab Amsterdam Science Park Living Labs European Union's DECODE project aiming to return data sovereignty to the citizens.	ASC platform Chief Technology Officer (CTO)
Barcelona	Strategy by the City of Barcelona to create a more sustainable,	Municipal data office for public data sovereignty	Smart City Expo and World Congress	City Council, Barcelona Provincial Council, and Area Metropolitana de	Smart innovation; virtual lab	22@ innovation district (to coordinate knowledge partners)

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Pathways	Origin (opportunity window)	Throughput				
		Management of input resources	*Policy*	*Leadership*	*Knowledge & Innovation*	*Coordination of actors*
	smart, and inclusive path for development (2011)	CityOS, Open Data Bcn, and Monitoring Gentrification 'Multi-tenant DIBA' platform	Smart City Program 'Barcelona Smart City Strategy, Planning and Implementation'	Barcelona (AMB).	Institute for Advanced Architecture of Catalonia (IAAC) Fab Lab Development of a community of citizens and developers, and installations for SMEs (early stage).	
	EU project funding and aligned with Horizon2020	Several platorms and applications that support smart mobility 'Dicdim Barcelona', a participatory democracy (digital) platform for communicating and empowering citizens	Subsidies to support solar energy installation		European Union's DECODE project aiming to return data sovereignty to the citizens. 22@ innovation district	
Dubai	Vision of Ruler of Dubai	Khazna Data Centers	Smart Dubai Strategy	Executive office for Dubai Smart City program was established.	Dubai International Academic City (DIAC)	Having all city stakeholders on board is a cornerstone of Smart Dubai strategy.

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Pathways	**Origin (opportunity window)**	**Throughput**				
		Management of input resources	*Policy*	*Leadership*	*Knowledge & Innovation*	*Coordination of actors*
		AI Lab (with IBM)	major training programs to develop human resources (train public staff; civil servants).	Visionary leadership to foster happiness (Ruler of Dubai)	Dubai Knowledge Village	Setting up a champion in line with the overarching policy of developing the Smart City
			Global Block chain Challenge, Dubai Smart City Accelerator and, Dubai Future Accelerators		Dubai Internet city	Happiness champions
		Dubai Pulse; central platform for providing compute, storage, and analytic services	Dubai Data	Dubai Data Establishment	Science parks	Hi-tech free zones
			AI roadmap	Dubai Electricity and Water Authority		
			Paperless government policy is the goal for	Dubai Health Authority		
		Dubai Now' platform (to support e-services to citizens)	smart administration	Dubai Supreme Council of Energy		Smart Dubai Office
Masdar	Abu Dhabi want to pursue the world's	Data management driving innovative solutions	Smart transportation policies	Mubadala Investment Company	Research & Academia	Large scale free economic zone

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Pathways	**Origin (opportunity window)**	**Throughput**				
		Management of input resources	*Policy*	*Leadership*	*Knowledge & Innovation*	*Coordination of actors*
	most sustainable city (2006)	IoT platform for increased health, productivity and sustainability (with Huawei)		Holistic approach to develop renewable energy and sustainability by creating the value chain from research to investments. Ruler of Abu Dhabi	Masdar Institute of Science and Technology (MIST) Honeywell Masdar Innovation Center Mobility Urban Value project	Sustainability week platform

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Table A3-Iranian Smart Cities' readiness assessment

	Operationalization	Qualitative Analysis			
		Tehran	Isfahan	Mashhad	Shiraz
Technological readiness assessment	Big data establishment	My Tehran' portal	Isfahan Integrated spatial portal	Mashhad' portal	N/A
	Sensors and actuator equipped devices, CCTVs,and cameras	Air quality sensors, traffic, and monitoring Cameras	Traffic and monitoring Cameras	Flood alert sensors, air quality sensors, and traffic sensors	Traffic and monitoring Cameras
	ICT Development Index (IDI)	7.24 (in 2017)	6.24 (in 2017)	5.35 (in 2017)	6.25 (in 2017)
	Data science centers	Supreme Council of Cyberspace, ICT research institute, Iranian Institute of Information Science and Technology, Iran's IoT Academy	N/A	IT and Cyberspace research center	Shiraz Data Center
	Data visualization platforms	IT, Judicial Affairs, Energy, Education, Financial and Commercial, Healthcare, Demography, Transportation and traffic, Social services, Buildings and housing, Environment, Industry, Landscape and urban services, Culture and religion, Agriculture, forestry and fisheries, Economy, Tourism	An integrated platform for spatial information	Mobile Mashhad Apps; Transportation and traffic, Business, Environment, Payment and Transactions, Waste management	N/A
	Data Laws	IoT laws and regulation issued by Supreme Council of Cyberspace (in 2017)	IoT laws and regulation issued by Supreme Council of Cyberspace (in 2017)	IoT laws and regulation issued by Supreme Council of Cyberspace (in 2017)	IoT laws and regulation issued by Supreme Council of Cyberspace (in 2017)

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	Operationalization	Qualitative Analysis			
		Tehran	Isfahan	Mashhad	Shiraz
	Establishing a cyber security framework	Cyber security research institute	Budget allocation for cyber security projects	Budget allocation for cyber security projects	N/A
Social Readiness assessment	Number of universities and research centers	119 (in 2019)	67 (in 2019)	30 (in 2019)	25 (in 2019)
	Knowledge transfer and knowledge sharing programs	Asian Smart Cities Committee of Asian Mayors Forum	Joint cooperation between the Technical and Vocational University and the ICT Organization of Isfahan Municipality	Mashhad SmartExpo	Shiraz Smart City Exhibition and Urban Investment Opportunities
	Specific policy in place to promote Smart City innovation	Tehran Urban Innovation Center (TUIC)	Isfahan Urban Creativity and Innovation Center	Mashhad Urban Innovation Center	Launching Shiraz Innovation Factory
	Supporting and encouraging programs for innovative companies (Science and technology parks, free zones, etc.)	8 Science &Technology Parks around Tehran, The National Festival of 'From Science to Practice' to support innovative companies with commercialization approach	13 Science and Technology parks and incubators	A Science and Technology parks and 11 incubators	6 Science and Technology parks and incubators
	The level of citizens' awareness of the Smart City program in their city	Citizens have heard about it but have no information of the program	Citizens have heard about it but have no information of the program	Citizens have heard about it but have no information of the program	Citizens have heard about it but have no information of the program
	The level of citizens' awareness of the Smart City concept and technologies	Average level of awareness	Average level of awareness	Average level of awareness	Average level of awareness

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	Operationalization	Qualitative Analysis			
		Tehran	Isfahan	Mashhad	Shiraz
	The level of perceived usefulness of the smart solutions for the city's challenges by citizens	The high level of citizens perceived usefulness is for pollution and traffic	The high level of citizens perceived usefulness is for pollution, traffic, and housing issues	The high level of citizens perceived usefulness is for pollution and traffic	The high level of citizens perceived usefulness is for pollution and traffic
	Citizens' opinion about a Smart City	Most frequent statements are related to 'green' and 'surveillance' city	Most frequent statements are related to 'surveillance' and 'happy' city 'surrounded by technology'	Most frequent statements are related to 'green' and 'surveillance' city	Most frequent statements are related to 'safe' and 'green' city
	Citizens' image of their cities	Most frequent images are 'polluted city', 'busy', 'expensive', and 'alive' city	Most frequent images are 'crowded', 'polluted', 'beautiful', 'historical' city 'with a lot of potentials'	Most frequent images are 'crowded', 'polluted' city with deficiencies in public transportation	Most frequent images are 'happy' and 'beautiful' city
	Citizens' different ideas of quality of life	Most frequent ideas are related to 'safety', 'prosperity', 'happiness', 'peace', and 'citizens (human) rights '	Most frequent ideas are related to 'health', 'safety', and 'happiness'	Most frequent ideas are related to 'prosperity' and 'happiness'	Most frequent ideas are related to 'safety', 'prosperity' and 'happiness'
Political Readiness assessment	Leadership vision/support for Smart City program	Ideological and religious dogmas	Ideological and religious dogmas	Ideological and religious dogmas	Ideological and religious dogmas
	Government structure, governance arrangements, policy networks	Multi-Level Governance, Centralized approach	Multi-Level Governance, Centralized approach	Multi-Level Governance, Centralized approach, the power of Astan-e-Qods, and the conservative ruler of Mashhad (the Friday Prayer leader)	Multi-Level Governance, Centralized approach

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	Operationalization	Qualitative Analysis			
		Tehran	Isfahan	Mashhad	Shiraz
	Rules, laws, legal and regulatory reforms	Existing municipal laws and regulations, upstream policy documents, Islamic law (Shariah)	Existing municipal laws and regulations, upstream policy documents, Islamic law (Shariah)	Existing municipal laws and regulations, upstream policy documents, Islamic law (Shariah), the Rules by the Friday Prayer leader	Existing municipal laws and regulations, upstream policy documents, Islamic law (Shariah)
	Policies, policy instruments	Policies of the different levels of national, regional and municipal, are under consideration	Policies of the different levels of national, regional and municipal, are under consideration	Policies of the different levels of national, regional and municipal, and Astan-e-Qods are under consideration	Policies of the different levels of national, regional and municipal, are under consideration
	Legitimacy, tranparency and trust	Extreme religious considerations, low level of transparency and trust	Extreme religious considerations, low level of transparency and trust	Super-extreme religious considerations, low level of transparency and trust	Extreme religious considerations, low level of transparency and trust
	Partnerships with industry, academia, and citizens	Lack of an integrated partnership platform	Lack of an integrated partnership platform	Lack of an integrated partnership platform	Lack of an integrated partnership platform
	Providing a platform for multi-stakeholder partnership	Lack of an integrated partnership platform	Lack of an integrated partnership platform	Lack of an integrated partnership platform	Lack of an integrated partnership platform

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CURRICULUM VITAE

Negar Noori

noori@law.eur.nl |ngrnoori@gmail.com

www.linkedin.com/in/negar-noori

Technology & Innovation Manager, Product Owner, Smart City Tech & Policy Specialist

A distinguished Technology and Innovation Manager with over seven years of working experience in a hi-tech industry. Fascinated to launch and develop new projects/products fostering innovation. Strong believe in problem-solving by using data, analytical skills and stakeholder management. Demonstrative practical knowledge in product development, innovation strategies, and market analysis. Recent experience includes Smart City Tech & Policy development, through change management and digital transition. Looking forward to combining tech hands-on experience and scientific research experience to put the knowledge in practice.

WORK & RESEARCH EXPERIENCES

Smart City Policy & Tech Researcher Sep 2017 – Present
Delft University of Technology, Erasmus University of Rotterdam

Joining a team of policy experts with limited technical background in an Inclusive Smart City development project, I was an intermediate between policymakers and practitioners using my technological knowledge. I mapped the Smart City design variables, policies and its development process in a conceptual model through studying the smart city good practices of Amsterdam, Barcelona, Dubai, and Masdar. Interacting with different stakeholders and site-visiting helped me to investigate the key facets, projects and design variables of the smart city programs. I worked with living labs to analyse end-user's engagement strategies for co-creating smart solutions and applications. To develop practical solutions from the results, I formulated the lessons learned from the good practices into recommendations to transfer to Smart City initiatives. The tangible outcomes are a roadmap and guidelines for Smart City initiative transition based on developing a Theory of Change.

Research Assistant Nov. 2019 – Mar. 2020
Franklin Vrede, The Hauge

During my PhD, as an ancillary work I joined a research project on improving coaching practices for NEDs conducted by a Coaching Practice Director at INSEAD. I analyzed and processed the data obtained from interviewing NEDs regarding their expectations and challenges during being coached. The result pertains to the improvements in the coaching practices.

Freelancer Mar.2015 – Aug. 2017
Project Coordinator, Kish Free Zone Organization, Kish Island, Iran

While Kish Free Zone joined the national smart city program of Iran, to facilitate the public-private collaboration, I initiated the 'Smart City and City Branding' project as a joint venture project between University of Tehran and Kish Island Organization. My role included writing proposals, fund raising in collaboration with private sector, and organizing workshops and events for urban managers and policy makers. This led to brand Kish as the first Smart Island in Iran.

WORK EXPERIENCES

Technology and Innovation Manager Apr.2012 – Feb. 2015
SRD Co. (A manufacturing company in telecommunication industry), Tehran, Iran

I helped the company to be sustainable with the help of fostering innovation and changing the organizational model. When I joined the managerial team at SRD, importing a high-tech product was expensive due to rising exchange rates, and domestic production from in-house R&D was a cost-effective solution. I initiated a new product development (a PDH digital microwave radio) from idea to commercialization through in-house R&D and applying agile manufacturing and lean production principles. I led the product development and innovation strategies and optimized the technological innovation process. Our team was able to sell the patented product in large quantities in one year. Another challenge to tackle was retaining talents who are the crucial assets for an innovative company, I executed an organizational model change and a mindset that targets the organizational culture through clarifying shared goals and values.

Technical Specialist Oct. 2008 – Apr. 2012
SRD Co., Tehran, Iran

I started as an 'Electronic Design & Assembly specialist' at SRD to test, quality control and edit printed circuit boards (PCBs). My tasks included testing sensitive electronic components in the cleanroom. Helping the company to reduce cost of defects, my assessments revealed major problems in manual assembly methods employed by the firm. To overcome the problems, I took the initiative to upgrade the assembly line to automatic pick and place machines.

SCIENTIFIC SKILLS

- Data analysis
- Data processing
- Conceptualization
- Modelling
- Policy & strategy formulation

INDUSTRY KNOWLEDGE

- UX/UI design
- DevOps principals
- Agile project management
- Lean production
- Change management
- Digital transition

INTERPERSONAL SKILLS

- Leadership
- Proactiveness
- Team building
- Ability to work in a complex environment
- Stakeholders management
- Cross-cultural communication

EDUCATION

Ph.D. in Policy and Management of Technology Sep. 2017 – Sep.2020
Delft University of Technology & Erasmus University of Rotterdam
Thesis title: Smart City Policy Transplantation

MBA in Management of Technology Sep.2011 – Nov. 2013
University of Tehran, Iran
Thesis title: Developing a technological innovation process model in Iran's ICT industry

B.Sc. in Physics- semiconductors Sep. 2003 – Sep. 2008
University of Tehran, Iran

VOLUNTEER EXPERIENCES

Member of 'The Women in Tech Youth Committee'. Member of Iranian student society of Technical University of Delft 2017-2019. Host of the Persian cultural events at TUDelft in 2017. Host of the TU Delft city branding workshop for Iranian urban managers at the University of Tehran in 2016.

LIST OF PUBLICATIONS

Noori, N., & De Jong, M. Towards credible city branding practices: How do Iran's largest cities face ecological modernization? *Sustainability*, 2018.

De Jong, M., Hoppe, T., & Noori, N. City Branding, Sustainable Urban Development and the Rentier State. How Do Qatar, Abu Dhabi and Dubai Present Themselves in the Age of Post Oil and Global Warming? *Energies* 2019.

Noori, N., Jong, M. De, Janssen, M., & Hoppe, T. (2019). Input-Output Modelling for Smart City Development: The Case of Smart Dubai. *Journal of Urban Technology* 2020.

Noori, N.; Hoppe, T.; de Jong, M. Classifying Pathways for Smart City Development: Comparing Design, Governance and Implementation in Amsterdam, Barcelona, Dubai, and Abu Dhabi. *Sustainability* 2020.

Noori, N.; de Jong, M.; Hoppe, T. Towards an Integrated Framework to Measure Smart City Readiness: The Case of Iranian Cities. *Smart Cities* 2020.

Noori, N.; Hoppe, T.; De Jong, M.; Stamhuis, E. Introducing a Conceptual Framework to Analyze Smart City Policy Transplantation. In Smart City: Strategies for City Development and Innovation, 1st ed.; Philips, F., Oh, D., Eds.; World Scientific Publishing Co (In press).

PHD TRAJECTORY

Joining a team of policy experts with limited technical background in an Inclusive Smart City development project, I was an intermediate between policymakers and practitioners using my technological knowledge. I mapped the Smart City design variables, policies and its development process in a conceptual model through studying the smart city good practices of Amsterdam, Barcelona, Dubai, and Masdar. Interacting with different stakeholders and site-visiting helped me to investigate the key facets, projects and design variables of the smart city programs. I worked with living labs to analyse end-user's engagement strategies for co-creating smart solutions and applications. To develop practical solutions from the results, I formulated the lessons learned from the good practices into innovation policies to transfer to Smart City initiatives. The tangible outcomes are a roadmap and guidelines for Smart City initiative transition based on developing a Theory of Change.

During my PhD, as an ancillary work I joined a research project on improving coaching practices for NEDs conducted by a Coaching Practice Director at INSEAD. I analyzed and processed the data obtained from interviewing NEDs regarding their expectations and challenges during being coached. The result pertains to the improvements in the coaching practices.

WORK AND RESEARCH ACTIVITIES

PhD Candidate; Smart City Policy & Tech **Sep 2017 – Sep 2018**

Delft University of Technology, Faculty of Technology, Policy and Management (TPM)

I have started my Ph.D. research project on 'Smart city policy transplantation' at the Department of Multi Actor Systems (TPM faculty, TU Delft). During my first year, I have completed all the graduate school courses (55 credits/ 45), passed Go/nGo, and published my first article. I attended the Smart City World Expo Congress in Barcelona, several events and workshops organized by Amsterdam Smart City (AMC), such as 'AMC Open-House'. I also have done the site-visiting and field research in Dubai and Abu-Dhabi.

PhD Candidate; Smart City Policy & Tech **Sep 2018 – Present**

Erasmus University of Rotterdam, Erasmus School of Law

After finishing the first year in TUDelft, I have been continuing my Ph.D. in the Erasmus Initiative 'Dynamics of Inclusive Prosperity' (a multidisciplinary partnership of Erasmus School of Law, Rotterdam School of Management and the Erasmus School of Philosophy). I have been developing my research skills at Erasmus University by attending a 'Scientific Writing' course at Law school when I arrived. I have attended the Smart City World Expo Congress in Barcelona for the second time in 2019. All the courses, field researches, workshops and seminars led me to publish four scientific journal articles alongside with developing a network with governmental entities and private companies active in Smart City programs.

PHD COURSES

Courses at TUDelft Graduate School: PhD Start-Up Module A,B &C(16 hours) |Becoming a Creative Researcher in Academia (8 hours)| Cross Cultural Communication(8 hours)| Developing Your Academic Skills(12 hours)| How to Interact Effectively with Your Research Team(16 hours)| How to make a questionnaire and conduct an interview(16 hours)| Leadership, Teamwork and Group Dynamics(12 hours)| Political Decision Making(12 hours)| Problem Solving(12 hours)| Research design(12 hours)| Self Presentation(16 hours)| Speed-reading and Mind Mapping(12 hours)|The Informed Researcher (12 hours) |Developing Your Academic Skills (12 hours) |The PhD Network Hub(8 hours) |Achieving Your Goals and Performing More Successfully in Your PhD (24 hours) |Creative Tools for Scientific Writing(16 hours) |Looking For a Job in Netherlands (8 hours)

Course at ESL Graduate School: Scientific Writing (15 hours)

Online Course at ETH University: Smart Cities

WORKSHOPS, SEMINARS AND PRESENTATIONS

Workshops: Working Together on The Central Innovation District (CID)_20 Nov 2017, The Hague| PhD Days for TPM's Students, March 2018, The Hague| Writing Effective Propositions, 2 Nov 2017, Delft |Workshop Personal Branding & Networking, 27 May 2020, Erasmus University| Job crafting workshop, 26 May 2020, Erasmus University |PNN National PhD Day, 24 Nov 2018, Tilburg University| Amsterdam Smart City Open-house, 30 March 2017, Amsterdam.

Conferences & Seminars: Netherlands Institute of Government (NIG) Annual Conference, 9 Nov 2017, Maastricht | Smart City World Expo Congress, Nov 2018 & 2019, Barcelona | Seminar on 'Are You Ready to Publish? The Importance of Being

Open, 20 Sep 2017, TUDelft Science Center |Seminar on Publish for Influence, 1 Nov 2017, Erasmus University.

Presentations: Presenting my first draft paper on City Branding at NIG Conference, 2017, Maastricht |Presenting my PhD research project for The Hauge Smart City Department, 2019, The Hague Municipality| Presenting my draft paper on Smart City IO Modelling for Chinese Delignates, 2019, Erasmus University | Presenting my PhD research project for TPM Research Frontiers Group, 2018, TUDelft |Presenting my draft paper on Classifying Pathways for Smart City Development during the Dynamics of Inclusive Prosperity's scientific meeting.

Teaching Assistance: Policy Game Simulation by Martin De Jong at TUDelft

PUBLICATIONS

Noori, N., & De Jong, M. Towards credible city branding practices: How do Iran's largest cities face ecological modernization? Sustainability, 2018.

De Jong, M., Hoppe, T., & Noori, N. City Branding, Sustainable Urban Development and the Rentier State. How Do Qatar, Abu Dhabi and Dubai Present Themselves in the Age of Post Oil and Global Warming? Energies 2019.

Noori, N., Jong, M. De, Janssen, M., & Hoppe, T. (2019). Input-Output Modelling for Smart City Development: The Case of Smart Dubai. Journal of Urban Technology 2020.

Noori, N.; Hoppe, T.; de Jong, M. Classifying Pathways for Smart City Development: Comparing Design, Governance and Implementation in Amsterdam, Barcelona, Dubai, and Abu Dhabi. Sustainability 2020.

Noori, N.; de Jong, M.; Hoppe, T. Towards an Integrated Framework to Measure Smart City Readiness: The Case of Iranian Cities. Smart Cities 2020.

Noori, N.; Hoppe, T.; De Jong, M.; Stamhuis, E. Introducing a Conceptual Framework to Analyze Smart City Policy Transplantation. In Smart City: Strategies for City Development and Innovation, 1st ed.; Philips, F., Oh, D., Eds.; World Scientific Publishing Co (In press).

POLICY TRANSPLANTATION FOR SMART CITIES INITIATIVES

NEGAR NOORI