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Procedia Computer Science 239 (2024) 166–176

Procedia Computer Science

www.elsevier.com/locate/procedia

CENTERIS – International Conference on ENTERprise Information Systems / ProjMAN – International Conference on Project MANagement / HCist – International Conference on Health and Social Care Information Systems and Technologies 2023

Literature review on the sustainable implementation of Robotic Process Automation (RPA) in medical and healthcare administrative services

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Abstract

The healthcare sector as a whole has a high administrative burden. Whether through doctors, nurses, laboratories, financial departments, accounting, pharmaceutical departments, among other entities, it is essential that everyone connects to monitor the patient. However, the administrative burden associated with these processes is extremely high which makes the tasks of the health sector more difficult to carry out. It is in this sense that the implementation of a technology such as Robotic Process Automation (RPA) allows all these routines but necessary tasks to be performed by capable software "robots" that respect rules that will allow to respond to all needs. It was found in the literature that there are few works related to the implementation of RPA in medical and healthcare services. The objective of this work is focused on a literature review to identify how RPA contributes to medical and health services in a context of sustainability. This work analyzes some studies available in the literature, analyzing them from the perspective of the Triple Bottom Line (TBL) related to environmental, social and economic effects. Regarding the results of this study, it appears that there is still a lot of room to improve research in this area, for example, with regard to the development of implementation models, governance and also to optimize the efficiency of RPA, in medical and healthcare administrative services, taking into account the TBL of the concept of sustainability.

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Peer-review under responsibility of the scientific committee of the CENTERIS / ProjMAN / HCist 2023
10.1016/j.procs.2024.06.159

Keywords: Robotic Process Automation (RPA); Sustainability; Medical and healthcare administrative services; Literature review.

1. Introduction

Patricio et al. (2022) in a study carried out identified important works on the main enabling technologies, methodologies, frameworks, tools and techniques of intelligent and sustainable systems [1].

Robotic Process Automation (RPA) aims to automate business processes or parts of them with software robots, reproducing human interactions with the graphical user interface [2]. Software robots make it possible to automate Backoffice/Administrative related jobs, which were first performed by human collaborators [3]. Recently, many RPA approaches have been implemented and the RPA software market grew by 60% in 2018 [4]. Companies/organizations thus have the objective of developing and producing one or more products/services in the desired quantities, responding promptly to a request or market opportunity [5]. In addition, RPA aims to soothe employees from boring jobs [6]. Employees may reject the use of automations for fear of leaving their jobs otherwise [7]. Robotic Process Automation (RPA) can be considered as one of the tools / technologies framed in the I4.0 paradigm, to enhance the implementation of intelligent and sustainable systems.

The concept of sustainability has received increasing global attention in several areas. The World Commission for the Development of the Environment (WCED) has presented sustainable development as development that takes into account the needs of the present without blaming the ability of future generations to meet their own needs [8]. Sustainability has been used in organizations that seek to reflect on social duties and environmental legislation. Sustainability reveals to organizations a new paradigm with an emphasis on business with a focus on social, environmental and economic responsibilities. These duties, of the organizations, were getting more and more value in the society and in the legislation imposed on the companies that followed this propensity. Sustainability is a challenge for many organizations, but over-coming this challenge is based on a good relationship with stakeholders that are customers, suppliers, employees and society in general. Since the term sustainability in business emerged, more companies have appeared that bring sustainability to their businesses, thus improving their economic, environmental and social objectives [9, 10, 11]. Organizations that seek to be sustainable should focus their execution on three pillars: economic, social and ecological [12, 13, 14]. In a special issue of governance and sustainability [15] they strengthen the value of the theme and reinforce the character of the word 'sustainability'. Explain why sustainability is now the main driver of innovation, according to your study of sustainability initiatives, including a set of 30 large corporations [16, 17].

The technology applied to medical administrative services has increasingly revolutionized the way diseases are treated and patients treated. The automation process helps doctors diagnose problems and even treat treatments that are being modernized over the years. The automation of prevention and treatment processes has also been an important ally in the control of health problems and even in the cure of diseases. Automation can also help in the management of people, supplies and help with a more assertive control in the financial and accounting sectors. The effectiveness of Robotic Process Automation (RPA) in the healthcare administrative sector was tested by implementing RPA in the analysis of value creation functions [18]. RPA can in-crease efficiency in repetitive healthcare procedures. Leveraging RPA in healthcare can help reduce the time and resources required to perform functions. Furthermore, it has high potential to increase job satisfaction and improve customer experience [18, 19].

Then, the central research question that presided over this research work is presented.

- ***In terms of sustainability, what are the benefits of implementing Robotic Process Automation (RPA) in medical and healthcare administrative services?***

The objective of this work is focused on a literature review to identify how Robotic Process Automation (RPA) contributes to medical and healthcare administrative ser-vices in a context of sustainability. To achieve the objective, a bibliographic analysis was developed, focusing on the identification of works that are related to this topic. In a second phase, we developed an analysis and synthesis of the works that address the issue of the implementation of Robotic Process Automation in the area of administrative and health services.

The remainder of this paper is organized as follows. Section 2 presents the research methodology used. Section 3 presents the synthesis of articles and analyses, summarizing the main information about the works found. Finally, the conclusions are presented in Section 4, together with a proposal for future work.

2. Methodology

The methodology underlying this work was based on the analysis of a set of considered relevant data sources. Throughout this work, relevant information for the topic under study will be put forward, based on the set of contributions analyzed, from leading authors who addressed this theme or some part of it. The collection of articles found and analyzed was obtained by using the database of the online "B-on" library. This platform was selected as it does enable to reach the full content of a wide range of scientific publications in relevant and indexed journals, along with publications in international scientific conferences, also indexed in ISI WOS and/ or Scopus systems. "B-on" is one of the most extensive databases, which include thousands of peer-reviewed journals in a widened range of fields of different scientific areas. Through the online scientific library "B-on", from the Portuguese Foundation for the Science and Technologies, researchers can access to most well-known international scientific databases, thus this library was used to carried out the search process underlying this work, based on the following three groups (Group 1, Group 2, and Group 3) of shown in the Table 1.

Table 1. Groups of searched through "B-on".

Group 1	Group 2	Group 3
"RPA" Or "Robotic Process Automation" Or "Intelligent Process Automation" Or "Tools Process Automation" Or "Artificial Intelligence In Business Process" Or "Machine Learning In Business Process" Or "Cognitive Process Automation"	"Medical" Or "Healthcare" Or "Medicine" Or "Health" Or "Medical Services" Or "Healthcare Services" Or "Medicine Services" Or "Health Services" Or "Medical Service" Or "Healthcare Service" Or "Medicine Service" Or "Health Service" Or "Medical and Healthcare Services" Or "Medical and Healthcare Service" Or "Medicine and Healthcare Services" Or "Medicine and Healthcare Service" Or "Medical and Health Services" Or "Medical and Health Service" Or "Medicine and Health Services" Or "Medicine and Health Service" Or "Medical Administrative Services" Or "Healthcare Administrative Services" Or "Medicine Administrative Services" Or "Health Administrative Services" Or "Medical and healthcare Administrative services"	"Sustainability" Or "Sustainable" Or "Social Sustainability" Or "Environment" Or "Environmental Sustainability" Or "Economic Sustainability" Or "Sustainable Development"

Four research tests were carried out through the "B-on" by using the three groups and the OR operator as a connector between the Title or the Keywords (KW) of the in-tended sets. In Table 2 are expressed the number of articles found in each research test.

Table 2. Research tests performed through the "B-on".

	Title	OR	Keywords (KW)	
Set 1	(Group 1 AND Group 2 AND Group 3)	OR	(Group 1 AND Group 2 AND Group 3)	n = 0

Set 2	(Group 1 AND Group 2)	OR	(Group 1 AND Group 2)	n = 162
Set 3	(Group 1 AND Group 3)	OR	(Group 1 AND Group 3)	n = 33

Next, throughout the research process, a set of filters were applied, based on the sets of publications obtained, and the results obtained, in terms of number of publications, are summarized in Table 3.

Table 3. Publications obtained through the B-on, after the application of some filters.

	Set 1	Set 2	Set 3
Initial result:	0	162	33
1 - Restrict to: Peer Reviewed	0	132	29
2 -Type of fonts: Academic Journals; Conference Materials; Books	0	131	29
3 - From: 2000 to 2023	0	128	29
4 - Language: English	0	122	28
5 - Restrict to: Full Text	0	98	25
Final result:	0	98	25

After the applied filters, a reading of the title, the key terms and the resume of each of the articles was carried out to verify which articles were directly related to the research. From the carried-out research, 195 papers were obtained, applied the filters we verified a total of 123 articles and of which only 20 were framed with the theme. One of the reasons for the small number of framed papers is related with the fact that most of them were related with evaluation of the formation of a collaborative network that is not the scope of this work. So, evaluating the formation of a network is not the same as evaluating the participation or integration of an organization in a network. Figure 1 represents a flow diagram of the literature search carried out, and respective screening of the methodology used in this research work.

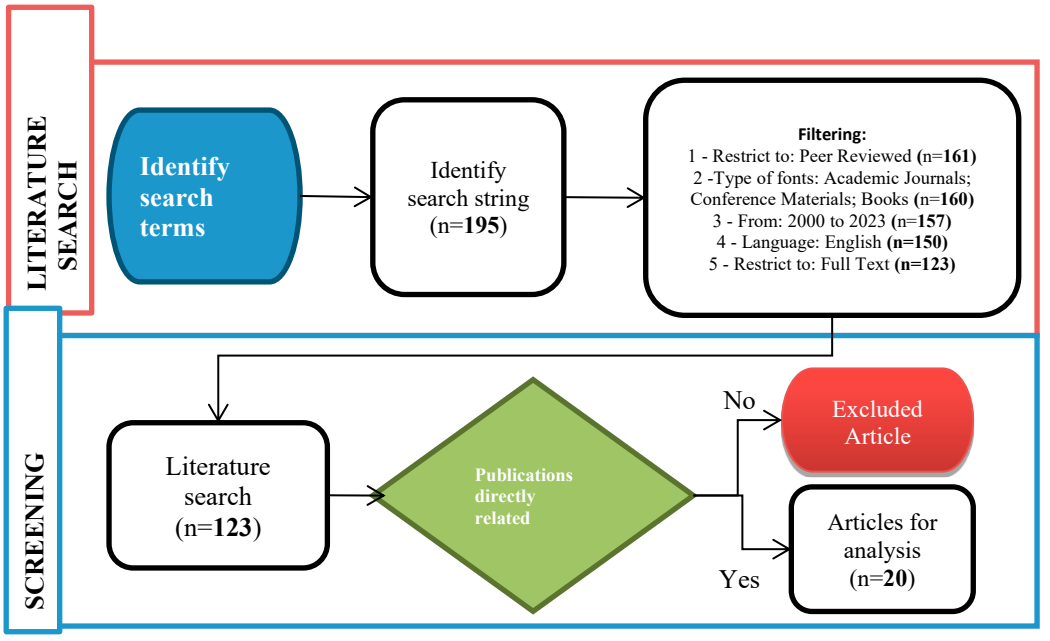

Fig. 1. Flow diagram of literature search and respective screening, adapted from [20].

The following section 3 the analysis and synthesis of the articles. Here, data about the articles is presented and we consider them relevant to the theme of this work. First, we analyze the selected articles, verifying which sustainability pillars (Environ-mental, Social and/or Economic) are addressed in each of the articles. Below, in Table 4, for each of the pillars of sustainability, the articles that address the corresponding pillar and identify the type of contribution of each of the articles. After that, a second analysis was carried out on the articles, in section 3.1 and 3.2, following the following criteria for reading, analyzing and identifying the objectives that each of the works presented, thus leading to the identification of positive impacts on sustain-able implementation. of RPA in administrative medical and health services. In section 3.3, the results obtained previously, in 3.1 and 3.2, were discussed.

3. Articles Synthesis and Analysis

In table 4 it will be shown an analysis before the pillars of sustainability of the articles selected in the research.

Table 4. Analysis before the pillars of sustainability of the articles selected in the research.

Pillars of Sustainability / Research papers	Environmental	Social	Economic	Type of contributions
Wiljer, D. et al. (2019)		x	x	Literature review
Soeny, K. et al. (2021)		x	x	Case study
Pramod, D. (2021)		x	x	Literature review
Thainimit, S. et al. (2022)		x	x	Case study
Ratia, M. et al. (2018)		x	x	Case study
Zou, K. et al. (2020)		x	x	Literature review
Khan, Z. et al. (2020)		x	x	Literature review
Saiya, H. et al. (2022)		x	x	Literature review
Davenport, T. and Kalakota, R. (2019)		x	x	Literature review
Shwetha, R. and Kirubanand, V. (2021)		x	x	Case study
Bhatnagar, N. (2019)		x	x	Framework
Wang, F. (2020)		x	x	Literature review
Ganesh, S. et al. (2019)		x	x	Literature review
Afriliana, N. and Ramadhan, A. (2022)		x	x	Literature review
Madakam, S. et al. (2019)		x	x	Literature review
Sobczak, A. (2022)		x	x	Literature review
Cresswell, K. et al. (2018)		x	x	Literature review
Lievano-Martínez, F. et al. (2022)		x	x	Framework
Siderska, J. (2020)		x	x	Literature review
Abdullah, R. and Fakieh, B. (2020)		x	x	Case study
% Articles p/ pillar	0%	100%	100%	

After analyzing the previous table, you can verify the following observations:

1. The pillars of economic and social sustainability are present in all identified works, with 100%;

2. The “environmental” sustainability pillar has a zero-percentage value, that is, no works were identified that address this sustainability pillar;

However, environmental sustainability in the context of information technologies has benefits, such as reducing costs in the organization, improving efficiency and creating healthier workplaces for employees, recycling waste, reducing carbon dioxide emissions and renewable energy production [21, 22, 23].

3. In the analysis, the contribution of the works to the literature review, cases study and framework was verified.

The following figure represents a circular graph with the percentages of each of the contributions identified in the analyzed works.

The contribution that was most identified was the literature review with 65%, then the case studies with 25% and, finally, the framework with 10% of the works.

To present the results of this work, below, we detail the selection of the important positive impacts to be considered in the sustainable implementation of Robotic Process Automation in the context of medical and healthcare services. Based on the analysis previously carried out, we considered the pillars of sustainability in which work, social and economic, were identified, in order to detail the positive impacts of the implementation of RPA technology in medical and healthcare services. This selection results from the in-depth analysis carried out in the investigated articles.

After analyzing the articles to identify the pillars of sustainability that they ad-dress, and also identifying the type of contribution of each of the works, a second reading analysis of each of the works was carried out in order to identify the main positive impacts of the implementation of RPA for economic and social sustainability.

3.1. Positive impact for economic sustainability

After analyzing the articles, below we can verify the positive impacts for the 'Economic sustainability' pillar [24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43].

Table 5. Identification of the positive impacts of RPA for economic sustainability.

Impact Positive	
1.	Increased in service productivity
2.	Financial processing improvements
3.	Reduce costs of health services
4.	Greater business scalability
5.	Increased service agility
6.	Operational efficiency gains
7.	Higher service profitability

3.2. Positive impact for social sustainability

After analyzing the articles, below we can verify the positive impacts for the 'Social sustainability' pillar [24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43].

Table 6. Identification of the positive impacts of RPA for social sustainability.

Impact Positive
1. Better quality of patient care
2. More satisfied patients
3. Patient privacy
4. Ease of regulatory compliance
5. Recording and synchronization of patient data
6. Information security
7. Appointment scheduling
8. Improved patient communications
9. Claims management
10. People management
11. Improve the organizational climate
12. Improved patient experience
13. Compliance guarantee
14. Improved quality of medical data analysis
15. Generating medical data reports
16. Document scanning

Discussion of results regarding positive impacts for economic sustainability will be presented below.

1. Increased in service productivity: administrative and healthcare workers can free themselves from certain repetitive tasks, giving them the opportunity to dedicate their time to more tasks directly related to patients.

2. Financial processing improvements: Especially in the case of private housing, the automation of health processes provides enormous agility in terms of invoicing. Programmed software bots automatically generate invoices and collections, cross-referencing information with each society and health insurance. Closely related to this, the entire hospital inventory management can also be optimized using RPA technology.

3. Reduce costs of health services: RPA allows a drastic cost reduction in the company. That's because, with the solution, we guarantee efficiency in the application of resources and dispense with labor for automatable tasks.

4. Greater business scalability: Managing machines and the number of robots that work in the company is much easier than hiring, training and reassigning employees to certain functions. With the power of the machine, we can only replicate the entire operational belt and ensure the scalability of the business to operate in fronts and regions that we would never imagine if we had a human workforce.

5. Increased service agility: by reducing process cycle time and continuously increasing productivity to 24 hours a day and 7 days a week.

6. Operational efficiency gains: reduced labor costs, and increased quality with reduced errors.

7. Higher service profitability: one of the benefits of RPA consists in increasing the team's daily service capacity and adds value from a financial point of view.

Discussion of results regarding positive impacts for social sustainability will be presented below.

1. Better quality of patient care: not only is it possible to speed up response times, but also provide care with higher levels of personalization without requiring human intervention to do so.

2. More satisfied patients: derived from the previous two, patients end up much more satisfied with the care provided to them. The patient experience is improved and more personalized. In addition, the patient is surrounded by himself from his first interaction, in which he perceives that his interlocutor knows his previous history.

3. Patient privacy: automating healthcare processes means that private data doesn't need to pass through so many hands; the system can classify it, extract it and explore it automatically, giving exclusive access to authorized personnel.

4. Ease of regulatory compliance: by automating healthcare processes through bots, it is possible to reduce errors and simplify regulatory compliance in an industry as regulated as healthcare.

5. Recording and synchronization of patient data: the health sector brings with it an enormous administrative burden; in the case of patients and it includes their personal data. To this information it is necessary to add that of the center and its staff, as well as related to suppliers.

6. Information security: one of the great advantages of automating healthcare processes is that RPA bots generate event logs of each step taken during these processes, which in the future allows for a complete audit and guarantees visibility in case of incidents. Furthermore, the digitization of this information simplifies the possibility of having backups and backup centers.

7. Appointment scheduling: consultations with patients are one of the tasks that takes up the most time for staff, despite being a very mechanical action. The application of RPA technology, the assignment of the day, time and doctor to each patient is done without surveillance, it is even possible to schedule reminders to keep the agenda as updated as possible and, in case a patient cancel at the last minute, fill that space.

8. Improved patient communications: in addition to managing appointments and their reminders, automating healthcare processes significantly improves communication with patients, being able to automatically send satisfaction surveys, medication reminders, check-ups.

9. Claims management: thanks to the automation of complaints, whether from suppliers or patients, the specific agents who handle each one of them are punctually notified and can extract all the necessary information in real time, seeing at a glance any exception or particularity that needs to be applied. Furthermore, the possibility of human error is minimized while attempts at insurance fraud are better detected.

10. People management: like any other company, the staff of a health center must also be managed, from their arrival and departure, to their payroll, management of shifts and guards, vacations, etc. Managing a good part of these tasks can gain agility by defining automated process flows.

11. Improve the organizational climate: we don't want to have our jobs replaced by machines, but we would like to automate bureaucratic and unnecessary tasks and that is the role of RPA. It is not about replacing the man altogether. it is an opportunity to focus on more intellectual, creative and truly human activities. RPA, therefore, can improve the organizational climate by enabling this.

12. Improved patient experience: this is done by increasing the speed of operations and improving quality and availability.

13. Compliance guarantee: increased consistency, security and accuracy of data and increased quality in processes in a scalable way.

14. Improved quality of medical data analysis: robots can interact with a number of different sources and databases, allowing them to collect this data and present it in an orderly manner to end users: humans. With this, we reduce the possibility of manual errors and guarantee much more quality for the organization's analysis and decision-making power.

15. Generating medical data reports: the volume of information generated in the health sector is enormous and, moreover, of all types. Thanks to advances in digital transformation processes, dependence on paper is drastically reduced, since all this data is accessible from anywhere and it is possible to generate reports and dash-boards automatically to make the best decisions at the most opportune time.

16. Document scanning: the digitization of clinical laboratories and the intelligent capture of data that apply RPA and Artificial Intelligence technologies allow for better and faster access to information.

3.3. Synthesis of the results

Analyzing the previous results, it is possible to verify that there are greater positive impacts in the implementation of Robotic Process Automation in administrative healthcare and medical services for social sustainability.

For the social sustainability pillar, an analysis was carried out with a total of 20 articles. In this set, there were 16 positive impacts regarding the implementation of RPA in medical and healthcare administrative services. In short, these impacts mainly refer to the improvement of patient care, quality of work of health professionals, improvement in data quality and satisfaction of both parties (health professionals and patients).

For the economic sustainability pillar, an analysis was carried out with a total of 20 articles. In this set, there were 7 positives regarding the implementation of RPA in medical and healthcare administrative services. In short, these impacts refer mainly to the improvement, increase in productivity and service quality, and also to the reduction of service costs. So, we move on to the conclusions of the work.

4. Conclusion

In conclusion, this literature review examined the sustainable implementation of Robotic Process Automation (RPA) in medical and healthcare administrative services. The study explored the benefits of RPA in terms of economic and social sustainability, but highlighted the lack of research on its environmental impact. Despite this gap, it is evident that RPA can positively impact the healthcare sector by automating routine tasks and reducing administrative burdens.

Moving forward, there is a need for further research in this area. Future studies should focus on developing implementation models, governance structures, and efficiency optimization strategies for RPA in medical and healthcare administrative services, while considering the concept of sustainability. Additionally, it is crucial to address the environmental sustainability pillar and explore the potential benefits and challenges associated with RPA technology in healthcare settings.

Based on the findings, it is recommended that researchers interested in exploring the implementation of RPA in hospitals prioritize interdisciplinary collaborations and adopt a holistic approach that considers the triple bottom line (TBL) framework—economic, social, and environmental impacts. Moreover, guidelines and recommendations should be provided to IT managers intending to implement RPA in healthcare facilities. These guidelines can assist in navigating challenges, identifying facilitators, and leveraging opportunities for successful RPA deployment.

Overall, this study emphasizes the importance of sustainable practices in implementing RPA technology in medical and healthcare administrative services. By addressing the identified gaps and following the suggested guidelines, researchers and IT managers can contribute to the advancement of this field, ultimately enhancing the efficiency and sustainability of healthcare systems.

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