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The Evaluation of Economic Benefits of Smart City Initiatives – A Category Approach

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Abstract

Cities around the world are investing heavily in the design and implementation of Smart City Initiatives. A lot of public money goes into the smart city approach [1]–[3]. Not only on the public side, but also for companies, smart city business models in this context are interesting. Global high-tech companies such as IBM, Cisco, SAP Research and Mitsubishi Electric are working on large projects in Asia and the Arab world. In Germany, there are also large telecommunications companies, mobile companies but also companies close to the city, such as energy suppliers or local IT companies with an important knowledge of the locality trying to enter the field. The global corona pandemic of 2020 is accelerating this path too. Various efforts have been made to assess the results of these projects and initiatives. This study offers an analysis of the economic benefits of Smart City Initiatives. The main drivers and evaluation criteria will be examined to identify their potential contribution to the development of the smart city. This article deals with the economic benefits of Smart City Initiatives. An attempt is made to develop and describe the most important economic benefits as categories based on research literature analysis.

Keywords: smart city, economic benefits, smart cities, economic development, urban studies
JEL Codes: O1, O18, 033

1. Introduction

Research on the smart city is very fragmented [4] and has grown strongly since 2012 [5]. In this development, the path of research is characterized by the concept of technological context, the impact on the various research areas as well as the implementation. More recently, the contribution of Smart City Initiatives (SCI) has been more closely studied.

The interpretation of smart city approaches raises several problems, e.g. how to measure smart city benefits in the first place, if one does not really know exactly what a smart city is. Nevertheless, a number of different studies on components, measurability and results have already been published [6]. The study was carried out using different research methods. Some research deals with the maturation of a city into a smart city [7] and its components and results [8]. With regard to the benefits of SCI, there are also papers that focus on the overall system [9] or refer to individual aspects, such as the quality of life [10]. An assessment of the economic value of a smart city, especially in Germany, is not yet available. What have the different initiatives and strategies achieved so far from an economic point of view and can these also be assigned to the SCI?

1.1. The concept of the smart city

The global trend of an increasing urban population is often cited as a trigger for smart city thoughts. The figures and statistics have so far also spoken clearly. Already, more than 50% of the world's population lives in cities [11] and growth is expected to continue. The reasons for this are manifold. Significantly better living conditions, job opportunities, education and culture are mentioned again and again. This fact contributes to the economic and social importance of cities, but also to their poor environmental sustainability. Awareness of this trend is driving research into new ways of adapting to rising requests and urgent problems; e.g. physical risks, such as the deterioration of air quality and transport conditions, and economic risks such as unemployment [12]. The smart city is a new way of looking at cities. The optimization of available and new resources as well as possible investments are required [13]. Cities use technologies, including information communication technology (ICT), to enable a more efficient provision of services [12].

Especially in the time of the COVID-19 pandemic period, the enormous need for data and information on the population which is mainly economically present in urban areas, is evident. The publications therefore show an increasing interest in transforming the physical environment and performance of a city into a digital one. The technological possibilities and networking allow it. Therefore, a greater urbanization, for which smart approaches are needed, will happen, as well as the transformation of the physical environment into a digital one. In addition to the development of the digital space through social media it is also increasingly meaningful to the city. The connection and interaction can be seen as a smart city transformation.

In the research literature, however, there is still no uniform picture and definition of a smart city. Depending on the definition, the concept of a smart city encompasses the meaning of the word "intelligent": smart city, knowledge city, ubiquitous city, sustainable city, digital city, etc. There are many definitions of smart city, but none that has been universally recognized [9]. A few definitions have been published in the research literature. Especially in the recent period, a lot of scientific papers have been published, many of them not older than 10 years, which deal with the subject [12]. Ruhlandt [6] has conducted a systematic method according to the Webster and Watson 2002 [14] review

standard to cluster the different definitions and studies. The picture remains confused as to how the concept of a smart city can be considered. Different approaches are used, but their differences are not sharp either [15].

The technological approach of a smart city strongly links "smart" with applications of ICT. "A smart city [...] is one that capitalizes on the opportunities presented by ICT in promoting its prosperity." [16] "The use of smart computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, interconnected, and efficient."

The governance-focused approach focuses on the "smart" interaction of many actors, but also on the possibility of differentiating themselves from other groups. Smart city as a strategic urban orientation, while networking with governance is of a certain importance. "We believe a smart city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance." [18] or "Academic literature highlights governance-related elements of smart cities. It suggests particularly three elements: (1) e-governance, (2) engagement by stakeholders, citizens and communities, and (3) network-based relationships such as partnerships and collaborations." [19]

Many of the definitions in the literature try to describe the multidimensionality and complexity of different areas of a city in a community approach. Giffinger [20] identified the area's economy, people, governance, mobility, environment, and living identifiers, which are combined with each other in a smart city. "A smart city is a city well performing in a forward-looking way in six 'smart' characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens." [20]

Due to the complexity of the smart city approaches and the skyrocketing number of publications, further systematic literature analysis and reviews are available on the various smart city definitions [5], [6], [21], [22].

1.2. The economic impact and value creation of SCI

Participation in the smart city market is not free and the corresponding investments are extensive, while they usually concern innovation development and always require careful planning [23]. In most cases, therefore, the question of economic impacts is justified. A study prepared by Capgemini Invent as part of the European Data Portal examines the economic impact of open data. Here, the question of the impact of freely accessible data plays a particular role [24]. Several benefits of using open data have been identified and consist of direct and indirect benefits. Direct advantages are realized in market transactions in the form of turnover and gross value added, the number of jobs associated with the production of a service or product, and cost savings. Indirect economic benefits include new goods and services, time savings for users of open data applications, growth of the knowledge-based economy, increased efficiency in public services and growth of related markets. According to this publication, the market size of open data is expected to

increase by 36.9% between 2016 and 2020 to a value of €75.7 billion in 2020. The projected number of direct open data jobs in 2016 is 75.000 jobs. Nearly 25.000 additional direct open data jobs will be created between 2016 and 2020. The projected cost savings of the public sector for the EU28+ in 2020 will be €1.7 billion. Efficiency gains are measured in a qualitative approach [24]

From a macro-economic point of view, too, there are important aspects to classification. In what form do Smart City Initiatives and, above all, the resulting data and information become a public good? Paul A. Samuelson [25] highlights the point of view of demand: in the case of public goods, the benefits are not limited to a particular consumer, but additional users also benefit at a marginal cost of zero. Exclusion is impossible, or at least prohibitively expensive.

Stiglitz [26] and others prepared an expert opinion on the role of the state in the digital age on behalf of the Clinton administration [27] from this study, 12 rules have been developed for the activities of the US government's online and information activities.

This cognition, as well as the Stiglitz study, also led to further European and national initiatives and laws. In Germany, for example, there is the e-government law, the Law on the Promotion of Electronic Administration. The legislature has assessed the economic viability of such a project. For example, it is assumed that for Germany, annual reliefs of up to €36 million are possible due to saved postage costs through secure electronic correspondence. In addition, there are savings for the economy of €191 million (over 30 years) due to the not applicable written information and a further €15 million per year for online data transmission [28]. Break-even is expected at nine years after implementation, the amortization of investments after 14 years.

The European perspective is also becoming increasingly important for the national legislator. While administrative procedural and organizational law has long been excluded from this development, the EU Services Directive (in particular Article 6 and Article 8 of the EU-DLR) has the obligation to establish points of contact and to guarantee electronic processing remotely and a strong interference with the administrative autonomy of the member states. In addition, the space and time independence of IT-based procedures favors cross-border transactions. Therefore, the digitalization of everyday life and the administrative procedure play a particular role as to recognize the importance of European initiatives [28].

The analysis shows how important it is to deal with the economic advantages of SCI.

Analysis of the literature already shows a wide range of publications about the smart city. Research focuses on the description and analysis of what a smart city really is and how to design the process. In doing so, subcomponents are repeatedly removed and examined for an influence. For this, the mentioned dimensions [20] are often used. This paper first tries to filter out the factors for the economic advantages of SCI.

The research question (RQ) in the foreground is:

What are the economic benefits of Smart City Initiatives?

The hypothesis behind this is that SCI create positive economic values. The big challenge is to determine whether benefits can be measured. This would have the advantage of being able to implement them even more specifically, with a control option. It is to be assumed that certain conditions must be created here in order to optimize the resources as well.

2. Material and Methods

2.1. Methodological selection

This section briefly explains why the quantitative content analysis methodology was chosen. The research question largely relates to the analysis of content on the subject of smart cities. In doing so, one has to take into account what has been communicated so far by the experts. It is therefore a question of analyzing the communication on the subject. Smart city is a fuzzy concept as described above. Therefore, one has to choose a method that takes the communication and its contents into account. Content analysis can therefore analyze communication and proceed systematically to draw conclusions about certain aspects of communication [29]. It is therefore a good idea that concepts that are difficult to press into a model should be provided with a textual content analysis in order to form categories that may have a universal approach. The strength of qualitative content analysis is the systematic approach, which is relatively easy to apply.

Category formation is of particular importance. In addition to the different meanings of terms, transparency as well as traceability by third parties are important for acceptance within the educational process. This process is started by working with the existing literature.

The simplest way of analyzing content-analytical work is to count certain elements of the material and to compare them in frequency with the occurrence of other elements [29]. In this work, the frequencies of economic benefits are determined and evaluated by SCI. With the help of highly involved experts, categories can be examined and deepened. Here, too, qualitative content analysis helps to refine the structure. The dissection of this method could have a detrimental effect on the economic benefits and lead to a misinterpretation of meaning. Nevertheless, with regard to the research question, it can be argued that the benefits of this method outweigh the disadvantages and that there currently isn't a more suitable alternative. Figure 1 shows the sequence again schematically.

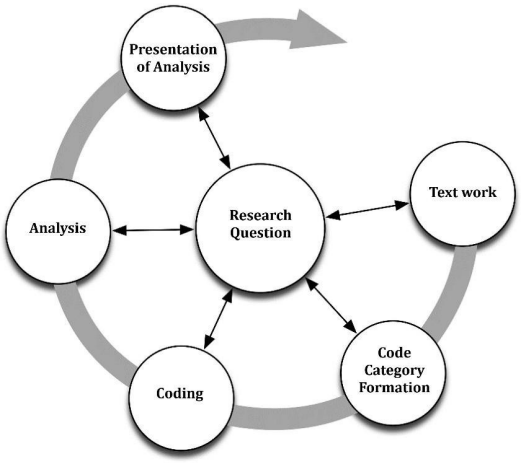

Figure 1: Procedure structured content analysis [30]

2.2. Material

In order to answer the question, where the economic benefits of SCI are, further intensive analysis is necessary. The study is still in its infancy. First, the scientific literature with qualitative content analysis has been investigated.

The following literature databases were surveyed:

- Springer Link
- Scopus
- ProQuest
- EBSCO Host

The search terms and clustering were defined as follows:

- "Smart Cit*" *and* "Economic Benefit*" *and*
- Publication not older than 10 years *and*
- scientific paper *or* conference paper *and*
- Reviewed

Research Databases	Potential Sources	Relevant Sources
Springer Link	652	74
Scopus	466	59
ProQuest	479	11
EBSCOHost	1760	21
Sum:	3357	165

The relevant sources were filtered by title, keywords and associated abstracts.

3. Results

It has been shown that there is no uniform picture of the economic benefits of SCI. Each SCI is considered separately in the literature. The coding of the literature can be summarized as follows in figure 2:

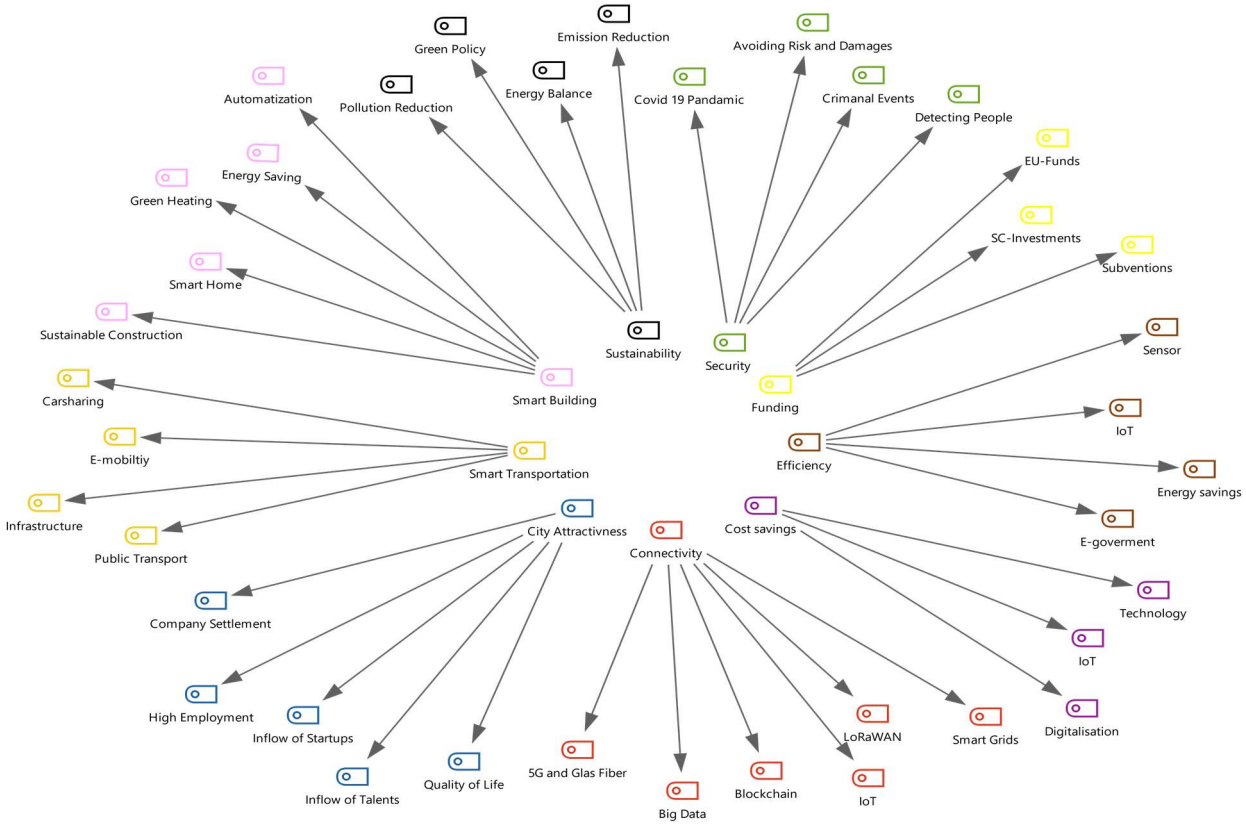

Figure 2: MAXQDA code system: codes and subcodes related to economic benefits

SCI can increase economic efficiency. The papers discuss the possible contributions, especially in the area of energy cost reduction [31]. The introduction of nationwide LED lighting to reduce energy demand is an example representative of many publications on this complex. Process efficiencies through the use of sensors are the starting point for connecting smart city and Industry 4.0 [32].

In the context of SCI, digitalization has great potential to save costs. The platform idea in the field of IoT can be used to better manage the existing resources [33]. There are already many approaches to smart government or e-government. There are some estimates of the potential for cost savings [28].

Security is a great need of people in urban areas. The SCI relates in particular to crime and terror prevention, safe event management, public life [34]–[36] and to improving the quality of life. Smart security concepts create added value within stable economic conditions from which the economy should benefit. Another economic benefit in the literature related to SCI is the impact on the city's attractiveness. Smart people work in smart cities too, i.e. talents go to the cities that also offer them the framework conditions

to develop. In addition, smart cities are also interesting for tourists, and these bring economic benefits [37].

In the area of connectivity, networking is particularly important in order to achieve economic advantages. The expansion of broadband allows new business models or the reduction of transaction costs in the form of a higher degree of automation.

Sustainability in the sense of a modern circular economy and the reduction of CO_2 as well as the prevention of pollution in general is part of many SCI. The economic benefits lie in the area of CO_2 reduction and associated costs. However, it seems to be very difficult to separate or measure such effects [38].

How much money can you save if the flow of traffic is better managed? In Berlin, congestion costs in 2019 amounted to around €792 million [39]. SCI for traffic control to avoid congestion can significantly reduce costs. In combination with public transport, individual transport can be reduced, especially in large cities, in order to avoid costs in the overall use of transport and thus represents a further area for the economic advantage.

Buildings consume about 40% of the world's total energy and heating; cooling and air conditioning account for about 50% of the total energy consumption of a typical building [40]. Here, too, smart home controls and smart grids can reduce costs. However, an economic advantage can also be the value of the buildings themselves, if corresponding technologies have been installed in the sense of the smart city.

The implementation of SCI is eligible in many countries as well as in the EU. The EU has its own marketplace for SCI. The Smart Cities Marketplace plays a distinctive and new role compared to other European Commission platforms. Engaging cities, industry and financiers in interest matching activities, leading to project design and delivery shall be the Marketplace's team objective. Building solutions and facilitation are the two main tasks of the Marketplace to help deliver investments [41]. The economic advantage lies in the favorable financing of clients and the very fast transfer of know-how and experience.

4. Conclusions and Discussion

Research with regard to the economic benefit of SCI is not yet broadly based.

In the literature, there are a number of descriptions that indicate an economic benefit of SCI. The publications suggest that there is a positive effect. However, everything remains very inaccurate. A generally valid proof could not be provided yet. A first classification by possible categories has been developed. In the area of cost savings and increased efficiency, concrete results can be hoped for. Figures for public administration have already been published, showing a high potential for savings [28]. The weighting of the criteria is missing in this context. However, it also shows that the potential is not currently being raised. None of the SCI-descriptions studied had the goal of generating a direct economic benefit. At present, this is seen as a clear infrastructure task. It remains to be seen what value these categories have that I have developed and what their significance will be in the development of SCI. To get a clearer picture, one could take a

closer look at smart city projects. If the categories can be found in the EU's big smart city lighthouse projects for example, then this will also have a meaning. This could also be an approach to further investigation.

Since SCI is created or pursued all over the world, it is also important to look at the participants. This could be solved by an expert survey. Experts have special knowledge, particularly the knowledge of the social contexts in which they operate and in which they are involved [42]. In the context of the research question, the experts who participate directly in SCI projects are responsible and advise directly on this topic. They have the knowledge relevant to answer the research question and are part of the recognized research method of qualitative content analysis [42]. A qualitative approach as a research method seems to be a good one. The measurability of economic benefit will be a major challenge. The SCI are per se very diverse, because cities and their connections are also very different.

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