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Robotic Process Automation (RPA) in Accounting: Measuring ROI and Workforce Displacement

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Abstract—The paper examines how Robotic Process Automation (RPA) can be applied to the accounting field in terms of both workforce displacement and the payback (return on investment) or ROI. It applies the dual-lens methodology of incorporating the financial performance analysis and workforce impact assessment. The information is gathered from industry surveys and vendor reports on case studies of the early adopters like the large professional service firms. The findings demonstrate that RPA has high financial advantages. The accounting processes save up to 25 to 50% and ROI in high-volume processes up to 135%. The payback period is also very short ranging between 6-18 months. It decreases the error rates by up to 90% and decreases the process time by 60% to 80%, resulting in quicker financial reporting and higher decision-making. The research also concludes that RPA also has an impact on employment. Simple tasks like data entry are reduced by approximately 40%. This illustrates the fact that RPA leads to change and not retrenchment. The paper suggests that the RPA can enhance the efficiency and performance in the accounting area; however, organizations will need to adapt to changes in the workforce by training and reskilling.

Keywords—*Robotic Process Automation, Accounting Automation, RPA, Return on Investment, Digital Labor, Workforce Displacement.*

I. INTRODUCTION

A. Background and Context

The past years have been characterized with numerous changes in the field of accounting due to new digital technologies. One of the most important technologies is Robotic Process Automation (RPA). The tasks that are repetitive, rule-based and have a structured data are automated using RPA. These can be journal entries, invoice processing, account reconciling and financial reporting in accounting. Manual processing of these tasks is normally time consuming and they are at high risk of human error.

Organizations are feeling pressured to save money, be more accurate and work faster. Due to this fact, some companies have begun to utilize RPA in accounting. Unlike a traditional automation system, RPA can work with existing software, without having to make major changes. This simplifies and expedites its implementation. Big organizations, especially those that work with a financial and accounting department, have, therefore, implemented RPA.

Simultaneously the profession of accountants is also evolving. Previously, it had mostly concerned itself with routine data processing. Analytical, decision-making and strategic thinking is now required to a greater extent. This change is inextricably connected with the application of automated technologies, such as RPA. Hence, the advantages of RPA as well as the overall effects it has on the accounting occupation must be studied.

CPA, CGMA.

B. Research Problem

Although RPA has become a popular concept, people are still unclear as to its general effect. In the majority of studies, attention is paid to cost savings and increase of the efficiency. Although these ones are vital, they do not provide the whole picture. Organizations also should be aware of the impact of RPA on employees and job functions.

The idea of measuring the return on investment (ROI) of RPA in an appropriate manner is one of the issues. A lot of firms estimate ROI with regard to labour cost savings. Other advantages like reduction of errors, increased speed and improved compliance are also developed by RPA. Such advantages are usually not quantifiable. Due to this reason, decision-makers might fail to know the real value of RPA.

Displacement of workforce is another crucial problem. It is widely held that automation will cause loss of jobs. In accounting, there are a lot of monotonous activities, and automation can be applied. This poses a question of what the future of the accounting job is going to be. Other analyses have indicated that automation does not necessarily mean that the jobs will be removed, but the work will also be transformed. This gives the impulse of investigating the workforce impact more profoundly.

C. Research Motivation

The primary motivation behind this research is to give a balanced view of RPA in accounting. RPA is an activity which many organizations are investing in yet they require a clear vision as to the benefits and the risks associated with it. The purpose of this study is to assist managers, in particular, CFOs and heads of

accounting, to make improved automation-related decisions.

The second reason is to fill the gap between financial and human effects. The majority of studies concentrate on one side. It either researches on cost savings, or it researches on job loss. This paper attempts to put together both the sides. It gives a more comprehensive picture of RPA adoption.

The rationale behind the study is also to develop a simple and workable framework to measure ROI. Numerous existing models are hard to comprehend. The paper formulates a framework that has several dimensions, yet is easy to comprehend and use. It can assist organizations to assess their projects on RPA in a better way.

D. Research Objectives

The primary aim of the paper is to analyze the role of RPA in accounting under two lenses: the changes in financial performance and changes in workforce. In order to do so, the research is centred around some objectives.

It will evaluate the ROI of RPA in a multi-dimensional manner. This involves cost saving, minimization of errors, timesaving and improvement on compliance. It tries to examine the impact of RPA on various accounting duties and procedures. It assesses the RPA effects on employment both in terms of job displacement and the creation of jobs.

The study will seek to offer practical guidelines to organizations. These suggestions directed on the implementation of RPA and dealing with the changes in the workforce. Through the attainment of these objectives, the paper will add an academic contribution as well as practical decision making.

E. Novelty and Contribution

This paper is a new direction in merging money analysis and work force analysis. A majority of the past research efforts have examined these areas individually. This research is new because its dual-lens research approach is to examine ROI and displacement of workers jointly. This is to assist in appreciating the overall impact of RPA.

The other significant input is the creation of a multi-dimensional ROI framework. The framework does not concentrate on a single issue like cost saving but encompasses other relevant issues like quality and speed. This renders the analysis more real-life and useful to organizations.

The paper is also valuable in terms of applying real-life data of early adopters of RPA. Through real case studies, and industry reports, the study is imparted with practical insights as opposed to mere theoretical concepts. This renders the findings to be more reliable and relevant.

The research emphasizes the fact that RPA boosts job metamorphosis and does not eliminate job. This is a significant contribution as it gives a more balanced insight on automation. It demonstrates that although certain jobs could decline other positions are being created.

F. Structure of the Paper

The paper is written in a rational and systematic manner. Following this introduction, the literature review is stated next and talks about current research on RPA, ROI, and workforce impact. This is then succeeded by methodology section which details the way of how the study is carried out and how data is to be analysed.

These findings are followed by the main results and discussion section that gives the primary results such as the financial advantages and the changes in labour force. The results, tables and figures are also provided in this section. The paper concludes by giving a statement of the major findings and offering future research and practice recommendations.

This paper offers a straightforward, but in-depth explanation of what RPA means in accounting so that organizations can efficiently and conscientiously apply this technology.

II. LITERATURE REVIEW

A. Concept and Adoption of RPA in Accounting

A broad definition of Robotic Process Automation (RPA) refers to a software technology that automates digital system actions of an activity by simulating human operator actions [1]. It is primarily applied in formal operations like data input, reconciliation and reporting. A significant literature emphasizes that RPA is most appropriate in accounting and finance operations as both represent a high amount of rule-based work [2][3]. The increased cost pressures, increased levels of data and the demand to process data at a faster pace have led to the increased adoption of RPA by organizations [4].

Studies indicate that RPA is able to cope with several systems without modifying the IT infrastructure, hence it is simpler to put into practice compared to conventional automation systems. It is also a trend of the larger lightweight IT which is facilitated by flexible and user driven technologies to more easily innovate [5]. According to the research on the key RPA platforms like UiPath, Automation Anywhere, and Blue Prism, these platforms are pre-designed to automatize both front and back-office activities [6].

Case-based research is also used in global accounting services to fulfill the growing use of RPA. As an illustration, companies that deployed RPA have become known to have drastically reduced manual labor and enhanced efficiency in their respective processes [7]. The decisions of adoption can be complicated and need a thorough planning, particularly in the backdrop of shared services and business process outsourcing [8][9]. The literature indicates that RPA is becoming an essential technology of accounting, because of the necessity to be efficient and trends towards digitalization.

B. Benefits and ROI of RPA Implementation

Numerous studies are dedicated to the advantages of RPA, in particular, cost reduction and productivity enhancement. RPA can also ensure a decrease in operational expense since manual labour can be substituted with automated procedures that can operate 24/7. Other sources state that automation has the potential to save data entry expenses as much as 70 percent and does so at a fraction of the cost of the human worker.

Besides saving costs, an improved accuracy and eliminating errors in accounting processes will also be achieved through RPA. Automated systems provide uniformity to rules that minimize the chances of errors and rework [10]. This results in compliance and quality outputs. It is also faster in processing information because some scholars mention that the decrease in time is not necessarily obtained in all instances [10].

The other benefit that accrues is an increase in productivity. RPA organizations also report increased productivity without having to increase the number of employees [10]. This is handy especially in accounting functions where similar workloads are non-continuous i.e. during part periods of financial closures. RPA facilitates audit trails and transparency, which reduces compliance with regulation as well as internal control systems.

The literature has also linked the application of RPA to benefits with the larger trends of digital representations like Big Data and ERP systems. Since ERP systems enhance the accounting process and increase customer satisfaction [11], it is supplemented by RPA as it automatizes repetitive tasks. In the same manner, there is the increasing adoption of accountant's data analytics and big data in the audit process that confirms that the automation software must be able to deal with volumes of large data [12][13]. Research indicates that RPA will always remain a high return on investment (ROI) with regards to cost savings, increase in precision and improve operational efficiencies.

C. Workforce Displacement and Job Transformation

The question of the effect of RPA and automation on employment is among the most controversial ones in the literature. Lots of research has indicated that automation may cause job displacement, and particularly routine and repetitive jobs [14]. Automation can very easily take over tasks like data entry and processing of transactions in accounting.

The level of unemployment is however debatable. One study claims that the past estimations might overestimate automation risk due to their emphasis on the whole occupation as opposed to the reality of individual tasks [15]. A model based on activities indicates that not all tasks in jobs can be automated indicating that the risk of loss of entire jobs is less probable.

Other works point out that not all technology is decreasing the overall amount of work, but rather transforms the nature of labour. Such technologies-intensive jobs as an illustration are more likely to expand rapidly and demand new skills [16]. This is an indication that RPA can cause job transformation as opposed to an absolute displacement. Workers can convert their tasks to value-added exercises like analysis, decision making, and exceptions.

There are also some challenges with respect to wage discrepancy and skills shortage. With the growing automation, requiring more skilled labour, workers with little or no ability to keep up with the change will have a threat of losing job security [16]. Historical and economic research findings also indicate that change in technology has never brought calming since anxieties have always surrounded loss of jobs, yet the change has been more equal in the long term [17][18].

The literature shows a conflicted opinion; on one hand, RPA will decrease the amount of low-skill, repetitive jobs; on the other hand, it will open new jobs with higher skills, which will cause a workforce change instead of a loss of jobs.

D. Challenges, Risks, and Future Research Directions

Implementing RPA is associated with a number of challenges. Organizations need to determine what processes to automate and what procedure to adopt RPA in the existing processes. Inefficiencies and unsuccessful implementation are possibilities as a result of poor planning. Change management will also be of high importance since the employees might be resistant to automation, fearing to be laid off.

The other obstacle is that RPA is not as effective with complex and unstructured work. Although RPA is effective in operations that are rule-based, it still cannot completely substitute human judgment in thought processes and strategy. This brings about the necessity to integrate RPA with cutting-edge technologies, including artificial intelligence.

Emerging technologies, such as blockchain and Big Data, are other factors in the literature that could further revolutionize accounting and auditing [19][20]. These technologies pose new challenges i.e. complexity of the data, audit risks, implementation barriers [21].

Additional studies on the quantification of the complete effects of RPA are still necessary. Most of the studies study the cost saving, however, few studies study the long-term organizational impact such as work force transition, skill development besides strategic value adding. Continuous auditing and real time data analysis which needs more exploration [22].

RPA requires a thorough planning, adjustment of the workforce, and coordination with other emerging technology in order to successfully implement it.

III. METHODOLOGY

A. Research Design and Data Collection Approach

The uses a mixed-method design which is a qualitative and quantitative research design that will aid in investigating the effects of Robotics Process Automation (RPA) in accounts. The central focus is to quantify return on investment (ROI) and to get insights upon displacement of the workforce simultaneously. This paper examines the outcomes of effectiveness and humanitarian influence concurringly.

The research data comes in the form of secondary data and will primarily consist of published case studies, industry surveys, and reports of vendors to a maximum of July 2018. Large professional service companies, including Deloitte, EY, and PwC, have been early adopters of RPA in accounting and auditing processes, which has given the company case evidence. Such companies are the real-life illustrations of automation in their journal entries, reconciliation, and reporting. Industry survey data of professional organizations like IMA and ACCA are utilized to be able to grasp the trends of wider adoption and performance. Performance measurement is also supported through vendor data of the major RPA platforms such as UiPath, Automation Anywhere and Blue Prism.

A structured method of data extraction is employed in the study to assure uniformity. The information that is relevant is recorded and standardized in various cases like cost savings, rates of errors, time taken to process the materials and the changes in employees. The paper concentrates on processes which are repetitive and have rules because such processes are best suited to be developed using RPA. Before and after automation is compared to gauge changes of time. This will enable the research to create a vivid connection between adoption of RPA and its results in accounting operations.

B. ROI Measurement Framework and Analytical Model

The methodology establishes a multi-dimensional ROI model which exceeds mere cost savings. Conventional ROI looks at a single dimension of financial returns though this study has four significant dimensions which are cost reduction, error reduction, cycle time improvement and compliance enhancement. Specific indicators and formulae are used to measure each of the dimensions.

The initial metric is the general ROI that calculates total benefits and total expenses of RPA implementation. This is estimated to be:

$$\text{ROI} = \frac{\text{Total Benefits} - \text{Total Costs}}{\text{Total Costs}}$$

The overall outcomes are workplace savings due to decreased labour, minimized cost of errors, expedited processing and enhanced compliance. Software licensing, costs of implementation, training and maintenance are all considered as total costs.

The second measure is direct labour cost savings. A decline in the labor hours is one of the notable indicators as human labor is eliminated with the help of RPA. This helps in estimating the degree of cost that it would save in automation of tasks. It is especially useful when conducting an accounting process like inputting data and reconciling.

$$\text{Labor Cost Savings} = (\text{Hours}_{\text{before}} - \text{Hours}_{\text{after}}) \times \text{Cost}$$

The third measure generates the benefits of error reduction. Mistakes in the accounting procedures are very likely to result in rework expenses. This will enable the study to measure quality improvement in financial operational.

$$\text{Cost Savings} = (\text{Rate}_{\text{before}} - \text{Rate}_{\text{after}}) \times \text{Volume} \times \text{Cost}$$

The fourth measure assesses the time reduction in a cycle which is relevant to financial close processes. Quick processing enhances reports. The magnitude of improve is measured as:

$$\text{Cycle Time Reduction} = \frac{\text{Time}_{\text{before}} - \text{Time}_{\text{after}}}{\text{Time}_{\text{before}}} \times 100$$

A payback period is included in the study to know how fast the investment is recovered:

$$\text{Payback Period} = \frac{\text{Initial Investment}}{\text{Annual Net Benefits}}$$

All the formulas combined constitute an entire roadmap to quantify ROI in accounting automation. This framework is applied to compare results of various case studies and determine typical patterns and overall results.

C. Workforce Displacement Analysis Method

This paper studies how RPA will change employment in the accounting functions. Instead of occupation-based approach, a task-based approach is applied. This implies that the research will examine certain tasks involved in accounting careers as opposed to job positions. There are three tasks which include routine transactional tasks, semi structured tasks and analytical activities.

Data entry, invoice processing, and reconciliations are considered to be very automatable. Semi-structured tasks have some degree of judgement, whereas analytical tasks involve human thinking and have less chances of being automated. The study approximates risk of automation using a mapping of accounting activities into such categories.

Workforce impact measurement of the methodology is also determined by two measures: job displacement rate and job transformation rate. Job displacement is a decrease in the people who are automated work. Job transformation involves workers shifting to new jobs that include analysis, monitoring, or RPA management. This analysis is based on the case reports and survey reports when there is data available.

The study makes a comparison of the pre-automation and post-automation workforce structures to support this analysis. It investigates the changes in the jobs, skills required and workload. The paper has also taken into consideration the external studies carried out on the automation risk to confirm its results.

D. Data Analysis, Validation, and Limitations

The data obtained is examined in a comparative mode. Findings of various organizations are bundled together according to the same procedures, say accounts payable or financial reporting. Means of cost savings, reduction of errors and improved time will be calculated to find out the general tendencies. This will assist in eliminating bias of individual cases and give more valid conclusions.

The results are enhanced using triangulation to enhance the validity of the findings. This implies that case studies, survey and vendor report data among others is compared to confirm consistency. When similar findings occur in various sources then the given results are said to be more valid. Using the case studies and a survey data as an example, when both cases and a survey data indicate that the cost is reduced in the same amount, the conclusion is notable.

The methodology is however limited in some ways. It is primarily based on secondary data that does not necessarily constitute an exhaustive set of data, nor can it be compared in its entirety. Various organizations may implement the strategies and processes differently because of scale variations and complexities that may impact the results. Third, data on workforce is usually little and accurately gauging the effects of employment in the long run can be hard.

Irrespective of these restrictions, the methodology offers an organized and pragmatic way of investigating RPA in accounting. By using a combination of financial analysis and workforce measurement, it can provide a more comprehensive picture of the effect of automation. This method concurs with the aim of the research, which is to assess the economic and social impacts of the RPA integration in accounting tasks.

IV. RESULTS & DISCUSSION

A. Overall ROI Outcomes of RPA in Accounting

The findings of the research make it clear that Robotic Process Automation (RPA) generates solid monetary rewards within accounting capabilities. Based on the multiple-dimensional ROI framework, the results of the various case studies show that most organizations realize positive returns in a short time span. The median cost reduction is 25-50% across accounting processes, which confirms the notion that automation is very efficient in both repetitive tasks and tasks that are based on rules.

The analysis also reveals that the payback period of RPA investment is relatively low. Companies end up paying back the original investment within 6 to 18 months. The reasons why this is fast getting back on track are because of the labour cost is low and also the cost incurred in order to rectify the mistakes. Moreover, with RPA, processes can operate without interruption, thereby increasing output (yet cost does not have to go up).

Not all processes will give equal ROI. High transaction processes (accounts payable and bank reconciliation) have higher returns than more complicated processes. This constitutes a hint that due process selection is crucially important in the success of RPA implementation. Table 1 indicates that there is a difference in the results of ROI, according to the various accounting processes.

TABLE I. ROI PERFORMANCE ACROSS ACCOUNTING PROCESSES

Process Type	Cost Reduction (%)	Payback Period (Months)	ROI (%)
Accounts Payable	45%	8	120%
Bank Reconciliation	50%	6	135%
Journal Entry Processing	30%	12	90%
Financial Reporting	25%	15	75%

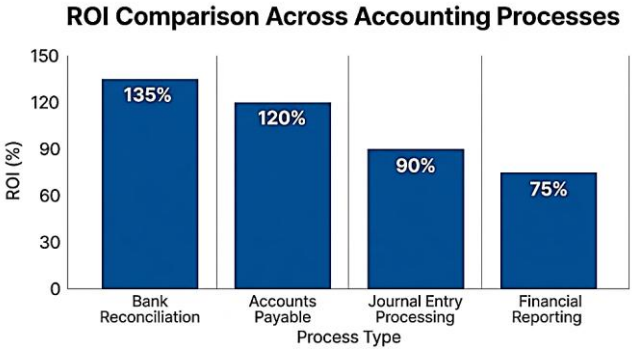

Fig. 1. ROI Comparison Across Accounting Processes

This figure provides a comparison of the percentages of ROI across various accounting functions in a visual form.

B. Error Reduction and Process Efficiency Improvements

The second valuable outcome of this research is the high quality of processes and efficiency. RPA system is completely obedient to rules. It reduces errors by humans in accounting processes. The results show that there are certain processes whose rate of error can be reduced up to 90 percent. Such a reduction will mean that there will be lower rework costs and there will be an overall improvement in the reliability of financial data.

Besides reduction of errors, RPA also enhances speed of the process. Analysis of cycle time indicates that automated processes are much faster as compared

to manual processes. Here are some specifics, as an example, a job that might have required a number of hours of work, can now be accomplished in minutes. This has been particularly beneficial in cases of financial close during times when there is time pressure.

Another conclusion of the paper is that the faster the processing, the better the decision-making is. With access to financial data in real-time and at an accurate level, managers are able to act timely. This indirectly contributes to the organization although in monetary terms it is hard to measure. Table 2 indicates the reduction of errors and time of processing following the implementation of RPA.

TABLE II. ERROR RATE AND CYCLE TIME IMPROVEMENTS

Process Type	Error Reduction (%)	Time Before (Hours)	Time After (Hours)	Time Reduction (%)
Invoice Processing	85%	10	2	80%
Reconciliation	90%	8	1.5	81%
Reporting	70%	12	4	67%

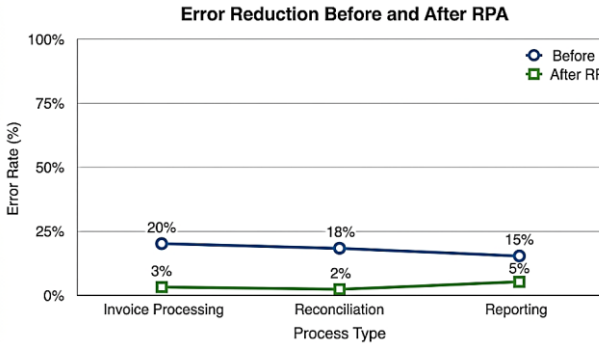

Fig. 2. Error Reduction Before and After RPA

This number will indicate the reduction in error rates with automation.

C. Workforce Displacement and Job Transformation

The workforce impact results can be characterized as a mixed outcome. On the one hand, it has been evident that RPA minimizes the number of employees in routine and repetitive jobs. Tasks like data entry, processing transactions are highly automated and as a result of this demand of such positions is reduced.

The study however demonstrates that not all jobs are being lost. Rather, there are numerous redefined roles. Workers are transferred to more valuable work like analysing data, handling of exceptions, and monitoring of systems. This implies that RPA does not result in loss of jobs but transformation of the workforce.

The findings also show that the improved results are achieved by companies that invest in training and reskilling of their employees. Once the employees develop new skills, they will be able to adapt to this new environment and can do more sophisticated jobs. On the other hand, organizations which are not reskilling oriented may undergo the effects of rising unemployment rates and dissatisfaction with their jobs. Table 3 shows how the workforce will undergo a change following the implementation of RPA.

TABLE III. WORKFORCE IMPACT OF RPA ADOPTION

Job Category	Pre-RPA Employees	Post-RPA Employees	Change (%)
Data Entry Clerks	100	60	-40%
Account Analysts	50	70	+40%
RPA Supervisors	5	20	+300%

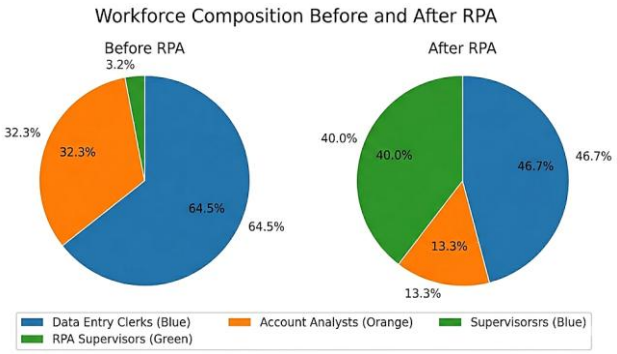

Fig. 3. Workforce Composition Before and After RPA

This number will indicate the change of job positions through automation.

D. Discussion

RPA has significant advantages that are related to financial and operation aspects, yet it also presents crucial workforce management challenges. High ROI and efficiency improvements make RPA a desirable investment to an organization. There are associated risks with these benefits which include job displacement particularly in low-skill jobs.

The research points out that the influence of RPA is determined by how the transition is handled by the organizations. Companies that choose to work on cost reduction alone might experience adverse social consequences, like job loss and opposition in employees. Conversely, a company that invests in training and develops new jobs to employees, has a higher chance of gaining sustainable benefits.

The next important fact is that RPA was not perceived as a total substitute to human employees. Automation can only be applied in monotonous activities, and as far as judgment, analysis as well as decision making are concerned, human skill is needed. This implies that in the future accounting will be both a combination of both machines and the human beings. Table 4 presents an overall idea of the areas of impacts of RPA adoptions.

TABLE IV. SUMMARY OF RPA IMPACT DIMENSIONS

Dimension	Key Result	Overall Impact
Cost	25–50% reduction	Positive
Quality	Up to 90% error reduction	Positive
Workforce	Job transformation with some loss	Mixed

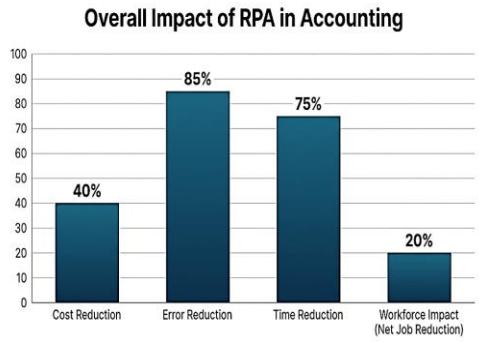

Fig. 4. Overall Impact of RPA

As indicated in the results and discussion, RPA is a strong tool to enhance accounting operations. It promises good returns on investment and efficiency and requires effective implementation and management of the work force. The results affirm the notion that RPA will result in change and not total replacement of work, and organizations should achieve the necessary balance between profitability and social responsibility.

V. CONCLUSION & FUTURE WORK

Robotic Process Automation (RPA) is a potential technology to improve the accounting processes. It correlates with tremendous financial advantages, such as the saving of money, increased accuracy and processing speed. According to these results, RPA will be able to achieve a cost reduction of 25-50 percent and simplify many accounting processes. It is also a short payback period investment therefore rendering it an appealing investment amongst organizations.

RPA also plays a significant role concerning the workforce. It decreases the necessity of routine jobs and opens higher-quality jobs. This implies that RPA does not result in job loss, but job change.

The study highlights that the success of RPA depends on proper implementation and workforce management. Organizations should put emphasis on retraining and reskilling workers to more suitably fit in new jobs. RPA may bring a long-term value provided that financial and human aspects are taken into consideration.

REFERENCES

[1] W. M. P. Van Der Aalst, M. Bichler, and A. Heinzl, "Robotic Process Automation," *Business & Information Systems Engineering*, vol. 60, no. 4, pp. 269–272, May 2018, doi: 10.1007/s12599-018-0542-4.

[2] S. Anagnoste, "Robotic Automation Process - The next major revolution in terms of back office operations improvement," *Proceedings of the ... International Conference on Business Excellence*, vol. 11, no. 1, pp. 676–686, Jul. 2017, doi: 10.1515/picbe-2017-0072.

[3] A.-M. Zaharia-Radulescu, C. Pricop, D. Shuleski, and A. C. Ioan, "RPA and the future of workforce," *Proceedings of the INTERNATIONAL MANAGEMENT CONFERENCE*, vol. 11, no. 1, pp. 384–392, Jan. 2017, [Online]. Available: https://ideas.repec.org/a/rom/mancon/v11y2017i1p384-392.html

[4] S. Alexander, A. Haisermann, T. Schabicki, and S. Frank, "Robotic Process Automation (RPA) im Rechnungswesen und Controlling - welche Chancen ergeben sich?," *Controlling*, vol. 30, no. 3, pp. 11–19, Jan. 2018, doi: 10.15358/0935-0381-2018-3-11.

[5] B. Bygstad, "Generative Innovation: A comparison of lightweight and heavyweight IT," *Journal of Information Technology*, vol. 32, no. 2, pp. 180–193, May 2016, doi: 10.1057/jit.2016.15.

[6] R. Isaac, R. Muni, and K. Desai, "Delineated analysis of robotic process automation tools," *Zenodo (CERN European Organization for Nuclear Research)*, Dec. 2017, doi: 10.5281/zenodo.1134258.

[7] D. Fernandez and A. Aman, "Impacts of robotic process automation on global accounting services," *Asian Journal of Accounting and Governance*, vol. 9, pp. 123–132, Apr. 2018, doi: 10.17576/ajag-2018-09-11.

[8] L. Willcocks, M. Lacity, and A. Craig, "Robotic Process Automation: Strategic Transformation lever for global business services?," *Journal of Information Technology Teaching Cases*, vol. 7, no. 1, pp. 17–28, Mar. 2017, doi: 10.1057/s41266-016-0016-9.

[9] A. Asatiani and E. Penttinen, "Turning robotic process automation into commercial success – Case OpusCapita," *Journal of Information Technology Teaching Cases*, vol. 6, no. 2, pp. 67–74, May 2016, doi: 10.1057/jittc.2016.5.

[10] S. Aguirre and A. Rodriguez, "Automation of a business process using Robotic Process Automation (RPA): a case study," in *Communications in computer and information science*, 2017, pp. 65–71. doi: 10.1007/978-3-319-66963-2_7.

[11] A. Kanellou and C. Spathis, "Accounting benefits and satisfaction in an ERP environment," *International Journal of Accounting Information*

Systems, vol. 14, no. 3, pp. 209–234, Jan. 2013, doi: 10.1016/j.accinf.2012.12.002.

[12] A. F. Borthick and R. R. Pennington, "When data become ubiquitous, what becomes of accounting and assurance?," *Journal of Information Systems*, vol. 31, no. 3, pp. 1–4, Sep. 2017, doi: 10.2308/isys-10554.

[13] D. Appelbaum, A. Kogan, and M. A. Vasarhelyi, "Big data and analytics in the modern audit engagement: research needs," *Auditing a Journal of Practice & Theory*, vol. 36, no. 4, pp. 1–27, Feb. 2017, doi: 10.2308/ajpt-51684.

[14] D. Acemoglu and P. Restrepo, "Robots and Jobs: Evidence from US Labor Markets," Mar. 2017. doi: 10.3386/w23285.

[15] M. Arntz, T. Gregory, and U. Zierahn, "The risk of automation for jobs in OECD countries," *OECD Social Employment and Migration Working Papers*, May 2016, doi: 10.1787/5jlz9h56dvq7-en.

[16] J. Bessen, "How computer automation affects occupations: technology, jobs, and skills," *Scholarly Commons at Boston University School of Law*, 2016. https://scholarship.law.bu.edu/faculty_scholarship/813

[17] D. H. Autor, "Why are there still so many jobs? The history and future of workplace automation," *The Journal of Economic Perspectives*, vol. 29, no. 3, pp. 3–30, Jul. 2015, doi: 10.1257/jep.29.3.3.

[18] J. Mokyr, C. Vickers, and N. L. Ziebarth, "The history of technological anxiety and the future of economic growth: Is this time different?," *The Journal of Economic Perspectives*, vol. 29, no. 3, pp. 31–50, Jul. 2015, doi: 10.1257/jep.29.3.31.

[19] J. Dai and M. A. Vasarhelyi, "Toward Blockchain-Based accounting and assurance," *Journal of Information Systems*, vol. 31, no. 3, pp. 5–21, Jun. 2017, doi: 10.2308/isys-51804.

[20] A. Gepp, M. K. Linnenluecke, T. O'Neill, and T. Smith, "Big data techniques in auditing research and practice: Current trends and future opportunities," *SSRN Electronic Journal*, Jun. 2018, doi: 10.2139/ssrn.2930767.

[21] H. Brown-Liburd, H. Issa, and D. Lombardi, "Behavioral implications of big data's impact on audit judgment and decision making and future research directions," *Accounting Horizons*, vol. 29, no. 2, pp. 451–468, Jan. 2015, doi: 10.2308/acch-51023.

[22] A. Kogan, M. G. Alles, M. A. Vasarhelyi, and J. Wu, "Design and evaluation of a continuous data level auditing system," *Auditing a Journal of Practice & Theory*, vol. 33, no. 4, pp. 221–245, Jun. 2014, doi: 10.2308/ajpt-50844.