The Impact of Real Estate Technology on Smart City Stakeholders

Master Thesis

International Master of Science in Construction and Real Estate Management

Joint Study Programme of Metropolia UAS Helsinki and HTW Berlin

Faculty 2

From

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Date:

Berlin, 28.10.2020

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To my family, to my lecturers, helping me to realize human values and love…

Metropolia

htw. Hochschule für Technik und Wirtschaft Berlin
University of Applied Sciences

International Master of Science in Construction and Real Estate Management
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Conceptual Formulation
Master Thesis for Mr. ARMIN ALAEI
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Topic:

The smart cities and the impact of real estate technology on customer business management

Background:

By 2050, is estimated that more than half of the population will live in the cities. Urbanization is happening faster than at any time in human history and cities cannot add housing at the same velocity as now. Nine hundred million people are still having residency in slums and from a consumption point of view cities consume three-quarter of the world's energy each year which are responsible for around 50% of greenhouse-gas emissions. There are a vast majority of challenges, and our cities have been facing for new sort of challenges. Some city leaders, businesses and even citizens are taking new approaches to tackle these old problems through innovation in housing, food, and water which give us some way of the forward-thinking city that might be only the right answer. Finite resources of drinkable water, the constant-secure source of energy, and clean power supply are the key issues for future cities.

Goals for study:

This research analysis the usage of real estate technology on growing cities, Study cases will be analysed to enable the identification of the main challenges faced during the implementation. This research aim is to write recommendations on how to avoid and minimize these main challenges.

Research question:

1- What is real estate technology and can it be used as a solution to future problems?
2- What would be the new construction guidelines?
3- How managerial implementation can help to reach sustainable goals?
4- What would be replaced in the gap between new cities and the old one?

Signature of the Supervisor

For the
Chairperson of the Examination Board

Received by faculty

of the **Programme** Construction and Real Estate Management
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REQUEST TO CHANGE THE TITLE OF THE FINAL THESIS

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I wish to request for the following change to the title of my thesis.

Previous title:

The Smart Cities and the impact of the real estate technology on Customer business management

New title to be confirmed:

The Impact of Real Estate Technology on Smart City Stakeholders

Please note that changing the title of the final thesis does not constitute a rejection of the topic as defined by § 21, no. 2 of HTW's Examination Framework Regulations!

Agreement of the 1st examiner: Eric Pollock

Agreement of the 2nd examiner: _____

Agreement of the examination board: _____

Berlin, 15.09.2020

Armin Alaei
Signature of the candidate

Abstract

This research explains what a smart city is looking for by providing an overview of innovative tools that are available for smart city stakeholders to reach their targets.

From different types of stakeholders, it discusses government, citizens, and the Real estate industry as types of those potential investor stakeholders who need to build up a collaborative approach based on the UN 2030 agenda for sustainable city development. It also verifies cities as space which in the effort to achieve the sustainable goals deals with every-day challenges ranges from detecting a problem in a district of a town to find a solution and problem forecasting.

Due to making a sustainable decision for different types of projects, gathering internal stakeholders' viewpoints and even subjective marginalized stakeholders should be into consideration. Real estate technology as a platform through gathering real-time data, genuine information analysis, connecting various smart city stakeholders which results in city administration to make a quick, appropriate and practical actions when it comes to the quick decision-making process before other problems emerge.

Affecting our city by this transformation is not without challenges, imminent changes concerning ICT development can potentially affect our built environment and our social capital. Adoption to technology and changes has not been fast and desirable for all stakeholders but during the history of this planet, calculated changes towards sustainable values and respect to the human as the core of this lifecycle have always been the key elements of every resilient city in the world.

Keywords: smart city; real estate technology; stakeholder engagement; property technology; smart cities, digital transformation

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List of Abbreviations

AI	Artificial Intelligence
BIM	Building Information Modelling
CBD	central business district
ConTech	Construction Technology
CPS	cyber-physical systems
DT	Digital Twin
ESG	environmental, social, and governance
Fig	Figure
Fintech	Finance and Technology
ICT	Information and communications technology
IoT	Internet of Things
ISO	International Organization for Standardization
POE	Post Occupancy Evaluation
POS	Point of Sale
PPP	Public-Private Partnership
Proptech	Property Technology
SDG	Sustainable development Goals
TAM	Technology Acceptance Models
UNECE	United Nations Economic Commission for Europe
WECD	World Commission on Environment and Development

1 Introduction

This Master thesis is research seeking to find a solution through several recommendations alongside United Nations sustainable goals defined by the year 2030. Based on what the UN describes, due to getting to the roots of world problems, a global consensus is of importance since neglect of this duty can lead to underlying damages to our civilization all around the world. Among those goals “SDG 11; make cities and human settlements inclusive, safe, resilient and sustainable”.

UN states before the pandemic COVID-19, “the percentage of people who were living in slums rose to up to 24% in 2018, and over 90% of COVID-19 cases are in urban areas. Only half of the world’s urban population have convenient access to public transport and 4.2 million premature deaths in 2016 caused by air pollution.” (UN, 2020) Moreover according to the World Bank by 2050, “with the urban population more than doubling its current size nearly 70% of people predicted to live in cities”. Obviously, demands for affordable housing, basic services, and well-organized infrastructure for better connectivity should be increased which requires high tech solutions for complicated problems.

Smart City as a complex of sustainable issues deals with different types of stakeholders that cooperating and building together. Stakeholders' cooperation can be highly time-consuming when it comes to find a common language and make a decision. As a solution stakeholders’ engagement is an effective way to implement city projects. (Carbonnell, 2019) A fact that can be embedded in real estate technologies.

“Property technology (also known as PropTech)” in the real estate industry is one of the platforms that allow us to have more collaboration between stakeholders. PropTech through a huge market of startups and applications, attempting to facilitate the interactions among different sectors such as buyers, sellers, renters, investors, developers, or real estate professionals in design, construction, and real estate operators. (Singer, 2020)

(Baum, et al., 2020) Explains that the measurement unit of real estate technology success using by enterprises or companies is profit. However, some other researchers discussing sensors if the companies are searching for long term success. Real estate platforms seem to have a fast-growing market a fact that (Faraudo, 2019) believes, the amount of money gets poured into the business interpreted as an index of health.

This paper will build on research and assumption about the impact of Real estate technology on the future of cities through describing how the means of technology by providing a platform and increasing stakeholders connection and transferring their needs through data can achieve a more durable and fast decision in the area of governing a smart city alongside the UN2030 goals.

1.1 Backgrounds

Based on the contemporary definition, a city can be defined as a settlement for the human which can be a permanent and densely settled place with determined limitations and territories defined by the administrator of the government whose dwellers' occupation is more about non-agricultural activities.

A city encompasses different systems as a toolkit for the utilization of the land in different sectors extensively. Some of those such as communication, transportation, housing, and sanitation have an underlying role in developing a city. Although, the concentration of the dense people facilitate some interactions between dwellers of the city and different groups of users at the same time causes some major undesirable side effects regarding the life quality of the inhabitant and impact on ecosystems such as overheating of some area and districts or lack of easy access to water resources. (Caves, R. W., 2004)

Citizens and stakeholders as the fundamental members of a city can have a different role during their interactions in the city, however, sometimes there are no clear boundaries for citizens in societies, which mainly comes from the characteristic's role of stakeholders originating from accepting different and other floating roles (Lasse Berntzen, 2016), but regarding this research, only their role of commitment and collaboration of stakeholders like citizens, property developers and experts in the decision-making process is the scope of this research.

It is of importance that citizens as one of the most important stakeholders having a more visible effect when it comes to participation. Participation as a key role in democracy enables citizens to influence city management criteria through different means of participation. (Lasse Berntzen, 2016) This fact when combines with real estate technology bring legal layers which should be intersected when affects people's right.

1.2 Objectives

This research aims to analyze the impact of real estate technology on city stakeholders which transforming into a smart city. Providing practical recommendations by referring to the below questions is the final aim.

1- What came before Smart City technology, and why does it need improvement?

2- How would be the new construction guidelines for stakeholders?

3- What is real estate technology and can it be used as a solution to future problems?

4- How managerial implementation can help to reach sustainable goals?

5- What is the gap between traditional cities and smart cities?

1.3 Research Scope

This research is based on United Nations' sustainable development goals by the year 2030, limits to analysis the impact of real estate technology on the group(s) of people who are known as "Internal stakeholders" in the process of the city development and transforming to a smart city. It also put a limitation on a detailed definition of all means of real estate technology and platforms which can be applied by different types of city stakeholders. As a result, at the final of this research recommendations due to avoiding and/or minimize the challenges will be considered in the objective's frame of this research. Selected case studies as a part of this research process, aim to strengthen alongside those given recommendations at the end of this research while tries to make a more tangible feeling to the subsequent researcher.

1.4 Research Method

This master thesis has been written by using a combination of academic sources, a review of thesis literature, and using the result of surveys and previous related case studies' results which have been carried out by other researchers in the relevant area. Using Google Scholar introduced more articles, papers which were the results of conferences, books. Comparing other tools that put a set of smart city core components as its priorities extracted from the academic literature review part.

1.5 Thesis Structure

This master thesis is structured into six chapters. After the current part, chapter 2 refers to the concept of a Smart City, the actual situation in recent years and clustering stakeholders of a smart city. It also discusses the key performance indicators of a smart city. Chapter 3 talks about the technology and the means of which potentially can leverage the real estate industry, and its following market and stakeholders player in that area. Chapter 4, searches about means of technology and tools that are applying in the world and their effects on stakeholders. Some examples as case studies Introduced in chapter 5. Those cases briefly analyzed some practices which have been done. Chapter 6, answers to the questions coming from the conceptual formulation. Finally, in Chapter 7. The conclusions of this paper with the following list of recommendations are provided.

2 Smart City

A smart city as an important term in the concept of urban development discusses the development model of a city that aims to consider social sustainability and environmental aspects considering stakeholders' benefits. Various definitions define the meaning of smart cities. In the field of urbanism. this term is being used as a concept of response to overcome a great part of challenges for cities in the future. In this thesis, the expression of a smart city is equal to sustainable cities and/or sustainable smart cities.

As the United Nations in the "Collection Methodology for Key Performance Indicators for Smart Sustainable Cities" states; "make cities and human settlements inclusive, safe, resilient and sustainable"

It should deal with these key factors:

- Affordable access to basic housing in an affordable way
- Providing affordable and sustainable means of transportation
- Sustainable urbanization enhancement
- deaths rates mitigation, reduction of displacements, and losses caused by disasters should be reduced
- Environmental impact mitigation
- world's natural and heritage protection
- green and public spaces providing
- bridging urban and rural areas and providing positive economic circumstances
- Innovative technologies and ICT development." (unece.org, 2017)

2.1 Current Cities Situation

These days about half of the world's population are living in urban districts, and it is expected that this figure increases up to 68 percent during the next 30 years. A combination of the overall growth of the world's population plus gradual movement from

rural districts to urban areas can increase another 2.5 billion people by 2050. The population in urban districts has grown fast between the years 1950 to 2018. Data shows the rapid growth of around 3.5 billion during these years. Distribution of the population in the world shows, the most rural areas with 43% in Africa and Asia by 50% experiencing the less amount of urbanization in between of all the continents. Oceania with the amount of 68%. Similar to Oceania, Europe, and Latin America's urban population reached 74% and 81% respectively. Northern America with 82% has the most urbanized region in this list. Low fertility cities in Europe and Asia show a decline in terms of population among some cities and rural areas. Based on the UNITED NATIONS reports, some sort of natural disaster and financial problems are the main reason for the reduction of population growth in the present situation. (un.org, 2018)

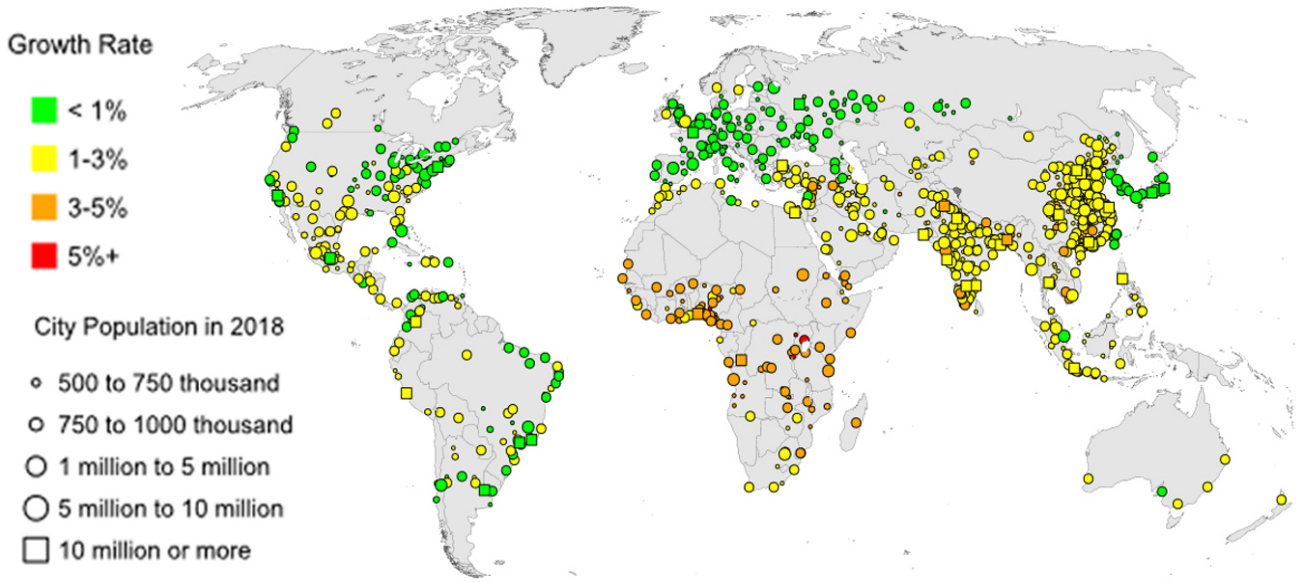


Figure 1. “The growth rate of urban agglomerations by size class” for 2018-2030 (un.org, 2018)

From a sustainable development point of view, understanding, the underlying trends in urbanization and population rate are important in the world. This subject might be more pivotal when it forecasted that about 43 megacities with a population of more than 10 million people are forming by 2030. Sustainable development can meet its targets only if successful management accompanies during the cities’ growth period. This could be

vital especially when it comes to low or/and lower-middle cities in terms of income and GDP of the countries. Besides, since the world continues to urbanize fast, addressing some of the topics regarding the needs for growing cities such as transportation, housing, integration of the infrastructure and energy system could be challenging topics. (un.org, 2018)

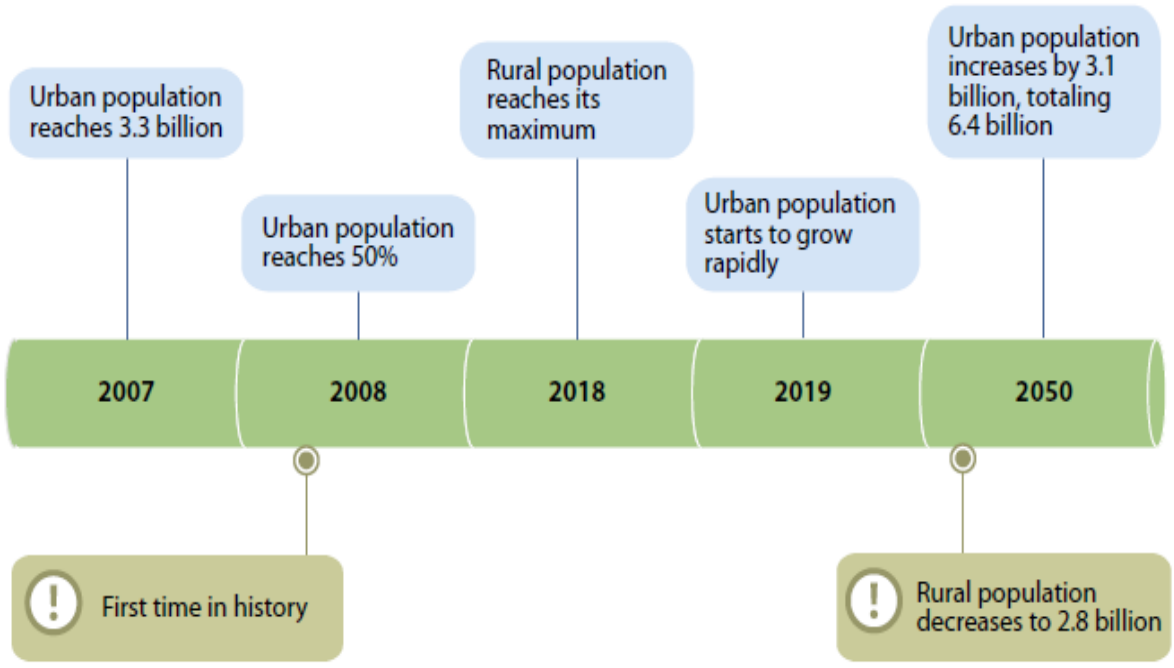


Figure 2. Urbanism over time - future prediction by 2050 (Doug Washburn, Usman Sindhu, 2010)

2.2 Present-day Challenges

In looking at the present-day situation, most of the cities delivering this message that there is a range of hazards involved with the topic of the world's rapid population increase. At the outset, especially in high population density cities and less developed countries with a high population's rate of birth lacking inadequate infrastructure and/or weak economy leads to widening the gap between classifications of the society. This

fact consequently poverty alleviation can be more complicated which leads to a lot of difficulties in urban societies and wasting social capital.

Secondly, beyond their borders, from the macroeconomics point of view, potentially, it causes some sort of difficulties for other countries especially those of which are known as the migration destinations which unmistakably lead to imposes some unpredictable changes in the countries' structure of what having a comprehensive program ahead.

On the other hand, based on the dependency theory of countries, collaboration on the global scale and to be consistent with permanent peace is of importance. This means that closing doors correspondingly leads to lateral side effects both in developed and under-developing countries.

2.3 Global Consensus Targets

17 Sustainable Development Goals defined by 2030 (SDGs) known as the 2030 Agenda are a great forwarding step for the problems mentioned before. In contrast with the Millennium Development Goals (MDGs), this time the UN applied 194 countries and represents its targets on a global scale in September 2015. These goals express the idea of demands and opportunities to build a more sustainable and depicted future in an increasingly interconnected world.

Some ecological economist and public policy leaders criticize that even if the 17 sustainable development goals brings a prominent consensus in a global scale, But, they provide no guidance on how would be the means to achieve those targets.

Such topics as "trade-offs" and "synergies of ecosystem well-being" and "human contribution". Are still without an answer. A big problem could be that there is not any

narrative of change or lack of description of changes in the societies such as the necessity of reforms in policies, aims to those targets. How to overcome these challenges within the current situation and how to cope with the geopolitical situation in the world are important questions that should be answered. (Robert Costanza, 2016)

Although these sustainable development goals are not specified as binding law it helps the societies if they can find appropriate solutions to how to apply those targets and bringing them into practice.

Figure 3: The Sustainable Development Agenda (UN, 2015)

Why Smart City?

As was mentioned before, cities are facing a considerable rate of population. This leads to increased economic burdens plus challenges in terms of resource management and task complexity in the city administration. This issue is weighed down with some major problems. Some of the most crucial predicaments can be a lack of resources, security issues, the health of inhabitants, and waste disposal. Data shows the more dense population we have the more complicated human behavior we will observe, which makes it more complicated to confront this topic.

To achieve sustainable growth and stay competitive, we should remember a city is responsible for find solutions for efficiency enhancement and cost reduction while ensuring qualified standards for its citizens. Smart City as a comprehensive approach,

provide a context for several actions that could be taken to decide by the administration level from the top or by citizens from the down from the stakeholders' side, to find the most effective way to get the root of this challenges, A fact that can happens thanks to the embedded technology and development in the ICT arena.

Backing to the UN 2030 Agenda, it shows that interestingly, around 20% of these goals are related to the Smart city but about 75% of the goals are related to the ICT sectors and technology implementation. (Rodrigo Arias, et al., 2018) which shows a high range of percentages that potentially can be applied.

Field of SDG	Relation to ICT
Good health and well-being	7%
Affordable and clean energy	19%
Infrastructure, innovative industry	25%
Smart City	19%
Responsible production and consumption	5%
TOTAL	75%

Table 1. UN’s 2030 SDGs and proportion to ICT (Rodrigo Arias, et al., 2018) depicted by Author

Smart city definition

The smart city concept is defined as a multidisciplinary notion, which through its technical information infrastructure can manage data and resources to increase people’s quality of life. (Ramaprasad, et al., 2017) It also benefits as a high-tech solution in an advanced city format which enables people more connected while promising a greener and sustainable city. Also, smart cities have been identified as improving factors of

strategies aiming to a better socio-economic situation considering ecology, transportation, and competitive performance of a city through physical IT, social, and business infrastructure. (K. Kourtit and P. Nijkamp, 2012)

There are some other definitions, as describes the smart city. an urban area which uses variant types of electronic system or/and sensors to gathering information, as a data format that can be used for assets management both in services and resources in an efficient form. While that data is processed for city operations and quality and quantity enhancement. This data includes collecting information from devices, buildings, citizens, and assets that are analyzed, processed, and monitor after. (Lai, C.S. et al., 2020)

The word “Smart city” has been entered into urbanism development terminology and built environment considering life quality improvement, environmental footprint reduction, and sustainable services provided by suppliers. Strongly commutative based and relying on data and management of information can be underlying identification part of a “smart city” definition. (Lasse Berntzen, 2016)

In addition, because of the large number of benefits that can be gained through converting our present-day city to a smart one, the concept of “smart city” has been found valuable to the city administration agenda. Among them, becoming sustainable and efficient are those potentials adjectives that are absorbed by the city administrations.

Moreover, proposes a better quality of life for citizens through increasing their participation because of innovative technology embedded in their structure of this concept. Because of all these points, “the European city of tomorrow” vision, considered future cities as:

- “places of advanced social progress, with a high degree of social cohesion, Socially-balanced housing such as social, health, and education for all services”
- “A democracy platform, diversity of cultural dialogue”
- “ecological, environmental regeneration and places of green”
- “Places of attraction and engines of economic growth.” (EuropeanUnion, 2011)

Other statements and definitions are mainly based on creativity, opportunity, innovation, and prosperity as a city with a “promise for the future” (Schaffers, et al., 2012)

2.4 Smart City Stakeholders

Different divers and components forming shapes of the cities. They are numerous and in different areas and territories such as urban planning, architecture, politics, industry and start-ups. In the middle of the last two decades ago, is a city was equipped with the modern infrastructure pushed by Information Technology companies interpreted as smart. This term has been developed after years. Based on the new definition, it will be a cooperation engaging stakeholders that are flexible on challenges, changes through bringing innovative ideas.

Stakeholders have two main characteristics; they are “people affected” because of an activity or some activities that people can influence on those activities and also because it can be clustered as user groups, interest groups, beneficiaries of the project, decision-makers, and all those of which who are often excluded from the decision making level. (MOBARAKI, 2014)

Complex issues are embedded in the characteristics of all smart cities. Different type of stakeholders cooperates to build a smart city, based on their expertise. On the other hand, Stakeholder cooperation can be highly time-consuming to find a common language, so having easier interactions and making a decision which is coming from stakeholders’ engagement will be categorized as one of the best ways to reach success and implementation of the smart city concept. (Carbonnell, 2019)

Gil-Garcia (2015) outlines 10 essential stakeholders that have been seen as the “core of a smart city both in the theory and in practice” according to their survey, namely:

- “Public services
- The city administration and management
- Institutional arrangements and Policies
- Collaboration and governance engagement
- Creative human capital
- Pro-business environment and knowledge economy
- City infrastructure and built environment
- Ecological sustainability regarding the natural environment

- Technologies especially ICT tools
- Information technology and data management”

Garcia assessed that the validity of a city what claims as a smart needed to include all of these items in its framework. It is also of importance that all of these ten elements should be categorized into four underlying factors like the personality of a smart city. The following figure shows that society, government, physical environment, technology, and data are the main underlying dimensions for this classification. For more detailed information please refer to the main source provided by the authors. (Gil-Garcia, et al., 2015)

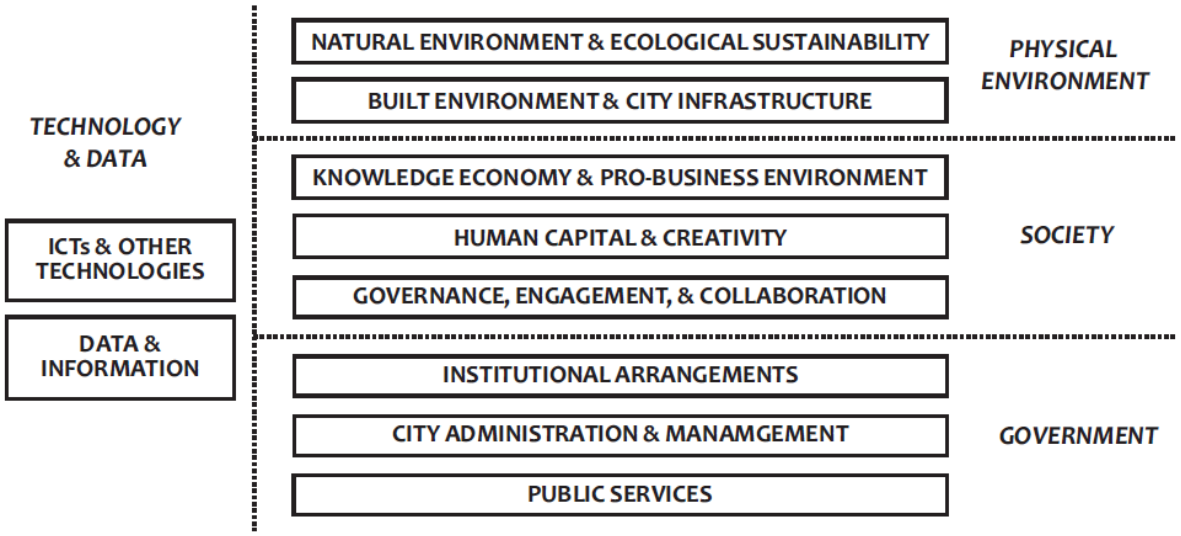


Figure 4: Smart city core components based on academic literature (Gil-Garcia, et al., 2015)

To have a better perception of involved stakeholders with more influence, analysis of stakeholders is of help. It is also helpful when it comes to dealing with the increasing contribution and demands of the stakeholders because of their underlying role in the implementation of smart cities' goals achievement. (Kondepudi, 2015) Also, due to showing the importance of the stakeholders' role ina smart city a result of research can be found in the following table. It is depicted as a review of smart city stakeholders' identification derived from seven literature review. (Jayasena, et al., 2019)

Here in this thesis we only discuss a certain number of stakeholders defined as internal stakeholders. Such as Government, Property developer, and citizens. However when it is necessary and relevant other stakeholders' role also will be mentioned. Stakeholders in a process both as persons and/or as organizations are actors with an interest. As an example the stakeholders can be categorized into the below groups based on the area of interest:

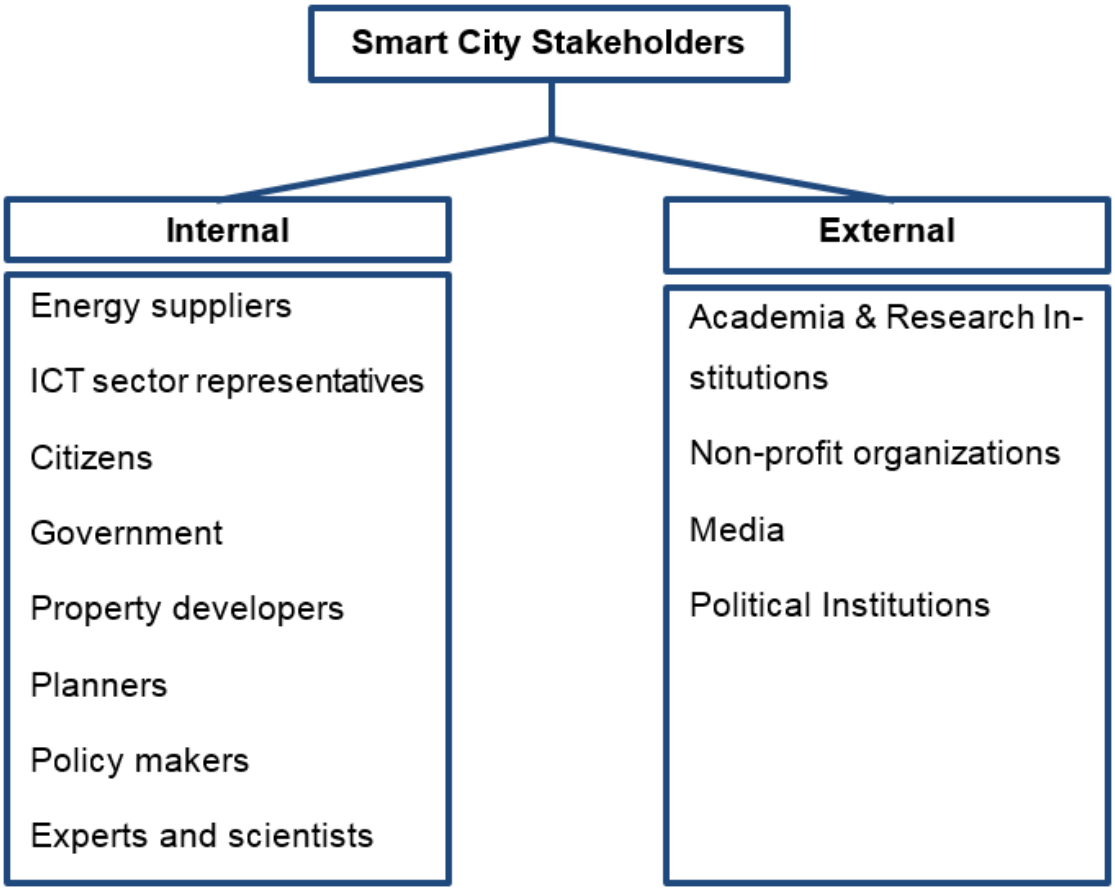


Figure 5: Smart City Stakeholders adopted from (Jayasena, et al., 2019) – depicted by Author

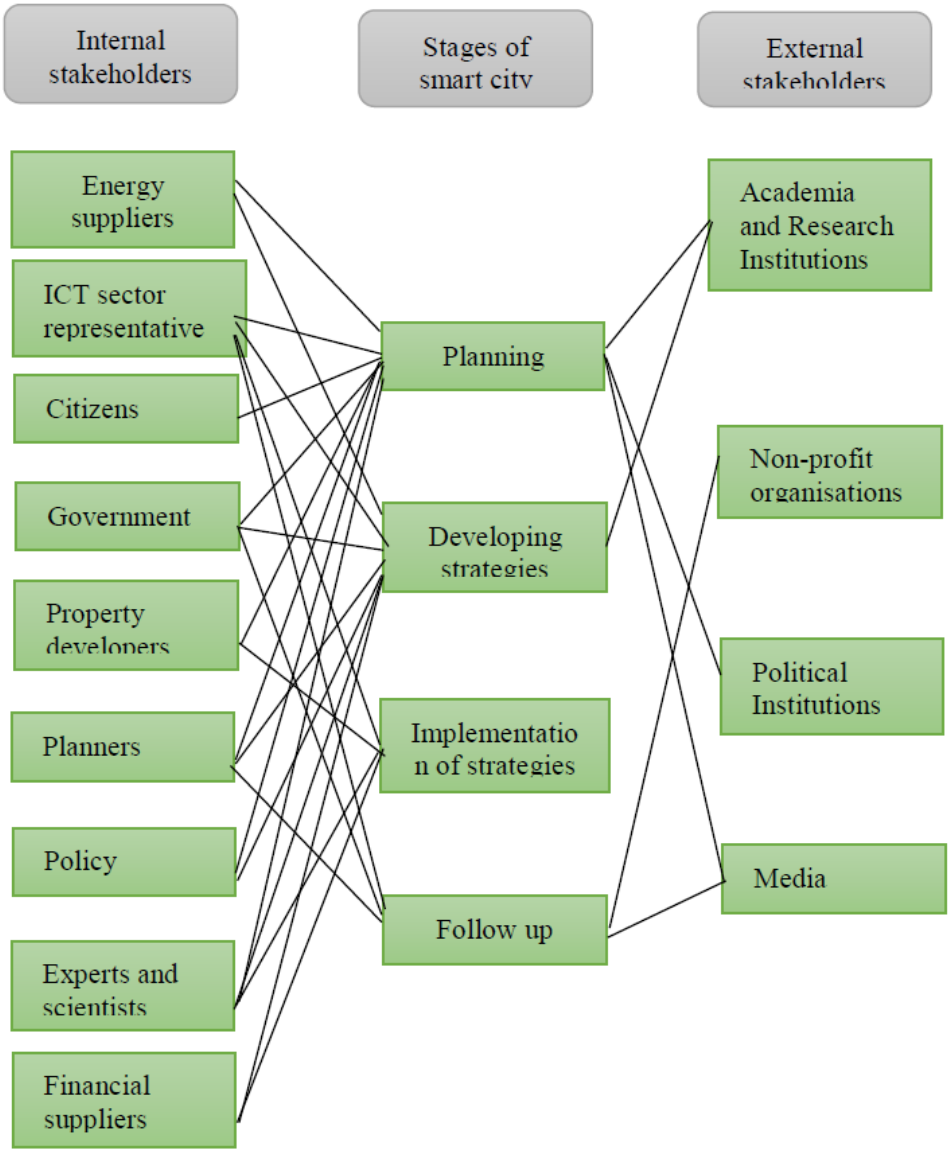


Figure 6: Conceptual Model of Smart City Stakeholders (Jayasena, et al., 2019)

The figure above shows a schematic of interactions between Internal Stakeholders and Externals, obviously more number of interactions on the left side shows the complexity of the actions.

Stakeholders' Role

As was outlined before, stakeholders are the most important members of a city and citizens regardless of the degree of their influence on the decision-making process at the top of this list. Stakeholders' role can even be more highlighted when it comes to participation as a decision-maker in the cities.

Smart city as a model, aiming to touch its targets, enables governments toward models that ushered in an ideal model for the future of sustainable development like zero-carbon paradigm, zero waste, and energy-autonomous model through a circular cash flow and economy. "Berntzen" argues that Government is one of the main players encouraging other stakeholders to implement innovative lifestyle and services through increasing their participation which leads to bottom-up improvements, especially in the citizen-driven arena.

Considering figure 6 (Jayasena, et al., 2019) describes that "a Smart city is a multi-stakeholder ecosystem where stakeholder engagement is important for success. She adds that Stakeholders of a city depend on the effect of the project have a different impact on a project"

They can be classified as internal and external stakeholders." Internal stakeholders were identified as stakeholders who are interested in financial activities and efficiency while "stakeholders in the external frame are interested in the value and quality while Internal stakeholders can be directly influenced or be influenced by the project. (Stravinskiene, 2015).

On the other hand, the participation of the citizens is often depicted as a game-changer of the smart city concept. "This affair comes to true through political approaches when sort of ideas are conducted by the politician decision-maker, but also with non-political where citizens participate to solve their city problems." (Lasse Berntzen, 2016)

The participation of citizens and stakeholders is to influence city management. The role of commitment has a great impact on the city managers especially when the tools have been provided before. Looking to Case study part of this research shows how Barcelona smart citizens can participate with a bottom to up approach through provided adequate infrastructure by the local government.

It is also identified that none of the stakeholders is above the others, and all the stakeholders are essential for a smart city's life-cycle. This means that when it is time to make a decision, a vertical approach with a facilitate connection should be provided. "Carbonnell explains that: Stakeholders can be defined as interest bearers, organized or not, in groups or corporations." (Carbonnell, 2019)

2.5 Data-Driven Construction

The values generated by smart cities are bound-up to the organizational approach, pool potentials, and releasing information and data from numerous urban platforms connecting citizens and inhabitants.

Unlike the previous decades, that the procedure of governing a city was defined and managed through limited operational tasks by a specific number of people in the group of stakeholders which were known as "Operational Silos[1]". A fundamental change originated from smart devices, which has been proved to be a strong game-changer by opening the doors to the citizens through having access to a large amount of data and dealing with inhabitants' actual desire. (Carbonnell, 2019)

Data-Driven Construction uses a large number of IT-technologies in the building or as long as the construction project life cycle exists, for better building process management and generating add value in terms of economy. (Pollock, et al., 2019)

[1] The term "Silo" refers to a circumstance that activities of a department members or management administration do not release data or/and prefer not to share their goals, process and priorities with others which later on can affect the companies' productivity (Saberton, 2018)

Figure 7: UN2030 Agenda acting in Digitalization Arena (UN, 2015) - Modified by Author

2.6 Smart City KPIs

Smart City KPIs provide a baseline to illustrate the current situation of smart cities. KPIs lays a foundation as a tool for smart cities' progress measurement and to compare these signs of progress with the other smart cities. So Key Performance indicators through sharing analytical data lead to facilitate and set up standards in cities. The appendix section of this thesis shows an example of KPIs for smart cities.

Bosch states that “Indicators have been selected that can function as Key Performance Indicators for tracking the progress towards city and project objectives.” (Bosch, et al., 2017)

To form a table of KPIs, a type of strategy considering the long-term investment back-ing-up with reliable policies seeking fundamental shreds of evidence is vital. Because one of the main aims of a smart city is to make the best and fast decision, so applying tools through collecting and processing data can measure the quality and quantity of decisions.

Therefore, selected Indexes of a smart city should have a function. Referring to the “CITYkeys indicators for smart city projects and smart cities”, decision making is the aim of Indicators. Indicator outcomes, either having an assessment approach or based

on multi-indicators or individual indicators should get to a similar decision-making process. (Bosch, et al., 2017) So each smart city project during the building has a different level and the index encompasses two target groups. Considering evolvement over the period is an important point:

1- Smart city managers, using the indicators, should have a decision making role connected to the relative success of smart city values by asking questions like: “How have they been performing or what kind of factors have been determining during the performance due to improving the process for the next projects” (of course being integrated in-depth knowledge of process result of the project is vital)

2- City council decision-makers, who seek insight into the quality and quantity wide range of projects, considering the same questions for smart city project managers.

Besides, Performance measurement is the key element both in the planning and implementing phases of every project, especially when it comes to the solutions regarding smart city evaluation. Interestingly, despite the wide demand for cities and this adoption, the cities still lack such performance measurement systems. Some certain areas in cities' performance usually need to be measured by indicators. The most important of them included the area of energy, means of transportation, greenhouse gas reduction, and infrastructure services acting in the area of digitalization. (Bosch, et al., 2017)For more research, the reader of this thesis can refer to the report of “CITYkeys” which has done vast research regarding this issue.

There are also some other tools to measure the amount of success for a city, Sensors and Matrix are some of the tools that can be used by a specialist due to measuring the smartness of a city or through comparing those data with other smart cities.

3 Real Estate Technology

Technology boomed by the Internet, mobile devices, and high-tech platforms, through applied different types of services. The activities near us are widely affected by utilizing digital technology which is known as the fourth industrial revolution especially after the automation era (3rd.revolution). A researcher describes innovation by three underlying factors; Information Provision, Transactions, Management, and control. (Schwab, 2017)

“Industry 4.0” era expectation is to open a new world for “cyber-physical systems.” Which defines by sort of machines that can control the production process lines through becoming more conscious and intelligent. Business models of “Industry 4.0” imply complete network(s) based on communication between various companies, suppliers, logistics, factories, resources, and targeted customers. (Kaivo-oja, et al., 2020) Industrial 4.0 has opened new gates to the broad means of technology and devices, defining these tools with a detailed approach is out of this research scope. Hence, a hand pick of platforms and technology which potentially can affect the major internal stakeholders in the area of this research scope will be discussed. The selection of them is also based on their impact on the built environment and how the transformation of the existing cities' infrastructure to smart cities happens.

A large number of changes in business and innovation emerges and still evolving. “Smartphone apps, Application Programme interfaces, The internet of Things, AI and Machine Learning, BlockChain and DLT, Sensors, VR, Cloud computing, Vehicles, and Drones” are some of the innovations coming from are the impact of industry 4.0 result.

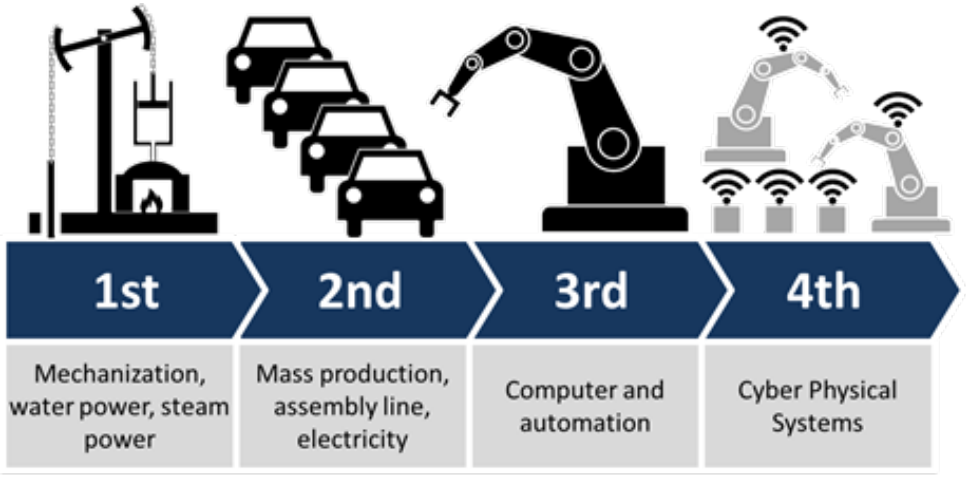


Figure 8. Sequences of industrial revolutions (Roser, 2020)

3.1 Digital Transformation

Cities are crawling along with sustainable enterprises, creating safer public urban districts and more responsive and interactive city administration thanks to the digital transformation.

Documentation of the projects before allocating resources should be “investor minded”. An important point for any potential stakeholders such as investors, constructors, developers. Especially, because of using these documents to evaluate their potential involvement in a construction project and/or during the utilization phase. This fact facilitates knowledge-sharing about present-day conditions of the city and the future of city development. Some other related topics such as risk management responsibilities can be split between the other parties relatively. (Rodriguez, et al., 2020)

As we know, verifying the business impact of stakeholders needs analysis of the stakeholders both during the developing and/or while during the policy implementing phase. This would be an analyzing and gathering information process through qualitative and quantitative mind-maps. It should be done systematically while making a reliable result and caring interests’ of those target groups that should be taken into consideration. (Schmeer, 1999)

On the other hand, accumulated data by every group of stakeholders should be processed so as a result the gaps and conflicts of interest can be assessed and with appropriate tools will be evaluated later. In general, the following 8 below steps are vital to every project data analysis. (Schmeer, 1999)

1. “Process planning
2. Policy selection
3. Key stakeholders identifying
4. Tools adoption
5. Information collection and data recording
6. Stakeholder table filling forms
7. Stakeholder table analysis
8. Information utilization”

All these steps imply that a great mass of information should proceed according to the plan. Changing some parts can affect the previous or next steps regarding the process of data. So considering a city with a large number of stakeholders in which changing decisions regardless of internal and external factors cannot be done easily. This mass of data known as “big data”, However, gives city administration a large number of information about details and components of a plan but also makes it difficult when it comes to decision-making level and analytical approach by using high-tech solution inextricably linked to the high-tech computing database.

The following pages will discuss how the means of technology relies on collected data, from various sources and how cumulative information leading “big data” which will enable smart city objectives into reality, achieving greater economies of scale. A fact that is derived from ongoing development in the ICT area.

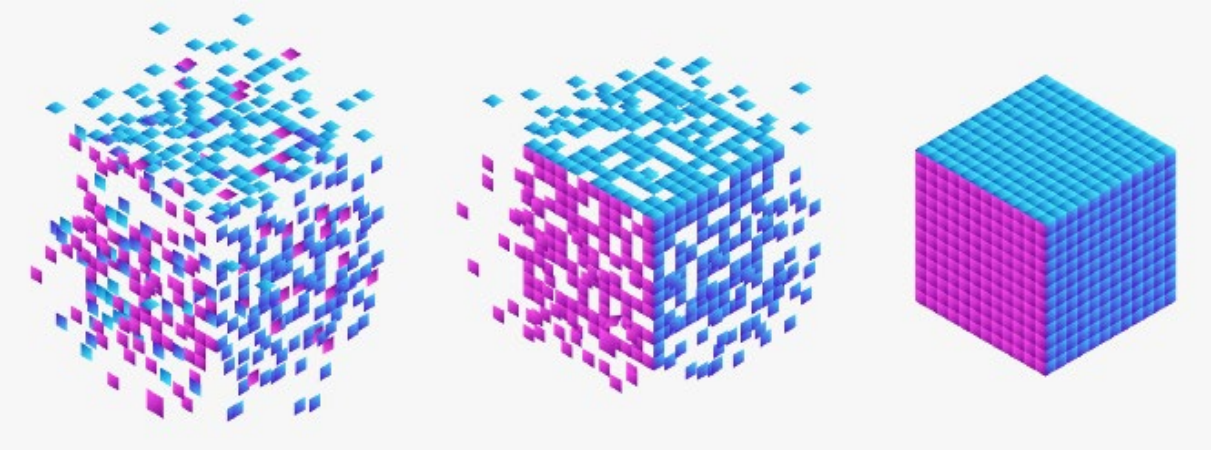


Figure 9. From Left to right: Big Data, Analytics, Decisions (Wadan, 2020)

3.2 PropTech

Real estate technology or Property technology (also known as PropTech) is an information technology platform to the real estate market chain which through a huge market of startups and applications, attempting to facilitate the interactions between different sectors such as buyers, sellers, renters, investors, developers, and real estate professionals in design, construction, and real estate operators. (Singer, 2020). It also can be seen as overlapping with financial technology. To eliminate bureaucracy and make transactions more effective and quicker is the main core of its activity. The Dot-com

boom was the first generation of emerging Real estate technology which had focused more on consumers. In that time, real estate files and residential lists were in printed format and enterprises, concentrated on converting their activity to the digital format. (Voices, 2019)

3.2.1 Background

Some companies such a RIGHTMOVE in the United Kingdom and ZILLOW in America were assessed in the summit list of their respective markets. Later after that, second waves, back to 2008, when the physical real estate market turns to be superseded, from holiday spaces to storage places. A tangible example close to this concept, which made it possible for the owners of the property to rent out their spaces, generated some applications like Airbnb later. Airbnb as a prominent example of this case revealed some pros and cons of this idea later. It has been reported that in the first half of 2019, $12.9 billion invested into the real-estate technology startups mainly by venture investors which is almost twice, compared to 2017. (Putzier, 2019)

On the other hand, the notion of a smart city involves technology implementation and sort of strategies to meet the present-day requirements without making extra challenges for the next generations. It also deals with understanding the city and its components, such as its goals, priorities, and stakeholders. So it is unique when it comes to the aspects of every city. Both in support and development phases, a fact that in smart city examples achieved through information and communicative approaches thanks to ICT development. (Rodriguez, et al., 2020)

For more information about other waves in the real estate market utilizing technology please refer to the sources of this thesis “PropTech2020: the future of real estate by Andrew Baum.”

“Andrew Baum, Chairman of Property Funds Research” reports that the starting points of real estate technology or Prop Tech as the roots lay in three individual impacts. Namely; “Smart Building technologies, Fintech and the notion of Shared Economy.”

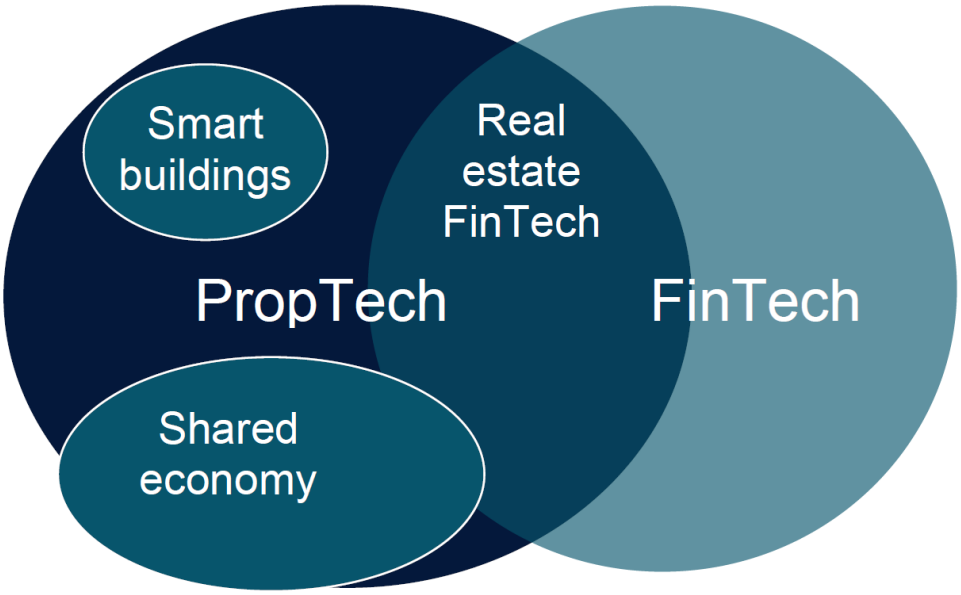


Figure 10: PropTech roots (Baum, 2017)

3.2.2 Smart Buildings

Smart building is described as a platform based on technology that helps managerial and operational tasks of real estate. It ranges from a whole city to even a single apartment. This platform gathers data about urban centers or information about a single property output. It also provides information that can control and facilitate the building services and is different from technology supporting during the design and construction phases of buildings and/or infrastructures. Another classification as ConTech is discussed for this concept as Baum reports.

3.2.3 FinTech

Refers to the means of technology which seeks to the trading of asset and its ownership ranging from funds, shares, equity, or debt. The engaged platforms bring data for

prospective investors like buyers and sellers, or the effect on the transaction process of asset ownership by increased facilitating mechanisms with a more direct approach.

3.2.4 Shared Economy

Another technology-based platform that makes real estate utilization more comfortable. Including a wide range of real estate, from a building, a shop, storage, or an official flat. This platform provides data for users and those people who want to sell space. More facilitating through a direct way or rent out a space based on the fee transaction would be possible, Shared economy provides adequate support for the occupant market in the real estate industry. (Baum, et al., 2020)

The following figure is an upgraded after the previous figure, with additional sectors namely; LegalTech and ConTech. depicted that other stakeholders are adding to the circumstance and make it more complex. Moreover, there is also technology acting in the area of means of transportation which tends to change the cities occupation (Baum, et al., 2020).

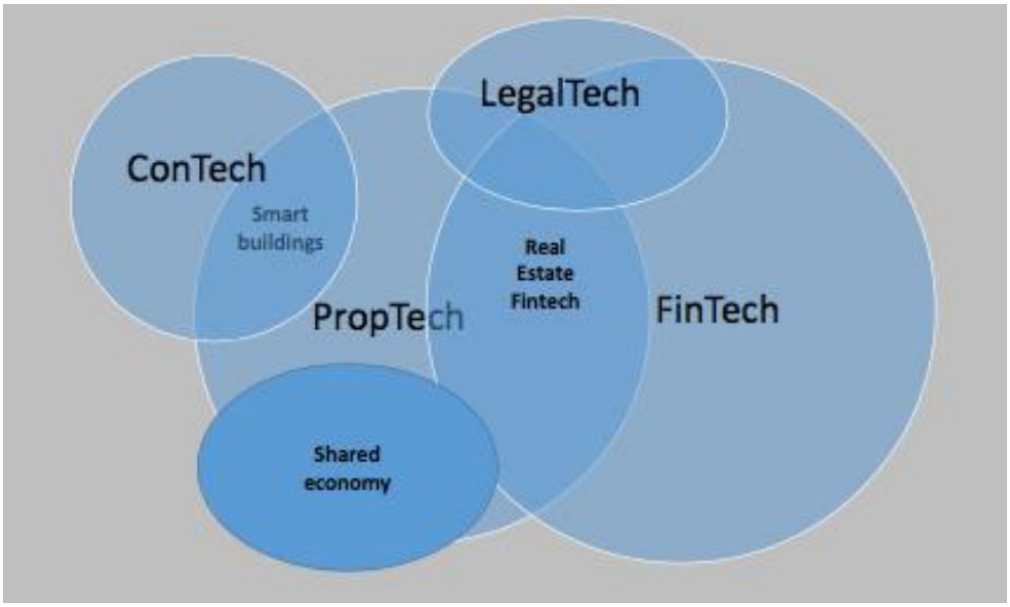


Figure 11: upgraded PropTech roots (Baum, et al., 2020)

Comparing to the previous figure, it shows that smart cities are beyond this scope but it is somewhat needed to verify their effects. So based on Baum research,

the author's perception is that because of the increased complexity of tasks in a smart city multi-layer stakeholder interactions are vital. However it is important to remind that when generalizing the digital-driven approach through political, environmental, economic, and social transformation happens, it is fraught with hazards when they come all together under one umbrella as Andrew Baum describes.

3.3 PropTech Market Analysis

Real estate technology makes the respective industry prepared rather than cyclical fall and rise of returns in the real estate market. However it is still hard to predict the value of the assets in this market, but it seems that in not so distant future, Real Estate is becoming an industry facing social, technological with distinctive demographical trends within its structure thanks to the ICT development and the potential added value, embedded in the structure of the IT sector.

Market Analysis Importance

The measurement unit of success which is used by enterprises or companies is profit. But, when it comes to the company's growth especially for those who are active in the technology world means that the investors have more chances of payback if they invest higher value in this sector. A fact that shows the amount of money gets poured into the business is interpreted as an index of health. (Faraudo, 2019) So the PropTech market shows every year the signals of the growth. PropTech's large range of variety in terms of classification shows that investment can be highly problematic. (Baum, et al., 2020)

Different research companies reporting largely and varied forecasts for their amount of the total funding. An example of this fact, "Venture Scanner measure over $20bn having been invested in PropTech businesses over the period 2014-2018; CB Insights is less optimistic, at around $10bn." (VS, 2019)

The following figure shows the growth of Real Estate Technology Funding over Time up to June 2019. Each investment as an individual has increased in terms of size significantly over time.

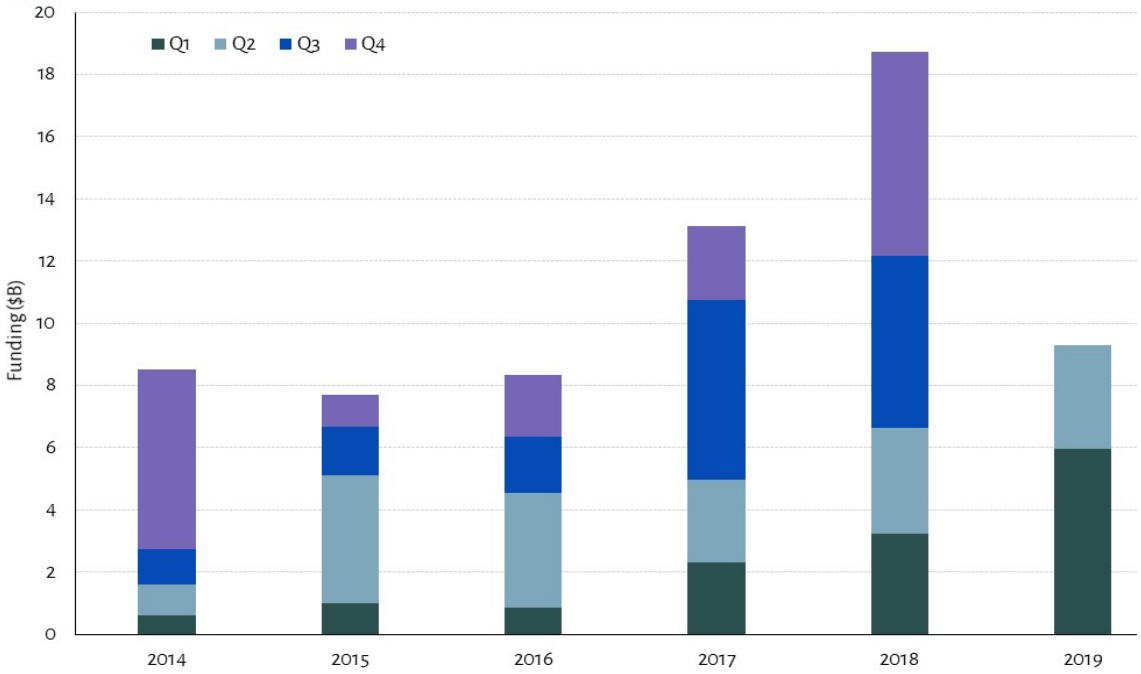


Figure 12: Real Estate Technology Funding over Time up to June 2019 **(VS, 2019)**

PropTech a verticals series of technology that is seeking Information facility management, control, and transaction management introduced by smart real estate, shared economy, and real estate FinTech industry's baseline. This fact has been tested through a survey after providing PropTech in verticals and horizontals by (Baum, 2017), using 600 companies, which shows that 51 percent tend to the FinTech active in the real estate vertically, and near to 62 percent focusing on horizontal transactions. Among PropTech, around 38 percent surveyed were focusing on transaction start-ups.

	Real Estate Fintech	Sharing Economy	Smart Buildings	Contech	Total
Information	12.9%	0.6%	0.9%	3.1%	17.5%
Transactions	38.3%	16.6%	3.4%	3.4%	61.7%
Control/management	0.0%	2.5%	15.0%	2.1%	19.7%
Total	51.2%	19.6%	19.3%	8.6%	98.8%

Figure 13: Pi Labs applications – segment analysis (Baum, 2017)

Based on the KPMG team survey report in 2018, it was clear that the real estate industry realization using PropTech has started. Clients' interviews revealed this fact for their team that it is not assessed only as a technology to them. Customer inclusion evolvement, collaboration, and innovation have been part of the discussion which is probably accompanied by some challenges. Real estate technology is often superseded by different lateral topics that criticize this topic when it comes to the decision-making stage.

Moreover, the real estate industry deals with the other players in the industry as well. SMEs, Service providers in the area of Finance, automotive industries

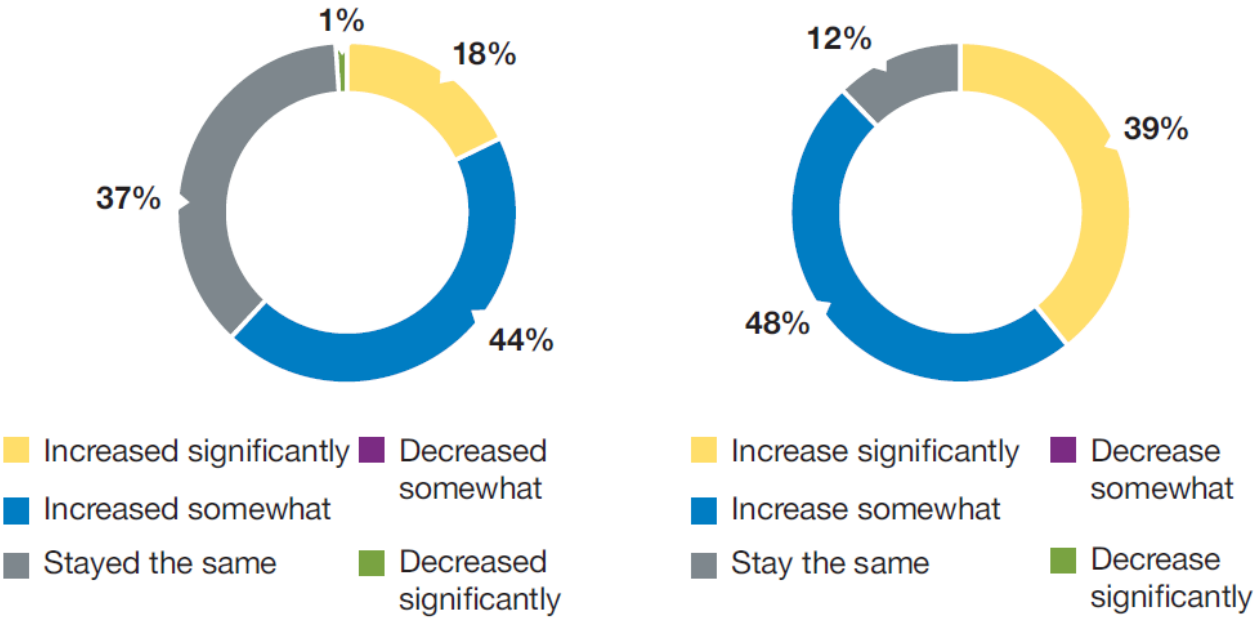


Figure 14: PropTech investment; Left: 2018 Trends, Right: Next 3-5 years forecast (PWC, 2019)

3.4 PropTech Dispersion

Real estate technology is becoming a global innovation. The following figure depicted start-ups PropTech distribution around the world. It is of help to mention that the size of each point represents the funding that the company gained. It also shows that they are clustered in a certain part of the world.

The aggregation of dots on the map shows California, the east coast of the United States, metropolitan areas in Asia, such as Beijing, Singapore, Seoul, Delhi, Shanghai,

and the western side of Europe, specifically the United Kingdom, as the hotspot of the PropTech industry. (Célérier, 2018)

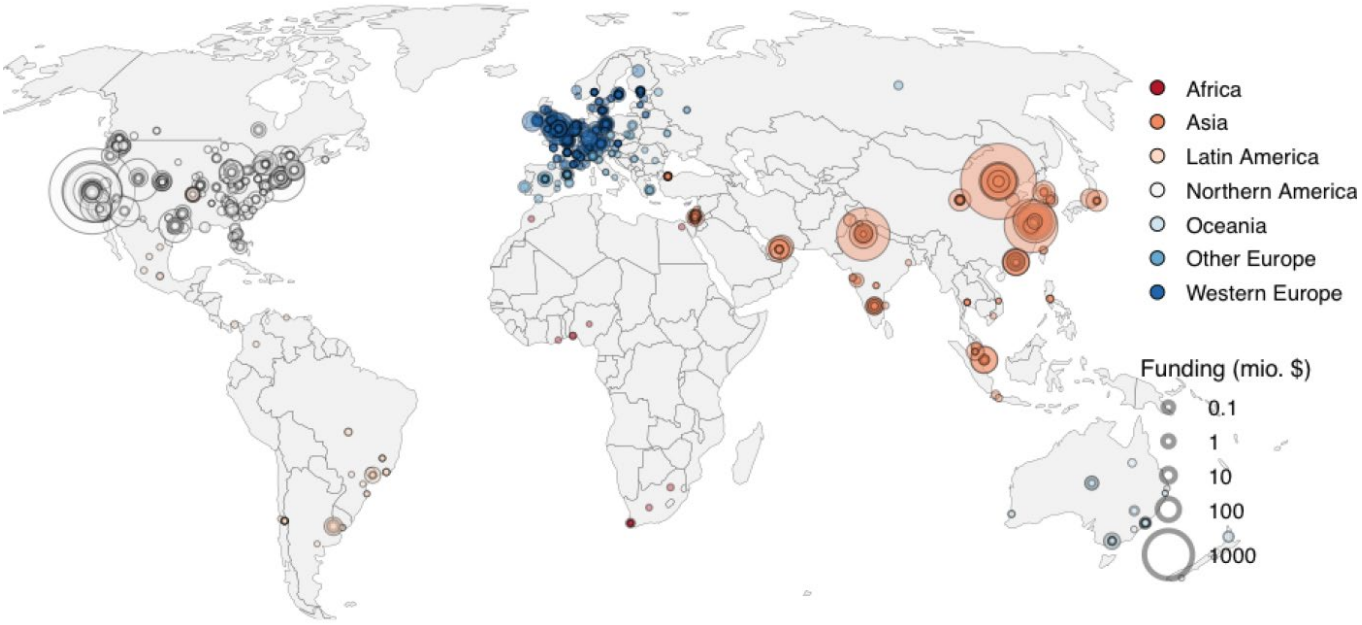


Figure 15: Global distribution of PropTech (Crunchbase, 2019)

This Situation in Europe shows 8 countries lay a foundation for around a hundred companies that encompasses around 3200 PropTech Start-ups. (Unissu, 2019) Following figures illustrated to show the market size of some European countries. Interestingly, the UK with over 5 billion dollars significantly generated an underlying market difference among other European countries.

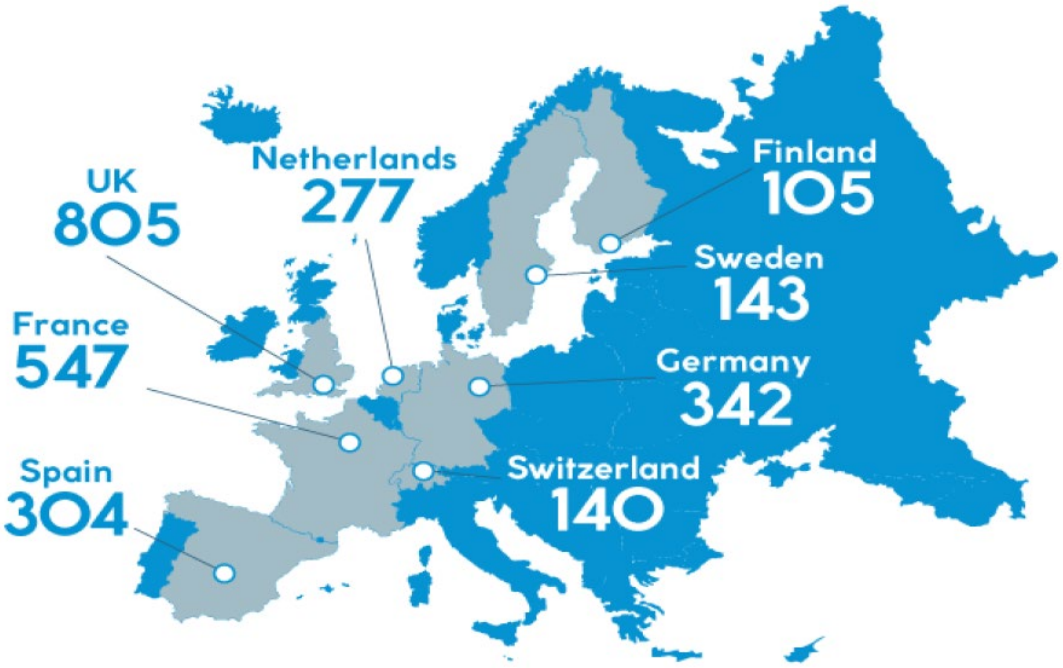


Figure 16: European Companies active in PropTech (Unissu, 2019)

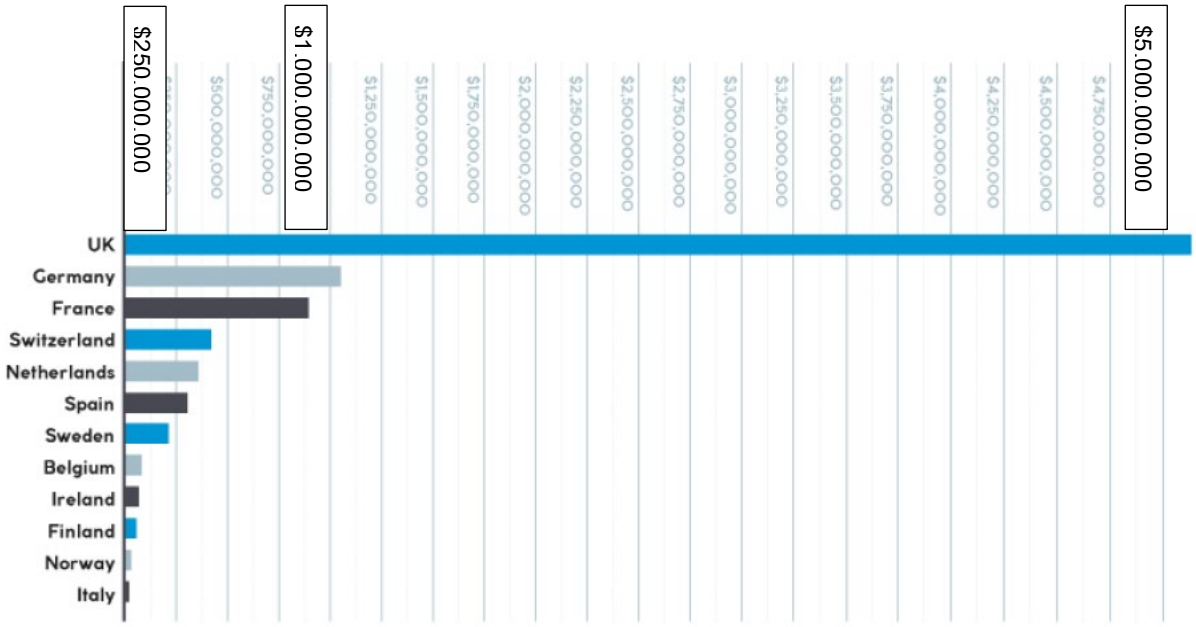


Figure 17: leading European countries and PropTech funding (Unissu, 2019)

4 Smart City Technologies and Stakeholder

As was mentioned, this master thesis seeks to introduce technology which expected to have a major impact on smart city and specifically internal stakeholders and built environment, based on the UN2030 targets. Among the list of technology provided below a hand pick of them will be discussed.

- “Smart Buildings and Smart residential
- Building Information Modelling and Digital Twins
- Modular Buildings
- Smart Materials
- Building Management Systems
- Occupant wellbeing tools
- Smart retails
- Smart logistics”

4.1.1 BIM and Digital Twins

Urban development and investment on the projects during all the stages need to be done with equal importance considering finishing them. For this goal, understanding the project's situation, demands some sort of data, collecting all vital data and information about the projects are essential. Data gathering ranges from basic input including, Project objectives, timetable of the project, key responsible people, and even the tools and instrument which are going to be used. In addition, it is agreed that project evaluation as one of the controlling tools in the assessment of the projects’ effectiveness is vital. This point also needs to be connected to the project implementation phases while feeding by building process data based on the urban planning infrastructure. So whole the project lifecycle needs effective communication to share the most appropriate feedback during the process stages. (Rodriguez, et al., 2020)

Among the above technology crawling into our cities, Based on a conducted survey (Appendix) Building Information Modelling or BIM as one of the top 3 technologies besides smart building technologies and modular prefabrication is the main selection of what respondents agreed that generates a great number of changes in the real estate sector. (Altus, 2019) This technology is a shared knowledge source of data with func-

tional characteristics in the facility representative sector. It tries to forms a reliable foundation for decisions during a project lifecycle ranges from conceptual design to demolition. (Standards, 2014)

(Melki, 2018) Argues:

“The creation of digital assets, such as an avatar of a building, will provide better control management and data. This will help lower costs and risks during the construction and lifetime of buildings since it will require less/fewer rework change orders and errors on site.”

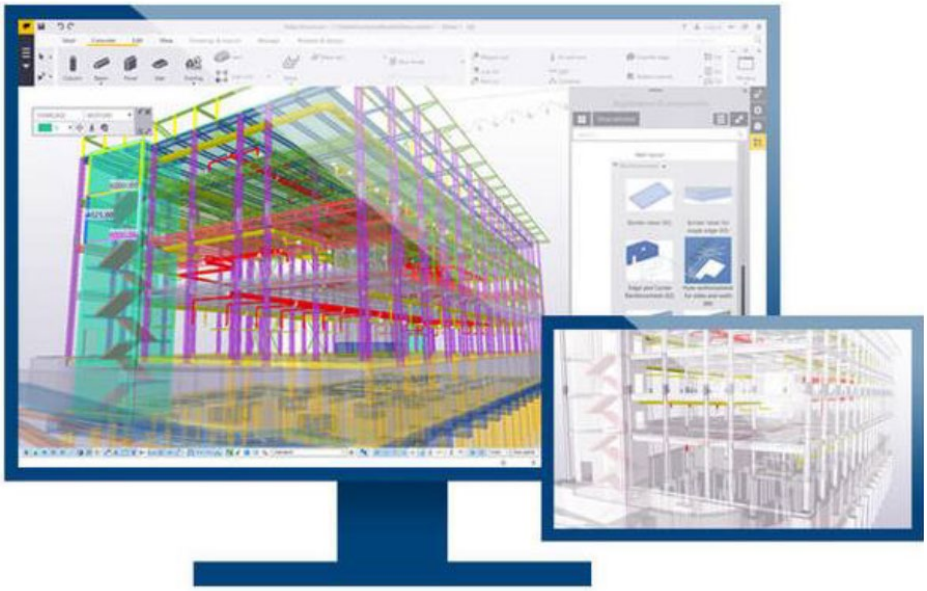


Figure 18: BIM (Tekla, 2018)

Digital Twin (DT) as one of those tools facilitates the data gathering process by making it a safe and reliable platform that all those data and other processes can be observed and controlled. This leads to expectations based on a real situation about quantity, quality, and time management of the projects by expected outcomes via resource management and preventing conflicts. DT seems to be connected with sectors such as maintenance and manufacturing activities. (Madani, 2019)

(Qinglin Qi, Fei Tao, 2018) Argue that “Digital Twin gives new conditions during the design process. For the conceptual design. As an example designers can integrate the physical properties of the product as well as the historical data of users. When designing a new bike, knowledge of the intended customer’s bike habits and physical traits can be important qualifiers. In the detailed design phase, dynamic feedback from the

shop floor or customers can in incorporated. And in a virtual verification stage, tests can be made of the final product against key parameters, allowing for rapid design changes before mass manufacturing."

(Qinglin Qi, Fei Tao, 2018) "Defines basic components of DT is composed of:

1- "Physical entities in the physical world"
2- "Virtual models in the virtual world"
3- "The connected data between these two worlds"

British Council for Offices adds that "A digital twin is a detailed virtual copy of a building (in some instances as a part of a larger network of buildings and services) and it's systems. The model can be created during the design stage and continue to be updated using post-occupancy data. The twin can be used for intuitive real-time monitoring of a building and will also then act as the cloud-based controller for the building systems. Also, it allows the building owner to simulate future scenarios to test possible methods for improving performance" (BCO, 2018)

Digital Twins Challenges

In the area of smart city applications, Digital Twins helps city administration by holding a single platform. A phenomenon that has recently come into consideration. Andrew Baum explains that vital developments both in regulation and technical aspects delivering this message which this platform is still far from the real world. Some platforms like "VU.CITY" provide a glance view of what such technology can look like for the future. (Baum, et al., 2020) He believes that "lack of digital infrastructure" and highly "absence of funding both in national and regional levels" are the main challenges of smart city solutions.

The United Kingdom and the US with similar results are facing this question that: "Do we want to out-source the city governance development structure to technology providers?" as an example of what Google does regarding "Sidewalk Labs" in Toronto. Or should seek for other corporations. Increasing the use of IoT devices in the built environment is another challenging topic which potentially can be under attack of crimes in

the area of cybersecurity and related crimes. A ransom paid in 2017 to hackers because of locking hotel doors in Austria is a fresh example of this threat. So in the middle of this connected era, risk mitigation is the first and vital step of a smart city. (Baum, et al., 2020)

4.1.2 Occupant wellbeing tools

Smart building technology has been accelerated these days, one of those applications serves to operators in a form of “space-as-a-service” software particularly “WeWork and Space” They are working based on customer maintain by modeling their business. Those owners of real estate who looking into a long lease contract are the potential customer of this application. The main core of the software works based on the user experiences to get the best decision and appropriate layout.

“The World Green Building Council” was stated that around 90% of the operational cost is coming from employees and the rest of them in order goes for renting out the required space and energy respectively with the amount of 9% and 1%. (WGBC, 2014)

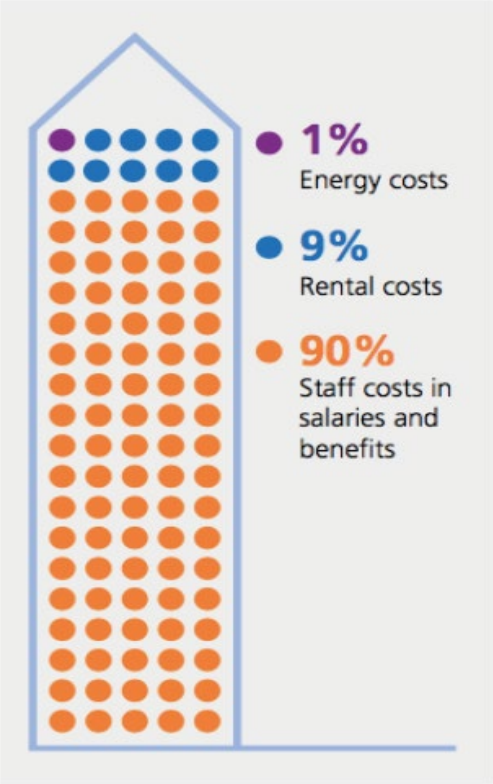


Figure 19: Example Model of business operating costs (WGBC, 2014)

It is an accepted fact that even minor changes in the health-related topic of staff lead to their productivity of them, this proves that it is likely that their rate of satisfaction, leads to more financial gain for their clients which is not comparable to energy-saving issues. (WGBC, 2014) This idea also is strengthening the idea of an effective approach to converting workplaces into more productive. The idea suggests even 1% improvements in the staff atmosphere might lead to a better result than increasing of 10% investment in the cost of the properties. (BCO, 2017)

Personal modification and building operation systems adjustment, individual requirement, seems to become feasible by monitoring of occupant related technology but their subjective indexes such as occupant pleasure are not measurable straightforward. (Baum, et al., 2020) However, some sensors can help the amount of happiness of the employees.

This fact can also impact the market, In 2019, PWC states; “Real estate owners in all sectors must now adapt to how space is best designed, constructed, operated and managed, but also respond to the challenge of what other services they should offer occupiers to stay ahead of the game. (PWC, 2019)

“Tenant Experience application (TeX), Apps HqO, District Technologies, Equiem, and Locale” are some example of single platforms which enabling efficient communication through bringing this approach to the digital version. This format of the application allows us to manage our activities in our built environment. Some activities like booking and canceling the meeting rooms or cleaning management based on the amount of space usage can be some of these examples. Integration of IoT by intelligent platform usage “will open new doors to improved wellbeing and enhanced productivity” as Network Control Group aims.

4.2 Prop Tech and Stakeholders

Stakeholders as the interest bearers, searching for their goals. Financial role as one of the main index players has a major role in this topic and the interactions’ level can be

measured by the financial data assessments, In other words, the more interactions the stakeholders have the more investment they have.

This means that Most of the city stakeholders, want to obtain profit from their investment financially and potentially by different means even through environmental, social, and governance (ESG) impacts. Due to reaching this goal, based on a report by the Member of UNECE Real Estate Market Advisory Board, United Nation Secretary-General depicted 3 financing strategies as the objectives to facilitate the role of UN in this financial circulation process:

1- Acquiring financial innovation potentials, digitalization and to obtain new technology and facilitating financial tools through an equitable access

2- Setting an economical approach and financial policies along with UN2030 goals.

3- Improving financial investment strategies sustainably both in-country and regional scale.

These three objectives show, how much financing of the urban development projects at the local scale like the international level is of importance. Moreover, the critical role of monetary strategies for urban development by applying private investment is into consideration, so potential investors with different natures, objectives, and approaches in smart cities include in this goal. (Rodriguez, et al., 2020)

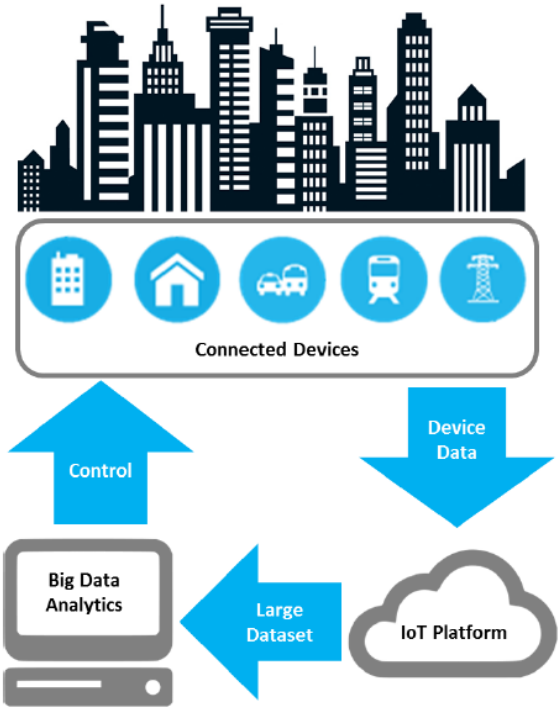


Figure 20: Smart City overall image (Capital, 2016)

Through stakeholders' collaboration:

Rapid urbanization, makes cities facing some sort of challenges during sustainable values achievement. The cities face some challenges which need a foundation before urban development. As was mentioned in the second chapter of this thesis, Stakeholders' engagement as an important factor for the success of the project is considered in smart city development.

The necessity of stakeholders recognition and their role grows smart city's requirement and appropriate stakeholder engagement. A large number of stakeholders were identified and categorized as "internal and external stakeholders". (Jayasena, et al., 2019)

Developer

After a brief explanation regarding the concept of stakeholders in chapter 2, here more detailed explanations due to verifying technology impact on stakeholders would be of help.

Based on the definition of the concept of the stakeholder derived from Golder (2005): Every person, group, or organization who has an interest or some degree of interest that has been vested in the resources of the project arena or/and everyone who potentially affects or will be affected by activities during a project whether having something to gain or lose depends on the changing of the conditions or stay in the same situation, can be a stakeholder in a project. This project can be named from building a small garage in a backyard or changing an extensive infrastructure of a city. (Bronwen Golder, 2005)

The impact of technology on real estate organizations and stakeholders unlike the other field of industry such as automotive factories, pharmaceuticals, and financial companies causes underlying effects and opens a new era. Also because of a large number of companies in this sector that did not meet success during the last decades, Stakeholders which are involved in the real estate industry decided to act with a conservative approach. Apart from Stakeholders and other players in the real estate sector, putting some questions about robotics, machine learning and other types of process in automation is of importance, since they overshadow some facts like new definitions of office spaces concept or the means that impact demands for vehicles and transportation systems. (KPMG, 2018)

On the other hand, it is not only about the impact of technology on stakeholders, but also, the stakeholders can enable the hidden potentials of technologic tools by giving the appropriate feedbacks and sequential maturation through an ongoing development procedure of the projects. Here In this chapter, Business impacts and the means of how technology can affect our built environment as the two underlying factors will be described. Due to the stop text extension, this chapter was limited to the effects of technology on the stakeholder’s perspective and some other lateral interactions were just mentioned shortly.

4.3 Financial Resources

Owners of real estate and landlords are looking to make sure that their buildings remain absorbing enough to their customer, and customer requirements through increased flexibility in technological features seem to be the new standards of the future, as the path in which citizens will expect from the evolvement of the built environment. So obviously both landlords and customers are facing new conditions which force them to re-adjust their expectations and services thanks to ICT development. As was mentioned in previous chapters and to be consistent with the UN2030 Agenda, providing a foundation to solve future cities' problems demands collaboration between stakeholders of every city, with or without having a smart city concept approach.

To achieve this target, verifying the stakeholders' collaboration role by briefly looking into some facts coming from successful organizations seems of help. WWF is one of the standards providers of management program reports, several motives are surrounding collaborative stakeholders' concept. (Bronwen Golder, 2005) These facts namely:

- Stakeholder collaboration is able to address conversations topics.
- When it comes to ecoregional scales like cities all involved key stakeholders during conversation are needed to participate in the process of collaboration
- Sharing and developing opportunities for stakeholders' agenda and vision are important.
- The terms of "inside" or "outside" a collaboration process will be related to the degree of their sustainability.
- Before any form of collaboration going to be initiated, stakeholders' history, dynamic positions, and interests must be understood.
- It is fundamental to success having a consensus on the ground rules.
- It is of importance to monitoring and evaluating the collaboration quality as a measurement specific tool when it comes to conservation outcomes.

Obviously, the more permanents agreements of stakeholders' collaboration forms, the more successful and sustainable results will be achieved.

Interest bearers, is the main specification of stakeholders task, regardless of the role whether as an organization, corporations, or individual, people have an underlying role in terms of analytical public policies and political sciences. This brings some rights later in which all even put a signed contract on hold level. So collaboration plays an important role and is a must to make a project feasible.

As an example, approved regulations in the area of environmental renewed after voluntary/non-governmental collaborative actions because of lacking world public authorities. It delivers this message that the round-table depicting a version of a binding law by the market, while customers' interactions and behaviors are into consideration as same as technical aspects. (Carbonnell, 2019)

5 Case Studies

This chapter aims to bring 3 study cases mainly related to the implementation of real estate technology in the smart city concept and to verify the impact of different means of technology on stakeholders such as local government, urban expertise, and citizens. These cases were chosen due to the availability of data and prominent leading of the cases which has been applied as a model for some other cities in the world. The inclusion of these cases aims to depict an image of a technologic impact on stakeholders and the future of real estate management in the dynamic role of not so distant future of cities. The first cases of this chapter were conducted by Hans Schaffers, Nicos Komninos, and Marc Pallot in 2012 and were permitted to be used by the author for this research. Additionally, some other relevant and updated information added to enrich the previous result as well.

5.1 Barcelona Smart Region

Description of the Case

Coordination of actions has been conducted within the ICT framework from 2010 to 2012. The goal was to a combination of stakeholders and communities mainly in the area of Future Internet, experimentation, research, and open user-driven innovation which is called “living Lab” and urban development to bring together. Common view on different approaches, to develop a previously agreed vision, policies, methodologies, and viewpoints alignments have been informed as the tools to increase innovation and development of the sociology-economic of cities. The most prominent point regarding this survey named “’ Fireball” was to show how cities form a creative atmosphere that can show the degree of creativity and the amount of change in the cities.

The point was that citizens’ participation and open creativity was seeking to bridge the gap between the “Research and Development” sector of Internet technology from one side and applications working with the Internet from the other side while considering how the experimental practices are working in a real context. The aim was to verify to

assess the applications through economic benefits from the societal perspective especially related to the independent living, small and medium-sized enterprises, healthcare, energy efficiency, healthcare systems, and quality of life of the built environment. (Schaffers, et al., 2012)

The conducted analysis by Fireball showed how cities in Europe are converting towards becoming more intelligent and smarter cities around that time. The case studies were based on desk research and through interviews in the cities.

This research mainly reflects the results of their research. Also, these case studies show the planning processes contribution both in the top to down and bottom to up to the cities transformation and different means of demonstration. Barcelona is one of Europe's most dynamic economy including 1,500 startups with a special focus on new technologies. Based on the latest report by Catalonia official website, it ranks Europe's 5th region for start-ups, After London, Paris, Berlin, and Amsterdam. Thanks to the entrepreneurs and industrial foundation which has helped the city to become an economy holding intensive knowledge, Barcelona is the 4th most innovative European city. (Anon., 2020)

The goal was to provide enterprises and citizens a powerful common area that connects elements of the city for an easy access interaction via informing the administration by electronic means of communication. Installation of "sensors" and "Optical fiber networks" cover in the city has been a backbone solution for the intelligent development of this city. Gathered Information from city daily activities was highly appreciated fact data that consistently need to be "collected" and should be "analyzed". Enabling a City data center to acts as the basis to deliver smart city management. Barcelona's smart city performance has been situated on triple columns consists of well-developed infrastructure, the human capital, and collected data. (Schaffers, et al., 2012)

Following Schaffer's report, two main sources of data were observed: Firstly, feeding data come from sensors and open data platform to inform the public sector. Secondly, digital footprint input from the citizens' side, crowdsources, and social media. "The model of Barcelona smart city constituents are:

- "Living Lab initiatives"
- "Smart District"
- "New Services for citizens"

- “Infrastructure”
- “Open Data” (Schaffers, et al., 2012)

Analysis of the Case

These case studies show how they tried to take advantage of the situation provided by technology in the area of ICT and the following applications. The underlying related points to this research are covered concern:

The adoption of the concept of “Smart City”, expectations and ambitions. It will search how these cities’ stakeholders define the term of “Smart City” based on their understanding and the level of their interpretation. Some questions like How do they confirm the key objectives of this concept or by what kind of means they priorities their policy objectives.

- The level of ICT infrastructure, online services, smart urban environment, and web-based applications have been implemented. Towards a smart city transformation, what kind of tools influence their city as a driver or which kind of elements causes hindering this aim.
- What type of collaboration network are playing in between stakeholders and the type of involved communities who have innovative approaches. What kind of open source or preference are they applying for ad-hoc or commercial projects.

The table below shows the Barcelona implementation outlook to become a smart city based on SWOT analysis.

Strengths	Opportunities
• Attractiveness for industry, tourism, cultural heritage • Knowledge intensive economy; cluster • Urban planning and regeneration history • Major initiatives e.g. smart districts (22@Barcelona), living labs, ubiquitous infrastructures • Leading role of City Hall	• Potential to attract companies • Services to enhance local entrepreneurship and innovation
Weaknesses	**Threats**
• Mostly top down orientation • Lacking coordination among government departments • Human capital level • Local entrepreneurship level	• Economic situation, affecting public funding • Existing projects may be affected by governmental change

Table 2. SWOT Implementation of strategy in smart city Barcelona (Schaffers, et al., 2012)

5.2 Singapore

Singapore as an island city-state had 1/3 of today's population before and about less than 1% of the current GDP and almost no considerable infrastructure during the last 40 years, nowadays, with about half the size of the London metropolitan, seeks to provide accommodation for about 5.7 million people while they have very constrained land and resources which is the major challenge for them. (Anon., 2018)

According to "Trading Economics" analysts' expectations and macro models on a global scale, it is expected that "Singapore about to touch 340.00 USD Billion by the end of 2020. Singapore GDP is projected to trend about 390.00 USD Billion during 2021 and 425.00 USD Billion in 2022 based on its long-term plan." (Anon., 2020)

Description of the Case

The city of Singapore innovatively applied high-tech solutions to not only provide adequate living spaces for its citizens but also as a successful platform to improve life quality for the next decades. The city planners and architects improving the quality of the environment in the city thanks to the sophisticated computer models. Since the geographical town situation is in the tropical area, a smart opening in between building blocks enables the breezes to come through. This will be provided through a computer simulation modeling system namely "Dassault systems" that provides to set a layout of urban zoning regarding official, residential and commercial areas with allocating spaces as an open area in such a way to reach this aim. (Pollock, et al., 2019)

"Dassault Systèms", provides people and businesses a depicted innovative sustainable image targets with virtual universes. As a world-leading system with high-tech solutions, it transforms the design, production, and means of support of a product. "Dassault Systèmes" foster social innovation, expanding possibilities with a collaborative approach to improve the virtual world before entering the real world stage. The "3DEXPERIENCE" company, brings added value for about 190,000 SMEs, all over the world (Villacoublay, 2015)

As one of the most prominent projects, Government aimed to synergize all the 3d models' efforts from different agencies of its body onto a collaborative platform which leads to the Singapore common 3D digital city model, in other words, this system works like many other programs but this time in between of multi-industry by bringing a different type of data and information as Christopher Holmes, “managing director of IDC insights” describes.

Because of creating a unique data referential, this platform improves the planning and consequently, life quality in Singapore through bringing an authoring environmental design and simulated scenarios into the city-wide context. (3DEXPERIENCity, 2016)

Having data and tag them into the 3D plan, allows the Singapore administration to visualize those data and spot trends and patterns as John Wong, the group director of housing and development explains.

6 Conclusion

The World's population set to double by 2050 and around more than half of the inhabitants predicted to live in cities at that time. Rate of population growth to be continued which leads to rapid urbanization and forces cities face to a large number of challenges in achieving sustainability. These challenges need a range of requirements for sustainable urban development within cities. Based on the latest global consensus provided by the United Nations, *"Making cities and human settlements inclusive, safe, resilient and sustainable"* is one of those pre-conditions to confront those challenges. Smart cities with having a list of beneficial influencer promote sustainable urban development.

Alongside this target, by looking into successful practices regarding smart cities on the European scale, delivering this message that *"multi-stakeholder, municipally based partnership"* has an underlying role as the European Commission defines the concept of the smart city. Different fields of action make a variety of stakeholders' approach both in their applying the technical tools and their objectives. Mutual understanding of the differences and setting sort of guidelines for a better connection between stakeholders which encompasses all viewpoints is one of the keynotes to the Smart City. For this reason, laying the foundations for multi-stakeholder cooperation is one of the first essentials of this goal.

This means that different stakeholders should be involved in a smart city and decision-making process by some sort of tools and guidelines while governments providing the basis of this arena seeking for its members' smooth task transmission. Regional government through bridging a gap between main definitions of municipality's objectives from one side, and stakeholders like private companies from the other side, try to facilitate reaching to the Smart City objectives. Although this is a fact that provides a better understanding for stakeholders about the general view of the activities but demands a sophisticated means of technology to compute and intersect with other stakeholders' interests or even verify conflict of their interest considering legal aspects and other stakeholders' rights.

Real estate technology as a means of communication by transferring data between stakeholders is vital and using modern technologies for being intelligent and sustainable should be embedded in the characteristics of a smart city. Real estate technology which is also known as PropTech is a platform integrates construction technology, legal

layers, FinTech, and the shared economy, thanks to the digital transformation and novel ICT development.

This is favorable because it is a platform acting both in the area of operation and management of the real estate industry which means that it can be used through the whole life cycle of a smart city and its projects, ranges from early stages as the strategic real estate management to planning/execution in the realization phase or even during utilization period by facility managers.

Besides, due to the increasing stakeholders' connectivity, it opens new online sales platforms, through the trading of real estate asset. Transferring the ownership, sharing funds, debt, or equity can be some examples of this technology known as FinTech. It also can provide a technology-based platform famous as "Shared Economy" to facilitate the transactions for prospective sellers/occupiers to rent out their property which leads to a reduction in time and costs of the stakeholders.

Therefore to be consistent with the aforementioned smart city goals, not only fast, reliable, and secure data transmission in between of smart city stakeholders is of importance but also conformity to governmental guidelines and to intersect with external stakeholders such as non-profit organizations, NGO's and marginalized groups for a durable and sustainable decision should be into the consideration.

The ubiquitous usage of smart tools potentially can influence underlying challenges that are inherently fraught with danger. Increasing the use of IoT devices in the built environment is one of those challenging topics which potentially can be under attack in the area of cybersecurity and related crimes. Job redundancy and impact on the economy especially in those areas of which experiencing rapid population growth poses many questions.

As a conclusion, the below definition aims to give a comprehensive statement about the impact of real estate technology on smart city stakeholder:

Real estate technology as an evolving solution through innovative management approach in natural and economic resources, enables multiple stakeholders to have a better understanding of their needs, realistic and faster data analysis by appropriate reactions and shorter process of decision-making on a smart city to address urbanism challenges and achieve sustainable development efficiently while caring human values and social capital.

6.1 Recommendations

- Having a smart strategy during all stages of the Smart City life-cycle is of Importance

- Stakeholders' engagement is an ongoing procedure and demands a high degree of attention to social capital and considering humans as the main core of cities.

- Smart City's strategic view should consider the future of the city through designing and implementing adequate infrastructure and possible changes compatible with future needs.

- Subjective transparency and security of data are vital.

- Real-time legal layers due to securing and durable development should always be at the frontline of those Real estates of which sharing risks.

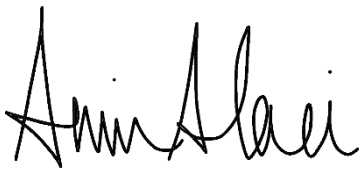
- Resource Management before starting a project is vital, because of the fast-developing means of technology integration of the infrastructure does matter.

- More Living lab projects and connections with scientific centers and universities lead to better results.

Declaration of Authorship

I hereby declare that the attached Master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

Berlin, 28.10.2020



Location, Date

Signature of the student

Appendix

DIMENSION	DESCRIPTION
Economy	ICT (including ICT infrastructure, water and sanitation, drainage, electricity supply, transport, public sector) productivity (including innovation and employment) Infrastructure (including water and sanitation, waste, electricity supply, transport, building and urban planning)
Environment	Environment (including air quality, water and sanitation, waste, environmental quality, public spaces and nature) Energy
Society and Culture	Education, health, and culture Safety, housing, social inclusion and food security

Table 3: Summary of the dimensions of smart cities in KPIs (unece.org, 2017)

	NO OR ONLY MINIMAL IMPACT ON DEVELOPMENT INDUSTRY	POTENTIAL FOR SIGNIFICANT IMPACT ON EFFICIENCIES AND HOW DEVELOPMENT IS CONDUCTED	WILL CREATE MAJOR DISRUPTIVE CHANGES IN THE DEVELOPMENT INDUSTRY
Smart Building technologies	8%	42%	49%
Pre-fabrication	16%	34%	49%
Building Information Modeling (BIM)	10%	42%	47%
Construction site robotics	32%	32%	34%
Intelligent building design (using Artificial Intelligence + Machine Learning)	30%	37%	30%
Drones	36%	36%	28%
Process automation (Contracts, Workflow, Proformas/Feasibility, Procurement)	56%	22%	22%
Connected job sites	54%	26%	20%
Augmented reality/Virtual reality	45%	34%	20%
3D printing	65%	19%	16%

Table 4: The impact of emerging technology on development (Altus, 2019)

Stakeholders of smart city	Sources						
	1	2	3	4	5	6	7
Academia and Research Institutions	√	√				√	√
local and regional administrations	√			√		√	
Financial suppliers/Investors	√		√				√
Energy suppliers	√					√	
ICT sector representatives	√	√		√	√	√	√
Citizens	√	√	√	√	√	√	√
Government		√	√		√	√	
Property developers		√					
Non-profit organisations				√		√	√
Planners					√		
Policy makers		√	√		√	√	
Experts and scientists					√		
Political Institutions							√
Media		√			√	√	
Sources: 1. [20]; 2. [21]; 3. [23]; 4. [19]; 5. [24]; 6. [25]; 7. [26]							

Table 5: Stakeholders of a smart city project (Jayasena, et al., 2019)

19 : (T. Nam, 2011) 20: (I. Ielite, 2015) 21: (Angelidou, 2014) 23: (Kondepudi, 2015)

24: (A. Stratigea, 2015) 25: (Buuse, 2017) 26: (V. Fernandez-Anez, 2016)

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