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Review Article

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Hyper Automation in Government Digital Transformation

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Abstract

This article presents the process of implementing Hyperautomation in the Brazilian public sector, especially within the scope of the Attorney General's Office of the State of Pernambuco. Due to the current competitive economy, the demand for intelligent and reliable solutions is increasing. To meet this need, innovative technologies that address the inherent complexity of digital transformation are desirable. Thus, public organizations have sought to apply process automation to meet the needs of citizens for a more efficient and effective service. However, we can observe that pure and direct automation is only part of the transformation process. Some of the reasons that explain the need to go beyond process automation and reach Hyper-automation is the abundance of data from various sources and types. Everything must be within legal standards, emphasizing that all technology must be aligned with transparency and auditability to be safely incorporated. For the experimentation, the action research method was used with the application of Hyperautomation, aiming to increase the state's collection and economy in the Attorney General's Office of the State of Pernambuco.

CCS CONCEPTS • Hyperautomation • Digital Transformation • Government

1. Introduction

Carrying out digital transformation is not just applying technology but changing organizational culture, breaking paradigms, and promoting sociocultural and economic changes, making the organization's activities more efficient and effective. However, the use of technology is fundamental in the process, and its application is not a trivial task since it is essential to use software engineering, which must be carried out before the construction and application of the technologies [1].

Technology Transformations require reflection and attention using standardization, multidisciplinary teams, and investment in hardware, software, and peopleware [2]. There should be even a higher level of work when the goal is to perform this between the current way of working with the use of an innovative model since, in this case, there will be a need to plan, design, test, and analyze hypotheses, that is, innovate.

All the additional work involves the formalization of a new conceptual model with the application of technologies such as Artificial Intelligence (AI) that can generate gains in productivity and reliability, both essential in the Public Sector.

The need to solve complex and interactive problems is quite frequent nowadays. Thus, the aggregation of quality and value in these systems is challenging and highly necessary [3] and is a fertile field for innovative applications that use Hyperautomation, that is, the automation of processes with the use of AI, which usually becomes a technological enabler as they are naturally suited to solving complex problems [2,3].

In this 4th Industrial Revolution, Artificial Intelligence has become one of the most strategic assets because it allows organizations to offer new data-based products and services, increasing efficiency and effectiveness in their operations [1]. Thus, algorithms and Machine Learning seem quite suitable, as they can add value to existing processes, especially for the Public Sector.

Despite the potential of innovative technologies to support complex problem solving, there is much care to be taken in digital transformation in the Public Sector. For example, compliance with the principles of good administration and protection of fundamental rights require observation in applying new technologies. In the case of Artificial Intelligence, this factor is even more latent, as can be seen in several discussions about the ethics and efficiency of algorithms and the application of AI, for example, the public consultation on AI and AI strategy for Brazil [4].

After the experimentation of the application of Hyperautomation (i.e., Process Automation using Artificial Intelligence) in the public service, a project whose topic is increasing revenue was selected. Then, through software engineering, the models of use are processed and constructed with the applicability of a case in the Attorney General's Office of the State of Pernambuco.

As a contribution of experimentation, we seek to offer: (1) a proposition of computational models; (2) an intelligent engine for solving complex problems; (3) support in data-oriented man-

agement; (4) apply robust methods for extraction, transformation, and loading; (5) apply a prediction model; and, (6) use of machine learning.

To validate the above-mentioned objectives, we used the analysis of requirements with the use of techniques such as interviews, and ethnography, among others, to identify processes that needed innovation, based on the verification of repetitive and massive works, performing the documentation of actions, and implementing automation and construction of robots using the CRISP/DM technique for data mining, used as a research method for verifying and validating the action research experiment.

This article is organized into five sections. After this introduction, the second section presents the theoretical framework. Section three is the research methodology, section four is the trial's results, and section five is with conclusions and works futures.

2. Backgrounds

In this section, the bases for a better understanding of the concepts that will be approached in this research are provided.

2.1 Hyperautomation

Hyperautomation uses Robotic Process Automation (RPA) integrated with Artificial Intelligence (AI), called robots or bots. These are business process automation technologies based on software robots, referred to as digital workers. It is essential to distinguish the term robot software used to specify software that controls the operation of mechatronic robots [5].

According to Hodson (2015), Hyperautomation aims to assist workers in business processes, performing repetitive and massive tasks, acting in these types of activities as digital workers, and leaving cognitive activities to human workers [5].

Thus, bots perform repetitively, tiring, and error-prone activities, performing this part of the business processes, being a set of activities structured in a sequence based on resulting rules in a service or a product.

For bots, there are two types, one called assisted, and the other called unassisted. The assisted robot needs human intervention for its operation since the unassisted there is no need because another robot called an orchestrator would perform execution and control [6].

Knowledge of business processes is necessary to determine the need for assisted and unassisted robots, as these will define the need for human intervention. The robot, as a digital worker, will perform the non-cognitive activities the human worker performs. Activities that are part of a business process repetitive, massive, and often tiring and thus prone to errors.

One of the uses of s bots is to allow integration between systems by constructing software that functions as an intermediate layer among other software, seeking to imitate human behavior in using them. However, it also allows for the most diverse processing, making the software robots take advantage of the existing information technology assets [7]. Thus, if there is a repetitive process, it is possible to automate it, developing a script that replicates it, leaving the human worker for the cognitive activities of the process.

The first impression one can have with the use of robots is that there will be a wave of unemployment due to the "substitution" of human workers for digital. However, the study published in 2015 by the Harvard Business Review shows that human workers are not being replaced but instead supported by robots in performing repetitive tasks. Consequently, some studies show the growing use of this technology [8].

The article published by Lacity and Willcocks with the title What knowledge Workers Stand to Gain from Automation shows that the impact expected with digital workers replacing human workers would generate a wave of unemployment.

Nevertheless, contrary to what was imagined, this research showed that the organizations that implemented automation did not fire their employees. They were relocated to cognitive work, failing to perform repetitive tasks that were previously part of the daily activities related to the processes of their responsibilities [8].

In this study, it was shown that the digital worker does not replace the human worker. Only the repetitive process steps are passed on to the machine because a worker performs several steps in a process, with those that are repetitive and those that have unique characteristics, which require analysis for decision-making. Removing humans from these repetitive activities that consume precious time from cognitive activities results in more time to do the analysis work with more quality.

However, often a robot is not only a script that performs a repetition of activities. It can also possess sophisticated algorithms to support decision-making using Machine Learning [9].

When we talk about Machine Learning (ML) applications, we also talk about bots because machine learning can happen. Data is needed. The more data obtained, the better it will be for the feature extraction process in the apprenticeship. Thus, using robots to perform these extractions is beneficial to the process.

Hyperautomation combines Artificial Intelligence and Computational Intelligence technologies with RPA to make automation more efficient and effective.

2.2 Digital Transformation

We can define Digital Transformation (DT) as a set of technological solutions that aim to solve problems. The use of DT in the Public Sector aims to apply technology in the solution of the most diverse problems of society, seeking to give more efficiency and effectiveness in the solution of social problems, aiming to achieve the effectiveness of missions and visions of public policies [10].

DT in the Public Sector does not aim to use technology by tech-

nology but to generate Public Value in the services offered by governments, which implies using technology to improve and bring governments closer to their citizens, offering services with less bureaucracy and greater transparency.

A digital government applies DT as the administration's guide, aiming to increase competitiveness and productivity in the various sectors of the economy, aiming at boosting production processes and society in multi-year planning [11].

The index that has been used to measure the digital revolution in the world, called the Digital Revolution Index (DRI) aims to present indicators of the ways we interact with social, political, commercial, media, and entertainment changes. Governments are increasingly committed to applying DT [12].

As an example of DT in the public sector, Estonia has been most referenced because, recently, it has been prioritized by the DT government in all public services. With investment in information security and training of its servers. The gain was significant because the Estonian citizen only needed to carry out a few processes in person [13].

DT makes use of data analysis of two fundamental technologies, which are: Business Intelligence (BI), which allows performing descriptive analysis of the data, making it possible to understand the problems that have already happened, and Business Analytics (BA) to perform a predictive analysis, which will allow discovering the problems before they happen [14].

Both BI and BA use statistical models and Models of Artificial Intelligence and Computational Intelligence (Machine Learning). They are using techniques to analyze the data descriptively and predictively. The former serves to understand the problems that have already occurred, and the second to predict problems that may happen. With the integration of these technologies with Robotic Process Automation (RPA), you can automate parts or even the entire process, thus gaining more speed and accuracy in its realization [9].

According to Klaus Schwab, the 4th. Industrial Revolution deals with the transformation of services through the use of new technologies, where the virtual world is merging into the physical world, "creating a new world," which goes from the use of Artificial Intelligence to solve complex problems to the application of virtual and augmented realities to the creation of the metaverse [15].

With all these technological resources being integrated, we have the use of Hyperautomation applied for Digital Transformation for Government 4.0, and com the use of all these innovative technologies referenced is allowing society
4.0 to be met more efficiently and effectively.

3. Search Method

The research method used in this study was action research. According to Carr (2006), action research is associated with the practices performed by Kurt Lewin in the 1940s during sociotechnical experiments. The initial stimulus for the emergence and design of the main objectives and aspirations of action research came from a generalized difficulty in translating social research results into practical actions [16].

According to Sjoberg et al. (2007), the action research method was pointed out as a study where a more realistic scenario is found because it involves the application of results of academic studies in a natural context [17].

To explicitly describe the objective of action research and guide its steps, for defined the following research question: How to support the government in increasing its efficiency and effectiveness of its responsibilities?

3.1 Research Context

Supported by The Systematic Mapping of Ahmad's Literature [18] and articles on the implementation of Action Research, published by Santos and Travassos (2011), this study plans to demonstrate the results of action research conducted at Attorney General's Office of the State of Pernambuco for the implementation of Hyperautomation. The expectation is that applying innovative technologies can improve state revenue, one of your missions [19].

The Attorney General's Office of the State of Pernambuco is the body responsible for the judicial representation of the State of Pernambuco and its municipalities, including in its competence the activities of legal advice to the Executive Branch and promotion of active debt collections, promotional measures of a legal nature aimed at the protection of public property and the defense of the State, among other activities of the State of Pernambuco.

The technology area of the attorney general's office of the State of Pernambuco is called Systems Coordination, Digital Automation, and Innovation, currently containing nineteen software engineers. This coordination is subordinate to the General Secretariat.

As the judicial collection is the attorney general's responsibility, it is necessary to apply technology to increase the success of the collection process. Aiming to increase the collection rule, not being restricted to electronic filing, but for this, being necessary the use of Hyperautomation because it is a big volume of data. With bots, one can gain scale and more assertiveness in the collection process since the goal is to use machine learning so that the intelligence engine can learn from the data and thus suggest of collection modality and can be the automated process. Conducting action research to evaluate the use of Hyperautomation will allow the discovery of new practices for the public sector, which can improve the mechanisms currently used by the Attorney General's Office of the State of Pernambuco.

3.2 Research Steps

According to Santos and Travassos (2011), action research consists of five basic steps: diagnosis, action planning, actions taken, evaluation, and lessons learned, and this research work was carried out using these steps [19].

Two research cycles were conducted: (1) The first cycle provided vital information to the attorney's office about the current situation and presented the perception of experts about the possibility of using Hyperautomation as a technology to increase revenue; (2) The second cycle put into practice the lessons learned in the first by making the necessary adjustments to achieve the goal.

3.2.1 Cycle 1

Diagnosis: the systems' coordination carried out the data collection in the active debt center, responsible for collecting the state's active debt and mapping all essential requirements.

Action planning: definition of the activities to be carried out by the study, recording the knowledge that was had with the business rules, using the method and tools that can be applied in the daily activities of Attorney General's Office of the State of Pernambuco, generating more efficiency in the execution of tasks.

Action taken: the implementation of evaluations for business and technology specialists to verify the results obtained. The analysis of the results identified the need to adapt the applied techniques aiming to legitimize the need to apply Hyperautomation of activities.

Evaluation: in verifying the knowledge of the method used, it was observed that there was an impact concerning the learning curve and paradigm break regarding changes in the responsibilities of stakeholders.

Lessons learned: the need to apply Hyperautomation in the attorney's office was initially identified concerning the deductive rules used. This need was only felt from the information collected by the attorney. Thus, the application of unsupervised machine learning was performed so that a new rule was inductively found.

3.2.2 Cycle 2

Diagnosis: during the application of Hyperautomation in the collection process, some difficulties were identified, such as the adaptation of the manual process to the automated process concerning the division of the steps that remained with workers and digital workers, emphasizing the need for better planning of assignments. However, the efficiency gain was observed with the increase in the assertiveness of the application model for collection.

Action planning: defined the processes of implementing the tool, with the development of bots, and carried out training of stakeholders. With the training and use of automation, the gains with greater assertiveness will be visible with the amounts collected.

Action taken: for solve the problems mentioned in the diagnosis, the following procedures were mapped, perform new data mining, and monitor and evaluate the results with metrics such as accuracy and accuracy. In tool update a procedure was created for the automatic display of Hyperautomation on the Intranet to monitor high management of results, thus facilitating stakeholders' access to information.

Evaluation: in the second cycle's execution, it was possible to verify that the learning curve of using technology was better because all involved already had the necessary knowledge.

Lessons learned: the applicability of Hyperautomation made it possible to verify the need for conditioning of use by business and technology specialists. Consequently, a new activity was generated for coordination and the verification of the results.

4. Analysis, Discussions and Results

This section aims to describe the application of Hyperautomation and present the results obtained with its application in the core of the active debt of the Attorney General's Office of the State of Pernambuco to increase the collection.

We aim to identify the problems of tax execution to improve the financial recovery of the state with the use of Hyperautomation, performing a classification of the debts entered to know, based on the occurrences, what debts were appropriate for what amount of collection.

In building Hyperautomation, several model trainings was carried out to identify which debts were most appropriate for judgment or protest. The idea here was to obtain the characteristics that pointed to a more excellent assertiveness d the automated sending of lots of debts to judge or to protest.

For the application of Hyperautomation, data mining was carried out using the Cross Process of the Industry Standard for Data Mining, better known by the acronym CRISP/DM, performing the activities: (1) understanding of the business; (2) understanding of the data; (3) data preparation; (4) data modeling; (5) evaluation of the data; and (6) deployment [20].

The objective of this step was to determine which data set was the most appropriate to solve the problem, and how the data should be standardized and balanced, to avoid bias in the Hyperautomation process.

The tests of the models ranging from the hyper par to meters were performed to identify which configuration was the most applicable to the data, and emphasizing that the classification techniques applied to the data were Neural Network (NN), Logistic Regression (LR), and Support Vector Machine (SVM).

4.1 Results

The results of the application of the techniques with the evaluation by the metrics of accuracy (AC) and precision (PR) had as a champion model for the Hyperautomation of the collection the Neural Network that obtained the rate of AC of 98% and PR with 97%. Table 1 shows the configurations of the hyperparameters applied to the neural network.

The column 'C' represents the number of layers used in the experiment, the column 'N' the number of neurons per layer, the column 'F' is the function used, the column 'M' the method applied, and the column 'T' the learning rate used that was 0.0001 for all, with the best results in bold.

C	N	F	M	T	AC	PR
1	32	ReLu	Gradient	0.0001	0.978	0.971
1	64	ReLu	Gradient	0.0001	0.978	0.970
1	128	ReLu	BFGS	0.0001	0.978	0.969
1	256	ReLu	Adam	0.0001	0.978	0.969
1	512	ReLu	Adam	0.0001	0.978	0.974
2	64	Adam	Gradient	0.0001	0.977	0.967
2	64	ReLu	Gradient	0.0001	0.979	0.972
2	64	Hyperbolic	Gradient	0.0001	0.978	0.971
2	64	ReLu	BFGS	0.0001	0.979	0.975
3	64	ReLu	Gradient	0.0001	0.978	0.970
3	128	ReLu	Gradient	0.0001	0.978	0.971
3	128	ReLu	Gradient	0.0001	0.979	0.972
4	256	ReLu	Gradient	0.0001	0.979	0.972
4	**256**	**ReLu**	**Adam**	**0.0001**	**0.980**	**0.977**

Table 1: Values used in NN hyperparameters and the results evaluated by ac and PR metrics.

Table 2 shows the regularization hyperparameters represented by column 'R' and f budget per column 'F' used in the LR model with the application of accuracy (AC) and precision (PR) metrics, with the best bold results.

R	F	AC	PR
L1	80	0.978	0.971
L1	70	0.978	0.971
L1	60	0.978	0.971
L1	50	0.978	0.971
L1	40	0.978	0.975
L2	50	0.977	0.965
L2	40	0.979	0.975
L2	30	0.978	0.975
L2	20	0.979	0.975
L2	10	0.978	0.976
L1	30	0.978	0.976
L1	20	0.979	0.976
L1	10	0.979	0.976
L1	**1**	**0.980**	**0.977**

Table 2: Values used in LR hyperparameters and the results evaluated by AC and PR metrics

Table 3 shows the cost hyperparameters represented by column 'C' and regression by column 'R' used in the SVM model with the application of accuracy (AC) and precision (PR) metrics, with the best bold results.

C	R	AC	PR
0.10	0.40	0.974	0.970
0.10	0.30	0.974	0.970
0.10	0.20	0.974	0.970
0.10	0.10	0.974	0.970
0.50	0.50	0.975	0.970
0.50	0.40	0.975	0.960
0.50	0.30	0.975	0.970
0.50	0.20	0.975	0.970
0.50	0.10	0.975	0.970
1.00	0.50	0.975	0.971
1.00	0.40	0.976	0.971
1.00	0.30	0.976	0.971
1.00	0.20	0.976	0.971
1.00	**0.10**	**0.978**	**0.971**

Table 3: Values used in VMS hyperparameters, and the results evaluated by ac, F1, PR and RC metrics

Table 4 presents the results of the metrics applied to compare the performance between the three models used: the neural network, logistic regression, and the vector support machine. With the neural network having the best performance among the tested models.

Technique	AC	PR
LR	0.978	0.970
SVM	0.978	0.971
NN	**0.980**	**0.977**

Table 4: Comparison of the results obtained with the experiments between the techniques of NN, LR and SVM

5. Conclusion

This article aimed to analyze the application of Hyperautomation in Government to solve a problem related to the modality of collection of active debt of the state that is one of the attributions of the Attorney General of the State of Pernambuco. Aiming to conduct action research to verify and validate the investment in Digital Transformation in the Government.

Based on the research method adopted, it was possible to observe the challenges and gains in the applicability of the Hyperautomation process that involves the application of Artificial Intelligence (AI) integrated with Robotic Process Automation (RPA).

In the experiment performed, the best Hyperautomation model evaluated was the Multilayer Perceptron technique used to recommend collecting the state's active debt. They were directing the debt to be filed or protested, thus aiming at optimizing the debt collection process, resulting from the gain of assertiveness.

The results made it possible to verify that the classification methods used obtained good results both in the accuracy and in precision metric, being above 97%. Thus, it is possible that the proposed Hyperautomation model can be considered dependable since all research metrics obtained a satisfactory result.

With the application of the champion technique, it was possible to improve the results in the collection, as can be observed concerning the collection performed before and after the application of Hyperautomation. With the collection of active debt of the state in 2018, before the application of Hyperautomation 212 million reais, and after the application of Hyperautomation in 2019, to 597 million reais, and even in 2020, in the middle of the pandemic coronavirus, the collection was around 219 million reais. Thus, emphasizing the degree of importance of the applicability of this technology.

In future work, the Hyper-automation process will be expanded to automate other data-intensive processes and use human workers to perform only cognitive tasks, leaving the repetitive and massive steps to machines.

References

1. Saltz, J., Sidorova, A., & Goul, M. (2020). Introduction to minitrack in artificial intelligence management and big data analysis governance and compliance. In Proc. 53rd Hawaii Int. Conf. Syst. Sci. (pp. 5255-5256).
2. Kuhl, N., Lobana, J., & Meske, C. (2020). Do you comply with AI?--Personalized explanations of learning algorithms and their impact on employees' compliance behavior. arXiv preprint arXiv:2002.08777.
3. Prencipe, A., Hobday, M., & Davies, A. (2003). The Business of Systems Integration. Illustrated edition.
4. Borges, A. F., Laurindo, F. J., Spínola, M. M., Gonçalves, R. F., & Mattos, C. A. (2021). The strategic use of artificial intelligence in the digital era: Systematic literature review and future research directions. International Journal of Information Management, 57, 102225.
5. Hodson, H. (2015). AI interns: Software already taking jobs from humans. New Scientist.
6. Aimdek Technologies. (2018). Evolution of Robotic Process Automation (RPA): The Path to Cognitive RPA. AIMDekTech.
7. Willcocks, L. P., & Lacity, M. C. Nine likely scenarios arising from the growing use of robots, September 2015.
8. Lacity, M., & Willcocks, L. (2015). What knowledge workers stand to gain from automation. Harvard Business Review, 19(6), 23-46.
9. Bamberger, P. (2021). How Automation is changing our World. Strategic Thinker, Problem Solver, Business Analyst, Project Manager and Developer. Phillipbamberger Medium.
10. Maddox, T. (2019). Top 10 Technology Trends for 2020 Include Hyperautomation, Human Augmentation and Distributed Cloud. TechRepublic, Technology Advice. TechRepublic article/hyperautomation.
11. Liu, S. (2022) Size of the robotic process automation (RPA) market worldwide 2020-2030. Statista: Technology & Telecommunications. Statista statistics/1259903.
12. Syed, R., Suriadi, S., Adams, M., Bandara, W., Leemans, S. J., Ouyang, C., ... & Reijers, H. A. (2020). Robotic process automation: contemporary themes and challenges. Computers in Industry, 115, 103162.
13. Januszewski, A., Kujawski, J., & Buchalska-Sugajska, N. (2021). Benefits of and obstacles to RPA implementation in accounting firms. Procedia Computer Science, 192, 4672-4680.
14. Sidorova, A., Torres, R., & Al Beayeyz, A. (2014). The role of information technology in business process management. In Handbook on Business Process Management 1: Introduction, Methods, and Information Systems (pp. 421-444). Berlin, Heidelberg: Springer Berlin Heidelberg.
15. Schwab, K. (2017). The fourth industrial revolution. Currency.
16. Carr, W. (2007). Philosophy, methodology and action research. In The Quality of Practitioner Research (pp. 29-42). Brill.
17. Sjoberg, D. I., Dyba, T., & Jorgensen, M. (2007, May). The future of empirical methods in software engineering research. In Future of Software Engineering (FOSE'07) (pp. 358-378). IEEE.
18. Ahmad, M. O., Dennehy, D., Conboy, K., Oivo, M. (2018). Kanban in software engineering: A study of systems mapping. Journal of Systems and Software, 137, 96 -113.

19. Santos, P., Travassos, G. (2011). Action research can balance the balance in experimental software engineering. Advances in computers, 83, 205-276.
20. Goldschmidt, R., Steps, E., Bezerra, E. (2015). Data Mining: concepts, techniques, algorithms, guidelines, and applications. Elsevier Editor Ltda.

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