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APPLICATION OF RPA TECHNOLOGY IN MANAGEMENT AND DECISION-MAKING PROCESSES

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Abstract. This paper analyses RPA technology and its place in management and decision-making processes. The aim of this paper is to analyze various sources on the use and implementation of this technology in order to assess the current state of research in this field, as well as to build a dynamics model to further analyze the possibility of applying the technology in the future. This research analizes research papers in the various fields of RPA technology research. Both English-language and Russian-language sources were analyzed. Based on the analysis, conclusions were made about the current state of research, as well as conclusions about the position of RPA in the field of automation and the risks that are associated with the use of the technology in question. Further, the paper highlights indicators and builds models of the process in question before and after implementation, as well as models of the dynamics of the process using RPA technology. On the basis of the analysis conclusions are made about the practical impact of RPA on the process, as well as conclusions about the possibility of transformation and use of the model in the future. The result of the work is a grouped research on the topic of RPA with conclusions about the status of RPA, the features of this technology, the possibilities of its application, as well as process models and dynamics, based on which the conclusion about the possibility of using RPA in management processes and decision-making is made.

Keywords: RPA, process control, process automation, robots, control process, decision-making process, artificial intelligence, dynamics model

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ПРИМЕНЕНИЕ ТЕХНОЛОГИИ RPA В ПРОЦЕССАХ УПРАВЛЕНИЯ И ПРИНЯТИЯ РЕШЕНИЙ

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Аннотация. В статье проводится анализ технологии RPA и её места в процессах управления и принятия решения. Целью данной работы является анализ различных источников по вопросам использования и внедрения данной технологии для оценки текущего состояния исследований в данной сфере, а также построение модели динамики для последующего анализа возможности применения технологии в будущем. Первая часть работы посвящена анализу научных работ в различных сферах исследования технологии RPA. Были проанализированы как англоязычные, так и русскоязычные источники. На основе данной части работы были сделаны выводы о текущем состояние исследования, а также выводы о положении RPA в сфере автоматизации и рисках, которые связаны с использованием рассматриваемой технологии. Вторая часть работы посвящена выделению показателей и построению моделей процесса до и после внедрения, а также модели динамики процесса с использованием технологии RPA. На основе данной части работы были сделаны выводы о практическом влиянии RPA на ход процесса, а также выводы о возможности преобразования и использования модели в будущем. Результатом данной работы являются сгруппированные исследования по теме RPA с выводами о состоянии RPA, особенностями этой технологии, а также возможностями для её применения, а также модели процесса и динамики, на основе которых сделан вывод о возможности применения RPA в процессах управления и принятия решения.

Ключевые слова: RPA, управление процессами, автоматизация процессов, роботы, процесс управления, процесс принятия решений, искусственный интеллект, модель динамики

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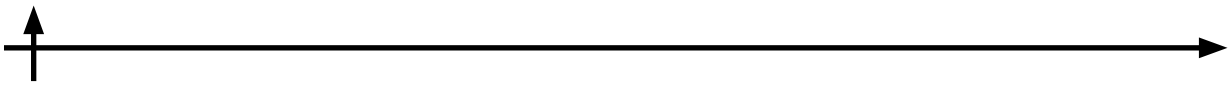
Introduction

The field of RPA (robotic process automation) technology is understudied, as the technology is new to the automation market. However, it is worth noting that the increased interest in process automation is allowing the technology to develop rapidly. This increases the number of scientific papers on the subject every year.

Let us characterize the technology. The original definition of the word "robot" was as follows: a universal automaton for performing mechanical actions similar to those performed by a human performing physical work (Yurevich, 2018), but the modern concept of this definition is somewhat different from the now obsolete ones. The first robots were created to replace humans in arduous and hazardous tasks, thereby reducing risk to workers' lives and increasing efficiency in the work performed. Modern robots, on the other hand, are capable of performing information tasks and have artificial intelligence, which allows them to be used not only in heavy mechanical tasks, but also in process automation.

"Process" or "process" is a word that everyone is familiar with, but different sources give different definitions of this concept. For example, GOST R ISO 9000:2008 defines process as "a set of interrelated



or interacting activities that transform inputs into outputs" ("GOST R 9000-2008. Quality management systems. Basic provisions and dictionary," 2009, pp. 9000–2008).

"Automation" is also a concept that is gaining traction in the current era of digitalization of enterprises. "Automation is the application of technologies and methods to partially or completely exclude humans from participating in an automated process. The main purpose of automation is to improve labour efficiency" (Fursenko et al., 2007). "Robotic process automation" or "robotic process automation" technology is a collection of images of virtual robots that perform various service tasks previously performed by humans. In business processes RPA is software that performs the tasks of unloading and transferring data from various systems used in the enterprise (CRM, ERP etc.), performing e-mail distributions, creating electronic documents and reports etc. (Madakam et al., 2019).

Some of the most popular vendors in the world in the RPA technology market include: IBM, UiPath, WorkFusion, AUTOMATION ANYWHERE, openspan 5 and BluePrism (Lavrov and Petyuk, 2017). Although it is difficult to identify a leader in such a dynamic market, many experts believe that UiPath is the leader at the moment due to their awareness and financial capability.

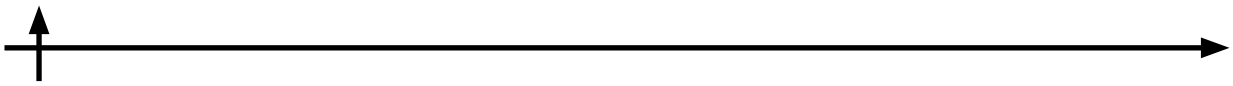
Materials and Methods

First of all, articles that raise the issue of the prevalence of this technology both in Russia and in the world at large, as well as examples of successful application of RPA technology were studied. It should be noted in advance that the theoretical side of technology research is raised in most articles.

The article "Robotic Process Automation (RPA)" describes the essence of the technology, the basic prerequisites for its use and diffusion, and also briefly describes and compares the current state of robotic process automation in Russia and abroad. In Russia RPA is just emerging and there are several problems associated with the technological state of the processes in organizations, low labour costs and other factors. The author reports that the number of successful applications of this technology in Russia is currently very low, however, one of the companies using this technology is X5. This information contrasts with the fact that RPA is already used in the public sector in some countries (Belomittsev, 2019).

The article "Utilizing robotic process automation technologies for streamlining the additive manufacturing design workflow" reveals an algorithm for selecting a framework for applying RPA technology to manufacturing within an additive manufacturing model to improve the optimality of basic manufacturing processes. In this study, the framework was deployed in a real enterprise. The main goal was to reduce the cost of production and to reduce the likelihood of human error (George et al., 2021). The article "Applying robotic process automation (RPA) in auditing: A framework" describes the benefits of using the developed framework. (Huang and Vasarhelyi, 2019) describes the benefits of using the RPA solution developed in the course of the study in the field of auditing. The authors single out the following as the main benefits: freeing auditors' time to perform more complex tasks, reducing human error in auditing, increasing the quality of auditing by reducing outsourcing.

In "Robotic process automation at Xchanging" the authors describe features of using RPA-technology shortly after direct implementation on the basis of experience of company-vendor and business process integrator Xchanging. Based on these experiences, the authors highlight the following features of process automation using modern technology (Willcocks et al., 2015a). Continuous improvement, which maximizes the benefits of implementing RPA technology. Voluminous repetitive tasks are better performed by robots, as the possibility of human error is eliminated. A robot can outperform a human in terms of quality, speed and error rate, but can only work at the pace at which the overall process allows it, which means the following: the robot is still constrained by process conditions, just like a normal human (Willcocks et al., 2015a). To maximize the efficiency of RPA implementation, both the IT architecture and the processes themselves must be improved continuously. The authors of "Robotic process automation at Telefonica O2" describe the characteristics of RPA technology after direct implementation based on the experience of a telecommunications company. The authors show the current effectiveness



of RPA, as well as predictions that the use of RPA technology will bring even greater benefits to the company.

The company's experience has shown that early adopters of RPA have to take a number of risks. For example, the authors point out that it is necessary to make sure that the growth rate of the company's own IT infrastructure is sufficient to match the growth rate of the level of automation in the enterprise. The following situation has occurred in the enterprise. Initially the facility had only 20 robots, allowing it to operate at optimum capacity, but as the number of robots increased the load on the mainframe became too great, leading to a system crash. The authors of the article reflect: "It was like driving a Ferrari with a lawnmower engine" (Lacity et al., 2015). The article "Robotic automation of auxiliary processes of RF radioelectronic industry enterprises under pandemic conditions" was also reviewed. The purpose of the authors' work was to solve the problem of task performer replacement in a pandemic environment through the use of RPA-system at the enterprise of radioelectronic industry. The article describes the peculiarities of the electronic industry enterprises, the list of tasks performed by robots in this enterprise, which include: creating and moving files, emulating pressing buttons, filling and copying forms, downloading data from external and internal sources, comparing and checking data, performing mathematical operations, text recognition (Zherenakov et al., 2020).

In addition, works on the specifics of deployment and interaction of RPA with other automation technologies in enterprises have been studied. The authors of "Robotic Process Automation" described the stages of process automation in the enterprise using RPA technology. The main criteria for system selection were also considered: functionality, configurability, scalability, infrastructure, and ease of use by end users (Lavrov and Petyuk, 2017). In their paper "Robotic Process Automation and Artificial Intelligence in Industry 4.0 - A Literature review" the authors consider the possibility of integrated application of ML, AI and RPA technologies. The synergy of these technologies will allow to use RPA more effectively and expand the area of processes in which this technology can be applied. The authors also identified criteria for selecting a suitable RPA based on their objectives for the set of technologies under investigation. These criteria included: recognition, level of optimization provided, classification, information extraction, computer vision, fuzzy matching, neural networks, solver trees, fuzzy logic, NLP (Ribeiro et al., 2021).

The paper "Early evidence of digital labour in accounting: Innovation with Robotic Process Automation" explores the features of RPA implementation. The author highlights that providing technical capabilities is only part of the RPA implementation process, and that organizations benefit from automating structured, repetitive, rule-based processes with digital inputs. The author reports that along with cost savings, organizations gain improved process documentation, fewer errors and better quality reports (Kokina and Blanchette, 2019).

The article "Process Mining and Robotic Process Automation: A Perfect Match" presents an example of joint use of process analytics technology and RPA. The authors point out that such combination of technologies allows increasing company's efficiency indicators in case of correct implementation and combination of technologies. The paper also proposes the author's approach for successful combination of the technologies studied in the paper. Briefly, the approach can be described by the following points: selection of a suitable use case; standardization of business processes of the enterprise to facilitate RPA implementation; prioritization of use cases in the context of limited resources; creation of a central unit of the organization to manage the RPA unit; constant monitoring of results and improvement of processes and technologies (Geyer Klingeberg et al., 2018).

The author of the article "RPA - Modern Business Process Automation Technology" talks about the different options for deploying RPA tools: auxiliary automation and full autonomy of the robot from the employee. The article provides examples for each type of automation and presents descriptions of different types of RPA robots. The author identified the following robots: an assistant robot, which requires human intervention to use; an autonomous robot that performs tasks without human control (Kuzmin,

2020).

A separate item worth highlighting are papers whose main idea is to investigate the risks of RPA implementation and to identify and solve possible problems that may arise during the implementation of RPA. For example, the paper "Main Problems in the Implementation of Robotic Process Automation (RPA) Solutions" examines the problems encountered during implementation, the main reasons for their occurrence, methods for solving problems, as well as ways of developing RPA technology in light of the possibility of new difficulties in implementation and development and ways to overcome them. The author identifies the following problems. Firstly, a lack of understanding of the process and its steps by implementers. As a solution to this problem, it was proposed to engage consultants to help analyze the process and provide professional commentary on it.

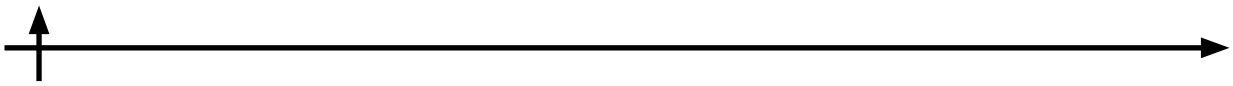
The second problem was the lack of understanding by the key users of the technology and how it would be used in their process. The solution to this problem is to educate the end users of the future RPA system and related technologies in advance, which will prepare staff for the changes in the process and information infrastructure of the enterprise (Belomittsev, 2019). The authors of other articles also highlight other problems. For example, the article "Main aspects and challenges of robotic process automation" highlights challenges such as the lack of a clear vision of the end goal of automation. It is believed that these difficulties could be overcome by the previously described method of training personnel to better understand the purpose of automation and its place in the process to be automated. Another problem highlighted by the authors is problems with defining the steps for implementing RPA and neglecting already proven techniques for implementing the technology. This problem is not unique to RPA technology, but is encountered in almost any enterprise process automation. One of the reasons for this problem is the testing of automation on a small business process and the desire to automate individual tasks that are not linked, resulting in patchwork automation (Arkhipov, 2019).

Another paper that describes the risks and problems of RPA implementation is "Risks of implementing RPA technology in a knowledge-intensive enterprise". The following risks are highlighted: the problem of process analysis; employee adaptation; the direct development of RPA; the cost of implementation; and maintenance. Solutions to some of the problems presented have already been proposed, but it is worth highlighting the problem of maintenance and RPA development (Badmayeva and Pererva, 2020). These problems can be solved by outsourcing RPA development and support. This solution will be most relevant for small and medium-sized enterprises. One source of information on the potential challenges that need to be addressed in the implementation of RPA is the paper "Robotic Process Automation: Contemporary themes and challenges". The paper describes the latest RPA technology at the time of writing, and provides a research programme on RPA applications in the form of solutions to 15 practical problems that need to be solved during implementation. Examples of such challenges are: infrastructure evaluation mechanisms, methodological support for implementation, socio-technical implications, allocation of sufficient benefit indicators, etc. (Syed et al., 2020).

The issue of internal problems with miscommunication of company structures when developing and implementing RPA is addressed in depth in the article "The IT function and robotic process automation". The authors describe and answer questions about one of the major problems that can arise when implementing RPA - a misunderstanding between the IT department and the client department. The authors answer questions that can arise from unfamiliarity with basic technology terms. For example, the first starting point is that customers are not dealing with a physical robot. However, it is a software robot, not ordinary software. The authors draw the following analogies.

"The RPA 'developer' customises the RPA software, whereas the IT 'developer' writes the software code.

"Analyst" RPA is a process expert who actively seeks automation opportunities and usually writes detailed RPA requirements, whereas the typical "business analyst" serves as a link between user needs and IT requirements (Willcocks et al., 2015b).



Results and Discussion

First of all, we would like to note the low level of development of RPA technology and the prevalence of its application in Russia. This fact is confirmed as the texts of the articles analyzed in the data, namely the paragraphs relating to the analysis of the domestic market and comparing it with foreign, and the extremely difficult process of finding information and scientific sources on the subject. It should also be noted that there are very few voluminous scientific papers on the topic.

Based on information from Russian-language scientific papers, it was concluded that the low prevalence of this technology is related to the risks entailed by the implementation of this technology, as well as the difficulties in its implementation. For example, many companies are just beginning to move to a high level of digitalisation, and for the application of RPA technology, this is one of the key factors. It has been noted that all the features and complexities are well understood by researchers in research papers related to the problems I have described above, which shows that RPA technology is slowly starting to penetrate the domestic market as well. More and more vendors of this technology are appearing among Russian and CIS companies.

It is also worth noting that Russian-language sources provide a number of examples of the use of technology in various areas of industry and services. Based on the analysis of English-language sources, it was concluded that among English-speaking researchers the problem is more elaborated. As in Russian-language sources, foreign researchers in their works often analyse the features of implementation and problems that may arise in the implementation and use of RPA technology. In some papers, authors describe a comparison of automation technologies, e.g. BPM and RPA. However, authors also cite examples of combined use of BPM and RPA technologies, as well as complementing RPA with AI, ML, CI and other technologies, which demonstrate a high level of RPA development potential and potential synergies with other technologies. Examples of the use of the technology in various fields, from banking to telecommunication, are also given.

English-language studies pay a lot of attention to the problem of optimising RPA algorithms and robots. Researchers create methodologies for choosing decision-making frameworks in various industries and services, and create mathematical models to optimize RPA by reducing the number of robots used in the work, which markedly reduces the cost of enterprises when using this technology. The authors also focus not only on the technical challenges of implementing the technology. For example, there are studies focusing on the linguistic problem of implementation, namely the problem of overlapping the terms RPA and IT in general.

The growing interest in RPA is also noted in many articles. For example, one article reports that according to Google Trends, interest in robot-assisted process automation has increased more than 5-fold in the last 5 years (Jovanovic et al., 2018). Based on the data collected from various sources, a study was conducted on the feasibility of RPA technology. To better understand the problem, a small case study was compiled in the form of models of the document management process before and after the implementation of RPA technology in the enterprise. These models are presented in Figures 1 and 2.

As can be seen from the model, the processes of obtaining signatures and processing documents are performed manually, which can entail both the risk of human error and increase the duration of rather simple sub-processes.

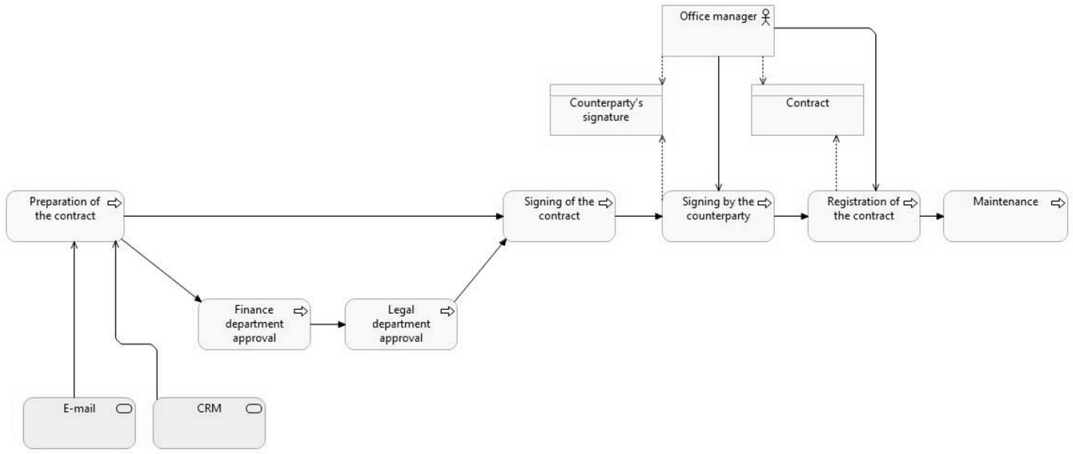


Fig. 1. Model of a document management process “as is”

As you can see from the model in Figure 2, the machine now solves these sub-processes, freeing the office manager from these tasks. These models are just a small example of the benefits of using RPA in enterprises.

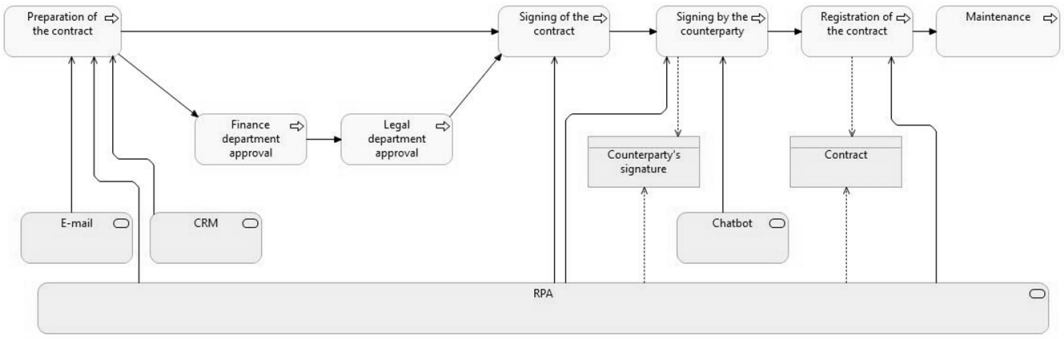


Fig. 2. A model of the “to be” document management process

A system dynamics model was also drawn up as part of the study. The purpose of this model is to predict and visualise the effect of RPA on the execution of the company's key processes. For this purpose, process cumulators and an accumulator demonstrating the overall work performed were generated. Figure 3 shows an example of model formation for 1 process. Figure 4 shows the complete model for all core processes of the company.

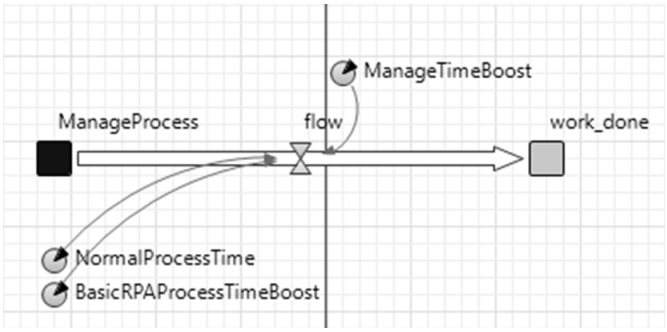


Fig. 3. Example of a model for a single process

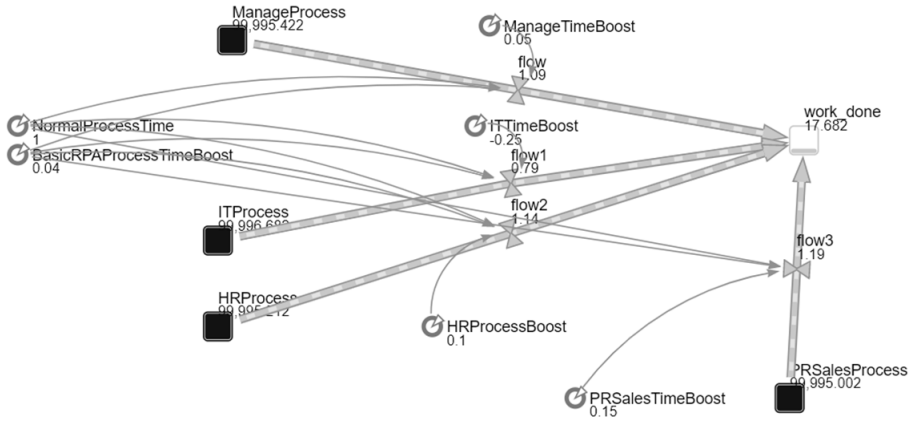


Fig. 4. Model of the impact of RPA on the speed of execution of a company's core processes

This model demonstrates the impact of the application of RPA technology on the speed of execution of a unit of process work. Table 1 will provide a list of variables with their descriptions.

Table 1. Variables and drivers of the model

Variable	Value	Description
NormalProcessTime	1	Describes the base rate of completion of a unit of work during the company's processes.
BasicPRAProcessTimeBoost	0.04	A measure of the acceleration of a unit of work that is common to all processes. It was obtained through peer review.
ManageTimeBoost	0.05	Shows the process unit of work acceleration for management processes.
ITTimeBoost	-0.25	Shows the impact of using RPA in the IT processes in the company. This is due to the increased workload on the IT department due to the need to support the new system.
HRProcessBoost	0.1	Shows the process unit of work acceleration for HR processes.
PRSalesTimeBoost	0.15	Shows the process unit of work for acceleration for sales processes.
ManageProcess	100000	Shows the number of work units of management processes. Examples of processes are strategic initiative management process, business plan management, organizational development management, quality management, inventory control, etc.
ITProcess	100000	Number of work units of IT processes. Examples of processes are RPA system support and management, information systems support and management, database support and management, technical support, maintenance, etc.
HRProcess	100000	Number of work units of HR processes. Examples of processes are processing resumes and applications, HR analytics, personnel records, training and development of personnel, recruitment
PRSalesProcess	100000	Number of units of work of sales processes. Examples of processes are processing applications, finding clients, attracting clients, processing, and creating documentation, etc.
work_done	0	The total number of completed units of work for all processes represented in the model. Examples of such processes would be all the above examples.

The drives are affected by 2 types of variables: variables common to all processes; process-specific variables.

The common variables are NormalProcessTime and BasicPRAProcessTimeBoost. A value of 1 was chosen for NormalProcessTime because this variable describes the basic process execution speed against which the effect of RPA failure is viewed. For BasicPRAProcessTimeBoost, a value of 0.04 (Fursenko et

al., 2007; "GOST R 9000-2008. Quality management systems. Basic provisions and dictionary," 2009) was selected based on the sources analysed earlier in this paper. These variables are shown in Figure 5.

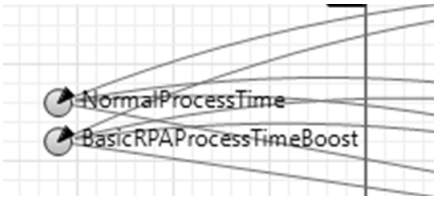


Fig. 5. Common variables

As can be seen from the figure, there are a large number of links from these variables to all the flows present in the model.

For specific variables, an analysis of sources was also carried out to select the most accurate parameters according to expert opinion (Asquith and Horsman, 2019; Flechsig et al., 2022; Lacity et al., 2015; Willcocks et al., 2015a). The values of these variables are presented in Table 1. Visually, these variables are presented in Figure 6. The relationships of the variables in question are highlighted in red.

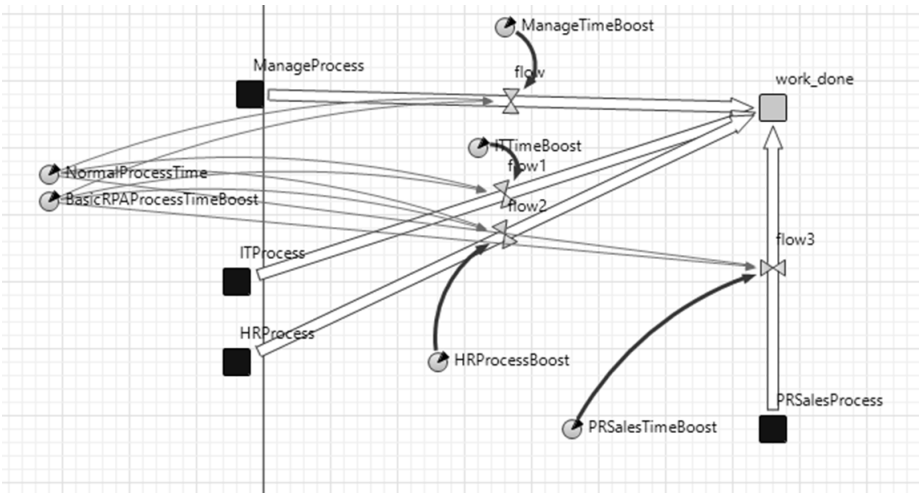


Fig. 6. Visualisation of relationships of specific variables

The impact of the variables on the respective drive streams is presented in Table 2.

Table 2. Influence of variables on drive streams

Aggregator	Influential variables
ManageProcess	NormalProcessTime, BasicPRAProcessTimeBoost, ManageTimeBoost
ITProcess	NormalProcessTime, BasicPRAProcessTimeBoost, ITTimeBoost
HRProcess	NormalProcessTime, BasicPRAProcessTimeBoost, HRProcessBoost
PRSalesProcess	NormalProcessTime, BasicPRAProcessTimeBoost, PRSalesTimeBoost
work_done	There are no influencing variables because this is the end of the process

Based on the results of this model, it can be concluded that the impact of RPA on the core processes of the company fully covers the risks associated with the implementation and use of this technology. The visual component of the model qualitatively reflects the impact on speed when the model is run in parallel with ManageTimeBoost, ITTimeBoost, HRProcessBoost, PRSales and TimeBoost parameters

"zeroed". In this case, the only parameter affecting the model remains NormalProcessTime. Thus the model will run in a simulation where RPA is not used. The execution speed of processes in such a system will be baseline. If the results of expert evaluation of RPA impact change (for example, in case the system is augmented with new functions), the expert may change the coefficients of variables and compare the old model with the new one.

Conclusions

Various scientific sources related to RPA and other technologies which facilitate the automation and operation of RPA systems have been reviewed in this paper. From the information obtained the following conclusions about the technology have been made. It is a developing technology worldwide, and in Russia many companies are sceptical about this innovation.

RPA-systems are extremely demanding not only on the infrastructure of the company, but also on its financial resources, as well as the management, which must be clearly aware of the purpose of the technology. The technology is suitable for any kind of enterprise and can be used there, from banking and public sector to heavy industry and small business. The implementation of the technology contributes to the IT development of the company, because as the number of robots used in RPA increases, so does the quality of the company's IT infrastructure.

The technology has great synergy potential with other emerging technologies: machine learning and neural networks. In the course of this work, a system dynamics model of the impact of RPA systems on the speed of execution of company processes was built. From this model it can be concluded that this technology is a powerful tool in the hands of a skilled manager. However, this technology requires serious IT support.

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