EVENTO ON-LINE
ConBRepro
XII CONGRESSO BRASILEIRO DE ENGENHARIA DE PRODUÇÃO
ESG nas Engenharias
30 a 02 de dezembro 2022

Sustainable business models in the context of smart cities: pathways and opportunities for entrepreneurs

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Abstract: Since the last decade, the world economy has been steered towards profound transformation. There has never been, in recent years, a more pressing need for the development of flexible, socially responsible, and sustainable business models than now. As cities become more densely populated the need for smarter solutions for day-to-day issues, as well as for the administration of public utilities, becomes a present issue. In this context, the interaction between population, government, private organizations, and some other issues involving cities, require advancements to turn them into smarter spaces to live. Thus, this paper aims to determine possible pathways and opportunities for sustainable business models to operate in the context of smart cities. A systematic literature review was employed, and the conclusions display five trending areas: (i) Platform economy, (ii) Exploration of the energy and water sectors, (iii) Open Data, (iv) Smart contracts, and (v) Internet of Things. The results indicate that there are several opportunities for entrepreneurs, given the displayed areas are consistently explored.

Keywords: Sustainable business models, Smart Cities, Sharing economy.

Modelos de Negócio sustentáveis no contexto de Smart Cities: Caminhos e oportunidades para empreendedores

Resumo: Desde a última década, a economia mundial tem sofrido severas transformações. Nunca houve uma necessidade tão grande, como nos últimos anos, de se desenvolver modelos de negócio flexíveis, socialmente responsáveis e sustentáveis, como agora. À medida que o crescimento populacional se densifica, a necessidade por soluções inteligentes para problemas do cotidiano, assim como no caso da administração de serviços públicos, se mostra cada vez mais presente. Nesse contexto, a interação entre população, governo, organizações privadas e outros aspectos de cidades, requerem atenção para que as cidades se tornam lugares mais inteligentes para se viver. Portanto, esse trabalho objetiva determinar possíveis caminhos e oportunidades para modelos de negócio sustentáveis operarem no contexto de cidades inteligentes. Uma revisão sistemática da

literatura foi conduzida, e as conclusões apontam para cinco áreas de interesse: (i) Economia de plataforma, (ii) Exploração dos setores de energia e água, (iii) *Open Data*, (iv) *Smart Contracts*, e (v) *Internet of Things*. Os resultados indicam que há várias oportunidades para empreendedores, uma vez que essas áreas podem ser exploradas consistentemente.

Palavras-chave: Modelos de negócio sustentáveis, *Smart Cities, Sharing Economy*.

1. Introduction

Since the last decade, the world economy has been steered towards deep transformations. In recent years societies have not observed a more pressing need for the development of flexible, socially responsible, and sustainable business models than now (BELK, 2014; MARTIN, 2016; HOSSAIN, 2020).

Previous business models that relied on mass consumption of limited resources are now exhausting, thus enabling new ones to take place. New alternatives are being created and put into practice, such as the employment of renewable energy sources, circular economic models, and sharing economy models (HOSSAIN, 2020).

As cities become more densely populated the need for smarter solutions for day-to-day issues, as well as for the administration of public utilities are more and more present. In this context, the interaction of population, government, private organizations, and some of the issues in which cities require to advance to become smart (DIAZ-DIAZ ET AL., 2017).

In this scenario, the concept of sharing economy (SE) has emerged. The consensual definition for the concept of a sharing economy (SE) can be quite elusive. While sharing as an economic model can be considered an old practice, SE driven by the internet and other technological features is considered quite a recent phenomenon, often regarded as Digital Sharing Economy (DSE) (HOSSAIN, 2020).

Practices such as the use of technology through mobile applications or other platforms, as well as rental relationships, are often regarded in the literature as valid examples of SE models, which can be observed in Uber and Airbnb business models (BELK, 2014; MARTIN, 2016).

Therefore, one should first examine the city's ecosystem to determine whether a certain business model can be fully implemented in the aimed region, giving special attention to the issues of each region (DIAZ-DIAZ ET AL., 2017).

Thus, this paper aims to determine possible pathways and opportunities for sustainable business models to operate in the context of smart cities.

The following section will provide an overview of this paper's material and methods, followed by an overview of the literature. The following section will present the opportunities and pathways identified, followed by the final remarks and conclusions.

2. Material and Methods

This section will demonstrate the steps that will take place to complete this research's aim. Table 1 demonstrates an overview of the methods that are going to take place:

Table 1 – Research methodology

First step	Second step	Third Step	Fourth step
To search in the Web of Science, Scopus and ScienceDirect databases the topics of "sustainable business models" AND "Smart cities".	To employ *Methodi Ordinatio* to ensure the quality of the findings, as well as a basis for future analyses.	To determine, whether sustainable business models are being proposed, and further explore the areas.	To analyze the gaps, looking for opportunities for sustainable business models.

Source: Authors (2021)

On the first stage, the searches on the three databases are going to be conducted by using the key terms indicated above. These findings are then going to be submitted to *Methodi Ordinatio* (PAGANI ET AL., 2015). This method will be employed as the main quality criteria, which is going to ensure the overall quality of the findings. The results of this stage are depicted in Table 2:

Table 2 – Main findings

Databases	Keywords	Results
Web of Science	"Smart cit*" AND "Sustain*" AND "Business model*"	58
Science Direct	"Smart Cities" AND "Sustainable business models"	69
Scopus	"Smart cit*" AND "Sustain*" AND "Business model*"	83

Source: Authors (2021)

Next, the overall analysis of the literature will take place. This step will determine whether the overlap of sustainable business models and smart cities can be commonly found in the literature, and whether there are aspects that need further analyses.

Finally, information regarding the sustainable business models will be collected in order to analyze how they are more commonly conceived, where is their most common field of action and finally, to look for concrete opportunities in this area.

The following section will present a brief overview of the literature regarding the topics of smart cities and sustainable business models.

3. Literature Review

To improve understanding on the topics, to the paper provides a brief overview of the literature regarding the topics of sustainable business models and smart cities.

3.1 Sustainable business models

The literature review allows us to assume that the business models (BMs) are understood in two ways. The first one is a synthetic description of the company's operation. Magretta (2002) follows this approach and explains the business model as a story that explains how enterprises work (MAGRETTA, 2002). The second way is to understand the business model

as a tool to create value for customers, and Teece (2017) describes the business model as a tool to design the mechanism of creating, describing, and capturing value for customers.

The literature offers several conceptions of business models. One of the most popular conceptions is the business model CANVAS. The idea was developed and disseminated by Osterwalder and Pgneur (2017). They include a framework based on nine elements: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partners, and cost structure. These nine elements are widely used as a tool to create new business models and describe existing ones. Another example is the Cube business model. It consists of seven blocks: value proposition, users and customers, value chain, competences, networks, relations, and value formula (LINDGREN, RASMUSSEN, 2013).

One last example mentioned in our work is the proposal of Johnson et al. (2008). It contains four elements of a "Successful Business Model": value proposition for the client, profit formula, key resources, and key processes. Literature analysis shows significant differences in the components of business models. However, one element is common. It is the value that the company offers to its clients.

In any given sector, business models are natural benefactors to nascent technologies from which revenues and markets are created. The study of (MASSEY ET AL., 2018) presents the idea that sustained citizen engagement needs a business model, in the same way that new markets need business models. The common focus has been on finding the trigger that engages communities in a sustainable way. model. The essence of a business model is in defining how the enterprise delivers value to customers, entices customers to pay for value and converts those payments to profit (TEECE, 2010).

3.2 Sustainable smart cities

Over half of the world's population lived in urban areas in 2010, and by the year 2050 this figure is expected to increase to three quarters. With the world's population expected to exceed 9 billion people by the year 2050 and more than half of the population living in cities, urban areas are facing the challenge of managing the rapid growth in a sustainable way.

Washburn et al (2009) define smart cities as the employment of smart computing technologies to make the critical infrastructure components and services of a city, including include city administration, education, healthcare, public safety, real estate, transportation, and utilities, more intelligent, interconnected, and efficient. The main idea behind smart cities is to connect people, institutions, and infrastructures to use resources more sustainably and efficiently (HARRISON, DONNELLY, 2011).

A sustainable smart city should have forms of smart communication/ICT infrastructure, smart mobility, smart living, smart economy, smart environment, smart governance, and smart citizens. It is also not only about technology providers offering solutions, but also integrating solutions, proving interoperability and cohesion among systems within a city in full collaboration with all stakeholders involved (WAFULA, 2016).

The study of (PERBOLI, ROSANO, 2020) reveals that both private and public sector are interested in promoting SCPs, with different purposes. The public sector aims to enhance the sustainability and livability of cities while reducing the emissions and negative externalities. The private sector aims to improve efficiency, both in economic and operative standpoints, gaining competitive advantage. In several cases, public and private entities cooperate to find sustainable solutions to the growing issues. In Europe, energy and the

reduction of CO2 Emissions are the most relevant objectives, followed by Buildings and Transportation (respectively, 56% and 52%).

In the United States, the significant part of SCPs is focused on Transportation (60%), followed by CO2 Emission (52%) and Energy (44%). In greater detail, the 68% of projects are multi-objective including Transportation, and the 36% of them involve all the three objectives mentioned above in the same project. On the contrary, Water, E-Governance and Building are the less explored sectors in smart city topic (about 24% of projects). management. The conclusion of (PERBOLI, ROSANO, 2020) is that, although Energy is a common objective, in Europe it is mainly associated with the reduction of CO2 Emissions, while in North America it is associated with Transportation.

4. Pathways and Opportunities

This section will present both the summary of the findings in the literature regarding the identified pathways and opportunities for entrepreneurship in smart cities.

This research has revealed at least five great areas of interest for entrepreneurship in smart cities: actions in Platform economy, opportunities in the Energy and water sectors, the employment of Open Data, Smart contracts, and Internet of things (IoT) to produce business models. These areas are exploited in the sequence.

4.1 Platform economy as a business model for smart cities

There are several business models based on services and products that already existed but are now offered in a more affordable and efficient way. The superiority of the platform economy over the traditional economy is based on a series of factors that make a company succeed in building an innovative platform with a common characteristic: they are all structured as networks, connecting individuals, companies, information, and goods among themselves (NIETO-MENGOTTI ET AL, 2019).

The greatest virtue of platforms consists not only in their scalability but also in their unlimited capacity to generate services or resources between suppliers and consumers. Therefore, the world is facing a scenario of great potential, which puts in check the large multinationals and the traditional operating structures of the industry. There are many entrepreneurs who no longer consider the idea of establishing a new company in the traditional style, with stable physical infrastructures, staffing, organizational resources (NIETO-MENGOTTI ET AL, 2019).

In this sense, collaborative economy is the sale, exchange or transfer of products or services, mainly by individuals, through online technological platforms that allow the connection and management of the relationship between suppliers and consumers (BULCHAND ET AL, 2016). Technology has a preponderant role, but it is not exclusive. It is necessary to think in terms of intelligent systems that efficiently integrate the capacities and competencies of each sector, adapting technology to them. Having a city as a platform full of options only draws value if its citizens know how to be integrated (NIETO-MENGOTTI ET AL, 2019).

In the broad sense, the public sector is the source of an enormous amount of data created or collected as part of its duties, e.g. schedules for public transport, government statistics, catalogues of libraries or museums, maps, information about government revenue and spending and public tenders (ZOTANO, BERSINI, 2016). Governments also hold great

amounts of data. Much of this information is published and available for re- use by others (ALANI ET AL, 2007) since the creation of open data portals.

4.2 Business models for the Energy and Water sectors

The second pathway identified are linked to the Energy and Water sectors. Nagel et al (2019) find P2P startups specifically in the smart city areas energy and transportation. Energy P2P platforms such as Sonnen enable to purchase green electricity from peers without using existing electricity grids. Moreover, governments are addressed by blockchain-based smart city startups. For example, *Bitfury* is working on a registry of land titles for the Republic of Georgia (UNDERWOOD, 2016).

According to Nunes et al (2017) buildings and transport are the two largest energy-consuming sectors, cities are Europe's power and traffic centers since they represent 75% of EU population, three-fourth of EU energy consumption and CO2 emissions is in cities. Wiser energy use while addressing climate change and providing the transition to a low-carbon secure and competitive economy will drive to improved competitiveness to cities environments and citizens' way of living. The project addresses the efficiency of energy flows across all the energy consuming sectors (buildings, transports, water and waste management, lighting etc.) evaluating economic, environmental, and social criteria intended to pave the way towards actual implementation of priority actions, involving different stakeholders from city planning bodies to private services (GOUVEIA ET AL, 2016).

The water sector presents unique characteristics. It is heavily regulated in many areas. The environment acts as a "non-paying customer". And water is seen as a fundamental human right rather than a for-profit commodity for sale. There are also several maturity models, such as Smart Grid Maturity Model (SGMM) and Capability Maturity Model Integration (CMMI), to address organizational maturity and performance (VAN LOOY ET AL, 2013). The application of either the existing enterprise control systems or maturity models is difficult in the water sector (LINER, FARID, 2015).

Energy efficiency, climate change, and resilience in smart cities are emerging drivers. Liner & Farid, (2015) studied a conceptual reference business model (Utility Analysis and Integration Model, or UAIM) whose concepts are People, Process, and Technology, overlaid with Strategic, Technical and Operational dimensions. The UAIM can be extended to a cross-sector perspective. According to the thought leaders participating in the Charting New Waters initiative, we will need systems approaches to the provision of infrastructure services across related sectors. The cross-infrastructure sector approach can already be seen in emerging frameworks, especially between water and energy. The UAIM proposed to use integration to enhance performance and efficiency in the water sector (VITASOVIC ET AL, 2015).

4.3 Open data

The third area for innovation in smart cities is related to the usage of Open Data. Governmental data is collected from the different databases and sources where they are stored and published as datasets. The biggest challenges and opportunities lie in connecting these disparate datasets to create new sets for analysis, and to discover interesting patterns and relationships (OMITOLA ET AL, 2010). The goal of Open Data initiatives is to open all non-personal and non-commercial data, especially (but not exclusively) all data collected and processed by government organizations (BRAUNSCHWEIG ET AL, 2012).

Zotano and Bersini (2016) define indicators to assess data quality for use by smart cities like availability and eligibility. Availability measures the number of these datasets. Availability, in the case of open data portals, is like the concept of open data, which states that data should be available as a whole and at no more than a reasonable reproduction cost, mainly by downloading over the internet (HANSSON ET AL, 2015).

Eligibility measures the number of successful datasets amongst the list of retrieved datasets. The concept of Eligibility, in terms of open data, is related to one of its main goals: the publication of data in a machine-readable format thus facilitating automated processing and fostering re-usability. This entails that almost all datasets could be easily processed by a machine, although in some cases is necessary to use specific tools to work with them, mainly GIS to deal with map-related-formats. (OPEN DEFINITION, 2014).

4.4 Smart Contracts

In addition to the concept of open data, another trend that favors sustainable business models in smart cities is the blockchain technology (BT). When Satoshi Nakamoto published his seminal work in 2008, he intended to create Bitcoin as an electronic peer-to-peer (P2P) cash system (NAKAMOTO, 2008). Blockchain technology (BT) has the potential of changing how our cities work and how we live in them. The blockchain, an innovation with general purpose character, represents a new form of a database technology with the novelty of being fully distributed (BECK ET AL, 2016).

Given the high relevance of BT for applications beyond finance such as smart cities (SWAN, 2015), the literature on concrete blockchain use cases is surprisingly scarce. Moreover, prior literature has focused primarily on technological features of BT but neglected the economic implications of using BT. Like the exchange of Bitcoins, which also follows a simple and highly standardized set of rules, sophisticated smart contracts have the potential to automate many types of transactional contracts such as spot market purchases or machine-to-machine transactions (SIKORSKI ET AL., 2017).

In sample analyzed by Nagel et al, (2019), the startups Arcade City, Chasyr, and La'Zooz are launching P2P ride sharing services that operate on a trustless basis, making intermediaries like Uber or Lyft obsolete. In the field of transportation, blockchain startups further address issues of parking (e.g. Parq) and solutions for plug-in electronic vehicle (PEV) charging (e.g. Slock.it). The startup Ubirch offers sensors that connect to a digital platform which allows users to track consumption and reduce their energy costs using blockchain for encryption.

According to Nagel et al (2019), auditability is primarily exploited by startups in the areas of donation tracking, pharmaceutical authentication, voting, and logistics. Smart contracts reduce transaction costs because expenses related to writing and enforcing contracts are significantly lowered (KIVIAT, 2015). Smart contracts are particularly effective regarding lowering transaction costs when transactions are highly standardized and occur frequently as in the energy sector (e.g., SunExchange, LO3) or when they occur between parties otherwise unknown to each other as in ride sharing or real estate funding.

The authors also offer an in-depth analysis of how startup firms build upon BT to increase the efficiency, sustainability, and life quality in urban agglomerations. Therefore, solutions for the smart city are considered in core areas including energy, transportation, building, health, and government (KOMNINOS ET AL., 2013; WASHBURN ET AL., 2009). BT is used to enable peer-to-peer transactions between consumers and the tracking of energy units, especially those generated by renewables. BT can thus store and transmit transactions to

include asset classes, such as intangible or fungible assets (e.g. patents, electricity) or rights associated with an asset (e.g. digital media).

4.5 Internet of Things

According to Foss and Saebi (2018), Business Model Innovation (BMI) refers to designed, novel, and non-trivial changes to the elements of a firm's business model and/or the architecture linking these elements. Sustainability must be balanced within the scope of BMs and BMI. Souza et al (2019) present a Brazilian case of IoT Implementation in the context of smart cities and discuss this case considering the topics and questions found in the literature.

Answering a call from BNDES (National Bank of Social Development), from Brazil, the Center for Research and Development in Telecommunications (CPqD) placed a bid for implementing four smart cities IoT projects in the city of Campinas. The projects proposed by CPqD are: (a) The use of cameras and computer vision for public safety; b) advanced microclimate prediction (for floods preparedness and response actions); c) provision of shared electric vehicles services; d) complete tele management platform for public lighting.

The evaluation of the BM for the scaling of the applications once they are approved is also included, following the proposals of sustainable business models which incorporate a triple bottom line approach and consider a wide range of stakeholder interests in their development including environment and society (BOCKEN ET AL, 2014). The Literature Review conducted by Souza et al, (2019) showed a small number of papers discussing sustainability issues linked with BM and BMI in IoT and this may indicate an opportunity for researchers in the field to explore these gaps.

5. Concluding Remarks

This paper aimed to determine possible pathways and opportunities for sustainable business models to operate in the context of smart cities. To this end, a systematic literature review was conducted to identify the main areas where sustainable business models were proposed in this context. The findings both provided this research with valuable theoretical basis regarding the topics of sustainable business models and smart cities, while providing a clear pathway regarding the opportunities found.

Thus, our main findings point towards five great areas where entrepreneurs can act in the context of smart cities. The usage of platform in this context was found to be quite an interesting approach, as it connects companies, individuals, information, and goods among themselves. Platform business models can also be considered sustainable as they borderline the sharing economy model, providing new services for clients and, at the same time, maintaining a satisfactory level of resource consumption according to demand.

Furthermore, several opportunities were found in the areas of energy and water sectors, whether in the public utilities, or in the private sector. Green electricity can be purchased on a peer-to-peer basis, which means that technology allows for both sustainable generation of electricity, as well as the consumption of the right amount of power, providing thus a new area for business models to act.

The employment of open data, where the data is generated and collected mainly by the government, non-commercial and non-private are made available for organizations to plot their strategy, whether to provide improved marketing capacities or to improve overall service efficiency. Cities, states and countries, public and private organizations are constantly collecting and generating data, meaning that the main opportunity in this case is to employ the data in order to generate useful information, and generate value and opportunities for business models.

We have then found a new trend which has been looming since 2008, where there is no longer the need for intermediaries in transactions. Smart contracts, which rely on the usage of blockchain technology have the potential to replace services that rely on intermediaries, such as Uber and Lyft, due to the technological capacity of offering machine-to-machine transactions, and the employment of a reliable, public database. This can only improve transparency, making transactions more reliable, and most importantly, reducing the cost of intermediaries and rendering them obsolete.

Finally, the Internet of Things (IoT) was found to be quite present in the context of smart cities, as well as the proposition and study of current and future business models. As data can be generated in the small appliances at home, this topic refers to the generation of great amounts of data to provide better public services in cities. The case of Campinas, Brazil, where IoT provides information regarding microclimate and security cameras are used to gather useful information and improve public safety are such examples. Furthermore, the low number of studies in the literature regarding this topic can be an indicator that there is still ground to be covered by researchers and entrepreneurs in this area.

Although the findings have been satisfactory for achieving this research, we are aware that this work has its limitations. The first one is the number of papers that were found available for analyzing, as most of the studies are quite recent and are still not open for free access. Furthermore, we have opted to include only sustainable business models in the context of smart cities. There is a risk that some studies, which have employed other sets of keywords or used other terms rather than “sustainability” have been left out of our research, and therefore did not participate in our analyses.

Nonetheless, other authors are provided with a clear pathway regarding opportunities for further exploring each of the topics presented in our study, to validate, explore and expand on this research.

Acknowledgements

We would like to thank *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior e Brasil* (CAPES) and *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq) for the support during this research.

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