The Use of Robotic Process Automation (RPA) as an Element of Smart City Implementation: A Case Study of Electricity Billing Document Management at Bydgoszcz City Hall

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Abstract: Smart cities are an extremely important, multi-faceted subject, both in terms of their practical aspects and in terms of research. This is expressed, among other things, in the multitude of approaches to this concept. These approaches differ based on the emphasis placed on individual aspects: some focus more on technology, and others put more weight on social issues, while still others value sustainable development issues. Currently, an important topic of discussion about the development of the smart city—the importance of which has become even greater in the context of the COVID-19 pandemic—is the digital transformation of the city. The use of robotic process automation (RPA) tools can be a part of such a transformation, as such tools, using advanced software, enable the automation of those tasks carried out thus far by humans. Although such an approach has, to date, been widespread in the case of enterprises (in particular, those operating in the financial and BPO/SSC sectors, but less often in the utilities sector, the first applications of these solutions in the context of process automation for cities are also beginning to emerge in various parts of the world. This article is based on a case study approach. The implementation conditions (including the constraints) of such an approach, the benefits achieved, and the lessons learned (which can be important for other local government units) are outlined using the example of the Bydgoszcz city hall's (Poland) electricity billing document management. The results of the case study presented here lead to the conclusion that the use of RPA tools enables, very quickly and at relatively low cost, measurable results to be achieved that are related to the processing of electricity billing documentation for the city of Bydgoszcz. This allows the assertion to be made that robotic process automation can be taken into consideration as one of the tools used to build smart cities.

Keywords: smart city; robotic process automation; software robot; digital transformation; electricity billing document management

1. Introduction

The issue of digital transformation has been the subject of research and scientific work for a number of years now [1]. There are already multiple research compilations in which it has been explored from very diverse points of view, with a substantial number of these focused on enterprises [2]. Only in recent years has the exploration of this topic in the context of building smart cities intensified [3]. The current COVID-19 pandemic and the related economic turbulence—along with the material impact on the functioning of local government—will accelerate activities in this area.

Observation of the IT market indicates that, currently, the fastest growing group of digital transformation tools consists of robotic process automation (RPA) tools [4]. This was indirectly confirmed by one of the largest IPOs (initial public offering) on the NYSE (New York Stock Exchange) in 2021. UiPath, a company that is a market leader in RPA tools, was

founded as a startup in Bucharest in 2005. The valuation following its IPO on the NYSE indicates that it is currently worth more than USD 60 billion (it was valued at USD 1 billion as recently as 2017) [5]. Using advanced software robots, RPA tools enable the automation of tasks thus far carried out by humans [6]. Today, the main users of these solutions include enterprises from the financial [7,8] and BPO/SSC [9–11] sectors in particular and, less often, those from the utilities sector [12,13]. Such enterprises are making the decision to implement RPA tools because they provide several benefits. The most important among them include reducing the costs of performing business processes; increasing the ability to carry out such processes without raising headcounts; improving employee experience by freeing employees from performing the most mundane and routine activities; improving the quality of the products/services delivered as a result of minimizing the number of errors committed by humans while performing business processes; and, finally, increasing the organizations' innovations by enabling the fast prototyping of new products/services that require various systems to be integrated, without the need to engage IT departments [6–17].

The research conducted by the authors indicates that RPA tools are just beginning to be used in city town halls, in particular in the context of implementing digital transformation as part of introducing the smart city concept [18]. This is why the research objectives of this article include (G1) determining the potential use of RPA tools in carrying out the digital transformation of cities and, thus, contributing to the implementation of the smart city concept; (G2) conducting an analysis of a project involving the use of RPA tools in a city town hall using the example of electricity billing document management; and (G3) identifying the determinants that have an impact on the success of robotic process automation in the case study related to the city, and comparing them to the determinants that apply in the cases of enterprises.

A diverse set of research tools was applied in order to accomplish the individual objectives of the paper. These include literature research, creative thinking techniques, and the case study method.

The following article structure was adopted on the basis of the aforementioned objectives. Section 2 presents the differentiators of robotic process automation as a means of implementing the elements of the digital transformation and discusses the options for using RPA tools in the context of building smart cities. This allows G1 to be accomplished. Section 3 includes a description of the methodological and organizational aspects of the case study on the Bydgoszcz city hall. This is related to the application of a software robot, developed using an RPA tool to process the electricity billing documentation. Section 4 presents the collected data for the case study under review. This allowed G2 to be accomplished. Section 5 includes a discussion of the results and a presentation of the determinants (factors) that had an impact on the success of developing and deploying a software robot in the city hall under review when compared to similar determinants applicable to enterprises (thus accomplishing G3). A summary of current considerations is presented in the last section, in which the limitations of the applied research procedure are also indicated, and potential directions for further research are discussed.

2. Theoretical Background

2.1. Robotic Process Automation as a Tool to Implement Digital Transformation

A steep increase in the role of digital technologies in the world economy has been observed over the last few years. Their broad application frequently leads to a profound transformation of the functioning of not only individual entities but also of entire industries [19] (p. 16), [20] (p. 57). Stolterman and Fors indicated that digital technologies are penetrating all aspects of business operations [21]. Day-Yang, Shou-Wei, and Tzu-Chuan emphasized that a transformation in the way organizations operate is taking place as a result of the application of such technologies, and its effect is the deep integration of digital technologies and business processes. Such integration leads to the development of new models for the functioning of such entities, with digital technologies being the core of the new models [22]. In a report prepared by the MIT Center for Digital Business

and Capgemini, such changes are defined as digital transformation. Its consequence is a radical improvement in the organization's productivity and achievements. According to the authors of the aforementioned report, such transformation impacts three areas of the organization's functioning:

- The experience of the organization's customers (understanding customer needs, introduction of multiple contact channels, and self-service elements);
- Operational processes (the organization's internal processes and work environment, and productivity-monitoring mechanisms);
- The organization's operational (business) model (what products and services the organization provides and in what markets) [23].

A starting point for an analysis of the use of RPA tools, as one of the approaches to implementing digital transformation, is to define the software robot concept. According to Willcocks and Lacity [24] (p. 65), it is software that automates certain activities carried out by human beings (most often by faithfully reproducing (mimicking) them) as part of performing the given business process. Based on such an approach, a robot is not identified with a technical device and does not possess human locomotion capabilities. Software robots do not operate based on a set algorithm, but more and more often they are being enriched with certain artificial intelligence elements and, as a consequence, they are able to make increasingly complex decisions (learning based on the data provided—both structured as well as unstructured) [25] (p. 26).

RPA tools are used to develop software robots. This is one of the fastest growing process automation software categories. Nevertheless, no coherent or commonly applicable definition of such tools has been developed as of yet. According to the literature [24–29], the authors made an attempt to identify the differentiators for this class of IT solutions. Based on an analysis of these works, the following assertions can be made:

- RPA enables the development of software robots that operate directly on the user interface of the IT systems, which automate mass (high-volume) activities (performed multiple times within an assumed time unit—for example, within a month or a year), most frequently faithfully reproducing (mimicking) the activities performed previously by an human operator (see Figure 1).
- Developing software robots using RPA tools does not require classic coding. Rather than being written, a robot's code is "developed by drawing" (like in modern low-code tools) using pre-defined code components (providing specific functionalities) that are presented as graphical objects, which are subsequently configured by entering specific parameters or logging activities (for example, clicks) performed by a human operator.
- When deploying software robots developed using RPA tools, the change in the business processes that are being robotically automated do not need to be changed (optimization or reengineering) is not required, although such action is recommended.
- Using RPA tools does not require developing dedicated programming interfaces for exchanging data between the individual systems.
- Using RPA tools does not require interfering with the source code or the application database (this implies that it is not necessary to have knowledge of the internal structure of the application, which is very important in the case of legacy systems).
- RPA tools use the business logic that constitutes an inherent part of the application that the software robot will be working with, which eliminates the problem of reproducing such logic taking place in the traditional IT system's integration model.
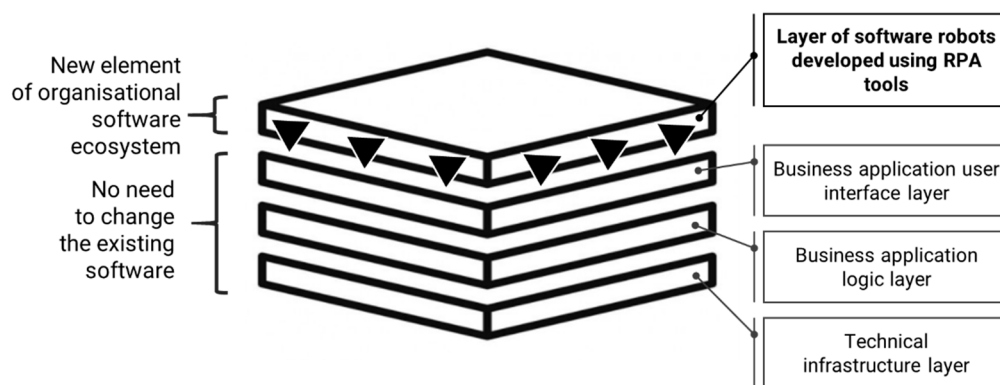
Figure 1. Positioning of software robots developed using robotic process automation (RPA) tools. Source: proprietary compilation.

It is important to demonstrate how RPA tools are positioned versus other, classic business process automation methods, such as workflow type systems or the BPMS (business process management system) [30] (pp. 92–94). It can be assumed that both RPA tools and the above-mentioned classic solutions—on business-concept level—have a common bundle of goals: increasing efficiency and minimizing the costs of performing business processes while ensuring the highest possible quality of delivered products from such processes. Such goals are, however, accomplished using totally different means (but it should be noted that some large organizations decide to use both BPMS and RPA solutions at the same time). The implementation of workflow or BPMS-type solutions involves altering processes, while introducing changes after the implementation has already been completed frequently involves the need to carry out programming works (which often require time and adequate IT competences). RPA tools are the opposite of such an approach. First, the suppliers of these tools strive to make them so intuitive to use that representatives of business units should be able to handle their operation on their own (i.e., they can develop software robots themselves without the support, or with the minimum support, of IT departments). Usually, this is performed by dedicated teams that constitute centers of excellence [31]. Another way to obtain software robots is to rent (outsource) them from an external company; in such cases, a robot acts as a robot-as-a-service, performing the role of a "digital employee" [10]. A business department "hires" such a robot, specifying its requirements, while an external company delivers (develops) and maintains it. In addition, in such cases, the supplier provides the RPA tool licenses as well as the entire IT infrastructure required for the robots' functioning. With this approach, the robots are usually delivered using a public cloud of one of the main providers in this area, for example, Microsoft, Google, or Amazon [32]. The main advantage of such a model is the implementation speed, which is due to the fact that the robot's supplier usually has a lot of experience in the field, with respect to both the organizational and technological layers. Furthermore, this model usually provides a high degree of flexibility: an employer can "dismiss" a "digital employee" without the need to fulfill a number of complex formalities. The robot's supplier may also frequently offer a very attractive billing (settlement) model based on, among other things, partnership agreements signed with the RPA tools' producers.

However, when RPA tools are implemented, certain risk factors are likely to materialize. The most important among these may include, inter alia, the risk of perceiving the whole idea of robotic automation wrongly (solely through the prism of reducing the costs related to human resources), the risk related to choosing the wrong robotic automation approach within the given organization, the risk related to choosing the wrong robotic automation tool, the risk related to using the wrong approach to changing management within robotically automated processes, the risk related to push-back from staff engaged in the robotically automated processes, and the risk of having a competence gap [33] (pp. 37–42). Additional risk factors may also include a continued high proportion of hard-copy documents that are entered as input to the robotically automated processes (this is a

material constraint as it requires the use of OCR software); a lack of up-to-date and codified knowledge about the actual course of the business processes, in particular with respect to how exceptions that occur during business processes should be dealt with; and a lack of coordination for changes in the systems that a robot is operating on, which results in emergency stoppages.

The RPA tools' deployment can be perceived as an element of implementing digital transformation and as a way of driving digital innovations. Such innovations can be understood as (a) the result of using digital technologies, and (b) the way the processes are implemented using such technologies, thus changing the nature, structure, or the way the products/services are delivered or the way value is created for such customers [34]. As a result, this may lead to the transformation of entire industries. Based on the digital innovation determinants (drivers) presented, an assertion can be made that (1) RPA tools are classified as digital technologies, (2) software robots enable the development of completely new products that would have been unprofitable or impossible to achieve using traditional enterprise operations methods, and (3) software robots are changing the way entire industries operate [35]. The banking and investment sectors, as well as companies providing advanced business services (BPO and SSC), can be seen as areas of the economy where the impact of robotic process automation is strongest [36]. In their cases, it is even said that the "cannibalization" of the traditional way of conducting business operations is taking place [37] (p. 50).

2.2. Use of Robotic Process Automation (RPA) Tools in the Context of Building Smart Cities

The digital transformation concept is usually used in reference to enterprises; however, increasingly, it is also being used in the context of the smart city development concept. This topic is subjected to an in-depth analysis in this section, with particular attention given to the role of RPA tools in undertakings in this area.

The smart city concept is not new [38]. The first research related to smart cities was conducted in the 1970s. The Los Angeles Community Analysis Bureau used cluster analysis and infrared aerial photography to produce reports about demographic data and housing quality [38]. A virtual digital city implemented in Amsterdam in 1994, where internet access was provided to a large group of citizens for the first time, could be considered the next milestone [1,39,40]. Smart city research picked up steam in 2000 when multinational technology conglomerates spent hundreds of millions of US dollars in order to gain detailed knowledge and experience in urban topics [41].

It should be noted that the smart city concept has evolved over recent decades [41–43]. Currently, it constitutes an answer to challenges related to progressing urbanization; the growing requirements of the public with respect to more productive and, at the same time, sustainable urban services; and to the improvement of quality of life [44]. As indicated by Elberzhager et al. [40], one of the most often cited works related to the smart city is the paper written by Giffinger and others [45]. It enumerates smart city dimensions: smart economy, smart people, smart management, smart mobility, smart environment, and smart living. Furthermore, it defines a smart city as being "a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens." According to Elberzhager et al. [40], the other frequently used approach to a smart city is provided in a paper by Yang et al. [46]. They note that there are "six application domains for smart cities: natural resources and energy, transportation and mobility, building and infrastructure, living, governance, industry, and human resources".

Recently, a number of papers—both theoretical and application themed—have focused on searching for potential factors that strengthened the direction of the transformation of cities more toward "smart" cities. These factors can be grouped into threads related to governance and digital technologies [47]. The approaches related to governance are focused on management and interactions among various city stakeholders, in particular, on combining and developing links between networks of city entities that target productivity, social

aspects and, also, innovations. In contrast, the approaches related to technology—primarily digital technology—are aimed at improving the efficiency of services and infrastructure (for example, communications, transportation, and supplies). The evolution of the perception of digital technologies in the context of developing smart cities has been emphasized in [40]. A number of smart city projects carried out earlier this decade were focused on developing smart infrastructure (equipped with sensors). Newer approaches have a tendency to focus on creating added value for citizens, companies, and NGOs thanks to digital solutions and the processing of applicable data, including open data (i.e., we are dealing with components used to implement digital transformation; see Figure 2).
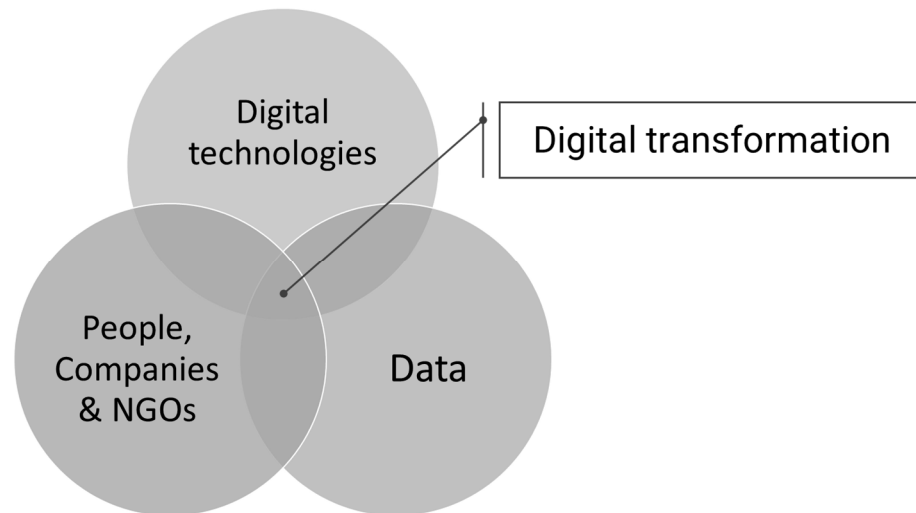
Figure 2. Components of digital transformation in the context of building smart cities. Source: proprietary compilation based on [48].

The digital transformation projects currently carried out in cities focus on several aspects. First, they are related to the implementation of new digital technologies to better control, monitor, and measure urban operations, which, for example, involve using real-time data to make decisions about city services. The second area in which transformational projects are implemented is in continuously improving the degree of process automation and digitization implemented by cities. Finally, the third direction of the work being undertaken is aimed at increasing the level of integration of existing data sources in order to improve the management of urban services [41,48].

RPA tools and software robots are applicable to the last two areas. However, the scope of their use today is still in the very early stages. This is confirmed both by the literature research conducted by the authors of this article and the analysis of the RPA tool suppliers' implementations. In May 2021, the authors searched the articles collected in the Web of Science (WoS) Core Collection. The search range was not limited to particular dates of publication.

After entering the following phrases in the WoS search engine, searches were carried out based on both article titles and topics:

- "Robotic Process Automation" and "Smart Cit *";
- "Robotic Process Automation" and "municipality";
- "Robotic Process Automation" and "town hall";
- "Software robot *" and "Smart Cit *";
- "RPA" and "Smart Cit *".

After which, only two items were identified.

Both were subjected to preliminary analysis, but their content turned out to be irrelevant to the issues discussed in this article. A similar study was also carried out in May 2021 using the SCOPUS database. As a result of the search, six items were identified. Three

of these contained irrelevant content, while one item was indirectly related to the smart city topic [49]. The authors of the cited paper [49] proposed a conceptual framework that integrated (1) artificial intelligence/machine learning, (2) institution/organization, and (3) business processes to support the use of AI in smart tourism, considered to be a component (building block) of smart cities. According to the authors of the analyzed article, advanced (smart) RPA tools—the so-called cognitive-RPAs—are among the components of artificial intelligence. The last two items were related to the use of software robots in Swedish cities. The articles presented very preliminary research results (in fact, research plans), which only confirmed that the topic is extremely new and also at the global scale.

The first item [50] referred to the use of software robots in Trelleborg city hall. The RPA tools are used in this office by the social support team. The goal of the presented research was to assess how the application of robots developed using the RPA tool would affect the employees' experience in the long term. The first results were promising, but according to the authors of the paper, the long-term effects of robotic process automation are an open issue. In the second paper [51], the author presents the concept for research commenced by Linköping University and the IT University of Copenhagen on the use of RPA tools by Swedish local government units. They have been scheduled for the years 2020–2022. In the article under review, the researchers analyzed strategies related to the automation of activities associated with services for citizens (public) provided by Swedish local government units and acquired data from two case studies in a large municipality in Sweden.

Analysis of the RPA tool implementations—based on data provided by tool producers or by cities where implementations had been carried out—allow a list of deployment examples to be created:

- Implementation of an RPA tool to support internal processes at the Copenhagen city hall (Denmark)—nearly 60 software robots are in operation there [52].
- Implementation of an RPA tool to automate processes at the Trelleborg city hall (Sweden) related to providing social support [53].
- Development of an intelligent bot to automate customer service (especially for residents) at the Oulu city hall (Finland); the bot will be focused on the entire process of handling cases, from initiating contact to the implementation of the process inside the city hall [54].
- Implementation of an RPA tool to automate processes at the Espoo city hall (Finland) related to providing social support and health care services [55].

To sum up, RPA tools are used today by a very small number of cities, and the scope of work carried out with respect to their implementation is usually limited (single processes/departments).

However, it should be noted that digital transformation is becoming an integral part of the process for developing smart cities. Therefore, its implementation in a way that factors in the conditions that must be taken into account by those responsible for city management is becoming key, in particular:

- Limited financial resources for the implementation of digital transformation projects. This is applicable, in particular, to large projects; this constraint has become especially important during the COVID-19 pandemic and the economic turmoil related to it, which has significantly curtailed local government budgets.
- Very lean human resources that can be allocated to the implementation of digital transformation projects. Very passionate people often work in city halls; however, there are not many of them, while wages in the Polish commercial sector for similar positions (developers, analysts, project managers) are sometimes 6–10 times higher than in city halls.
- City hall IT systems are often not integrated with one another; there is also no integration of city hall systems with solutions used by external entities (such as city companies or central government units). Very often, the role of the integration mechanism must be played by a human official (city hall personnel), as it is not possible to

implement data exchange between applications within a reasonable time and budget using an API (application programming interface).

- IT solutions operated by city halls are not based on common technological standards, and they are often stuck with a large technological debt. In general, the development of the cities' IT solutions was an emerging and not deliberately planned process, as is often the case in enterprises that use the enterprise architecture concept.
- Pro-innovation attitudes and the levels of digital competence among local government unit staff are much lower than is the case for enterprise personnel.

Meanwhile, residents and entrepreneurs expect public services to be delivered in a manner similar to what they experience in the ever greater numbers of digital banks, telecommunications companies, and various other services (such as streaming services).

The existing discrepancies between the conditions in which city halls operate and the needs of residents and entrepreneurs indicate that it is necessary to search for non-classic methods of implementing digital transformation.

The use of RPA tools can achieve a number of benefits [50–55]:

- The costs of developing software robots are much lower than the costs of developing classic applications, and the time it takes to develop such a solution is much shorter than the time needed to develop applications from scratch: it is estimated that developing a classic application takes about three to four times longer and costs about three times more than developing a software robot.
- Developing software robots does not require complicated programming competences—knowledge of the business aspects of the given issue is much more important; additionally, a robot can be sourced based on the "virtual employee" model (robot-as-a-service), as demonstrated by a case discussed later in this article.
- Software robots minimize problems related to data exchange between systems (including external ones); in addition, they do not require the development of dedicated APIs and, at the same time, relieve employees from the task of acting as "protein interfaces".
- Software robots are not constrained by the lack of standards that are applicable to IT solutions used by city halls or the large technological debt of such solutions.
- The development of software robots has a very low entry barrier: the first robots can be developed by city hall personnel after 2–3 days of training.

Therefore, presenting examples of model RPA tool implementations at city halls is becoming of key importance. On the one hand, they will be able to serve as inspiration for other cities while, at the same time, the experience gathered during such deployments will be used to identify the success determinants (factors) for subsequent projects in this area.

3. Methods of Analysis

The decision was made to use one of the qualitative analysis methods—i.e., the case study method—as a way to verify the choice of using RPA tools as part of the digital transformation of cities, in particular in the area related to electricity management. There are a number of definitions for this concept in the subject literature. For the purpose of the research procedure, the authors adopted the approaches presented by Dul et al. [56] (p. 4). In accordance with this study, a selected single case or a small number of cases, embedded in the real everyday context of their functioning, are subjected to qualitative analysis. A case is understood as a single research object, analyzed for a specific purpose, and situated at a specific place and time, taking into account the relevant circumstances. The case study method can take a holistic or nested form and involve single or multiple case studies [57,58].

The arguments in favor of opting for this approach with respect to the research conducted by the authors of the article on the use of RPA in local government units were as follows:

- It is necessary to evaluate the option of using the RPA tools in real conditions and not in laboratory tests; this takes into account not only the technological but also the organizational (taking particular note of the process aspects), cultural (undoubtedly the organizational culture in public units is significantly different from that in enterprises), and legal context (it should be taken into account that local government units operate strictly in line with legal regulations, which means that they have much less room to maneuver than enterprises).
- Implementation of RPA tools is a complex process, involving many variables and elements, and, therefore, one cannot expect only a single result from the entire project.

At the same time, the authors are aware of the disadvantages of such an approach, in particular, of narrowing down the analysis to a single case study [59]. Certain difficulties may arise in a case study, for example, a lack of openness by the respondents or a low level of communicativeness. In addition, misinterpreting the obtained information is possible. Furthermore, the literature on the subject includes recommendations that between 2 and 15 use cases should be analyzed; hence, the authors of the article concluded that the conducted research is preliminary and that further work is required. Narrowing down the analysis to a single case study was due to the fact that only one city in Poland has a software robot deployed in the production environment that is used to process electricity billing documents. Apart from Bydgoszcz, the subject of this analysis, only one other city, Łódź, has a software robot, which is used in the Social (Public) Participation Office [60]. According to the authors, this indirectly demonstrates the innovative nature of the implementation presented in the article.

It should be noted that a popular opinion in management theory suggests that results obtained based on a single case cannot be generalized (extrapolated) to apply to an entire population. Moreover, developing a theory based on several case studies rather than a single one is considered more reliable (accurate). However, the article assumes the perspective that the case study method should not be used to generalize but mainly to revise the theory [57,58].

4. Choice of Case Study

Bydgoszcz city hall implementation was selected as the case study. Bydgoszcz is one of Poland's largest cities; it is ranked eighth in terms of population (approximately 345 thousand inhabitants in 2020). It is a large industrial, commercial, and logistics center, as well as being a road, railway, and inland waterway junction (hub). An international airport and a river port are located in the city. Bydgoszcz is also an academic, scientific (research), and cultural center, where approximately 35,000 students attend 15 universities. Since 2010, worldwide travel sites have been recommending Bydgoszcz as one of Poland's top 10 destinations. There is a large military garrison in the city as well as the headquarters for most of the NATO institutions present in Poland [61].

In the context of further deliberations, it is also important to emphasize that Bydgoszcz was among the winners of the seventh edition of the Eco-City 2020 competition. The competition committee applauded the city for its energy efficiency. The initiators of the competition include the Embassy of France in Poland and the UNEP/GRID-Warsaw Center. A number of international projects related to energy efficiency are implemented in Bydgoszcz, among others:

- CitiEnGov—Cities for good energy management;
- ENERGY@SCHOOL—Energy Optimization and Behavior Change at Central European Schools;
- mySMARTLife—Smart transformation of EU cities towards a new concept of smart living and economy;
- eNeuron—the study of the application of local energy, balancing areas for optimization and development of distributed networks.

4.1. Reasoning behind the Choice

The decision to select the Bydgoszcz city hall as the case study was based on the following premises:

- Fulfillment of the boundary condition—deployment of a software robot in Bydgoszcz city hall, developed using an RPA tool; the robot has been used in the production environment since November 2020.
- Above-standard approach (within the Polish market) of Bydgoszcz city hall to the issue of electricity management, which is expressed, among other things, by the functioning of a dedicated energy management team at city hall.
- Use of a software robot to perform a business process related to the processing (management) of documentation associated with electricity billing for the needs of the city hall and that of its subordinate units (a total of 1400 electricity consumption points).
- Availability of data (there is an obvious push-back among Polish organizations against engaging in research processes and providing information, especially when it is in-depth research that is subsequently to be made available to the public, e.g., in the form of an article).

Due to the fact that public data were obtained as part of the description of the case study (this stems from the fact that the selection of the enterprise entrusted with developing the robot was made under a public procurement procedure) and the entire documentation of the procedure is available on Bydgoszcz city hall's official website, there was no need to anonymize the entity (the authors often observe such requirements where the case study method is applied with respect to enterprises).

It is worth noting that the scientific value of the case study method is demonstrated by the objectivized, rational, organized, systematic, and orderly activities aimed at ensuring the credibility of the conclusions. Therefore, the most important principle is the triangulation method, in this case understood as obtaining data from several independent sources [59]. This also minimizes the risk of encountering the limitations of the case study method, which were mentioned earlier in this section [59]. In practice, this means that anything can be data: not only what is said during interviews, how it is said, and under what circumstances, but also the documents related to the issue, press articles, observation results, and audio and video recordings.

4.2. Data Collection

Therefore, the decision was made to use the presentations provided by Bydgoszcz city hall in the description of the case study (e.g., [62]), press releases, recordings of speeches by the city hall's representatives during industry webinars devoted to robotic process automation, information provided directly to the authors of the study by the city hall's staff during conference calls (Zoom communicator was used), and telephone interviews, as direct contact was restricted due to the COVID-19 pandemic. All interviews were held during May 2021. Additionally, the following conference calls were held in order to ensure a multifaceted approach to the software robot's deployment:

- With ForProgress, the company that developed, deployed, and maintains the robot;
- With First Byte, the author of the Wizlink tool used to develop the software robots that were applied at Bydgoszcz city hall.

Table 1 contains a description of the respondents with whom the conversations were conducted and of the interviews themselves. Selecting the respondents with whom to conduct interviews was purposeful, and this achieved a comprehensive view of the development, deployment, and operation of the software robot deployed to manage the electricity billing documents. It is worth noting that there was no representative from Bydgoszcz city hall's IT Office among the persons with whom interviews were conducted. This is due to the fact that the implementation was initiated and managed by a business unit—the energy management team.

Table 1. List of the interviewees.

Interviewee's ID	Interviewee's Position	Organization	Education	Years of Professional Experience	Interview Duration
1	Energy Management Team Coordinator	Bydgoszcz city hall	University degree (Energy, Economics)	>20 years	60 min
2	Member of the Energy Management Team	Bydgoszcz city hall	University degree (Mechatronics)	5–10 years	60 min
3	CEO	ForProgress Sp. z o.o.	University degree (IT)	>20 years	90 min
4	CEO	First Byte Sp. z o.o.	University degree (IT)	15–20 years	60 min

Source: proprietary compilation.

All the interviews (both with the representatives of the city hall and the companies) were, with the consent of their participants, recorded at the Zoom tool level and subsequently transcribed into text form. Ultimately, nearly 60 standardized pages of Polish text were created. In the next step, the interviews were encoded. For the sake of objectivity and in order to avoid potential errors, the encoding was carried out independently by two people. The last step was the analysis of the results obtained.

The following documents constitute the legal basis for the actions they have taken:

- Act on Municipal Local Government of 1990 (consolidated text of 2020);
- Energy Law Act of 1997;
- Poland's energy policy until 2040 adopted by the Council of Ministers;
- National Action Plan on energy efficiency adopted by the Council of Ministers in 2018;
- Assumptions for the National Low-Emission Economy Development Program, adopted by the Council of Ministers in 2011.

4.3. Project Description

The topic of energy management has been developing at Bydgoszcz city hall for a number of years. A one-person position for a municipal energy engineer was established at Bydgoszcz city hall in 2013. As a result of Bydgoszcz's participation in the international CitiEnGov and ENERGY@SCHOOL projects as part of the INTERREG Central Europe program, the energy management team was established in 2016, and it is currently made up of six people. This team undertakes activities aimed at saving energy consumption in the city's public sector by,

- Organizing tenders for group purchases of electricity and gas fuel for the Bydgoszcz Purchasing Group, made up of the City of Bydgoszcz and the municipalities of the Bydgoszcz Metropolis Association;
- Concluding contracts for the supply of heat, electricity, and gas;
- Analyzing the demand of municipal institutions for energy media in order to select the right tariff and optimize consumption;
- Seeking to automate the acquisition of energy data in municipal buildings;
- Investing in energy efficiency and RES;
- The city's participation in EU and international programs and projects in the field of efficient use of energy, and water and environment protection;
- Disseminating best practices and information on implemented tasks and projects.

In July 2020, the energy management team announced a public tender for the robotic automation of the process for acquiring, distributing, and archiving electricity billing documents received from the electricity supplier (Enea—Poland's third largest electricity supply company) and the electricity distributor (Enea Operator—one of Poland's largest electricity distributors) for the City of Bydgoszcz' units, including capturing data from these documents. The announcement of this tender was preceded by a business analysis conducted by the team members, which demonstrated the following:

- The city hall uses approximately 1400 electricity consumption points, and a gradual increase in the number of such points should be expected.
- The city hall and its units are charged for electricity based on 14 different electricity tariffs, the number of which may vary over time.
- On average, around 20,000 electricity-related invoices are processed annually by the city hall and its subordinate units; additionally, requests for payment, liquidated damages, and interest notes are processed. Such documents are issued by both the electricity distributor as well as the electricity supplier (a statutory separation of electricity distributors and suppliers (unbundling) is in force in Poland).
- Electricity billing documents arrive at the city hall and its subordinate units in paper form and are, on average, between a few and more than a dozen pages long (the most extensive invoice was 150 A4 pages long).
- It is not expected that the electricity suppliers and distributors that the city hall cooperates with will introduce solutions that allows invoice data to be exchanged through a direct integration between systems in the near future; it should be noted that the electricity supplier and the electricity distributor are selected by public tender, and they may change from time to time.
- Methods of collecting information about required payments using solutions based on a centralized database or similar solution do not work in practice.
- Any delay in the payment of electricity invoices results in an interest note being issued, which must be paid from the private funds of the official responsible for the given organizational unit—Polish law prohibits covering the costs of interest notes from public funds.

Based on the completed analyses, the energy management team's personnel, practically without the participation of the IT office, compiled the following assumptions concerning the work to be performed by the planned software robot [63] (see Figure 4):

- The robot will log in (in the same way that an employee of the city hall does) to the portals of the electricity supplier and the electricity distributor's electronic customer service centers at least once a day and download any documents that have not been downloaded since the last login. The robot will download invoices, payment requests, liquidated damages documents, interest notes, and other available documents (for example, payment extensions and requests to supplementary data). The robot will download documents in their source formats and assign them a unique name containing, at least, the document number so as to enable their further processing and data acquisition (see Figure 3).
- Having downloaded the documents, the robot will identify the source document type and convert it into a digital data stream using a data mapping mechanism. The data collected from the documents will be fed into the database set up. In the case of invoices, the following minimum data set will be downloaded:
  ○ VAT invoice number;
  ○ Amount to be paid;
  ○ Total consumption (in kWh, in the case of another unit, the robot is to convert it to kWh);
  ○ Electricity consumption location (site);
  ○ Code of the electricity consumption point;
  ○ Period, from–to;
  ○ Tariff;
  ○ Contracted power;
  ○ Meter number;
  ○ Consumed power;
  ○ Active energy meter: 24 h a day;
  ○ Inductive reactive energy meter: 24 h a day;
  ○ Capacitive reactive energy meter: 24 h a day;
  ○ Fixed grid fee, transition fee, quality related fee, variable grid fee;

- ○ Renewable energy source fee;
- ○ Cogeneration fee;
- ○ Subscription fee;
- ○ Charge for excess consumption of capacitive reactive power above the contracted amount;
- ○ Charge for excess consumption of inductive reactive power above the contracted amount;
- ○ Total net amount;
- ○ Consumption.

- Additionally, the robot must provide information on changes in the documents by sending an alert to an indicated e-mail address, in the event of the following:
  - ○ Deviations from fixed data, such as rates and charges for electricity and electricity distribution, commercial (trading) fees, contracted capacity (power), meter number, and no electricity consumption;
  - ○ An occurrence of double counting for the same billing period (cycle) for a given electricity consumption point;
  - ○ No information about the electricity consumption point on the document, no link between the electricity consumption point and the e-mail address, or no link between the document downloaded with no electricity consumption and the source document from the electricity consumption point.

- The results of the robot's work (the downloaded and pre-processed electricity-related documents) will be stored in a dedicated database, which will contain data from all the downloaded documents, including detailed data from invoices and links to source files. The data collected every day will automatically be added to the database. The energy management team's staff will be able to view the data, including an option to filter data by document types and by any of the fields. In addition, the solution developed must be equipped with a mechanism for exporting in XLS format, the data stored in the database.

- The robot must ensure the continuity of its operation even in the event of a change in the system/format for downloading documents in the electronic customer service systems of the electricity distributor or the electricity supplier.

- The energy management team left the choice of whether the robot would be delivered based on the robot-as-a-service model or installed on Bydgoszcz city hall's servers by the contractor (in the latter case, all technical aspects were to be dealt with by the robot's supplier, and, additionally, the robot-as-a-service operating model was awarded a higher score in the tender procedure).

- The energy management team made the decision that the supplier would provide one year (technical) of care service for the software robot they delivered. In particular, the supplier will be implementing changes stemming from potential amendments to the documents sent by the electric utilities.

- The energy management team also decided that the transfer of knowledge should be one of the elements of the robotic process automation's implementation; therefore, it requested training for the city hall's personnel (officials), broken down into the following:
  - ○ The users (business owners) of the robot;
  - ○ The technical administrators of the robot.
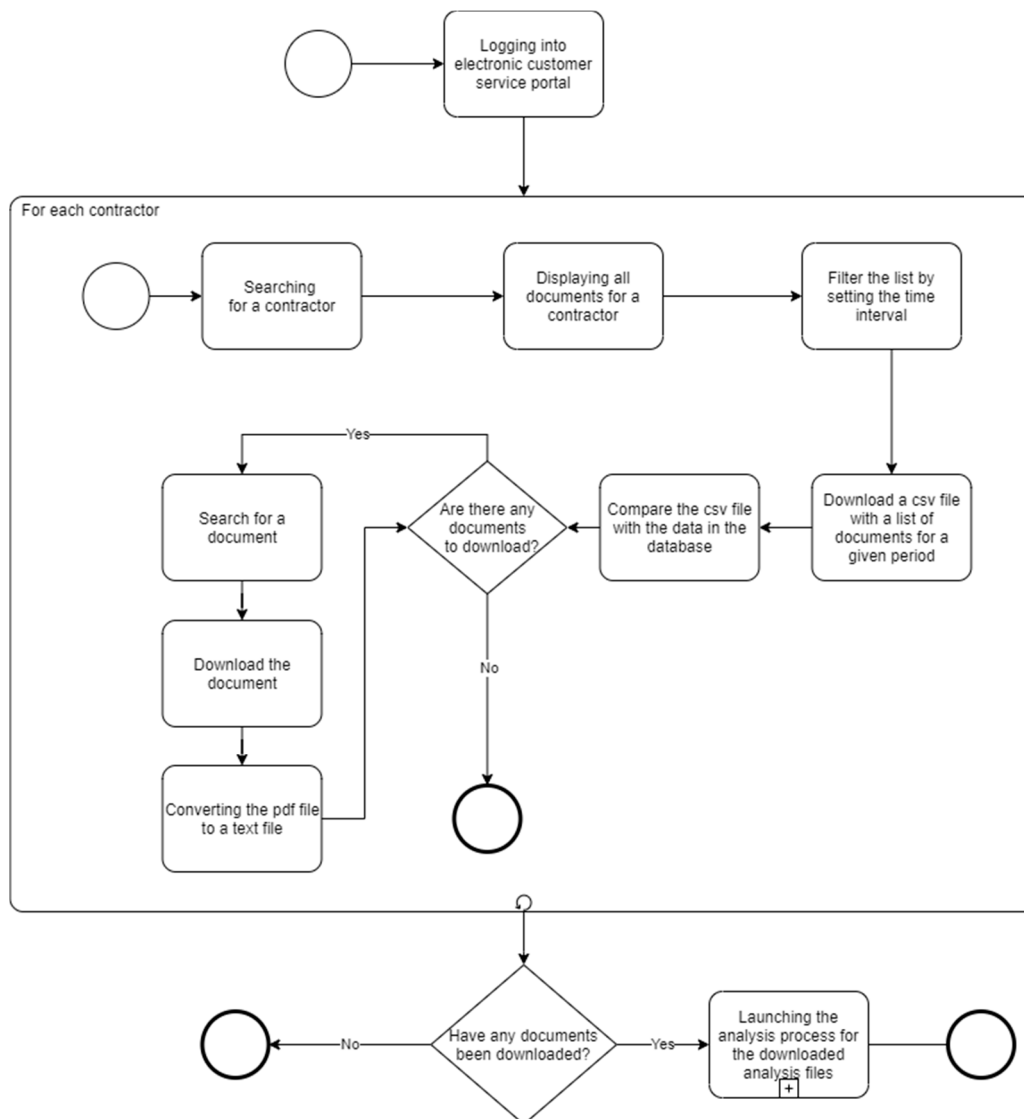
Figure 3. Model of the process flow for electricity billing documents for the city of Bydgoszcz. Source: proprietary compilation based on ForProgress CEO interview.
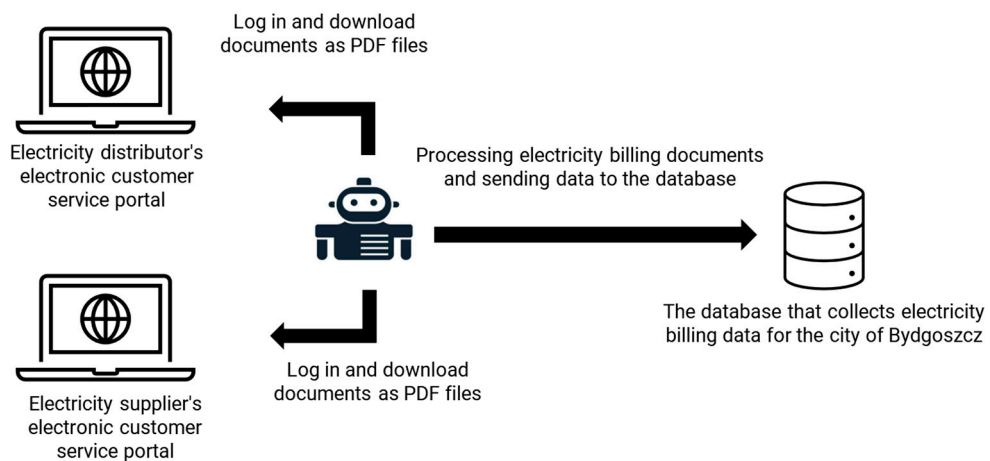
Figure 4. The operational model of the software robot developed using the RPA tool addressing the processing of electricity billing documents for the City of Bydgoszcz. Source: proprietary compilation based on [63].

Four companies responded to the announced public tender procedure. The prices for developing the robot and its implementation time significantly differed across individual bidders, ranging between, approximately, EUR 35,000 and nearly EUR 80,000 (bid amounts were provided in PLN; the authors converted them into EUR for the purpose of the article) and between one and three months. The bid submitted by ForProgress won, with the company offering to develop and maintain the robot for around EUR 35,000 and to complete the project within a month. This deadline was met, and the robot began operating in the production environment in December 2020. ForProgress selected a Polish producer of RPA tools—First Byte—which supplied a tool called Wizlink. According to the CEO of ForProgress, the choice of this tool was determined by "the ability to meet all of the functional requirements indicated by the Energy Management Team, and, at the same time, a very friendly tool licensing model".

5. Data Analysis and Results

Sufficient time has passed between the launch of the software robot in the production environment at Bydgoszcz city hall in December 2020 and the preparation of this article to allow for the formulation of many important methodological and practical conclusions regarding software robot deployments in local government units, in particular in the field of electricity management. The discussion of the conclusions is divided into three thematic threads:

- Assumed vs. actual benefits of deploying software robots using the example of processing documents related to electricity management;
- Identified limitations of deploying software robots using the example of processing documents related to electricity management;
- Prerequisites for the success (success determinants) of developing and implementing software robots using the example of processing documents related to electricity management.

5.1. Assumed Benefits of Software Robot Implementation (Implementation Goals) and the Results Achieved

When preparing the software robot implementation concept, the representatives of the team assumed the following:

- The software robot would relieve the personnel of Bydgoszcz city hall and its subordinate units of the need to manually rewrite the data from electricity invoices received in paper form. This goal has been achieved in full. As the energy management team coordinator pointed out during their interview, "300 people had been involved, directly and indirectly, in the processing of invoices prior to the robotic automation of the process—now this number has decreased to a single person".
- The software robot would change the nature of the work related to electricity invoices—from operator type work to analytical work. This goal has been achieved in full. As the energy management team coordinator indicated during their interview, "currently only a single person representing the energy management team, is responsible for dealing with emergency situations or disruptions of the robot's standard operation (e.g., double appearance of certain data on the invoice)".
- The use of the software robot would improve the quality of the collected data that are obtained from electricity billing documents. Before the robot's deployment, such data had been processed by people with various competences and for whom the data entry task was an additional activity. Moreover, this work was monotonous by nature. All parts of this process could result in errors. The energy management team coordinator indicated that the "people responsible for entering this data were the weakest link; such people changed frequently [. . .], besides, please show me an accountant who can read the electricity invoice correctly". This goal has been achieved in full. Thanks to the built-in validation rules (12 validation rules were formulated by the energy

management team), the robot transfers data from the electricity billing documents to the analytical database practically flawlessly.

- The use of the software robot would speed up the time it takes to process electricity billing documents (before the robot's deployment, there were situations when Bydgoszcz city hall's financial team, which provided funds for the payment of the issued invoices, received the data very late, which was caused by information flow bottlenecks on the part of the units that were receiving the invoices). This goal has been achieved in full. The robot processes incoming electricity billing documents within 24 h of the moment they appear in the electricity utilities' electronic customer service center. As the CEO of First Byte pointed out in his statement, "the stability of the RPA tool and the robots built with the use thereof is extremely important from the point of view of the speed and continuity of the business processes performed". The use of the software robot linked to the set up database would allow the preparation of advanced analyses to be accelerated with respect to electricity consumption. This goal has been achieved in full. The solution deployed made it possible to generate reports for the needs of Bydgoszcz city hall's management, as indicated by the energy management team coordinator: "we are able to make the decision on selecting further locations for a photovoltaic installation by generating reports from the database fed by the robot. Previously, we had no confidence in the data collected and it took a long time to prepare such a report".

An additional benefit, not originally planned for, materialized on the part of the electric utilities that distribute and supply electricity to Bydgoszcz city hall and its subordinate units. The use of the software robot allowed the energy companies to stop sending electricity billing documents, which became a source of savings for these entities (savings were related to printing and packing of the documents as well as the shipping costs). Bydgoszcz city hall is planning to take advantage of these savings in the proceedings to be conducted in the coming years when selecting an electricity supplier. As it was put by the energy management team coordinator, "The electricity supplier should share the savings generated on their part in connection with our use of the robot".

5.2. Software Robot Implementation Limitations

The members of the energy management team identified several limitations during the operation of the software robot in the production environment.

First, it was observed that although the invoices from the electricity utilities (electricity distributors and suppliers) are now sent in electronic form (PDF files), due to Polish law, they must be printed by the city hall and archived for five years. It should be noted that this requirement is applicable to at least 200,000 paper pages per annum. As a result, for formal and legal reasons only, there are no actual ecological savings in this area.

Second, the key to the robot's efficient operation is the correct functioning of the dedicated portals provided by the electricity supplier and the electricity distributor (electronic customer service centers), from which the robot downloads the electricity billing documents. In practice, it turns out that there are interruptions in the operation of these portals. The robot had to be enriched with functionalities for handling such situations.

5.3. Software Robot Development and Implementation Determinant Factors

Based on the experience gathered during the software robot development and implementation project, as well as the six-month period of the robot's operation, the following factors that ensured the success of the work carried out can be identified and grouped in 4 areas:

- Social factors:
  ○ The culture of innovation nurtured throughout Bydgoszcz city hall, with particular emphasis placed on the energy management team; it is, among other things, the results of the team's involvement in international research projects, as indicated by the team coordinator: "Bydgoszcz city hall is involved in the

implementation of a number of international projects that open up multiple new opportunities".

- Competency factors:
  - An awareness on the part of the energy management team of what a software robot is, what capabilities this type of solution offers, and what its limitations are, from the very beginning of the project to the situation where, with respect to the implementation, there was a designated person on the part of the energy management team who was, on an ongoing basis, dealing with emergency situations and business errors occurring during the robot's processing of the documents related to electricity consumption.
  - The correctly defined business expectations formulated by the energy management team regarding the software robot's operating principles, which were communicated to the contractor, as indicated by the energy management team coordinator: "With no offence meant to any IT companies that want to profit by offering solutions to local governments, I am warning you that we have already passed the stage of learning from our own mistakes; we had bought systems that did not work out for us twice and now we know perfectly well what we need".

- Organizational factors:
  - The correctly selected business process in terms of its characteristics (in the context of the software robot's development principles): a relatively stable process over time, part of which was many monotonous and repetitive activities (to date, performed by operators—city hall personnel) carried out in the form of electronic input (no need to scan electricity billing documents).
  - The energy management team correctly selected the model for acquiring a software robot, i.e., robot-as-a-service, taking into account the implementation capabilities of Bydgoszcz city hall. According to the CEO of First Byte, the "robot-as-a-service model is extremely interesting for cities that do not want to build their own robotic automation competence center—as it allows for achieving the assumed business benefits within a very short time frame".
  - Close cooperation and efficient communication between the energy management team and the contractor implementing the software robot; it is worth noting that apart from a single three-hour meeting at the beginning of the project works, the remaining communication was carried out using electronic means of communication (messaging applications). As a representative of ForProgress pointed out, the "close cooperation with the employer was the key from the very beginning; [...] we agreed that we were working in weekly sprints; we presented the obtained results remotely at the end of each week; we visited the Bydgoszcz city hall only once—at the very beginning, in order to establish the ground rules for our work, and we were only working remotely afterwards".
  - No obstacles to the implementation of the robot from the Bydgoszcz city hall's IT office.

- Technology factors:
  - The correctly selected RPA class software development tool (First Byte's Wizlink). According to both First Byte's CEO and ForProgress' CEO, it offers all the required functionalities, is easy to use, is stable in operation, and, at the same time, is available at a price that is several times lower than that of products offered by global RPA tool vendors (which was important in the context of the supplier selection procedure, a tender in which the price represented 60% of the criteria weight).
  - Minimal interference with the robotically automated business process: only a single change was introduced—the electricity billing documentation was no

longer provided in paper form; it was made available by the electricity supplier and the electricity distributor through their dedicated portals (electronic customer service centers) in PDF file form. Conducting an in-depth restructuring of this process could have significantly extended the project completion time while not necessarily bringing much greater business benefits.

5.4. RPA Tool Implementation Success Determinants

The RPA tool's implementation success determinants (factors) for enterprises are identified below based on the literature research. They are compared with the determinant factors identified in the Bydgoszcz city hall case study.

The analysis of the determinants listed in Table 2 demonstrates a significant convergence between the city hall's case under review and the results of the literature analysis. Therefore, the conclusion can be drawn that when implementing software robots in city halls, it is possible to follow RPA tool implementation success determinants for enterprises.

Table 2. A list of the RPA tool's implementation success determinants in the context of the Bydgoszcz city hall case study.

RPA Tool Implementation Success Determinant [6–11,24–29,32]	Bydgoszcz City Hall Case Study Context
Compiled criteria for the selection of business processes to be robotically automated	Bydgoszcz city hall's previous experience with the implementation of IT systems allowed for the correct selection of the process to be robotically automated, taking into account the city hall's implementation capabilities and, at the same time, implementation that will bring certain benefits (source: Energy Management Team Coordinator interview).
Building awareness of the capabilities and limitations of RPA tools among the subject matter (business) department's personnel	Selected city hall employees took part in the training on software robot development, targeted at presenting the benefits provided by such technology (source: Energy Management Team Coordinator interview).
Developing and promoting a pro-innovative organizational culture among enterprise personnel	The city hall is now participating in many European projects, including those in the field of energy management, e.g., the eNeuron Project—a study of the application of local energy, balancing areas to optimize and develop dispersed (distributed) networks (Horizon 2020); mySMARTLife Project—the smart transition of EU cities towards a new concept of smart life and economy (Horizon 2020) (source: press releases).
A strong leader responsible for the RPA tool's implementation	The energy management team coordinator is the undisputed leader with the vision of using a software robot for processing electricity billing documents (source: ForProgress CEO interview).
Monitoring the progress of the robotic automation's implementation by enterprise management	The progress of robotic process automation work was communicated to the city hall's management (source: Energy Management Team Coordinator interview).
Direct involvement of the subject matter's (business) part of the organization in the implementation of the RPA tool	The implementation of the software robot was initiated and carried out by a business unit, the energy management team. The role of the IT office was marginal (source: Energy Management Team Coordinator interview).
Ensuring technological and management support of the consulting/IT companies	The city hall selected a company that had many years of experience in this area to be responsible for developing a software robot (source: (source: Energy Management Team Coordinator interview, ForProgress CEO interview).
A correctly selected and interconnected (integrated) RPA toolkit	The implementation of the software robot in the city hall was preceded by an analysis of the RPA solutions available on the market. The decision was made to select a tool that met both functional and non-functional requirements and, at the same time, allowed the financial regime to be maintained (source: Energy Management Team Coordinator interview).

Source: proprietary compilation.

6. Conclusions

This study contains recommendations stemming from a literature analysis and empirical research on ways to implement digital transformation in the context of building a smart city. One of these recommendations is to use RPA tools to develop software robots. This recommendation may be supported by a comparison between the assumed benefits and the results achieved in the project analyzed in the case study.

In the first part of the article, the authors formulated three research goals. In the second part of the article, an attempt was made to accomplish the first objective: determining

the potential for using software robots developed using RPA tools to carry out the digital transformation of cities and support the smart city concept's implementation. In order to achieve the second research goal, an analysis of selected aspects of a software robot's development and implementation in a city hall using the example of electricity billing documentation management was presented in the fourth part of the paper.

In the next part of the article, the software robot's development and implementation success determinants for the city hall described in the case study were identified and compared with the determinants applicable to enterprises.

The conclusion was that when implementing software robots in city halls, it is possible to follow the determinants of the RPA tool's implementation success for enterprises, as presented in Table 2. In this way, the third research goal was accomplished.

The authors are aware of the limitations of the conducted research, in particular, due to a reliance on only a single case study (as indicated in Section 3 of the article—this is a consequence of the fact that, currently, there are no similar implementations in other local government units in Poland, which may be indirect proof of the innovation of the implementation described). However, the authors are planning to continue research in several areas in the near future:

- Further exploration of the option for using software robots in the area of energy (not only electricity) management in cities; in particular, it may be important to combine software robots developed using RPA tools and the Internet of Things solutions (data collected from sensors installed in energy devices can be loaded into a city hall's domain systems using software robots).
- Identifying software robot use cases in areas of city functioning other than energy management; they could include such areas as city finances, resident and entrepreneur (business) support management, and handling of public procurement processes carried out by city halls.
- Developing a comprehensive robotic automation model for cities; following the example of enterprises, developing a robotic automation center of excellence concept may be worth considering not only with respect to city halls but also their subordinate units.

It would be extremely interesting to conduct the aforementioned research not only with respect to cities in Poland or, more broadly, in the European Union, but also in a global context (it should be noted that out of the 20 largest cities in the world, none is located in Europe).

Recent years have been a period of very intensive dissemination of RPA tools in enterprises. In response to this trend, an interdisciplinary area of research dealing with advanced automation technologies, including robotic automation, from the perspective of their impact on economic and organizational aspects of the functioning of enterprises, which is referred to as "robonomics", is beginning to take shape [64]. The research carried out as part of the case study presented in this article brings us to the conclusion that an area of interest for robonomics could, and even should, be public organizations—in particular, city halls and their subordinate units. Residents expect city managers to implement the smart city concept, and what sets ordinary urban improvements and innovations apart from smart solutions is that "the latter include omnipresent and significant components of urban data acquisition and processing, which are often pursued automatically and in real time along with autonomous decision-making" [65]. This is why machine learning, big data, and artificial intelligence solutions, as well as NLP (natural language processing) methods, are also starting to play an increasingly important role in smart city management [66].

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