Key Factors Determining Decisions on the Implementation of Robotic Process Automation

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Abstract

The article presents the results of research into the identification of key factors influencing decisions on the implementation of Robotic Process Automation (RPA) in enterprises. The study uses the theoretical framework of Davis' Technology Acceptance Model (TAM) and its modifications which apply to the study of acceptance of new technologies. The study results indicate a direct impact of the following variables: Perceived Ease of Use and Perceived Usefulness on Behavioural Intention. They also confirm that the Perceived Usefulness variable is statistically significantly influenced by the Social Influence, Price Value, and Process Adequacy variables. For the Perceived Ease of Use variable, a statistically significant effect of the User Involvement and Facilitating Conditions variables was presented, and no statistically significant effect of the Implementation Method variable was demonstrated. The obtained results contribute to reducing the indicated research gap concerning the identification of factors that are very important for the implementation of RPA.

Keywords: Robotic Process Automation (RPA), RPA implementation, RPA implementation factors.

1. Introduction

Modern organisations are constantly striving to improve efficiency not only in basic processes, such as production or services, but also in management processes. New technologies open up significant opportunities for them in this aspect. Many companies are currently looking for innovative solutions based on cognitive computing and artificial intelligence that allow them to automate increasingly complex decision-making processes [9]. One of the tools used in this area is Robotic Process Automation (RPA) which enables streamlining and optimising repetitive and particularly error-prone activities. The lack of industry barriers to its application means this technology can be used in the banking, insurance, telecommunications, energy, health care, and industry sectors [10]. The number of RPA implementations observed in recent years has been consistently growing, and the expected significant increase in investments in

these solutions in the coming years indicates a great interest in this issue on the part of entrepreneurs [13]. According to research done by the largest consulting companies, new technologies including robots will play an increasingly important role in company processes [4, 5], [7]. The importance of this issue increases in connection with the main assumptions of the European Union's policy on the digital transformation of enterprises [6]. Digitalisation is one of the key priorities of the EU in achieving the goals of the 2030 Agenda [17]. It specifies that by 2030 at least 90% of the EU's small and medium-sized enterprises (SMEs) should achieve a basic level of digital intensity.

2. Literature review

The RPA issue is of interest to a growing number of researchers, resulting in many scientific publications related to RPA implementations in enterprises. Based on a review of publications constituting the existing literature [2], [8], [11], [15], it can be indicated that the topics of articles on RPA implementation include identification of benefits related to RPA implementation, identification of challenges and risks related to RPA implementation, identification of readiness and possibilities of RPA implementation by organisations, identification of guidelines or good practices resulting from previous experiences in the field of RPA implementation, and prediction of further directions of development of RPA technology.

In the previous works, as part of the analysis of factors that are important for the implementation of RPA, one can point to studies aimed at identifying key success factors for the implementation of RPA, which include: human factors (*e.g.*, involvement of employees, management and stakeholders, convincement of management employees and IT, training of involved persons), organisational factors (*e.g.*, risk management, resource planning, involvement of external service providers, process identification, process selection, process compatibility) and technical factors (*e.g.*, data security, existing IT infrastructure, vendor selection, testing, pilot processes) [14]. Moreover, the literature indicates that the implementation of RPA is positively influenced by the country's digital competitiveness and high level of Information and Communications Technology maturity [8]. In turn, the authors of studies using the theoretical framework of Davis' Technology Acceptance Model (TAM) indicate that factors such as conditions facilitating implementation, the ability to demonstrate implementation results, the joy of innovation and social influence, which are factors influencing perceived usefulness and perceived ease of use, favour the acceptance of RPA by users [20].

The literature draws attention to the lack of a comprehensive overview of the factors that are of great importance for RPA implementation and should be taken into account when organisations conduct an RPA project [14]. The results obtained in our research, presented in this article, contribute to reducing the indicated research gap.

3. Purpose and method

The aim of this article is to identify and assess the impact of key factors that influence the decision-making process of implementing RPA in enterprises. The authors believe that this may contribute to further popularisation of RPA implementations. The theoretical framework of Davis' TAM [3] and its modifications developed by Venkatesh et al. in the Unified Theory of Acceptance and Use of Technology (UTAUT) [18] and UTAUT2 [19] were used to identify factors that may affect the decision to implement RPA. In TAM, two constructs, Perceived Usefulness and Perceived Ease of Use, explain Behavioural Intention to use a new technology [3]. In UTAUT, core constructs include Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions [18], whereas UTAUT2 comprises all UTAUT constructs and additionally Hedonic Motivation, Price Value, and Habit [19]. These models are applicable to the study of acceptance of new technologies.

In our model, in addition to internal variables that affect the acceptance of technology, such as Perceived Usefulness (PU) – "the degree to which a person believes that using a particular system would enhance his or her job performance" [3], Perceived Ease of Use (PE) – "the degree to which a person believes that using a particular system would be free of effort" [3] and Behavioural Intention (BI) – the willingness of a person to perform a given behaviour [18], the

model was modified to include selected external variables. As a result of the literature review [1], [15], [20] and expert discussion, the following external variables were adopted for the model: Social Influence (SI) – the degree to which an individual perceives that most people who are important to him think they should or should not use the system [18], Price Value (PV) – a trade-off between the perceived benefits of RPA and costs for using it [1], [19], Process Adequacy (PA) – the extent to which processes are prepared for the implementation of new technology [1], [20], Implementation Method (IM) – RPA implementation approaches [15], User Involvement (UI) – it refers to the user involvement during the design and implementation of RPA bots and whether the user has been informed about the opportunities provided by automation [20], Facilitating Conditions (FC) – the degree to which a person believes that an organisation and a technical infrastructure exist to support the usage of a system [18].

The following research hypotheses were formulated:

H1: Social influence positively affects Perceived usefulness.

H2: Price value positively influences Perceived usefulness.

H3: Process adequacy positively influences Perceived usefulness.

H4: Implementation method has a positive influence on Perceived ease of use.

H5: User involvement has a positive influence on Perceived ease of use.

H6: Facilitating conditions has a positive influence on Perceived ease of use.

H7: Perceived ease of use has a positive influence on Perceived usefulness.

H8: Perceived ease of use has a positive influence on Behavioural intention.

H9: Perceived usefulness has a positive influence on Behavioural intention.

To verify the research hypotheses, the authors conducted a targeted survey among UiPath customers in Poland, Germany, and Portugal. UiPath is a leading provider of RPA solutions [16]. The study was conducted in 2022. 492 respondents took part in the study; however, because 27 people only partially completed the survey questionnaire, the answers obtained from 465 respondents qualified for further analysis. The questionnaire was distributed via mailing lists. The survey research was announced by a social networking platform - LinkedIn. The group of respondents was diverse in many aspects. In terms of company size, 76.99% of respondents represented large enterprises, 22.58% medium-sized ones, and 0.43% small businesses. They came from a wide range of industries, including: “Industry, construction, and transport” (20.64%), “Consumer goods – production, trade, and services” (17.20%), “Finance and insurance” (13.98%), “Telecommunications services” (12.26%), “Healthcare – production, trade, and services” (10.97%), “Information technology and services” (9.46%), “Raw materials and construction materials” (6.24%), and other industries (9.25%). The majority of participants (76.78%) held positions directly related to RPA operations, such as RPA Lead, Business Process Owner, Process Improvement Manager, Automation Leader, or IT department heads (*e.g.*, CIOs). The remaining 23.22% of respondents were C-suite executives, including business owners, CEOs, and CFOs. We also analysed respondents, taking into consideration the stage of RPA implementation. To define the stage of RPA implementation, an approach was adopted that takes into account five phases of RPA implementation: 1) Not considering, 2) Planning/ Experimenting/ Testing, 3) Implementing in some processes, 4) Maturing: maintaining many RPA and implementing new ones, 5) Advanced when most processes are automated [12]. Most of the respondents (94.19%) represented companies maintaining many RPA and implementing new ones, or with most processes automated. The Computer Assisted Web-Interviews technique (CAWI) was used to conduct the study. The questions used to test the hypotheses used a five-point Likert scale. The main method used in data analysis was structural equation modelling (SEM). The R programming language with the following libraries was used to perform structural equation modelling: dplyr (data modification and aggregation), cSEM (structural model generation), lavaan, tidySEM, semPlot, gtools (graphical graph generation).

4. Results

In order to conduct the analyses, the reliability of the question groups was tested using Cronbach's alpha method. The obtained results are presented in Table 1:

Table 1. Table of Cronbach's alpha coefficients and values after dimension correction.

Group of variables	Alpha value	Alpha value after correction	Removed question
SI	0.751	-	-
PV	0.842	-	-
PA	0.847	-	-
IM	0.849	-	-
UI	0.61	0.645	UI_1
FC	0.861	-	-
PE	0.948	-	-
PU	0.658	-	No improvement
BI	0.855	-	-

An additional dimension reduction analysis was performed for groups of questions concerning the UI and PU variables. The algorithm aimed to check whether there was a question that could be removed without significant damage to the information contained in the group. This action only served to improve the coherence of groups of questions because even in the case of the impossibility of rejecting one of them, the obtained coefficient values were sufficient for further analysis. Table 2 presents the results obtained for the UI variable.

Table 2. Table of variance explanation by principal components.

Total explained variance						
Principal component	**Initial eigenvalues**			**Sums of squared loadings after extraction**		
	Total	**% of variance**	**% cumulated**	**Total**	**% of variance**	**% cumulated**
1	1.864	46.593	46.593	1.864	46.593	46.593
2	0.941	23.530	70.123	0.941	23.530	70.123
3	0.802	20.043	90.165	0.802	20.043	90.165
4	0.393	9.835	100.000	0.393	9.835	100.000

This means that a reduction to three dimensions can be performed, as the three component variables still explain more than 90% of the variance. Further analyses showed that the most beneficial in terms of Cronbach's alpha value is the removal of question UI_1. An iterative reliability analysis was performed for each of the three questions from the UI group to select the question. The one with the highest alpha parameter value was selected. Similarly, the analysis conducted for the PU variable showed that removing any of the questions does not improve the value of the coefficient. Therefore, it was decided to leave all four variables. In the further part of the analysis, answers to four questions concerning the SI, PV, PA, IM, FC, PE, PU, and BI groups and three questions related to the UI group were considered.

The latent variables SI, PV, PA, PU, IM, UI, FC, PE, and BI were built using the survey questions to construct structural models. They have the following form:

$$SI = \alpha_{11}SI_1 + \alpha_{12}SI_2 + \alpha_{13}SI_3 + \alpha_{14}SI_4, \quad (1)$$
$$PV = \alpha_{21}PV_1 + \alpha_{22}PV_2 + \alpha_{23}PV_3 + \alpha_{24}PV_4, \quad (2)$$
$$PA = \alpha_{31}PA_1 + \alpha_{32}PA_2 + \alpha_{33}PA_3 + \alpha_{34}PA_4, \quad (3)$$
$$\mathrm{PU} = \alpha_{41}\mathrm{PU}_1 + \alpha_{42}\mathrm{PU}_2 + \alpha_{43}\mathrm{PU}_3 + \alpha_{44}\mathrm{PU}_{4,} \quad (4)$$
$$IM = \alpha_{51}IM_1 + \alpha_{52}IM_2 + \alpha_{53}IM_3 + \alpha_{54}IM_4, \quad (5)$$
$$UI = \alpha_{62}UI_2 + \alpha_{63}UI_3 + \alpha_{64}UI_4, \quad (6)$$
$$FC = \alpha_{71}FC_1 + \alpha_{72}FC_2 + \alpha_{73}FC_3 + \alpha_{74}FC_4, \quad (7)$$
$$PE = \alpha_{81}PE_1 + \alpha_{82}PE_2 + \alpha_{83}PE_3 + \alpha_{84}PE_4, \quad (8)$$
$$BI = \alpha_{91}BI_1 + \alpha_{92}BI_2 + \alpha_{93}BI_3 + \alpha_{94}BI_4, \quad (9)$$

where the variables α_{ij} denote the weight of variable *j* for variable *i*. The following relationships between latent variables were defined:

$$PU = \beta_{11}SI + \beta_{12}PV + \beta_{13}PA + \beta_{14}PE, \quad (10)$$
$$PE = \beta_{21}IM + \beta_{22}UI + \beta_{23}FC, \quad (11)$$
$$BI = \beta_{31}PE + \beta_{32}PU \quad (12)$$

where the parameters β_{ij} denote the coefficients of latent variable j for relation i. The model was generated in two ways. In the first one, the entire analysed model was considered as a whole. In the second one, each of the dependencies between latent variables was considered separately. In both approaches bootstrap methods with repetitions equal to 5,000 were used to determine the significance levels of dependencies between variables and the PLS-SEM algorithm to determine the values of parameters and the fit coefficient. The results of this research are shown in Table 3 and Table 4.

This means that the PU variable is statistically significantly influenced by the variables SI, PV, and PA, which means that there is no basis for rejecting hypotheses H1, H2, and H3. The influence of the PE variable on the PU variable is statistically insignificant, which means that hypothesis H7 is rejected. Carrying out analogous reasoning for the PE variable, we show a statistically significant influence of the variables UI and FC and no influence of the variable IM. This means there is no basis for rejecting hypotheses H5 and H6, but we reject hypothesis H4. A statistically significant influence of both predictors was observed for the BI variable, so there is no basis for rejecting hypotheses H8 and H9. The analysis is summarised in Table 6, where we present the decisions made for each hypothesis.

Table 3. Table of alpha weighting coefficients.

Name	Estimate	Std_err	t_stat	p_value	CI_percentile.95%	
					Lower	Upper
α_{11}	-0.1095	0.1524	-0.7180	0.4728	-0.3586	0.2343
α_{12}	-0.1727	0.1545	-1.1179	0.2636	-0.4683	0.1382
α_{13}	**0.6124**	**0.1690**	**3.6245**	**<0.001 *** **	0.2417	0.9134
α_{14}	**0.5514**	**0.1717**	**3.2106**	**0.001 *** **	0.1799	0.8536
α_{21}	0.1502	0.1252	1.1996	0.2303	-0.0909	0.3972
α_{22}	-0.0747	0.1366	-0.5471	0.5843	-0.3469	0.1942
α_{23}	**0.6999**	**0.1133**	**6.1762**	**<0.001 *** **	0.4672	0.9159
α_{24}	**0.3850**	**0.0979**	**3.9326**	**<0.001 *** **	0.1745	0.5615
α_{31}	-0.0361	0.1504	-0.2401	0.8102	-0.3439	0.2495
α_{32}	**0.4197**	**0.1481**	**2.8333**	**0.0046 ** **	0.1299	0.7267
α_{33}	0.2045	0.1627	1.2567	0.2089	-0.1646	0.4799
α_{34}	**0.5706**	**0.1128**	**5.0585**	**<0.001 *** **	0.3479	0.7892
α_{41}	**0.2678**	**0.0880**	**3.0444**	**0.0023 ** **	0.0992	0.4406
α_{42}	0.1322	0.1436	0.9205	0.3573	-0.1437	0.4086
α_{43}	**0.7456**	**0.0862**	**8.6509**	**<0.001 *** **	0.5617	0.8977
α_{44}	0.1635	0.0985	1.6604	0.0968	-0.0203	0.3647
α_{51}	0.1715	0.3402	0.5040	0.6143	-0.5314	0.8095
α_{52}	**0.9515**	**0.4350**	**2.1871**	**0.0287 ** **	-0.2636	1.3750
α_{53}	-0.6290	0.6094	-1.0321	0.3020	-1.5318	0.8601
α_{54}	0.5366	0.5599	0.9584	0.3378	-0.7932	1.4170
α_{62}	**-0.4541**	**0.1296**	**-3.5033**	**<0.001 *** **	-0.7100	-0.1965
α_{63}	**0.7420**	**0.0821**	**9.0326**	**<0.001 *** **	0.5600	0.8848
α_{64}	**0.8915**	**0.0870**	**10.2514**	**<0.001 *** **	0.7148	1.0547
α_{71}	**0.2358**	**0.0654**	**3.6078**	**<0.001 *** **	0.1051	0.3655
α_{72}	**0.5158**	**0.0683**	**7.5539**	**<0.001 *** **	0.3791	0.6468
α_{73}	**0.3421**	**0.0568**	**6.0225**	**<0.001 *** **	0.2325	0.4575
α_{74}	0.0323	0.0460	0.7024	0.4824	-0.0580	0.1216
α_{81}	**0.2513**	**0.0594**	**4.2292**	**<0.001 *** **	0.1339	0.3658
α_{82}	**0.3092**	**0.0546**	**5.6628**	**<0.001 *** **	0.1944	0.4087
α_{83}	**0.2955**	**0.0782**	**3.7762**	**<0.001 *** **	0.1418	0.4478
α_{84}	**0.2191**	**0.0828**	**2.6456**	**0.0082 ** **	0.0616	0.3844
α_{91}	**0.3386**	**0.0528**	**6.4075**	**<0.001 *** **	0.2407	0.4481
α_{92}	**0.3000**	**0.0714**	**4.2038**	**<0.001 *** **	0.1554	0.4335
α_{93}	**0.4046**	**0.0834**	**4.8525**	**<0.001 *** **	0.2431	0.5689
α_{94}	**0.1289**	**0.0583**	**2.2091**	**0.0272 ** **	0.0116	0.2384

Note: Coefficients with values that are statistically significantly different from zero are bolded. All analyses were performed assuming a significance level of 0.05. The following significance level gradations were adopted in the figures: *** - significance level below 0.001, ** - significance level between 0.01 and 0.001, * - significance level between 0.05 and 0.01.

Table 4. Table of regression coefficients, their significance level and the corresponding hypothesis.

Name	Estimate	Std_err	t_stat	p_value	Thesis	CI_percentile.95%	
						Lower	Upper
β_{11}	0.2471	0.0531	4.6570	**<0.001**	H1	0.1443	0.354
β_{12}	0.3127	0.0607	5.1517	**<0.001**	H2	0.2016	0.438
β_{13}	0.2431	0.0552	4.4037	**<0.001**	H3	0.1400	0.357
β_{14}	-0.0513	0.0601	-0.8544	0.3929	H7	-	0.069
β_{21}	-0.0008	0.0297	-0.0276	0.9780	H4	-	0.042
β_{22}	0.1551	0.0263	5.8879	**<0.001**	H5	0.1046	0.209
β_{23}	0.7818	0.0217	36.077	**<0.001**	H6	0.7360	0.819
β_{31}	0.7404	0.0256	28.939	**<0.001**	H8	0.6875	0.789
β_{32}	0.1405	0.0369	3.8028	**<0.001**	H9	0.0726	0.216

Note: All analyses were performed. assuming a significance level of 0.05. The following significance level gradations were adopted in the figures: *** - significance level below 0.001, ** - significance level between 0.01 and 0.001, * - significance level between 0.05 and 0.01.

Table 5. Table of model fit coefficients in the first approach.

Explained variable	PE	PU	BI
R^2 coefficient value	0.731	0.334	0.646
Fitted R^2 coefficient value	0.729	0.329	0.645

To describe the quality of the model, the R^2 and fitted R^2 coefficients were generated for the analysed regression models (Table 5). We can see that in terms of fit to the linear model the predictive model of the PU variable is the worst. The remaining models have high R^2 coefficient values, which indicates a good fit of the obtained regression equations to the data set analysed.

Table 6. Table of decisions made for hypotheses H1-H9.

Hypothesis	Decision
H1, H2, H3, H5, H6, H8, H9	There is no reason to reject the hypothesis; a significant positive effect was demonstrated
H4, H7	Null hypothesis rejected; no significant effect

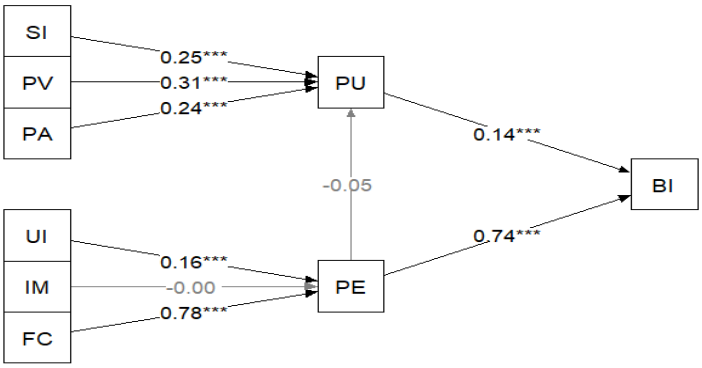

Fig 1. Schematic diagram of the model together with the obtained coefficients and their significance.

Note: All analyses were performed assuming a significance level of 0.05. The following significance level gradations were adopted in the figures: *** - significance level below 0.001, ** - significance level between 0.01 and 0.001, * - significance level between 0.05 and 0.01.

The visualisation of the approach used to analyse the dependencies, together with the obtained main coefficients and their significance, is presented in Figure 1.

5. Conclusions

The structural equation modelling analysis allows us to determine the relationships between latent variables adopted into the model. The study results indicate a direct influence of internal variables, PE, and PU on BI. In both cases, the significance level was below 0.001, which means

there is no basis for rejecting hypotheses H8 and H9. As a result, it can be assumed that both PE and PU have a positive impact on BI. The strength of the impact of both variables on BI was tested using the estimated regression coefficient, which indicated a much greater impact of PE on BI (0.7404) than of PU on BI (0.1405). The positive impact of PE on PU suggested in the TAM model was not confirmed (the coefficient –0.0513 was obtained). The p-value in this case was 0.3929, which, with the significance level of 0.05 adopted in the study, resulted in the rejection of hypothesis H7. The relationship indicating that the easier RPA is to use, the greater usefulness of this solution has not been confirmed. This may be connected with the fact that in our study, respondents represented companies that are advanced in the RPA implementation stage.

An important part of the constructed model is connected with external factors, which were selected based on the analysis of the literature and expert discussion. The results of the study confirmed that the SI, PV, and PA variables have a statistically significant impact on the PU variable. However, it should be noted that these variables explain only 33% of the variance of PU. Thus, in the future, it would be appropriate to look for new external factors to explain PU's variability better. PV has the strongest influence on PU, which may indicate that the price of the RPA solution is an important issue when deciding on the RPA implementation (0.3127). Analogous reasoning was carried out for the PE variable, and a statistically significant impact of the UI and FC variables was demonstrated. These two variables explain 73% of the variance of PE. Considering the strength of the impact based on the estimated regression coefficient, the key factor influencing PE is FC, with a coefficient of 0.7818. The coefficient for FC also indicates the highest influence among all external variables considered in the model. It may suggest that while deciding on implementing RPA, the company needs to have the necessary resources and knowledge. Moreover, the organisation's support and the possibility of obtaining help in case of difficulty are also important. In turn, the factor with the lowest value of the estimated regression coefficient was UI (0.1551). Additionally, no impact of the IM variable was demonstrated. These results may stem from the respondents' characteristics. The research was addressed to managers who may decide about RPA implementations and may not use the RPA bots daily. The research was also conducted among UiPath customers, and maybe the cooperation with this RPA vendor caused the implementation method to be unimportant when deciding on the RPA implementation.

The study results complement the existing research, including the analysis of RPA implementation factors [11], [15]. The authors of the study are aware that the decision to initiate the implementation of RPA does not guarantee the successful completion of this process. Furthermore, many companies have not taken this key decision yet.

The presented research results are also burdened with certain limitations. One is that the value of Cronbach's alpha coefficient was assumed at a level slightly higher than 0.6. However, one can find research results in the literature in which Cronbach's alpha value was assumed at a similar level [20]. Another limitation of the study is that it was conducted only among customers of one RPA solution provider. Therefore, the obtained results mainly represent the opinions of large and medium-sized entities that maintain many RPA and implement new ones or have most processes automated and are UiPath customers. This should be taken into account when interpreting the results and drawing conclusions. The conclusions included in the article are important, especially due to the growing interest in the broadly understood digitalisation of processes in enterprises. They have cognitive value and can be used in further analyses. Considering the importance and complexity of the problem of RPA implementation in enterprises discussed in the article, the presented conclusions are a starting point for further quantitative and qualitative research.

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