Prosumers—A New Mindset for Citizens in Smart Cities

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Abstract: Developing smart cities as a practical component of sustainability is an initiative being promoted worldwide at the international level. The European Union has a strong focus on creating awareness regarding the necessity of new consumption models in energy, considering the current energy crisis and increasing inflation. The aim of the present paper is to assess the paradigm shift from consumers to prosumers in smart cities of the European Union in the international context of promoting sustainability and finding solutions to the current energy crisis. New solutions have to be found and implemented in order to ensure citizens in the European Union have better living conditions under these given circumstances. Developing smart cities in the countries of the European Union is a response to this international context and a solution for better life quality for citizens. Smart cities are not just high-tech cities, but are sustainable cities putting the consumer first. Consumer living in smart cities has new functions in this sustainable environment: they will develop from consumer to prosumer. This paradigm shift brings new consumption models to be implemented in smart cities, centered on the prosumer. The proactive role of the prosumer will change their mindset. This is the research hypothesis of the present paper: smart cities will help consumers to become prosumers and a new mindset will be created for citizens living in smart cities. This development will have a social impact beyond academia and will shape society in a new way. Qualitative comparative analysis is used as a research method in the present article. A case study is presented to support the research hypothesis. The novelty and originality of the present research is the citizen-oriented approach of developing smart cities, considering the perception and the new roles or functions of the citizen living in a smart city regarding these new sustainable cities. Smart cities are analyzed as social hubs offering improved life quality and a sustainable life perspective, beyond the technical or technological components which are usually debated related to smart cities. The resumption theory explains the paradigm shift from consumer to prosumer and the related development of a new mindset for citizens of smart cities in the European Union. Economic, environmental and social incentives trigger a change of mindset from consumers to prosumers in EU smart cities, which is validated in the present paper.

Keywords: prosumers; smart cities; sustainability; energy crisis; consumer; new consumption models; citizen-oriented approach of developing smart cities

1. Introduction

The international community is currently focusing on the topic of sustainability, given the energy crisis with increasing energy prices and the scarcity of resources. Finding new solutions for renewable energy business models to be applied in our society is a goal to be accomplished. Initiatives promoting smart cities saving energy and protecting the environment support this type of approach. Municipalities are implementing these ideas by promoting smart cities. Companies are promoting these principles by formulating corporate social responsibility principles with a special emphasis on environment protection and sustainability.

The European Union has expressed great concerns regarding energy efficiency and the promotion of renewable energies, which has been led to the development of smart cities.
at the level of the European Union [1]. The trend of promoting a circular economy cannot be implemented only by policy measures, but should also be a value felt by European Union citizens. In order to achieve such a mindset, it is necessary to empower citizens to participate in shaping this new, sustainable future. A participative, proactive approach is therefore needed when promoting the development of smart cities [2]. This idea is stated in the policies formulated by the European Commission as an approach to promote smart cities [3]. These initiatives of the European Union reflected in policies and concrete measures formulated by the European Commission are in line with international trends stated by international organizations, such as the United Nations in its sustainability goals [4]. Global actors have also stated these principles and have included them in their strategies by means of ESG (Environmental Social Governance) and CSR (Corporate Social Responsibility) [5]. The trend towards sustainability can thus be found both at the institutional level and at the private sector level in international companies.

Given the current international context and the related energy crisis, it is necessary to develop new business and consumption models for citizens living in cities of the European Union. Creating awareness regarding the energy crisis would help to achieve a responsible and efficient energy consumption. Energy consumption is very high in big cities, so awareness raising helps in creating and implementing better consumption models in urban areas [6]. A change of paradigm in consumption models in urban areas switching from consumers to prosumers may help implement the idea of sustainability in cities of the European Union.

The aim of the present paper is to assess the changing paradigm from consumers to prosumers in smart cities of the European Union in the international context of promoting sustainability and of finding solutions to the current energy crisis. Economic models and theories of prosumption and produsage formulated by Alvin Toffler in an earlier context mainly for the IT industry [7] can now successfully be implemented in the context of the energy crisis and of creating sustainable cities at European Union level. The research hypothesis of the present paper is that smart cities will help consumers to become prosumers, achieving a better consumption model for urban areas. The prosumption theory may explain the change of paradigm from consumer to prosumer and the related development of a new mindset for citizens of smart cities in the European Union. This new mindset for citizens living in smart cities will help to achieve sustainable cities and to implement the principles of sustainability and a circular economy. The concrete measures of the authorities and institutions are complemented by the switch in the mindset of consumers, so that the implementation is more successful. Studying this development has an impact beyond academia in shaping society, so the present paper has a social impact. Given the importance of this topic, this paper has a social impact beyond academic research, through awareness-raising regarding the analyzed aspects and the importance of accepting proactive roles as citizens of smart cities.

A research gap has been identified in the studied literature, so that there is need to further analyze the topic of smart cities as social hubs with an important role in the community. The research literature mainly presents the concept of smart cities linked to the use of technology, without emphasizing the importance of the concept for the community and its social impact.

Regarding the methodology of the present paper, a research approach based on a qualitative dimension is used. A qualitative comparative analysis with international dimensions is performed at the level of the European Union. Case studies of cities from Germany and Romania are analyzed in detail. The relevant literature is presented in order to assess the change of paradigm from consumers to prosumers in smart cities. Metadata provided by the European Commission and European-Commission-funded projects is also assessed in connection with the formulated research hypothesis. Indicators proposed by the European Commission, e.g., the Circular Economy Index, are analyzed in a comparative manner at the level of the European Union, taking into consideration the proposed research topic.
2. The Current State of Research (Literature Review)
2.1. Smart Cities—Beyond Technology towards Sustainability

The relevant specific literature refers to smart cities as urban establishments where technology is used in order to ensure a better life quality for citizens [8]. The IT component, e.g., the role of artificial intelligence, is often mentioned in the literature [9]. It is important to emphasize not only the technology component, which is definitely part of building a smart city, but also the concept of smart sustainable cities [10]. This perspective is related to the model of sustainability seen as a term with economic, social and environmental dimensions [11]. A very important component of the sustainability model, which is of highest importance when describing smart cities, is the social component, as smart cities should offer better life quality to the inhabitants, including the social component [12]. This integrated view with emphasis on the socio-cultural component of smart cities is not mentioned as often in the literature as the technology component of smart cities. This is why analyzing the topic from this perspective is an element of novelty of the present paper. The present research is in line with previous research articles, and also brings some new elements and a new research dimension. An interdisciplinary view, considering not only the economic and the environmental component but also the social component, is taken [13].

2.2. Prosumers—A New Mindset for Consumption Models in Smart Cities

The economic model of prosumption brings together the idea of production and consumption and was initially created related to the internet and its development in time, based on the models proposed by Alvin Toffler around 1980 [7]. The main idea stated in this model is that there is no clear separation between production and consumption. This idea applies in the field of internet use and of digitalization, where the consumer is also a content creator. The prosumption theory was further developed when IT giants such as Google, LinkedIn and Facebook gained more and more market power and increased importance [14]. The theory of prosumption and produsage was further developed by Axel Bruns, referring to the fact that these economic theories present ways of involving the user or the consumer in a production process, so that the end-user or consumer does not only have a passive role, but an active one [15]. These economic theories and models can be successfully applied in the field of energy policies to understand the change of paradigm from consumer to prosumer in the context of new energy policies promoting sustainability and developing new concepts for society, such as smart cities using renewable energy. The paradigm shift from consumer to prosumer generates a new mindset related to new consumption models applied in smart cities.

Facilities granted to renewable energy systems such as solar photovoltaics are incentives triggering motivation for consumers to become prosumers [16]. As described in the researched literature, the role of communities is extremely important in this context. The participative role of citizens is mentioned in the literature and is an important incentive in promoting sustainability policies, which have a concrete expression in developing smart cities [17].

New business and consumption models are a consequence of the fact that new market models have been put in place in the field of energy. This development is also a consequence of changes in market structures in the energy sector, for example after the liberalization of the electricity sector [18]. Economic efficiency but also social and cultural acceptability are important criteria when accepting new business models [19]. A proactive attitude with support from municipalities and from companies might help to eliminate possible barriers for developing smart cities, such as the lack of knowledge regarding IT tools or low acceptance of IT tools. Such barriers might appear especially in emerging countries and in emerging markets [20]. Fragmentation of data is a main problem in cities trying to achieve the status of a smart city. Consumers search for best solutions to their daily requirements and are willing to implement such solutions, if they are familiarized with technology and if they perceive an improvement of their living conditions with the help of
technology. This attitude can be influenced by reducing institutional barriers that could affect consumers in a negative way. The governance of institutional networks might help in order to eliminate such barriers in developing smart cities [21]. Important variables such as social acceptance and the intention to use technological systems in smart cities might be improved by these means and this would help to eliminate barriers in developing smart cities. This approach is important and relevant especially in emerging markets, such as the Romanian market, where smart cities are a new concept that may be successfully implemented. Consumer-centered business models are more likely to be successful [22]. In order to create acceptance towards new consumption models such as the shift from consumer to prosumer, the socio-cultural component of inhabitants of smart cities also has to be considered and awareness-raising campaigns can help to achieve this shift in the consumption model [23].

Inflation is currently a major problem for all economies, so it is crucial to find adequate measures in order to keep the inflation process under control as much as possible [24]. The concerns regarding energy efficiency are related to the price increase of energy and to the inflation context, so that the purchasing power of citizens decreases and solutions also need to be found in order to maintain the living standards of citizens. Some major economies (e.g., Germany) have already drafted very strict measures to reduce energy costs, like reducing lightening of public buildings or promoting cold water instead of warm water in public schools, in gyms in Germany, in Hessen [25] as well as in public swimming pools. Another important topic of smart cities is the switch from consumer to prosumer, which is the subject of the present research.

3. Materials and Methods

The present paper uses a mixed research approach, combining qualitative and quantitative research in the method of qualitative comparative analysis. The research is based on multiple cases from the European Union. A detailed case study from Romania, which is a new, emerging energy market, was analyzed in order to emphasize the switch from consumers to prosumers. A case study from the German market, which is a well-established, mature energy market, was also analyzed. Within this research method, causal conditions were identified that could trigger the switch from consumer to prosumer. Such causal conditions are the wish to reduce CO$_2$ emissions [26], the wish to achieve energy efficiency and to be autonomous, income issues, and the proactive participation in shaping smart cities. These causal conditions were analyzed in the countries of the European Union by means of indicators provided by Eurostat which reflect these aspects. For each factor, one or more indicators reflecting it was identified. The wish to reduce CO$_2$ emissions is reflected in the indicators Average CO$_2$ emissions per km from new passenger cars and Net greenhouse gas emissions [27,28] which are assessed at the level of the EU Member States. The wish to achieve energy efficiency and to be autonomous is reflected in the indicators Energy efficiency [29], Energy productivity and Energy import dependency by products [30]. Income issues are reflected in the indicator Population unable to keep home adequately warm by poverty status [30]. The proactive participation in shaping smart cities is reflected in the indicators Share of energy from renewable sources and Share of renewable energy in gross final energy consumption by sector [28] as well as in the Circular Economy Indicators. Metadata from Eurostat, provided by European Union institutions, were analyzed. Indicators provided by the European Commission were also analyzed, such as the Circular Economic Indicators [31]. We evaluated if these conditions trigger a specific outcome by means of a scoreboard, where each of these conditions were rated by analyzing the development of the indicators reflecting the conditions. We assumed that such a change of mindset from consumers to prosumers is not the result of only one factor, but of more factors influencing this outcome. Nevertheless, the outcome is different depending on the EU Member State. This research method was used as it is appropriate for an intermediate number of cases, such as the number of the EU Member-States (27).
As a first research step, the outcome was defined, meaning the paradigm shift from consumer to prosumer. In a next step, causal conditions were defined (the wish to reduce CO₂ emissions, the wish to achieve energy efficiency and to be autonomous, income issues, and the proactive participation in shaping smart cities). Eurostat energy indicators reflecting these conditions were then established, as previously explained. Having the cases and the factors identified, scoring of each factor was carried out. After the scoring process, the data set was analyzed. The interpretation of the data was performed in order to verify the research hypothesis.

This paper has a multidisciplinary research approach, analyzing the impact of the shift from consumers to prosumers at microeconomic, macroeconomic and social levels, in the international context of promoting sustainability. A change of mindset from consumer to prosumer has an impact on society, not only at an economic level. It is also related to societal behavior, not only to economic parameters.

The international comparative perspective is ensured by providing case studies from different countries in the European Union, e.g., Germany, with its mature and well-established economy, and Romania, a country trying to implement circular economy principles and trying to develop smart cities, even though its economic background is not as well developed and is not comparable to Germany.

4. Results

Smart cities are based on sustainable business models combining aspects of economics, environmental protection and social topics. Some basic topics with relevance for smart cities are energy efficiency, the use of renewable energies in smart cities and the support of prosumers. Based on these assumptions, a matrix was created to obtain the causal factors and to analyze if the research hypothesis that there is a new mindset triggering a paradigm shift from consumers to prosumers in smart cities is validated. The matrix is represented in Table 1.

Table 1. Matrix—Paradigm shift from consumers to prosumers in smart cities.

| Causal Factor | Indicator | Causal Factor | Indicator | Causal Factor | Indicator | Causal Factor | Indicator |
|---------------|-----------|---------------|-----------|---------------|-----------|---------------|-----------|
| The wish to reduce CO₂-emissions | Average CO₂ emissions per km from new passenger cars | The wish to achieve energy efficiency and to be autonomous | Energy efficiency | Income issues | Population unable to keep home adequately warm by poverty status | The proactive participation in shaping smart cities | Share of energy from renewable sources |
| Net greenhouse gas emissions | Energy productivity | | | | | | |
| Energy import dependency | | | | | | | |
| | | | | | | | |

Source: Own representation based on own conducted research.

Based on this scoring matrix, the indicators and the causal factors were analyzed at the level of the EU Member States to assess the paradigm shift from consumers to prosumers in smart cities of the EU.
The research results show that citizens are preoccupied with developing renewable energies in smart cities. The results from the interpretation of the indicator Share of energy from renewable sources are represented in Figure 1.

![Figure 1. Share of energy from renewable sources in the EU. Source: Own representation based on Eurostat data.](image)

This development is also explained by the international context of the energy crisis. Energy prices have increased, so new solutions have to be found in order to keep energy affordable, as it used to be. To promote the use of renewable energies is in this context a long-term measure to keep generalized price increases under control. The research hypothesis of the present paper regarding the development of a new mindset for inhabitants of smart cities is thus confirmed.

The incentives regarding the switch from consumer to prosumer are the wish to contribute to the energy transition by reducing CO₂ emissions (environmental concerns), the wish to become autonomous, positive effects on the income of the citizen or household and the proactive participation in shaping smart cities, seen as a social responsibility. Monetary incentives as well as non-monetary incentives play an important role when motivating citizens in smart cities to approach a new consumption model and to become prosumers.

It is important to notice that not only do monetary incentives play a role in motivating citizens to become prosumers, but also non-monetary incentives, such as the responsibility towards the environment and the social responsibility expressed through wanting to be proactive in designing smart cities. These research results confirm the proposed research hypothesis and the analyzed new mindset from consumers to prosumers. The research results are represented in Figure 2.

At the EU level, the goal of implementing circular economy principles can be assessed by analyzing three indicators provided by Eurostat. The first indicator reflects the dimension of sustainable resource management. These indicators are reflected in Figure 3, expressed in tons per capita. The data provided by Eurostat refer to the year 2015.
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Another dimension of Circular Economy Indicators reflecting the mindset of EU citizens are societal behavior indices, e.g., citizens choosing alternatives to buying new products. This indicator provides information about possible changes in the mindset...
of citizens of the European Union, a change that can be triggered by awareness raising regarding this issue (Figure 4).

![Figure 4. Citizens choosing alternatives to buying new products. Source: Own representation based on Eurostat data [33].](image)

A third dimension reflecting a change in the mindset of EU citizens and that is likely to trigger a paradigm shift from consumer to prosumer are business operations reflecting this change of paradigm, such as the share of enterprises facilitating recycling (Figure 5).

![Figure 5. Share of enterprises facilitating recycling. Source: Own representation based on Eurostat data [34].](image)

This paradigm shift is complemented by the fact that at the business level, enterprises are willing to implement recycling principles, as concluded by the present research.
5. Discussion
5.1. Case Studies

Germany is a country promoting prosumers and the shift in the consumption model from consumer to prosumer. As a consequence, the number of prosumers increased in Germany from 2019 to 2020 by nearly 100,000. Thus, they contribute to more stability of the electricity network. The socio-economic effects of this consumption model and the environmental effects that have a concrete impact on the reduction of CO\textsubscript{2} emissions have been considered when promoting prosumers as a new consumption model [35]. Germany can be seen as a best-practice model and could have an impact on other countries trying to achieve this model.

The motivation for consumers in Germany to become prosumers is given by the fact that they want to contribute to a better energy transition. They want to ensure a more stable grid and contribute to the achievement of this stability. Environmental concerns as well as the wish to have more stability and security related to energy supply are important drivers of German households to become prosumers. This is a solid argument, especially in the context of the current energy crisis, with its increasing energy prices. By means of energy savings, households have more disposable income [36], which is an important aspect given the current inflation which is a major problem in the European Union.

In Romania, the energy market is a new, emerging market. Smart cities are not well-established, like in other countries in the European Union, but there is a high potential to develop sustainable cities. The first smart city projects in Romania were created five years ago. The problems in ensuring continuity of these projects are the lack of competencies of personnel managing this kind of projects and the bureaucracy at the level of the public administration. Defining a smart city in Romania is, like at the European Union level, a concept dealing with solutions for citizens by creating a sustainable city centered on its inhabitants, rather than just focusing on technology. Some examples of cities that could become smart cities in Romania are Cluj-Napoca, Iasi, Alba Iulia and Bucharest. These cities have delivered an important number of smart city projects. Cluj-Napoca has completed 56 smart city projects, Iasi has completed 39, Alba Iulia has completed 31 and Bucharest has completed 23 [37].

Romania also has small cities with important smart city projects. This is the case of the small city Bistrita, in the northern of the country. This city is concerned with environmental protection, uses electric buses, has smart lighting systems, and is concerned with energy savings, using bicycles and having as many green areas as possible.

At a smaller level, at the level of smart communities, there are in Romania villages such as Ciugud in Transylvania where smart city projects have been implemented. The school in Ciugud is functioning based on smart city projects, as it is a digitalized smart building known as the “Ciugud Smart School”.

In Bucharest there is a passive house which functions as a prototype (Pache Protopopescu Str. no. 66) where citizens can see what a passive house would look like and how it would function. Such a project has the aim of awareness raising and information, which are important aspects when promoting sustainability. Awareness-raising measures are important in supporting the shift in the consumption model from consumer to prosumer, as inhabitants of smart cities can see in a very concrete manner what their house could look like and could imagine living in such a home.

The smart city verticals known at the European Union level, which also apply in Romania, are Smart Living, Smart Mobility, Smart Environment, Smart Governance, Smart Economy and Smart People. In Romania, Smart Mobility is the vertical with the most projects, while the Smart People component still has to be improved, as there is lack of skills and competencies in this field [37].

The differences between the analyzed case studies are in line with the expectations, considering the research hypothesis of the present paper. The debated results of the case studies are in line with previous research performed in this field. The barriers encountered
in the development of smart cities in Romania are also in line with the barriers that have occurred in some other emerging markets studied in the literature.

The paradigm shift from consumers to prosumers is complemented by the fact that, at the business level, enterprises are willing to implement recycling principles, as concluded by the present research. This research is in line with the studied literature and with the results from other studies [38]. The analyzed case studies validate the research hypothesis of the present paper, confirming that there is a change of mindset from consumers to prosumers in EU smart cities.

5.2. Limitations of the Research

The idea of a paradigm shift from consumer to prosumer is still very new, so a possible problem for research is represented by the fact that there are no data regarding this subject collected at the European Union level, so that the research topic can be analyzed in a comparative manner for the level of the European Union. Another aspect making comparisons difficult are the discrepancies between the economies of European Union Member States, so that comparative analysis is still quite difficult with this topic. In Romania there are several smart cities projects but there are no smart cities as in other countries (e.g., Paris or London). Components of smart cities can nevertheless be found at the level of big cities and small cities, and even at the level of communities and villages.

Other possible discussions or limitations to the research are given by the fact that there are no general formulated definitions for smart cities to assess on a common, harmonized basis if a city is a smart city or not.

Another possible limitation of the present research might be the qualitative component of the approach. Nevertheless, this approach is in line with recommendations in the literature [39]. A quantitative view might give a more objective perspective. However, again there are limitations given the lack of data on prosumers at the European Union level. For quantitative research, more data are necessary, so the lack of information might be a problem limiting the research to the available data.

5.3. Implications for Further Research

The lack of data regarding prosumers is a problem for research and this can be followed up in future research. Some research projects may provide in the future more data regarding this subject [40].

The present paper has a focus on awareness raising regarding the positive aspects of supporting sustainability and the change of consumption models from consumers to prosumers in line with the energy transition. More information and more awareness raising is needed in this field. There are efforts being made at the level of public administrations in order to implement more projects in this field. Other countries have also drafted measures in order to achieve such improvements of the public administration in order to manage aspects related to smart cities [41]. Further research may focus on the elements where progress has been done, also considering some new ideas that could improve the current status [42].

6. Conclusions

The results of the present article validate the formulated research hypothesis that there is a new mindset triggering a paradigm shift from consumers to prosumers in smart cities.

The novelty and originality of the present research is represented by the fact that it moves away from the perspective defining smart cities via technology and engineering towards a more human, sustainable perspective of smart cities, seen as human-friendly, human-centered sustainable cities. The paradigm shift from the consumption model of the consumer to the consumption model of the prosumer using and promoting renewable energy is a solution for better dealing with the current energy crisis, with the announced recession and with the increasing inflation which is a major problem in the European Union and worldwide. Prosumers could better face these difficult economic situations generated
by the energy crisis, with increasing prices for energy but also for all other consumer goods, in the context of an inflation that was not expected to be so high, which is dangerous and which seems to be moving towards a galloping inflation. In order to better support prosumers, a regulatory framework is needed as well as more awareness-raising campaigns and information for citizens willing to support this switch from consumer to prosumer. Implications for policy-making in order to establish a better regulatory framework also have to be considered in order to support the implementation of these concrete measures in smart cities, transposing the principles of sustainability in the daily environment of citizens in the European Union.

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