MASTER THESIS

HOW ROBOTIC PROCESS AUTOMATION (RPA) INFLUENCES FIRM FINANCIAL PERFORMANCE IN THE NETHERLANDS

UNIVERSITY OF TWENTE.

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Abstract

Literature suggests that firms employ technology in a firm to achieve better firm performance, several studies have proven that employing some sort of technology (or IT) in a firm does indeed result in a better firm performance and thus, achieve competitive advantage. This thesis examined to what extent financial firm performance is influenced by the emerging construct Robotic Process Automation (RPA). In addition, research suggested that IS capabilities and IS resources should have a moderating impact on this relationship. Since RPA is a relative new concept, it has not been researched that much, with this thesis, I would like to fill this gap. With the help of a survey, the posited hypotheses and research question were tested, where the respondents were financial and technology employees of firms in The Netherlands. The results of the partial least squares regression showed that no evidence is found to support the hypotheses and research question.

Keywords: *firm performance, robotic process automation, RPA, IS capabilities, IS resources, The Netherlands*.

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1. Introduction

1.1 Background

Do you executives, managers and stakeholders in the financial environment ever wonder how the finance function will look like in the future? Well, this question keeps many people occupied, including me. Robotics is expected to be the biggest factor influencing the finance function. Robotic Process Automation (abbreviated: RPA) are beginning to have a profound effect on the business and is a promising new development (Lhuer, 2016). Humans are humans, working with humans involves risk taking. Robots and computers on the other hand can execute 'human' tasks more quickly, accurately and tirelessly. Due to this emerging development, data is hugely increasing. Less people are sought after for executing repetitive tasks, though more people are needed with analytical skills to investigate the bulk of data harvested. Also, with this change in work, RPA means that people will have more interesting and more challenging jobs. Usually, people were used to do repetitive, boring, uninterested and deskilled tasks. RPA has the ability to make a shift that some activities involving the job will be lost, but just parts, in addition it can also reassemble work into different types of job.

Moreover, Mahlendorf (2014) mentioned the relevance of this under-researched subject. Due to the shift in information technology, traditional finance tasks, such as processing data and reporting, can now be done with less manpower than before.

In a recent report by McKinsey and Company (Ostdick, 2016) on emerging and disruptive technologies, it is predicted that automation technologies, such as RPA is, will have a potential economic impact of nearly $6.7 trillion by 2025. It is expected to have the second largest economic impact of the technologies considered, behind the rise of mobile internet for smartphones and tablets. Therefore, obviously the growth of RPA is happening quickly and does have the ability to be one of the leading technological platforms and is expected to be the standard for doing business.

To understand RPA we should know where it came from, it is not a concept that appeared out of the blue. There are three identified key predecessors of Robotic Process Automation (Ostdick, 2016). First, screen scraping was used to create a bridge between current systems and incompatible legacy systems in the time before the development of the internet. More recently, it is been used to extract data from the web on the presentation layer. Second, workflow automation and management tools dates back to 1920s where the term workflow automation was first introduced, though, the term has become more frequently used since the 1990s. It is capable of providing aid in order processing by capturing certain fields of interest, such as customer information, invoice total and which and how many items are ordered, translating them into your database. Advantages of workflow automation include increased speed, efficiency and accuracy. And third, artificial intelligence was used first in 1956. It refers to the capability of computer systems to perform tasks that normally involves human intervention and intelligence. While AI can be costly, the advantages gained from AI include increased accuracy and precision in tasks of replacement of repetitive and time-consuming manual labor. The aim of RPA is to cohere these three predecessors into a well fully functional system, namely Robotic Process Automation. As the saying goes, one plus one is three, is definitely applicable in this situation. All three separate technologies can be somewhat of a small impact, but combining these three technologies is what truly makes RPA such an impactful technological platform.

The term 'Robotic Process Automation' can be dated to the early 2000s where it first was used. Deloitte (in Ostdick, 2016) even suggests that RPA is the combination of AI and automation: "Robotic Process Automation (RPA), a synonym to AI, is the application of technology allowing employees in a company to configure computer software or a 'robot' to reason, collect and extract knowledge, recognize patterns, learn and adapt to new situations or environments". So, the question that arises then is: where is RPA headed? In particular, we are interested whether this emergence of RPA does have an impact on the financial performance of a firm, and if it indeed, as suggested, will create competitive advantage.

1.2 Relevance

Several research has been done in the field of computerization/automation and the effect on (financial) firm performance (Brown, Gatian, & Hicks, Jr., 1995; Bharadwaj, 2000; Kotha & Swamidass, 2000; Ravichandran & Lertwongsatien, 2005). These four key papers are the basis for conducting this study. They all investigated the effect of technology on firm performance. This study contributes to the literature in a way that these before mentioned studies are dated from 2005 and further back in time, so this study can provide new insights. In addition, these studies were conducted in a period where computer technologies were very new to the market, in a way that computer-based firms are not the standard. Nowadays, technology is inseparable of doing business. This study deviates in a way that several constructs are included which are supposed to be of moderating impact. Also, RPA is a relatively new concept and the effect on firm performance has not been researched yet.

1.3 Objective

The main objective that will framework this study is twofold. First, we would like to assess the effect of the extent RPA is active in firms on firm performance. And second, we build our research upon Ravichandran & Lertwongsatien (2005) for understanding the framework they researched. We would like to assess the moderation impact of IS[1] capabilities and IS resources on the main relationship RPA and firm performance. The before mentioned research investigated whether this framework was intercorrelated and found indeed sufficient evidence, we employ this framework in a way that it is of moderating impact. Based on the literature review, we have indeed strong evidence that this framework will be of moderating impact between the relationship RPA and firm performance. Moderating indicates that the strength of the effect of RPA on firm performance is explained by the framework. Based on this information, the following research question has been formulated.

Research question: "In what direction (positive/negative) and to what extent does RPA influence the financial performance of firms in particular industries for firms in the Netherlands, and to what extent does IS capabilities and IS resources moderate the impact?"

1.4 Outline

This study is organized as follows. First of all, a literature review will be provided. This section starts with pointing out relevant theories involving this subject. They are used to interpret to interpret the results. After that, empirical research for Robotic Process Automation, IS capabilities, IS resources, firm performance and the control variables will be discussed, followed by a visual representation of the research model. Based on this empirical research, several hypotheses are developed in order to be able to answer the research question. Chapter three will include the research model, the selected research method, a description of how to measure the constructs and hypotheses, a variable overview and model specification for the hypotheses. The selected target group, which firms are being researched and how the results are being collected and analyzed are presented in chapter four. The results will be presented in chapter five, first, several adjustments are made to the data to increase the validity. Also, the descriptive statistics and frequencies are given, subsequently a factor analysis and a partial least squares regression are carried out. A discussion and conclusion of the results are presented in chapter six for the former and chapter seven for the

[1] IS stands for Information Systems

latter. Next, a couple of implications of the research are explained and to make this research complete, a section of limitations and directions for further research is included.

2. Literature review

2.1 Theories

This thesis investigates the effect of RPA on firm performance. Therefore, several theoretical perspectives should provide this study's theoretical rationale for the investigation of the effect of RPA on firm performance. There is a wide variety of theories that possibly could underpin the mentioned relationship. Literature (Brown, Gatian, & Hicks, Jr., 1995; Bharadwaj, 2000; Kotha & Swamidass, 2000; Ravichandran & Lertwongsatien, 2005) employs (1) resource-based theory and (2) the information processing perspective, in addition (3) contingency theory will be used as theoretical perspective. The reason for including the contingency theory as a theoretical perspective is that firm performance is in a way dependable of how an organization is structured. These theories are employed in this research, to mainly underpin the importance of the internal characteristics of a firm in order to create competitive advantages. The internal characteristics are the foundation to establish and maintain a healthy and organized firm.

Subsequently two perspectives of information technology are utilized: (4) enabling IT[2] potential, and the (5) theory of irreversible investment under uncertainty. These two theories are employed for the reasons to understand how IT even can be enabled in a firm and what the best ways to invest are. Theories 1, 2 and 3 will therefore form the basis for theories 4 and 5. For example: a well-organized firm, that possesses strong internal characteristics, is better able to enable the invested IT in the desired results: more results with less effort. Besides, all the theories are used to interpret the results, the intention is not to formally test these theories but rather adopt them as an eyeglass to look through.

2.1.1 Resource-based theory

This study draws upon the resource-based theory. The resource-based theory prescribes that it addresses performance differences between firms using asymmetries in knowledge; the resources of a firm are the main driver of firm performance and should enable a firm to achieve its objectives and goals (Barrutia & Echebarria, 2015; Conner & Prahalad, 1996; Dierickx & Cool, 1989). In addition, Das & Teng (2000) suggests that most traditional firms

[2] IT stands for Information Technology

rely heavily on the analysis of the competitive environment and the resource-based view focuses on the analysis of various resources possessed by the firm. Sustained firm resource heterogeneity becomes a possible source of competitive advantage, due to the firm-specific resources which are not perfectly mobile and imitable. Firms should seek a 'perfect' fit between their internal characteristics (strengths and weaknesses) and their external environment (opportunities and threats). The resource-based view stresses the internal characteristics over the external environment in order to gain a competitive advantage over competitors. Competitive advantage can be defined as a firm being able to produce a good or service of equal value at a lower price or in a more desirable fashion.

2.1.2 Information processing perspective

The underlying definition of the information processing perspective is that organizations are open social systems that must cope with environmental and organizational uncertainty (Egelhoff, 1982; Keller, 1994). Developing information processing mechanisms capable of dealing with uncertainty enables a firm to be effective, whereby uncertainty is defined as the difference between the amount of information required to perform a task and the amount of information already possessed by the firm (Galbraith, 1973, in Kotha & Swamidass, 2000).

According to Egelhoff (1988, in Kotha & Swamidass, 2000), a key assumption involving the information processing perspective is that firms will attempt to close the uncertainty gap by processing information. This can be achieved by gathering of additional data, transforming the data, and storing or communicating the resultant information. Thus, there is a relationship between the extent of uncertainty an organization faces and the amount of information processing within the organization. To be an effective organization, one should seek the 'perfect' fit between their information-processing capacities and the extent of uncertainty they face. In the context of this thesis, we assume that RPA is able to come closer to reducing the uncertainty gap to a reasonable amount.

2.1.3 Contingency theory

This study also draws upon the perception of the contingency theory. It states that there is no best way to organize an organization, to make decisions or to lead a firm. It claims that the optimal course of action is dependable (contingent) upon the internal and external environment (Luthans, 1973). So, a leader should choose the right action for the right situation.

The contingency approach was derived from other approaches that were not able to cope with all the different situations of a firm. The classical approach claimed that a bureaucratic design would lead to maximum efficiency under any circumstances, but it was not able to cope with highly dynamic situations. The neo-classical theorists claimed that decentralization was the best way to organize an organization under any circumstances. Though, this approach did not work well in a highly cybernated (read: the automatic control of a process or operation by means of computers) situation. The modern free-form systems and matrix designs do have universal applicability, but even these approaches did not hold up under all situations because they were not adaptable to a situation demanding cutbacks and stability. The approaches (or designs) are conditional in nature. For a stable situation, bureaucracy may be the best option and for a dynamic situation, the free form may be the most appropriate approach. In a contingent organizational design, technology, economic, social conditions and (human) resources are some of the variables that must be considered in order to determine the best fit.

Fiedler (1967) even developed a contingency model of leadership effectiveness, based on years of empirical research. Short saying, the model states that a task-directed leader is most effective in very favorable and very unfavorable situations, and in addition, a human relations-oriented leader is most effective in moderately favorable and unfavorable situations. So, the human relations-oriented leader is in between the very two extremists of the task-directed leader. To classify the situations, he used three dimensions: position power, acceptance by subordinates and task definition. Classifying situations is the necessary goal of any contingency approach.

2.1.4 Potential IT value

Research suggests that investments in complimentary assets, such as management skills, user training, and application of standards, are critical to understanding the return on IT investments (Barua, Lee & Whinston, 1996; Brynjolfsson & Yang, 1997; Milgrom & Roberts, 1990, in Davern & Kauffman, 2000). Davern & Kauffman (2000), emphasize on the consideration of potential value for an IT investment both in ex-ante project selection and ex-post investment evaluation. In addition to considering IT expenditures and returns on investment, they argue that it serves to distinguish, to compare the potential of an IT project and its realized value.

The value of an IT investment is likely to be influenced by a spectrum of things within the organization (e.g., once an application or infrastructure is built and implemented). This is known as the conversion-effectiveness problems within the firm (Weill, 1990; Weill & Olson, 1989; in Davern & Kauffman, 2000). The primary emphasis was to understand that internal, as well as external, factors are weakening or strengthening the results of potential IT investments. Management can play a huge role in achieving the highest possible realized value by promoting the project in order to gain support within the firm. External factors, such as, the actions of competitors, changes in technology in the marketplace and the actions of government regulators may also influence the realized value of an IT investment. They recognized in their paper internal and external moderators for IT value.

A lot of (senior) managers, who invest in IT, fail to appreciate the pervasive impacts of conversion contingencies within the organization. In other words, managers undervalue the power of internal and external factors, which are weakening or strengthening the results of potential IT investments. This ought to be of huge importance. Consider the following situation. Imagine you are sitting in a car and you would like to know what the car is capable of. You already may be going very fast, but in the end you would like to know the maximum qualities of the car. What is the car's potential to go even faster? Is the handling precise? What is the environmental context, for example, which road and weather conditions suits the car best? This situation can be compared to IT investments, one should conduct an appropriate assessment methodology that should lead to an understanding of the potential value of an IT investment. So, for the practitioner, the potential value of IT investments should be of more interest than the actual realized value. Therefore, it is crucial to assess potential value and then sort out what kinds of complementary investments are needed, to ensure that full potential value can be achieved.

2.1.5 Theory of irreversible investment under uncertainty

The theory of irreversible investment under uncertainty mainly focus on real options, nevertheless it can be used as a perspective for investing in IT or in particular RPA. It implies the similarity between a financial call option and an opportunity to invest in a real asset (Murto & Keppo, 2002). Benaroch & Kauffman (1999), argue that this theory emphasizes the option-like-characteristics of IT project investments and that a project embeds a real option when it is able for management to take some further action (e.g., cancel, postpone or scale up) in response to events occuring within the firm and its environment. Vercammen (2000) is even more specific, he concludes that the standard problem comprised of a firm who must decide when to invest a fixed amount P in exchange for a project with the value of V, where the change of V goes hand in hand with time. An option's value associated with waiting normally exists, because the decision to invest is irreversible. And, therefore, P must be significantly less than V in order for the investment to occur.

According to Murto & Keppo (2002), the value of the real option is equal to the net present value of the investment after all costs plus the time value of the real option, in a market with no large investors. The value of the option is maximized due to the selected entry time. In other words, an investment is made at a moment when the time value is zero and the net present value is strictly positive. On the contrary, with the presence of large investors, it is much more complicated, because we then have to consider the impact of investments on the net present values. Due to this, an investment game between firms arises. Long story short, an investor should consider at what time to invest in a particular IT project.

2.2 Empirical study and Hypotheses development

2.2.1 Robotic Process Automation (RPA) and technological developments

As mentioned in the introduction, Robotic Process Automation does begin to have a profound effect on the business. Anagnoste (2018) made even the distinction of four different robotic stages. Orchestrated automation can be translated as: 5-20% is automated. This is mainly rule-based including scripting, macros and other. Robotic Process Automation (RPA) involves a minimum of 40% automation of tasks. RPA do have complex rules and includes cross-application and system workflow automation. In addition, process automation of legacy systems and user activity replication are included. Upward of 60% we find the cognitive robotics (CRPA) and lastly, 80% and more is considered to be intelligent robotics (IRPA). At CRPA we can think of natural language processing, such as voice recognition, cognitive virtual assistants, voice assistants and cognitive computer vision. At IRPA the starting point is self-learning and programming. In this phase, programmed robots can even learn and are able to held a conversation. Anagnoste (2018) even stated that RPA is in the maturity phase and CRPA and IRPA are on the rise.

Endsley (1999) developed a hierarchy in the context of the use of expert systems to supplement human decision making by employees and can be seen in appendix 1. This list is most applicable to cognitive tasks in which operators should respond to and make decisions based on the system. Another list, including a 10-level taxonomy, should therefore be more applicable to this study, since this taxonomy involves not merely cognitive tasks also psychomotor tasks (physical movement), this list can be seen in appendix 2. This 10-level taxonomy enables the researcher to distinguish and measure the level of automation active in a firm.

For achieving competitive advantage, several organizations tend to involve in strategic technology partnering, which can be described as the establishment of cooperative agreements aimed at joint innovative efforts or technology transfer that can have a lasting effect on the product-market positioning of participating companies (Hagedoorn & Schakendraad, 1994). They even found evidence supporting their claim. The content and direction of strategic linkages (or alliances) do significantly influence profitability in several industries. Also, evidence suggests that companies attracting technology through their alliances and companies concentrating on R&D cooperation have significantly higher rates of profit. Thus, this implies that engaging in strategic technology alliances appears to be more relevant to improve performance than just having a 'normal' alliance.

As the global competition and the threats of, for example, outsourcing and off-shoring to low-cost countries increase, competitive manufacturing capability becomes more and more urgent and critical for a firm. Automated systems are often regarded as highly efficient, and have the potential to improve competitiveness (Mehrabi, Ulsoy & Koren, 2000; Yu, Yin, Sheng & Chen, 2003). Säfsten, Winroth & Stahre (2007) even found evidence that it is important to seek the right fit between the level of automation since it is found to be affecting firm performance. With appropiate levels of automation, is it considered that a firm could achieve the most positive effects on manufacturing performance. If the automation level is too low, under-automation, or too high, over-automation, the potential positive benefits are not fully utilized. Where we define appropiate as suitable for the best occasion, some firms do require a lot more automation to enhance their firm performance than other firms. Considering automation strategy as part of the manufacturing strategy is potentially supporting improved manufacturing performance and competitiveness. Although, Säfsten, Winroth & Stahre (2007) mainly focused on manufacturing, we could presume this applies to all industries, whether or not to a lesser degree. Since firms automate and adopting technology in their firm for several reasons; differentiation, growth, innovation and cost reduction, we could presume that the main goal is to achieve competitive advantage and thus a better firm performance (Brown et al., 1995). Therefore, we predict a positive effect of the extent RPA is active in a firm to firm performance. In addition, it is important to filter for firms operating in a stable environment, whereby we operationalize a stable environment as a firm of which the threat of financial distress is not imminent. Firms facing, for example, financial distress which are spending heavily on IT or RPA may encounter not any return at all. Firms facing financial distress are excluded from this research.

H1: Firms with a higher degree of RPA experience a significantly higher degree of financial firm performance.

2.2.2 IS capabilities

A given firm's resources and capabilities are of upmost importance, resources enables a firm to develop capabilities. Capabilities can be described as socially complex routines that determine the efficiency with which firms transform inputs (resources) into outputs (Collis, 1994) (López-Cabarcos, Göttling-Oliveira-Monteiro, & Vázquez-Rodríquez, 2015). However, resources alone are not enough to gain and sustain competitive advantage. These benefits generally only emerge and endure if several activities and resources are complementary. In addition, one of the main focusses of the resource-based theory is that firms must base their strategic decisions on a strong set of resources that can generate complex capabilities and lead to superior performance (López-Cabarcos et al., 2015). For the sake of this research we follow Ravichandran & Lertwongsatien (2005) to limit the focus to capabilities in the core functional areas such as planning, systems development, IS support and IS operations for two reasons. First, consistent with prior research in strategy where Grant (1991) stated that capabilities can be identified and appraised using a standard functional classification of the firm's activities. Second, IS capabilities have not been the focus of prior IT-firm performance research.

Building upon Grant's (1991) framework of capabilities, we argue that the ability to achieve a better firm performance through RPA is dependent on the level of IS capabilities. Based on the literature review we can formally state that an organization is more likely to achieve a better firm performance in case the IS capabilities are well established. In this thesis, we employ two of the four core functional areas, planning and systems development. IS planning is for example an important process, it enables organizations to prioritize business tasks and firms are therefore more likely to achieve its goals. With sophisticated IS planning, convergence between IS and business managers on IT priorities can be achieved (Boynton, Zmud, & Jacobs, 1994). In addition, to ensure their (IT) targets, which are set up at the planning process, will be met, firms need to have a well functioning system development. These two items will be the main focus of this thesis. Effectively utilized systems can be obtained through a maintained mature IS support system, the most benefits can only be achieved when the systems are fully utilized. Also, the continuity of the systems is an important aspect for gaining the most benefits. System failures can lead to significant business disruptions and financial losses.

In this research I focus on the first two items, IS planning sophistication and systems development in order to test the IS capabilities of a firm, due to time and money reasons. One cannot have a well established IS operations capability (support and operations) if the first two items are not well established, therefore we are more interested in the first two items rather than the IS operations capabilities. This claim is supported with evidence (Ravichandran & Lertwongsatien, 2005). Organizations that do not have strong IS capabilities may encounter problems to be succesfull at innovative projects which are meant to enhance the firm's performance. Therefore a moderate effect of IS capabilities between RPA and firm performance is predicted.

H2: Well established IS capabilities in a firm will strengthen the relationship between RPA and financial firm performance.

2.2.3 IS resources

Resources are the main raw materials in the development of capabilities. In the dynamic capabilities perspective, the causal relationship between resources and capabilities is more formally stated, where asset positions are posited to affect capability development (Teece, Pisano, & Shuen, 1997). Teece et al. (1997) even argued that competencies and capabilities are embedded in the organizational processes of a firm and the opportunities they afford for developing competitive advantage are shaped by the assets the firm possesses and the path it has adopted. Since IS resources are embedded in the organizational processes and based on the literature review, in particular the resource-based theory, we also argue that the ability to achieve better firm performance through RPA is dependent on the efficiency and wisely chosen IS resources. Therefore, we predict a moderate effect of IS resources between RPA and firm performance

H3: Well established IS resources in a firm will strengthen the relationship between RPA and financial firm performance.

2.2.4 Firm performance

Detailed information about financial firm performance can be retrieved from companies' profit and loss account, balance sheets and stock price data (Gosh, 2010). Gosh (2010) made the distinction between accounting and a market-based measure of performance. Return on assets (ROA) for the former and market to book value ratio for the latter. Bharadwaj (2000), used the halo index as described in Brown and Perry (1994) to measure the operating and financial firm performance. It was created by using five-year performance data prior to the period during which the firms were ranked as IT leaders. The halo index includes measures of corporate earnings, returns, growth, size, and risk. Kotha & Swamidass (2000), included six performance measure in their research: after-tax return on total assets, after-tax return on total sales, net profit position, market share relative to competition, sales growth position relative to competitors, and overall firm performance. A combination of these six items proved to be successful in previous research (e.g., Swamidass & Newell, 1987; Robinson & Pearce, 1988; Venkatraman, 1989).

Another method to measure firm performance of a company involves benchmarking. Brown, Gatian, & Hicks, Jr. (1995), assessed the performance of the sample firms by relating sample firm financial performance to the performance of two industry benchmarks for all comparisons. Benchmark 1 was calculated by computing the simple arithemic average of the ratio of interest for all other firms in a sample firm's industry, and weights all firms equally. The second benchmark was computed by calculating the ratio of interest from appropiate industry totals.

2.2.5 Control variables

In addition to the theoretical variables, control variables are used to test the relative relationship of the independent and dependent variables. Following Ravichandran & Lertwongsatien (2005), firm size, firm age and the information intensity of the industry are used as control variables. These are held constant and remain unchanged throughout the course of the study and are not the focus of this research, though they are included to test the relative relationship of the dependent and independent variables. The size of a firm reflects past success and may influence current performance, therefore it is included as control variable (Aldrich & Auster, 1986). Firm age can also affect current performance, it can be recognized as indication of external legitimacy of the existence of interfirm relationships, of the staying power, and of the pervasiveness of internal routines.

And since we are using a cross-industry sample, it is required to control for the effect of information intensity of the industry. Young firms (0 – 5 years in business), e.g., can be subject to liability of newness which can disrupt their performance. Particular industries may require a higher density of technology usage and the potential payoff from using technology can therefore vary (Ravichandran & Lertwongsatien, 2005). Measurement of the control variables is explained in section 3.3.4.

3. Research method

3.1 Research model

Below, a visual representation of the research model is provided. Robotic Process Automation is the independent variable, IS capabilities and IS resources are the moderating variables and firm performance is the dependent variable. The main relationship that will be researched is RPA on firm performance. All effects are predicted to be positive. In addition, three control variables are included: firm size, firm age and information intensity.

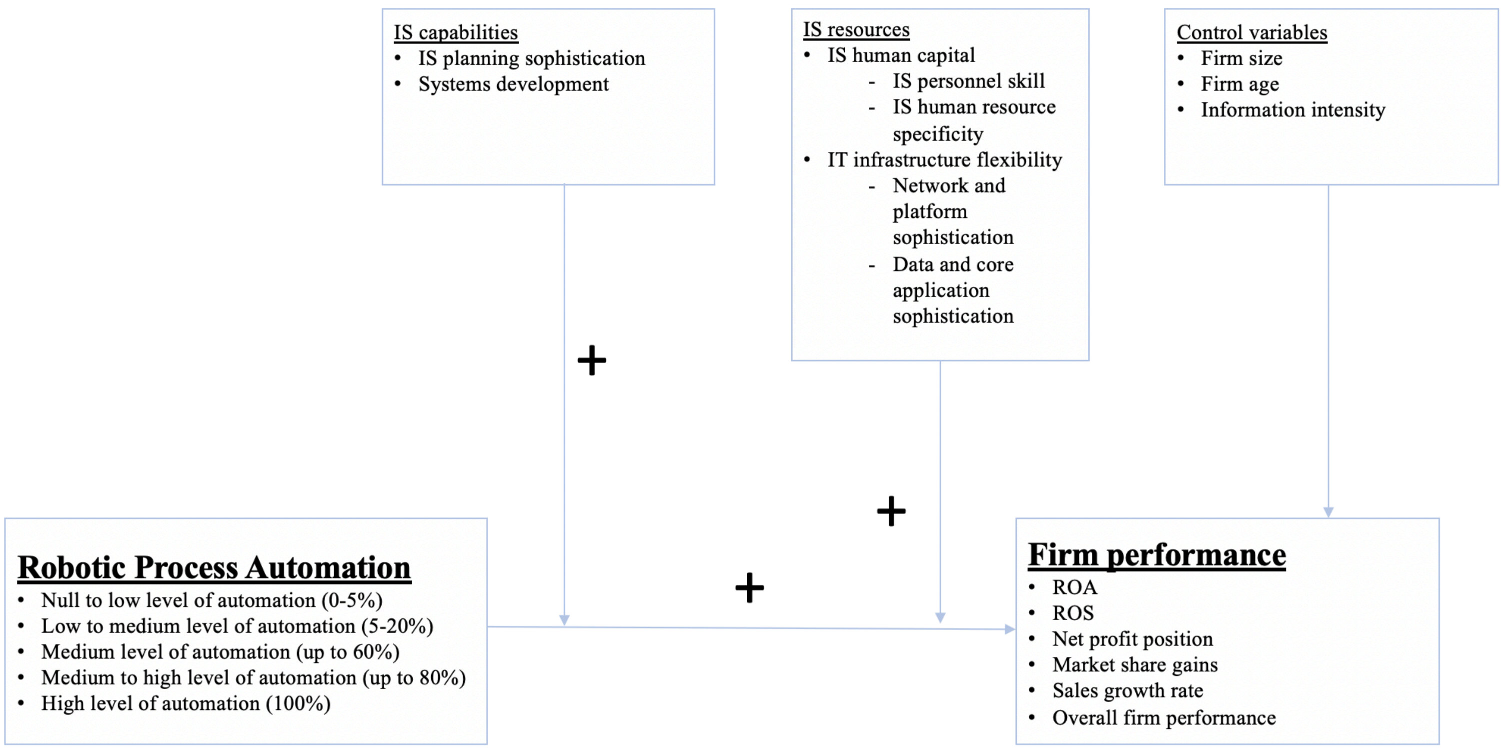


Figure 1: Research model

3.2 Method

For this research, three data collection methods were investigated. The first one was in-dept interviews, a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents (Boyce & Neale, 2006). The main reason for not employing this method is that it was not necessary to obtain (very) detailed information, in addition, cost-related and time-related problems occurred when this method should be employed. The second method (secondary data collection) was to use different databases to obtain financial and technological information about firms. Since we are dealing with a relative great number of indicators for the different variables, it was also a time-consuming method to obtain data which met the requirements. The third method that was considered is conducting a survey. It is a data collection method of gathering information, through a pre-defined questionnaire, from a sample with the intention to generalize this simple to a larger population. A survey offers a lot of advantages, it is for example easy and fast to obtain a lot of data (Wright, 2005). So, with zero to a low amount of costs a lot of data can be obtained in a really short period of time. Therefore, in according to Ravichandran & Lertwongsatien (2005) and Kotha & Swamidass (2000) on this topic, the research method for this study is conducting a survey. Both studies achieved a response rate of around 20%, so we can expect the same percentage. This survey is not industry specific, all industries will be included. The questions in the survey will be spread out regarding the control variables and four constructs: RPA, firm performance, IS capabilities and IS resources. To guarantee the firms' anonymity, company names will not be disclosed. Therefore, it is not possible to include retrieved additional information.

To test the three hypotheses, first of all factor analysis will be conducted. It is used to measure the correlation between different statements corresponding to the constructs a variable consists of and is used to measure the construct validity. Subsequently, a partial least squares (PLS) path analysis will be executed, to test whether the independent variables affect the dependent variable firm performance (Urbach & Ahlemann, 2010) (Henseler, Hubona, & Ray, 2016). We use several different models to test all three hypotheses.

3.3 Measures

3.3.1 Dependent variable

For the measurement of firm performance, we follow Kotha & Swamidass (2000). The combination of the items they used, were found to be successful by previous researchers, therefore we chose to adhere to these items. This section contains six items: after-tax return on total assets, after-tax return on total sales, net profit position, market share gains relative to competition, sales growth position relative to competition, and overall firm performance/success. For the first three items, respondents will be asked questions in order to enable the researcher to successfully calculate and interpret these items. For the last three items, respondents will be asked to rate their firm on this item using a Likert-type scale where 1 = lowest 20% and 5 = top 20 %. However, it has to be said that the last three items are not 100% valid. A firm can, for example, perform worse for 5 years and only last year see improvements in overall success. This type of firms will likely be very positive about the last item; overall firm performance/success. On the contrary, firms performing well over 5 years and only last year see a decrease in overall success may answer this question relatively low in comparison to the other group. So, to minimalize this problem, a question of how the trend of overall firm performance over the last 10 years was (or for newly incorporated firms: from begin to year t) is asked. Where overall firm performance can be seen as a combination of:

- After-tax return on total assets (ROA)
- After-tax return on total sales (ROS)
- Net profit position
- Market share gains relative to competition
- Sales growth position relative to competition
- Overall firm performance

3.3.2 Independent variable

As for the independent variable, we only have one: Robotic Process Automation (RPA). For the first hypothesis, respondents will be asked what level of RPA is active in the firm. We make the distinction between five different 'levels'. These levels are based on Endsley's (1999) taxonomy and are reformulated to achieve a better level of understanding for the respondents and also, Anagnoste's (2018) work is considered. Below, the five levels of automation used in this thesis.

1. Null to low level of automation (0-5%)
   Employee is completely in charge and performs all the tasks or employee is almost completely in charge and system provide some assistance in what to do. Example: physically process orders in folders based on the system.
2. Low to medium level of automation (5-20%)

Employee and/or system generates and selects what to do and system will execute the action. Employee still retains full control and can easily intervene. Mainly rule-based including scripts, macros and other.
Example: generating tables in Excel based on the input of employee.

3. Medium level of automation (up to 60%)
Computer generates a list of decision options and selects one and carries it out if employee consents or employee selects one. This level involves complex rules and includes cross-application and system workflow automation.
Example: computer generates a list of options (e.g., calculate revenue for month) based on date (system sees it is time for month-end) and executes this action. Data is gathered through multiple applications (ERP-system).
4. Medium to high level of automation (up to 80%)
System presents a limited amount of possible actions, user can only select one of these presented or system selects the best option and carries it out. Employee can still intervene and monitor. From this stage on, dealing with cognitive robotics such as natural language processing, voice recognition and cognitive computer vision.
Example: system knows inventory is running low, provides two options: buy inventory or produce inventory itself. Based on selected option, system will initiate the process. Employee can still cancel or adjust the selected option.
5. High level of automation (up to 100%)
System is completely in charge and will carry out all actions, employee is out of control and cannot intervene. This level is self-learning and programming, programmed robots can learn and are able to held a conversation.
Example: system knows inventory is running low, it will initiate a machine to produce more items, subsequently another machine provides the delivery to the place where inventory is held.

In addition, the distinction between seven different departments that specific level is applicable is made. These will be the following ones:

- Production (when not manufacturing firm: responsible for the turnover)
- Supply chain (export, import, delivering, planning)
- Marketing
- Human Resource Management (HRM)
- Finance & Accounting (control)

- Information Technology (IT)
- Research & Development (R&D)

In case a firm consists of fewer departments, one can just answer: not applicable.

3.3.3 Moderating variables

Since we follow Ravichandran & Lertwongsatien (2005) for testing hypothesis 2 and 3, we adhere to this study for measurement, all measurements are one on one related to their statements. IS capabilities can be defined into two constructs: *IS planning sophistication* and *systems development capability.* IS planning sophistication relates to the characteristics (formality, comprehensiveness participation of key stakeholders) of the IS planning process. Systems development capability relates to the quality of the systems delivery process and the routines that lead to a reliable and controlled process. It measures the maturity, flexibility and degree of control of the systems development. Measurement of these two constructs will be both done by six statements, for the former and latter, as shown in table 1.

In the research model, two resources will be included: *IS human capital* and *IT infrastructure flexibility.* IS human capital can subsequently be divided into two constructs: *IS personnel skill* and *IS human resource specificity*. The former will be measured by four statements and the latter by six statements, as shown in table 2a. IS personnel skill measures the extent to which IS personnel is possessed with critical business, technology, managerial, and interpersonal skills. IS human resource specificity relates to the extent to which IS personnel had firm-specific knowledge and measures the extent to which IS personnel had a good understanding of the organization's product and services, its business processes, its unique culture and routines and the extent of their acquaintanceship with people in the organization. IT infrastructure is divided into *network and platform sophistication* and *data and core application sophistication*. Network and platform sophistication measure the connectivity, speed, capacity and the extent of standardization of the networks and computer platforms in the organization. It is measured by five statements, shown in table 2b. Data and core application sophistication measures the share-ability and reusability of the corporate data and applications modules in core business applications. This construct is measured by four statements, also shown in table 2b.

3.3.4 Control variables

In addition to the theoretical variables, we include three control variables. Firm size is measured by the number of full-time employees active in the firm. Firm age is measured by the number of years since the firm was incorporated. Information intensity (industry control) is measured by three statements that assessed the extent to which suppliers, competitors and business partners in the industry used IS. Measurement of information intensity is shown in table 3. For the analysis of the PLS path models, we include an additional control variable for the subjective firm performance measures (market share gains, sales growth rate and overall firm performance), so for models 4, 6 and 8, to control for the fact that firms tend to answer overall firm performance based on their recent performance. Therefore, a question of how the trend of overall firm performance over the last 10 was (or for newly incorporated firms: from begin to year t) is asked, as explained already in section 3.3.1. The respondent can choose between five different 'levels': strong decreased, slightly decreased, more or less the same, slightly increased and strong increased. The question is presented in appendix 5, question 7.

Items	IS planning sophistication	Systems development
IS planning is an ongoing process in our organization; planning is not a once-a-year activity.	X	
Business units' participation in the IS planning process is very high.	X	
IS planning is initiated by senior management; senior management participation in IS planning is very high.	X	
We have a formalized methodology for IS planning.	X	
Our planning methodology has many guidelines to ensure that critical business, organizational, and technological issues are addressed in evolving a IS plan.	X	
We try to be very comprehensive in our planning, every facet is covered.	X	
Our systems development process can be easily adapted to different types of development projects.		X
The systems development is continuously improved using formal measurement and feedback systems.		X
Our systems development process has adequate controls to achieve development outcomes in a predictable manner.		X
Our systems development process is flexible to allow quick infusion of new development methodology, tools, and techniques.		X
Our systems development process facilitates reuse of software assets such as programs, design, and requirement specifications.		X
We have a mature systems development process, the process is well defined and documented.		X

Table 1: measurement IS capabilities

Items	IS personnel skill	IS human resource specificity
Our IS staff has very good technical knowledge; they are one of the best technical groups an IS department could have.	X	
Our IS staff has the ability to quickly learn and apply new technologies as they become available.	X	
Our IS staff has the skills and knowledge to manage IT projects in the current business environment.	X	
Our IS staff has the ability to work closely with customers and maintain productive user or client relationships.	X	
Our IS staff has excellent business knowledge; they have a deep understanding of the business priorities and goals of our organization.		X
Our IS staff understands our firm's technologies and business processes very well.		X
Our IS staff understands our firm's procedures and policies very well.		X
Our IS staff is aware of the core beliefs and values of our organization.		X
Our IS staff often do know who are responsible for the important tasks in this organization.		X
Our IS staff is are familiar with the routines and methods used in the IS department.		X

Table 2a: measurement IS resources; IS human capital

Items	Network and platform sophistication	Data and core applications sophistication
The technology infrastructure needed to electronically link our business units is present and in place today.	X	
The technology infrastructure needed to electronically link our firm with external business partners is present and in place today.	X	
The technology infrastructure needed for current business operations is present and in place today.	X	
The capacity of our network infrastructure adequately meets our current business needs.	X	
The speed of our network infrastructure adequately meets our current business needs.	X	
Corporate data is currently sharable across business units and organizational boundaries.		X
The complexity of our current application systems seriously restricts our ability to develop modular systems with reusable software components.		X
Our application systems are very modular; most program modules can be easily reused in other business applications.		X
We have standardized the various components of our technology infrastructure (e.g. hardware, network, database).		X

Table 2b: measurement IS resources; IT infrastructure flexibility

Items	**Information intensity**
IT is used extensively by our competitors in this industry	X
IT is used extensively by our suppliers and business partners in this industry	X
IT is a critical means to interact with customers in this industry	X

Table 3: measurement information intensit

3.4 Variable overview

Based on the information above, we can conclude that we are dealing with four constructs, which consists of more variables. For construct one, Robotic Process Automation, we only have one measurement for seven different departments. This variable is categorized in five levels, therefore this variable RPA is of categorical nature. Construct two, firm performance, consists of six measurements, after-tax return on total assets, after-tax return on total sales, net profit position, market share gains relative to competition, sales growth position relative to competitors, and overall firm performance/success. The first three variables are considered to be continuous, it can take on infinitely many values. The last three variables are categorical, due to the Likert-type scale. Construct three and four, IS capabilities and IS resources, consists of two variables for the former; IS planning sophistication and systems development, and four variables for the latter; IS personnel skill, IS human resource specificity, network and platform sophistication and data and core applications sophistication. All of these variables are categorical, one can respond in a five-item scale ranging from strongly disagree to strongly agree. For these variables which are measured by statements, the loadings per variable are aggregated. So, we have for example one aggregated loading for IS planning sophistication. For the control variables are firm size and firm age continuous variables and information intensity will be, again, a categorical variable. Below an overview of all the constructs, related variables and the abbreviation that will be used in the testing and analysis. As said before, IS capabilities and IS resources are variables that consists of one aggregated loading derived from the statements. The survey questions can be found in appendix 5.

Construct	Variable	Abbreviation	# of measures
Robotic Process Automation	Robotic Process Automation	RPA	7
Firm performance	After-tax return on total assets	ROA	1
Firm performance	After-tax return on total sales	ROS	1
Firm performance	Net profit position (after-tax income)	INC	1
Firm performance	Market share gains relative to competition	MSG	1

Firm performance	Sales growth position relative to competition	SGP	1
Firm performance	Overall firm performance/success	OFP	1
IS capabilities	IS planning sophistication	PLS	6
IS capabilities	Systems development	SYD	6
IS resources	IS personnel skill	PES	4
IS resources	IS human resource specificity	HRS	6
IS resources	Network and platform sophistication	NPS	5
IS resources	Data and core applications sophistication	DCS	4
Control variable	Firm size	SIZ	1
Control variable	Firm age	AGE	1
Control variable	Industry control	IND_CNTRL	3

Table 4: variable overview

3.5 Model specification

For this research, we investigated three different regression techniques, ordinary least squares, structural equation modelling and partial least squares. For several reasons we initial argued that OLS, instead of SEM method, is a better fit for this study (Xiao, 2013) (Little, Card & Bovaird, 2007). First of all, for the sake of this study we do not need the dependent variable to be simultaneous, it can appear on both sides of the equation. Secondly, SEM is able to deal with time-series data, which we do not have in this thesis. And third, SEM is a really complex model, in this case we prefer simplicity because the fitting ability is similar. In addition, another concern is the requirement for a much larger sample size. OLS can be regressed with a minimum of 50 respondents, where SEM can be regressed with atleast a minimum of around 200 respondents (Xiao, 2013).

But, in case we are dealing with a greater number of observations than the number of variables (or parameters), PLS provides estimates for this kind of complex models (Henseler, et al., 2013). It can be applied in many instances of small samples when other methods fail. When the given assumptions of OLS are not met, OLS will not provide us with the best estimates. Also, when we are dealing with a relatively small sample size, missing values and the existence of any multicollinearity PLS provide much more accurate estimates than OLS does (Farahani, Rahiminezhad, Same, & Immannezhad, 2010). And since we are dealing with latent (hidden) variables, a relatively small sample size, a lot of indicators (for the constructs) and some missing values, PLS can provides us with better insights than OLS. Therefore, we chose, in adherence to Ravichandran & Lertwongsatien (2005), to test the models using the partial least squared regression method. In addition, (Henseler, Hubona, & Ray, 2016) even states that PLS is a variance-based SEM method which is regarded as the "most fully developed and general system" and has been widely used in information systems research (Marcoulides & Saunders, 2006), and other fields.

Partial least squares (PLS) is a multivariate statistical technique which allows a comparison between multiple response variable and multiple explanatory variables and is one of a number of covariance based statistical methods (Farahani, et al., 2010). The prediction of y from x and to describe the common structure underlying the two variables is the main goal of this technique.

Hypothesis 1 will be tested by the following model.

$$FIRM\ PERFORMANCE_{i,t} = \beta_0 + \beta_1 RPA_{i,t} + \beta_x CONTROLS_{i,t} + \varepsilon_{i,t}$$

Where:

FIRM PERFORMANCE $_{i,t}$ = firm performance of firm i in year t, measured using six items

RPA $_{i,t}$ = the extent of Robotic Process Automation active in firm i in year t, whereby a distinction between seven departments is made.

CONTROLS = the control variables; firm size and age of firm i in year t, plus information intensity.

$\varepsilon_{i,t}$ = idiosyncratic error term of firm i in year t.

Hypothesis 2 and 3 include the presence of the moderating variables IS capabilities and IS resources. Therefore, another PLS regression model is constructed to test whether the moderating variables are indeed, as suggested, moderating the impact of RPA on firm performance.

$$FIRM\ PERFORMANCE_{i,t} = \beta_0 + \beta_1 RPA_{i,t} + \beta_2 IS\ capabilities_{i,t} + \beta_3 IS\ resources_{i,t} + \beta_4 RPA_{i,t} * IS\ capabilities_{i,t} + \beta_5 RPA_{i,t} * IS\ resources_{i,t} + \beta_x CONTROLS_{i,t} + \varepsilon_{i,t}$$

Where, in addition to the above:

IS capabilities $_{i,t}$ = the moderating variable IS capabilities of firm i in year t, which consists of IS planning sophistication and systems development.

IS resources $_{i,t}$ = the moderating variable IS resources of firm i in year t, which consists of IS personnel skill, IS human resource specificity, network and platform sophistication, and data and core applications sophistication.

RPA $_{i,t}$ * IS capabilities $_{i,t}$ = the interaction term of RPA and IS capabilities of firm i in year t.

RPA $_{i,t}$ * IS resources $_{i,t}$ = the interaction term of RPA and IS resources of firm i in year t.

4. Data

4.1 Target group

This study generates data by survey and will be sent out to respondents in the function level of CFO, financial managers and senior- level finance professionals (finance related) and CTO, technology/IT managers and senior- level technology professionals (technology related) as 'professional group' and also innovative, young professionals will be included as the 'young professional group'. Young professionals are the future for organizations and they may have a different opinion about technology and the firm itself in comparison to professionals. So, we include four different respondent groups: Financial Professional, Technology Professional, Financial Young Professional and Technology Young Professional. For this research it is interesting to check whether there are differences among those four groups. Though, it should be noted that young professionals should have the same information about the firm as the professionals do. The targeted firms will be SME's (under 250 employees) and big sized firms (over 250 employees). The survey will be produced by a mobile friendly survey tool (Qualtrics). Sample period will be spread over 1 month, starting at the end of May 2019.

Bakos (1987) identified five levels at which IT business value can be carried out:

- the economy as whole;
- the industry within an economy;
- the firm within an industry;
- a work group or division within a firm;
- the individual or information system.

This thesis is focusing on the firm within an industry (underlined) and departments within a firm. The target group will be reached through researcher's own network, which are all spread over the country; The Netherlands.

4.2 Collection

Due to the fact of proper data collection, the survey will be tested on forehand on a pilot group. This pilot group enables the researcher to include the feedback into an adjusted survey which eventually leads to an increase in validity and reliability, due to reducing the measurement error, and in particular systematic error (Hair, Black, Babin, & Anderson, 2006).

The pilot group did indeed provided feedback about the survey. First of all, the opening statement contained some sentence structure errors in the translated (Dutch) version. These errors are adjusted. Questions 8-10 about the financial numbers should be asked in thousands or millions, was the general feedback. Therefore, question is formulated to force respondents to answer in thousands (x1,000). Question 11, a performance measure, was not really clear, more explanation is needed. An example, for more clarification, is given now. In addition, the third answer option does now possess the name 'average', also to increase clarification for respondents. Lastly, an option 'unknown' is added for respondents who are not able to answer this question. Question 13-15 are questions that involves a five-item scale, in the initial version only two values were given: strongly disagree and strongly agree. Respondents of the pilot group found it to be better to see at least one more value. Therefore, the third item is now valued as 'neutral'. In addition to question specific feedback, there was some general feedback that involved translation errors in the language Dutch, these errors are now adjusted.

4.3 Industry conversion

The article of Anagnoste (2018), included a chart in which different industries are being categorized. He used for his research the following industries: banking & financial services, insurance, healthcare, manufacturing, hi-tech & telecom and energy & utilities. In addition, he included the potential for RPA for these different industries in different roles. At least for all of the before mentioned industries, the potential for RPA is moderate to high. With the exception of banking & financial services and manufacturing, these industries do have a high potential for RPA, which could indicate that in the finance & accounting industry there are many tasks that can be, or already are, automated.

According to the U.S. Securities and Exchange Commission (2018), the following industries are categorized: [agriculture, forestry and fishing], mining, construction, manufacturing, [transportation, communications, electric, gas and sanitary service], wholesale trade, retail trade, [finance, insurance and real estate], services and lastly, public administration. For a closer look to the range of SIC Codes and the corresponding divisions, I would like to refer to the appendix 3, table 16.

For the sake of this study, we make the distinction between resource winning, manufacturing of products, providing service and selling the actual products. We would like to assess whether there is a significant difference among industries, this can only be realized if we make a clear distinction. In addition, we included financial services and public administration.

Industry conversion			
Range of code	Category	Abbreviation	Division(s)
0100 – 0999, 1000 – 1499, 1500 – 1799	Resource winning	RES	Agriculture, forestry and fishing; mining; construction.
2000 – 3999	Manufacturing	MAN	Manufacturing
4000 – 4999, 7000 – 8999	Services	SER	Transportation, communications, electric, gas and sanitary service; services.
5000 – 5199, 5200 – 5999	Retail	RET	Wholesale trade; retail trade.
6000 – 6799	Financial services	FIN	Finance, insurance and real estate.
9100 – 9729	Public administration	PUB	Public administration.

Table 5: Industry conversion

4.4 Analyzing

To analyze the results following of the Likert-scale questions, parametric statistics cannot be used for interpretation. The analysis should rely on the ordinal nature of the data. Therefore, we use nonparametric procedures—based on rank, median or range—and distribution free methods such as tabulations, frequencies, contingency tables and chi-squared statistics to analyze Likert-scale results (Clasen & Dormody, 1994).

For the PLS path analysis, it is necessary to check for multicollinearity, which refers to predictors that are correlated to other predictors. It exists if a predictor is not just correlated to the dependent variable, but also to each other (SPSS Test, n.d.). To test for multicollinearity, we will use VIF values, whereby a value of 1-10 means no existence of multicollinearity and a value of <1 or >10 means multicollinearity exists. (Statistics Solutions, n.d.).

5. Results

In this chapter, the data gained from the survey will be analyzed. The data is analyzed by the program called SPSS Statistics, version 25. Data collection is ended on the 12^{th} of June, the collection period stretched over around three weeks. To increase the reliability, the aim of this survey was to obtain the highest possible number of respondents. To regress the models explained in 3.5, we use the program SmartPLS, version 3.2.8. This program enables us to regress the latent variables, including the moderating variables.

5.1 Validity adjustments

To increase the validity some adjustments were made. 1 line contained wrong inserted performance (profit, assets sales) numbers, there was a point placed between the numbers. So, for example, 1,400 was given as answer, but Qualtrics recorded it as it was 1.4. Therefore, this line is adjusted to the right amount. 2 other lines contained also errors, the reported performance measures were not given in thousands. They were reported as whole. Therefore, adjustments were made in order to increase the validity. Another action that took place involved missing values. Missing values can disturb the mean and variance values, therefore missing values were identified. For the performance measures (Q8-Q10), some respondents answered with 0. This is identified as a missing value, respondents were not able or did not want to give that information. For question 11 and question 12 there were also identified missing values. If answered unknown for the former and not applicable for the latter, it is identified as missing value.

Not only missing values were identified, also outliers were identified and excluded from the analysis. For the size (number of employees), all above 5000 employees is excluded.

This leads to an exclusion of 2 fields. For age, all above 100 years is excluded. This leads to an exclusion of 3 fields. For the performance measures (Q8-Q10) the following values were excluded. After-tax income (Q8) above 100,000, resulted in 3 excluded outliers. Total assets (Q9) above 10,000,000, resulted in 1 excluded outlier. And sales revenue (Q10), above 1,000,000 resulted in 3 excluded outliers. For detecting the outliers, the inter-quartile range method was used. Values 1,5 times above or below the box-and-whisker plot were deleted.

5.2 Descriptive statistics & frequencies

A total of 70 respondents started the survey. Due to the filter, introduced in chapter 2.2.1, firms facing financial distress are excluded from this research. Respondents who answered question 1 with probably yes or definitely yes are being considered to be facing financial distress in the near future. There were in total six respondents who did answer probably yes or definitely yes, which leads to a valid N of 64. So, in every table from now on we will see missing values of at least six. A cumulative percentage of 91.4% of the respondents are not facing imminent financial distress, whereby almost 61.4% of the respondents answered with definitely not, as shown in appendix 4, table distress.

Table 6 depicts the descriptive statistics for Robotic Process Automation, where a value of 1 means null to low level of automation and a value of 5 means a high level of automation active in that particular department in the firm. The results show us the highest value (mean) of 3.73 for the IT department and the lowest value of 2.95 for the marketing department, which means that it is more likely that firms employ automation in their IT department than their marketing department.

Table 7 depicts the descriptive statistics for firm performance. As you can see, there are 6 items that measures the firm performance. The first number is given in thousands, where no pre-defined range was set. The second and third were calculated by dividing income by total assets for the former and by dividing income by total revenue for the latter. The last three items are subjective, where a value of 1 means lowest 20% and a value of 5 top 20%. The questions are all in comparison to competition. So, for example, for market share gains, if answered lowest 20% it will mean that at least 80% of competitors are experiencing more market share gains than you.

Descriptive Statistics RPA					
Variable name	N	Minimum	Maximum	Mean	Std. Deviation
RPA production	58	1	5	3.36	1.038
RPA supply chain	55	1	5	3.15	0.970
RPA marketing	62	1	5	2.95	0.982
RPA HRM	64	1	5	3.16	1.057
RPA finance	64	2	5	3.66	0.821
RPA IT	64	2	5	3.73	0.821
RPA R&D	54	1	5	2.96	1.149

Table 6: Descriptive Statistics RPA

Descriptive Statistics Firm Performance					
Variable name	N	Minimum	Maximum	Mean	Std. Deviation
After-tax income	49	-1800	100,000	8313.95	18,862.900
Return on assets	49	-0.72	10.00	0.6217	1.61836
Return on sales	48	-6.00	20.00	0.5051	3.07043
Market share gains	47	1	5	3.30	1.366
Sales growth	48	1	5	3.44	1.183
Overall performance	49	1	5	3.57	1.155

Table 7: Descriptive Statistics Firm Performance

Descriptive Statistics control variables					
Variable name	N	Minimum	Maximum	Mean	Std. Deviation
Size	62	15	3500	491.61	764.750
Age	61	2	100	44.64	32.797
Industry control | Competitors	64	1	5	4.03	1.154
Industry control | Suppliers, Business	64	1	5	3.81	1.220
Industry control | IT critical means	64	1	5	3.83	1.336

Table 8: Descriptive Statistics control variables

Also, a descriptive statistics table for the control variable is shown in table 8. Size can be read as the number of employees in the firm, with a mean of almost 500 employees. The average age of the sampled firms is a somewhat above 44,5 years, where the 'youngest' firm is 2. The last three items that measures the industry intensity are Likert-type questions, where a value of 1 means strongly disagree and a value of 5 strongly agree. The statements can be found in table 3 on page 28.

The respondents who filled in the survey could, initial, be divided into four groups: Financial Professional, Financial Young Professional, Technology Professional and Technology Young Professional. The most interesting finding is that the last group did not fill in any survey at all, which leaves us to only three groups. Another interesting finding is that 87,5% of all the respondents are financials. This could indicate that technology employees did not possess all the information needed to complete the survey ór that technology employees are not keen on filling in any surveys at all.

Function level				
	Frequency	Percent	Valid Percent	Cumulative Percent
Financial Professional (senior level up to CFO)	47	73.4	73.4	73.4
Financial Young Professional (junior)	9	14.1	14.1	87.5
Technology Professional (senior level up to CTO)	8	12.5	12.5	100.0
Total	64	100.0	100.0	

Table 9: Function level

The respondents were also asked in what industry their firm is operating in. We see, in table 10, that resource winning is under represented with only 6.3%, where the manufacturing and services sectors are over represented with both 28.1% (56.2% in total). Retail, financial services and public administration account for 37.5% (three times 12.5%). So, all industries are included in this survey to a lesser or greater extent.

Industry				
	Frequency	Percent	Valid Percent	Cumulative Percent
Resource winning (agriculture; forestry and fishing; mining; construction)	4	6.3	6.3	6.3
Manufacturing	18	28.1	28.1	34.4
Services (transportation; communications; electric, gas and sanitary service; services)	18	28.1	28.1	62.5
Retail (wholesale trade; retail trade)	8	12.5	12.5	75.0
Financial services (finance, insurance and real trade)	8	12.5	12.5	87.5
Public administration	8	12.5	12.5	100.0
Total	64	100.0	100.0	

Table 10: Industry of sample

5.3 Factor analysis

The second part of the data analysis is to run a factor analysis to test for convergent and discriminant validity. Where convergent validity is met when all its items load highly on one factor. So, when some items do not have sufficient loadings (>0.70) they were dropped from the construct in order to achieve convergent validity. Convergent validity is tested using factor analysis. Discriminant validity is met when the square root of every average variance extracted (AVE) value belonging to each latent construct is larger than any correlation among any pair of latent constructs (Zait & Bertea, 2011). It is tested using a calculation sheet in Excel and can be found in appendix 6.

5.3.1 Convergent validity

Since we are dealing with latent constructs; hypothetical conceptual variables that represent some underlying variables that are not directly observable (Bollen, 2002), they are all identified as formative constructs, which in turn means that the indicators cause the construct (Cenfetelli & Bassellier, 2009). We do have 37 different statements all divided over 8 latent constructs; IS planning sophistication, systems development, IS personnel skill, IS human resource specificity, network and platform sophistication, data and core applications sophistication, industry control and last but not least firm performance.

The factor loadings of each item should be 0.70 or higher to be classified as valid (Hair et al., 2006). In table 11, 12a, 12b and 13 the factor loadings for each construct are given. For the content of the statements, I would like to refer to chapter 3.1 or appendix 5. Only 3 out of 37 statements, the loadings are lower than 0.70, where the loading of DCS_2 is almost zero, even after reverse coding. When we run a correlations matrix for that specific construct, we do indeed see that DCS_2 does not correlate with statement 1, 3 and 4. So for the further analyses, we exclude DCS from the research, due to its invalid measurement. We cannot aggregate DCS into one variable that represents all the data, even if we exclude DCS_2 we still have an alpha of only 0.628. Thus, we only use the aggregated variable of network and platform sophistication to represent the data of IS resources; IT infrastructure flexibility. This is sufficient, because we now have three, instead of four, measurements for IS resources, whereas IS capabilities only have two measurements. That being said, all other values for Cronbach's alpha do meet the test prerequisite that the value should be 0.70 or higher. The test of Cronbach's alpha is known as a reliability measure (Bernstein & Nunnaly, 1994).

Following the research (Ravichandran & Lertwongsatien, 2005; Cenfetelli & Bassellier, 2009), we are able to aggregate the indicators per measurement into one representing construct, by using the regression method in SPSS, centering the values. So the mean for the 'new' variable is 0 and the variance is equal to the squared multiple correlation between the estimated factor scores and the true factor values. IS planning sophistication and systems development were used as formative indicators of IS capabilities. Two factor loadings are just below 0.70 and they are, therefore, excluded from the construct; they are not fit to be an indicator for the construct. IS personnel skills and IS human resource specificity were used as formative indicators of IS resources; human capital. Network and platform sophistication and data and core applications sophistication were used as formative indicators of IS resources; IT infrastructure flexibility, though, due to its invalid measurement, as explained above, we cannot include data and core applications sophistication into the model, which leaves us to a formative indicator of network and platform sophistication for IS resources; IT infrastructure flexiblity. In addition, we factored the data from question 11, the three objective firm performance measures, in table 14.

Items	IS planning sophistication (initial)		IS planning sophistication (revised)		Systems development	
	Loadings		Loadings		Loadings	
Cronbach's alpha	0.825		0.797			
PLS_1		0.702		0.720		
PLS_2		0.793		0.848		
PLS_3		0.650		-		
PLS_4		0.798		0.830		
PLS_5		0.773		0.760		
PLS_6		0.670		-		
Cronbach's alpha					0.881	
SYD_1						0.776
SYD_2						0.733
SYD_3						0.819
SYD_4						0.851
SYD_5						0.818
SYD_6						0.756

Table 11: factor loadings and Cronbach's alpha for IS capabilities

Items	IS personnel skill		IS human resource specificity	
	Loadings		Loadings	
Cronbach's alpha	0.903			
PES_1		0.862		
PES_2		0.869		
PES_3		0.916		
PES_4		0.876		
Cronbach's alpha			0.871	
HRS_1				0.732
HRS_2				0.789
HRS_3				0.852
HRS_4				0.765
HRS_5				0.723

HRS_6				0.836

Table 12a: factor loadings and Cronbach's alpha for IS resources; IS human capital

Items	**Network and platform sophistication**		**Data and core applications sophistication**	
Cronbach's alpha	0.858			
NPS_1		0.850		
NPS_2		0.704		
NPS_3		0.879		
NPS_4		0.876		
NPS_5		0.709		
Cronbach's alpha			0.450	
DCS_1				0.802
DCS_2 *(R)				0.066
DCS_3				0.681
DCS_4				0.785

Table 12b: factor loadings and Cronbach's alpha for IS resources; IT infrastructure flexibility

Note: (R) is reverse coded.

Items	**Industry control**	
Cronbach's alpha	0.864	
IND_CNTRL1		0.906
IND_CNTRL2		0.926
IND_CNTRL3		0.835

Table 13: factor loadings and Cronbach's alpha for industry control.

Items	Firm performance	
Cronbach's alpha	0.899	
MSG		0.864
SGP		0.941
OFP		0.941

Table 14: factor loadings and Cronbach's alpha for firm performance.

5.3.2 Discriminant validity

For the measurement of discriminant validity, we used the following equation (Zait & Bertea, 2011):

$$AVE = \frac{\Sigma[\lambda_i^2]}{\Sigma[\lambda_i^2]+\Sigma[Var(\varepsilon_i)]},$$

Equation 1: discriminant validity

Where λi is the loading of each measurement item on its corresponding construct and the measurement error is εi. As said before discriminant validity is met when the square root of every AVE value belonging to each latent construct is larger than any correlation among any pair of latent constructs (Zait & Bertea, 2011). As a threshold, the value of AVE for each construct should be above 0.50 (Fornell & Larcker, 1981). First, we calculated the AVE for every construct, which are all above 0.50. Then we used the square root of the correlation between the two constructs to test for discriminant validity. The constructs that were the closest related were tested with each other, so for IS capabilities PLS & SYD were taken together. For IS human capital, PES & HRS were taken together. For IT infrastructure flexibility, NPS & DCS were taken together. The measurements of industry control and firm performance were not tested for discriminant validity, cause both constructs were not closely related to another construct. As you can see, in appendix 6, for all constructs, the AVE was greater than 0.50 and were greater than the square root of the correlation, which indicates that discriminant validity is established.

5.4 PLS path analysis

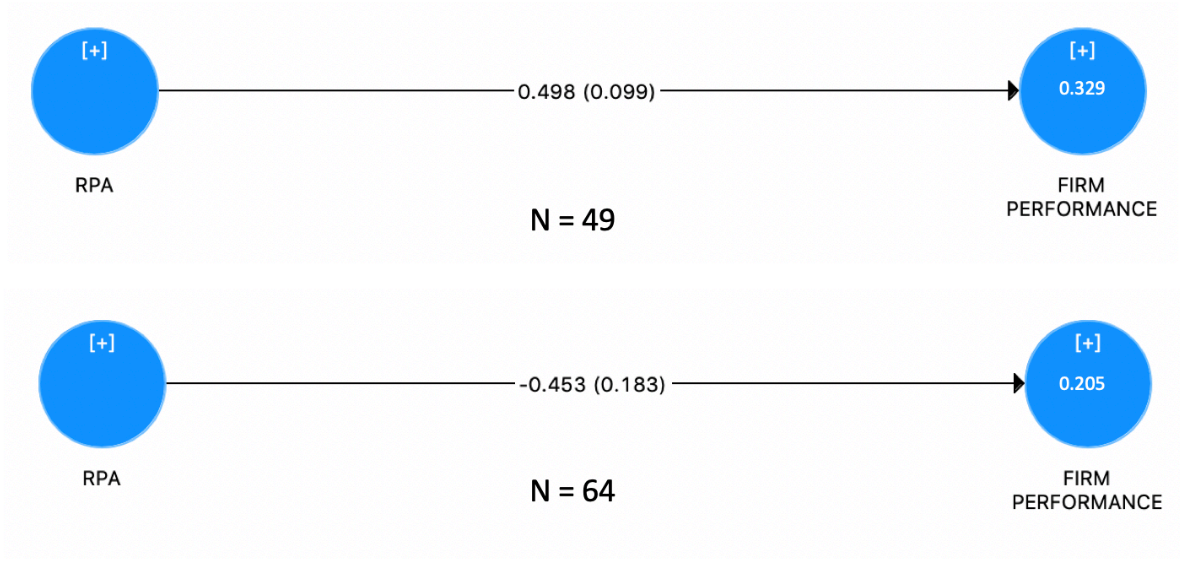
The main part of the data analysis will be the partial least squares (PLS) path analysis. We make the distinction between two different measures of firm performance. The first model will always consist of the log function of income, return on assets and return on sales. The second model will always consist of the three different performance measures: market share gains (in relative to competitors), sales growth position (in relative to competitors) and overall performance. The distinction is made, because the first model primarily focuses on 'hard' measurable numbers (objective) and the second model primarily focuses on somewhat subjective measures. The first number in the models mentioned represents the weights/loadings, where the number in brackets represents the P-value. Numbers within the construct represent the R Squared values, which means the total variance explained. Since we use the pairwise deletion option in SmartPLS, we do have different numbers of valid N. Pairwise deletion aims to retain as much information as possible. So, if we have, for example, two constructs where one does have 64 values and the other does have only 49 values, the valid N is then 49. In table 15, an overview of all regressed models is given.

For the control variables, age and size, we used the log function to respond to skewness towards large values. As you can see in section 5.2, we do have some large values for size and age.

PLS path analysis, all models			**Support?**
Model	Hypothesis	Description	H1 not supported
1	1	RPA -> firm performance (objective)	H1 not supported
2	1	RPA -> firm performance (subjective)	H1 not supported
3	1	RPA + controls -> firm performance (objective)	H1 not supported
4	1	RPA + controls -> firm performance (subjective)	H1 not supported
5	2	RPA + IS capabilities + interaction terms + controls -> firm performance (objective)	H2 not supported
6	2	RPA + IS capabilities + interaction terms + controls -> firm performance (subjective)	H2 not supported
7	3	RPA + IS resources + interaction terms + controls -> firm performance (objective)	H3 not supported
8	3	RPA + IS resources + interaction terms + controls -> firm performance (subjective)	H3 not supported

Table 15: overview of all models for PLS path analysis

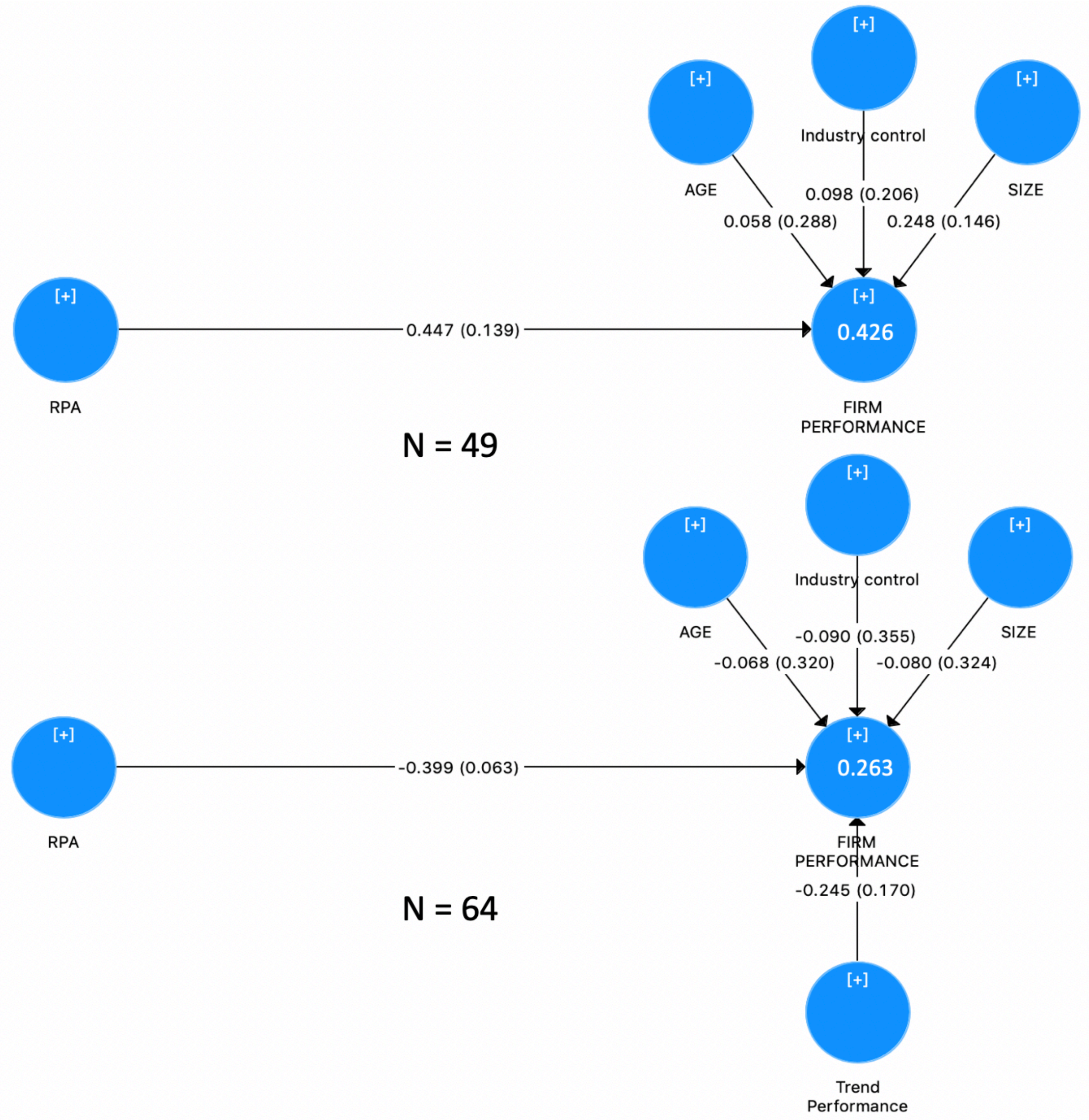
5.4.1 Hypothesis 1



** p < 0.05; ** p < 0.01; *** p < 0.001.*
Figure 2: Model 1 & 2: path coefficients and R Squared value, control variables excluded

The first two models that are regressed is the dependent variable (firm performance) versus the independent variable (RPA), in this model we exclude the control variables to see whether there are differences in significance and/or variance explained (R Squared).
The first model does not have significant values at the 5 percent level. The main effect (RPA on firm performance) just fell short of statistical significance. The second model, figure 3, also did not result in any significance. Where the R Squared of model 1 is 32.9%, the R Squared of model 2 is 20.5%. The drop can be explained due to the fact that the second model only consist of Likert-type scale items. Also, Low R Squared is totally normal in the social sciences, because there are probably a lot more factors influencing the performance of a company. Model 1 does have a lower N than model 2, the reason is that the first three performance measures were not required to fill in for the respondents, where the last three were. For both models, the VIF values range from 1 to 5, which means that we are not dealing with any multicollinearity problems (Statistics Solutions, n.d.).

In order to determine the model fit, the standardized root mean square residual (SRMR) will be used. According to Hooper, Coughlan, & Mullen (2008), a value of 0 means perfect fit, where a value of 1 means no fit at all. Well-fitting models should have values less than 0.05, but values as high as 0.10 are acceptable. Both models do meet the prerequisite as the values do not exceed 0.061, which means the models have an acceptable fit.

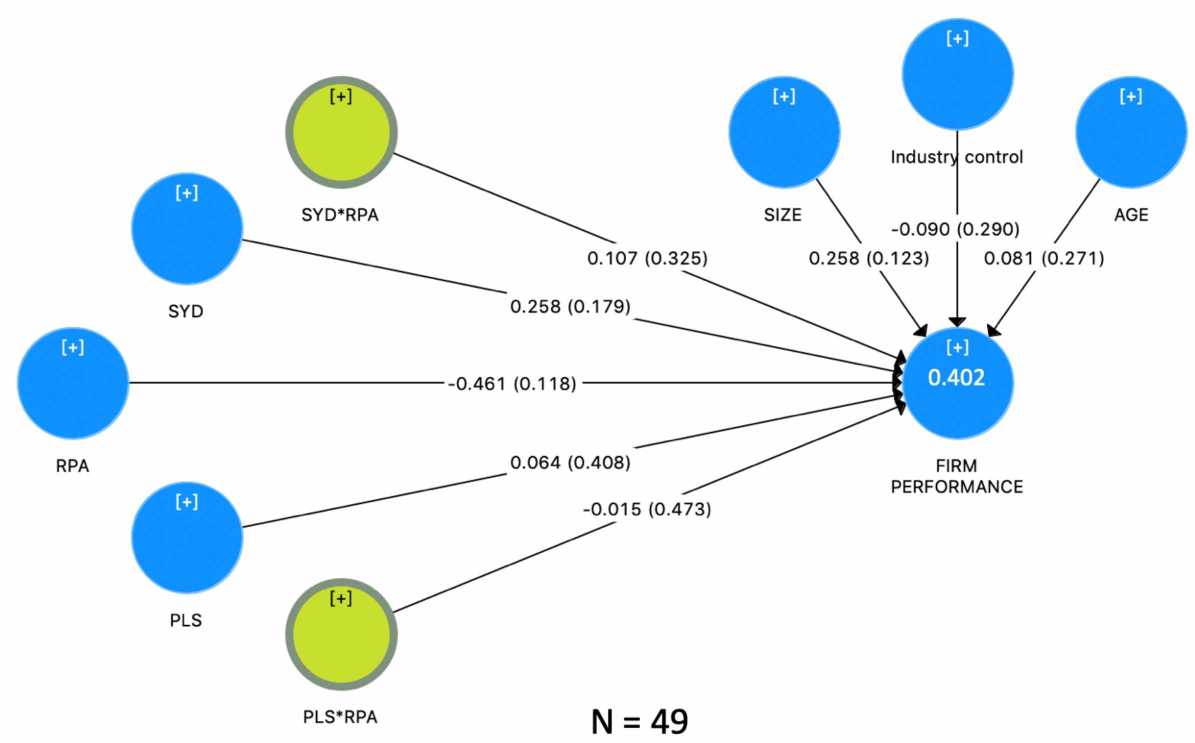


** p < 0.05; ** p < 0.01; *** p < 0.001.*
Figure 3: Model 3 & 4: path coefficients and R Squared value, control variables included

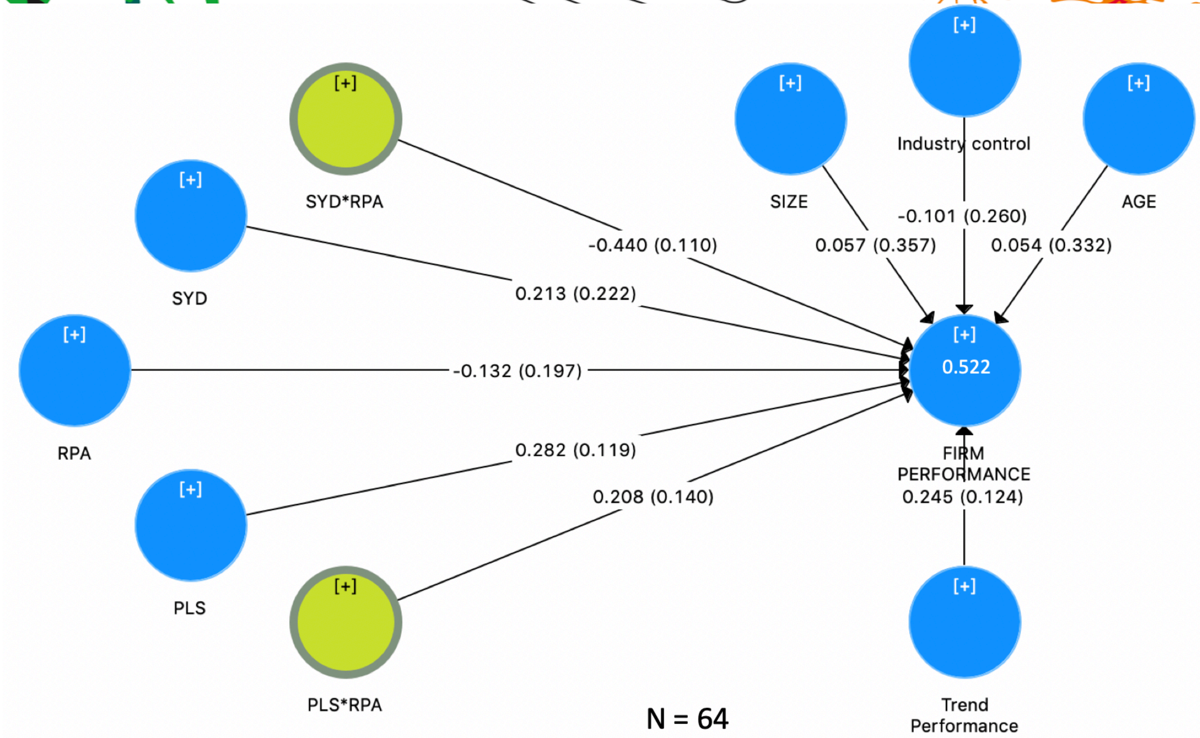
Model 3 and 4 differ from model 1 and 2 in a way that control variables are included. As expected, we do see an increase in the R Squared values. If we compare model 1 and 3, we see an increase of 9.7% (42.6% - 32.9%). And if we compare model 2 and 4, we see an increase of 5.8% (26.3% - 20.5%), where both models almost see an increase of 30% (29% for the former and 28% for the latter). So, for both models, the control variables do explain a lot more variance than the models excluding the control variables do. The differences do not count for the significance levels, introducing control variables do not result in the effect being significant. For all models (1 to 4), we do not have a significant effect of the independent variable on the dependent variable. As explained in section 3.1 measures, we included a control variable, trend performance, for the three Likert-type scale items (model 4). Models 3 and 4 were also tested for SRMR, and the values for both models did not exceed 0.088, which are acceptable values. Also, VIF values were sufficient, ranging from 1 to 5.

In conclusion, models 1, 2, 3 and 4 tested hypothesis 1: "*Firms with a higher degree of RPA experience a significantly higher degree of financial firm performance.*" According to the regression outcomes of the PLS path analysis we can conclude that the findings do not support this hypothesis. I.e. we cannot conclude that firms with a higher degree of RPA active in their firm also do experience a higher degree of financial firm performance.

5.4.2 Hypothesis 2



** p < 0.05; ** p < 0.01; *** p < 0.001.*
Figure 4: Model 5: path coefficients and R Squared value, moderating impact IS capabilities



*$p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.*

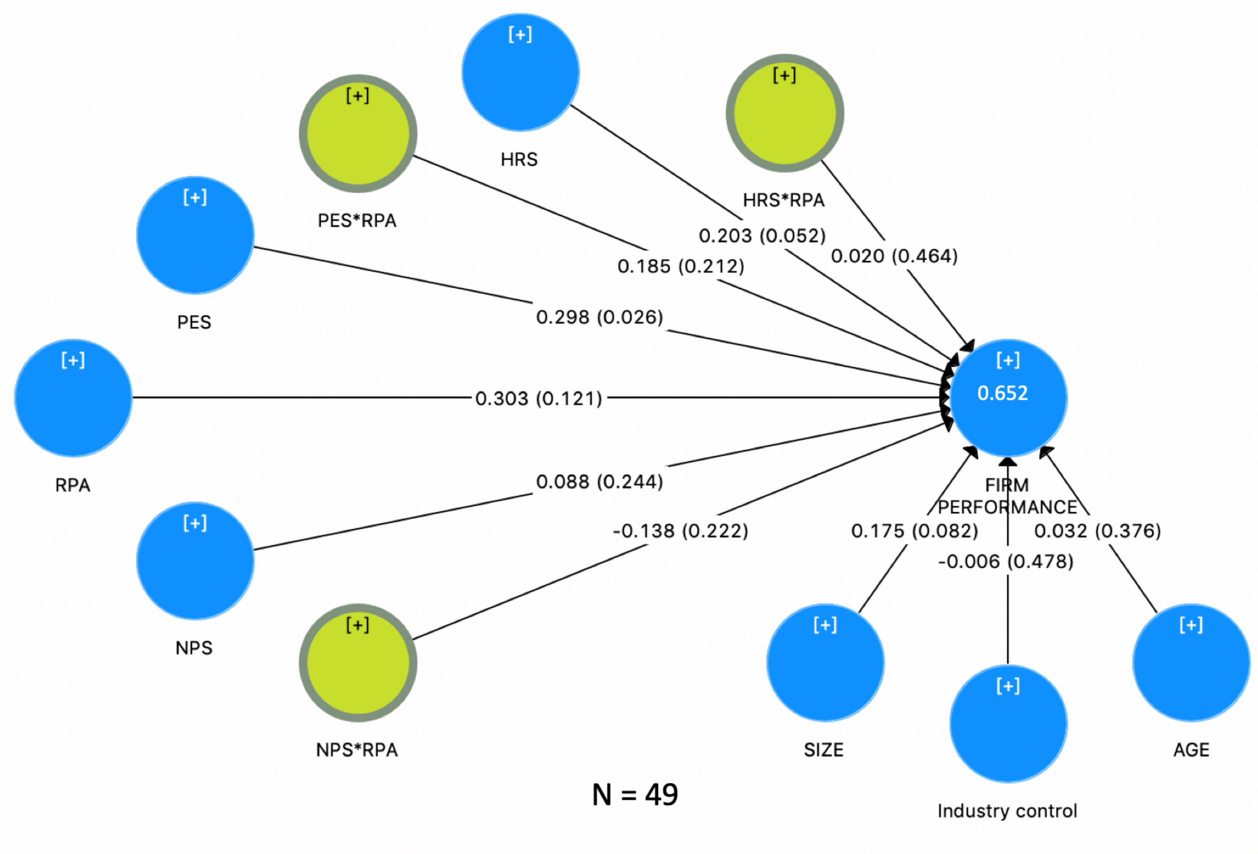
Figure 5: Model 6: path coefficients and R Squared value, moderating impact IS capabilities

Models 5 and 6 are employed to test for the moderation of IS capabilities on RPA to firm performance. As explained above, the first model, consist of the log function of income, return on assets and return on sales. Where the second model consist of the three different performance measures: market share gains (in relative to competitors), sales growth position (in relative to competitors) and overall performance. Number of observations are, as explained above, 49 for the former and 64 for the latter.

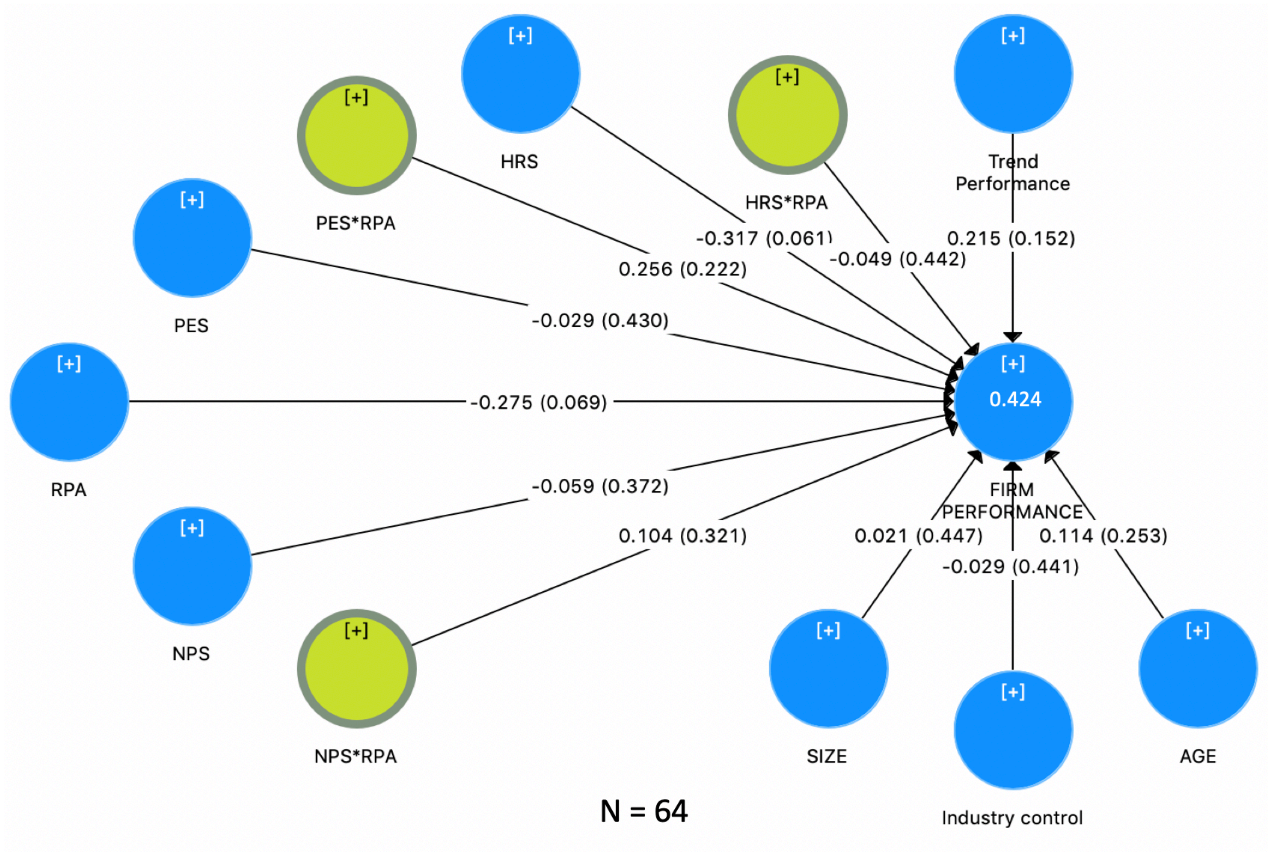
Only for model 6 the SRMR measure did exceed the value of 0.10 (0.100 for model 5 and 0.152 for model 6). Though, since Kenny (2015) argued that SRMR is a positively biased measure for model fit and that bias is greater for small N and research with low degrees of freedom, we are not stressed since we do indeed have a small N. R Squared values are still acceptable for both models, 0.402 for the former and 0.522 for the latter. VIF values range from 1 to 5, thus sufficient.

In both models, there is no significant relationship found. Even the moderation effects; PLS*RPA and SYD*RPA are not significant, which indicates that we did not found evidence to support hypothesis 2: "*Well established IS capabilities in a firm will strengthen the relationship between RPA and financial firm performance.*" I.e. we cannot conclude that well established IS capabilities in a firm strengthen the relationship between RPA and financial firm performance.

5.4.3 Hypothesis 3



** p < 0.05; ** p < 0.01; *** p < 0.001.*
Figure 6: Model 7: path coefficients and R Squared value, moderating impact IS resources



** p < 0.05; ** p < 0.01; *** p < 0.001.*
Figure 7: Model 8: path coefficients and R Squared value, moderating impact IS resources

Models 7 and 8 are employed to test for the moderation of IS resources on RPA to firm performance. The firm performance indicators are the same as previous models. SRMR did, again, exceed the value of 0.10 (0.218 for model 7 and 0.216 for model 8). R Squared values did differ from previous two models. Model 7 compared to model 5, we see an increase of 62% (from 0.402 to 0.652). Model 8 compared to model 6, we see a decrease of 23% (from 0.552 to 0.424). We can explain the increase of the variance due to an increase of one moderating variable (3 instead of 2), therefore we are surprised by the decrease of model 8. We did not found evidence or any explanation of this occurrence. VIF values range from 1 to 5, thus sufficient.

In both models, there is, again, no significant relationship found. Even the moderation effects; NPS*RPA, PES*RPA and HRS*RPA are not significant, which indicates that we did not found evidence to support hypothesis 3: "*Well established IS resources in a firm will strengthen the relationship between RPA and financial firm performance.*" I.e. we cannot conclude that well established IS resources in a firm strengthen the relationship between RPA and firm performance.

6. Discussion

In this study we drew from the resource-based theory, the information processing perspective and the contingency theory to examine how the internal characteristics of a firm, in particular Robotic Process Automation (RPA), the IS capabilities and IS resources affect firm performance. This study contributes to the growing literature in linking IT characteristics of a firm and firm performance. In addition, this is one of the first studies that linked RPA to firm performance. Based on the empirical research, we predicted that firms who do experience a higher degree of RPA in their firm, should also experience better financial firm performance. We also predicted that this relationship is enhanced by well-established IS capabilities and IS resources.

The results do not provide us with empirical support for all three hypotheses. Though, this does not implicate, by no means, that no effect exists. Significance tests can help to discover whether the obtained data is subjected to any present effect. These findings are somewhat surprisingly, since literature certainly suggests that a well-established IT framework results in higher firm performance. On the other hand, most research linking IT and firm performance is dated (10 years and older) and since the business is rapidly changing, we are dealing fast emerging markets. I.e. RPA was not thoroughly researched, and we incorporated this technology as one of the first in our research. As stated in the introduction, RPA is a construct which evolved from three key predecessors.

So, as introduced before, this research is built open several papers. They have done research in the field of computerization/automation and the effect on firm performance (Brown, Gatian, & Hicks, Jr., 1995; Bharadwaj, 2000; Kotha & Swamidass, 2000; Ravichandran & Lertwongsatien, 2005). Bharadwaj (2000), found evidence for the relationship between superior IT capability and firm performance. Where in turn, Ravichandran & Lertwongsatien (2005), also found evidence for the claim that intangible IS resources and IS functional capabilities are critical determinants of how IT is deployed in the organization, which in turn can affect firm performance. Brown, Gatian & Hicks, Jr. (1995), researched the relationship of employing Strategic Information Systems (SIS) and firm performance, and also found evidence supporting their claim that investments in SIS provides firms with a competitive advantage, thus some financial indication should be noted of that advantage. Kotha & Swamidass (2000), investigated the relationships between advanced manufacturing technology (AMT) use and strategy orientations. Their results indicate that firms with a well-thought strategy orientation are more likely to use AMT, which creates in turn competitive advantage. So, to conclude, our results are not in line what literature suggests. Based on earlier research in this field, we argued that RPA should also have a positive effect on firm performance. This claim is not supported.

The reason for this unsupported claim cannot be explained right away. In the social sciences we are dealing with a lot of other influencing factors. There may be other factors (for example: external factors, such as government regulations) that do influence the firm performance of a firm much more than any technology investment does. Another suggestion we can think of is that the internal technology framework in a firm is more like a part of the firm rather than an addition. In the early stages when technology was on the rise, firms could gain competitive advantage over other firms if they managed to maintain a well-established internal technology framework, since most firms did not have the resources to employ it in their firm. Nowadays, most of the firms, if not all, do have any form of automation active in their firm. Though it should be noted that this suggestion should be taken with a high level of cautiousness. A metaphor with the internet can be established. In the 90's only a couple of households we able to use the internet, for a short period of time (due to practical and cost-related reasons). Nowadays, 30 years later, we cannot think of a society without internet.

7. Conclusion

The main objective of this study is to assess the effect of the extent RPA is active in a firm on firm performance. In addition, the moderating impact of the IS capabilities and the IS resources, drawn from the resource-based theory, is considered to have a moderating impact on the main relationship. Based on this objective, the following research question was formulated in order to give this study a solid research objective: “In what direction (positive/negative) and to what extent does RPA influence the financial performance of firms in particular industries for firms in the Netherlands, and to what extent does IS capabilities and IS resources moderate the impact?” To be able to give a well substantiated answer to this question, we drew up three hypotheses, based on empirical research.

The first one involves the main relationship we are interested in; “Firms with a higher degree of RPA experience a significantly higher degree of financial firm performance.” For this hypothesis, we employed four different PLS path models, where we make the distinction between two different models with and without control variables where one model measures the first three performance indicators (log function income, ROA and ROS) and where the other model measures the last three performance indicators (OFP, MSG and SGP). As expected, we see an increase of the R Squared values when we incorporate control variables. Though, hypothesis 1 is by all four models not supported. We did not find exclusive evidence to support the claim that firms with a higher degree of RPA active experience significantly higher degrees of financial firm performance.

The second and third hypothesis involves the moderating impact of IS capabilities for the former and IS resources for the latter on the main relationship (RPA on firm performance). Hypothesis 2 is formulated as: “Well established IS capabilities in a firm will strengthen the relationship between RPA and financial firm performance.” Hypothesis 3 is formulated as: “Well established IS resources in a firm will strengthen the relationship between RPA and financial firm performance.” For these hypotheses, we employed two different models per hypothesis (four in total), where the same distinction for the performance measures are made. In these models, we included, in addition to the original model, the constructs for IS capabilities and IS resources and the moderation effects of these latent variables. Just like hypothesis 1, we did not find any evidence supporting hypothesis 2 and 3. Which indicates that we cannot conclude that well established IS capabilities and IS resources in a firm will strengthen the relationship between RPA and financial firm performance.

Last but not least, based on the outcomes of the hypotheses, we can give a concise answer to the research question. We cannot confirm that RPA does influence the financial performance of firms in The Netherlands. In addition, well-established IS capabilities and IS resources appear not to be influencing this, before mentioned, relationship.

8. Implications

Our aim was to build upon several research which investigated the relationship of different aspects of IT automation in a firm and firm performance. Also, since RPA is a new emerging technology, it has not been researched thoroughly. With this study, we aimed to bridge that gap. The major practical contribution is that we, in contrast to the prior predictions, found no evidence to support the before mentioned claims. Managers and other executives of firms can, therefore, be indifferent as to how much should be automated in their firm. This gives further research the opportunity to support or refute our findings.

Firms that tend to aim for the best or highest possible firm performance should not try to achieve that with employing more or less automation/technology, since our results suggests that no competitive advantage can be obtained through employing more automation. On the other hand, neglecting the IT policy and every other thing involved with automation can possible lead to negative, undesired effects. So, it is really arguable if one should just simply pay no more attention to IT anymore. We definitely think that IT should be well managed, even if we did not found evidence supporting the claim that a better IT framework results in better firm performance. Though, it is a thoughtful assumption and we cannot support this with any evidence or data.

9. Limitations and directions for further research

As with any other research, this study has also its limitations. The data obtained was cross-sectional data, a snapshot in time. Therefore, we were only able to compare firms with other firms. A suggestion for further research can therefore be, employing a longitudinal study for different firms and measure whether there are significant differences between time-stamps. I.e. measure at two different time-stamps the automation active in a firm and the firm performance.

Due to time and cost related issues we were not able to obtain a relatively large sample size. We initial got 70 responses, where 6 were invalid. So, to increase the power of the research model and this study as whole, we recommend achieving a sample size as high as possible for the most accurate results. Though, it has to be said that everything is done to achieve the highest possible sample size. In addition, we used a data collection method where only one representative of firm answered the survey. This method, therefore, suffers from the fact that the data represents the opinions of only one person in the firm. However, the data represents the perceptions of financials and technology employees in the firm, who are most likely to possess the most information about automation active in a firm and the firm performance. Hence, their answers are likely to be valid. A suggestion for further research can be, obtaining data not only from one representative of firm but multiple.

Another limitation that we faced is the fact that Robotic Process Automation has not been researched thoroughly and was therefore much more difficult to measure than other variables. Also, we measured RPA with reference to different scales and the perceptions of one representative of a firm. Suggestions for further research can be, employing a research on RPA to enable the science to better understand this construct. In addition, new research can measure RPA in a different way. Observations may suit this construct better, but it does cost more money and can be really time-consuming.

This study is conducted in The Netherlands with no exception of any specific areas, but due to convenience sampling and due to the fact that the researcher of this study has a network where most of the representatives were located in the north-east of The Netherlands, most of the respondents were located in the north-east of the country. A suggestion for further research is therefore quite logical, other studies can consider other countries or specific regions. In addition, we included every industry in this thesis, other studies could consider focusing on fewer industries than we did.

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11. Appendices

1. Hierarchy in the context of the use of expert systems to supplement human decision making by employees (Endsley, 1999):

1. manual control – no assistance from the system or any technology;
2. decision support – by the operator with input in the form of recommendations provided by the system;
3. consensual artificial intelligence (AI) – by the system with the consent of the operator required to carry out any actions;
4. monitored AI – by the system to be automatically implemented unless cancelled by the operator; and
5. full automation with no operator interaction.

2. 10-level taxonomy involving cognitive and psychomotor tasks.

1. Manual Control (MC) – employee performs all tasks including monitoring the state of the system, generating performance options, selection the option to perform (decision making) and physically implementing it.
2. Action Support (AS) – system assists the operator with performance of the selected action, although some human control actions are required.
3. Batch Processing (BP) – employee generates and selects the options to be performed, system will execute the action. This automation is, primarily in terms of physical implementation of tasks.
4. Shared Control (SC) – both employee and system generate possible decision options. Employee still retains full control over the selection of which option to implement; however, execution of actions is shared among those two.
5. Decision support (DS) – computer generates a list of decision options the employee can select from or the operator may generate its own options. Once an option is chosen, the system will carry out the selected option. This level is also capable of carrying out tasks, while SC is indicative of one that is not.
6. Blended decision making (BDM) – computer generates a list of decision options that it selects from and carries it out if employee consents. This level represents a higher level decision support system that is capable of selecting among alternatives as well as implementing the second option.

7. Rigid system (RS) – system only presents a limited set of actions to the operator. Operator's role is to select one and cannot generate any other options.
8. Automated decision making (ADM) – system selects the best option to implement and carry out that action, based upon a list of alternatives it generates.
9. Supervisory control (SC) – system generates options, selects the option to implement and carries out that action. Employee monitors the system and intervenes only if necessary.
10. Full automation (FA) – system carries out all actions. Employee is completely out of control in the process and cannot intervene.

3. Range of SIC Codes per division.

Range of SIC Codes	Division
0100 – 0999	Agriculture, Forestry and Fishing
1000 – 1499	Mining
1500 – 1799	Construction
1800 – 1999	Not used
2000 – 3999	Manufacturing
4000 – 4999	Transportation, Communications, Electric, Gas and Sanitary service
5000 – 5199	Wholesale trade
5200 – 5999	Retail trade
6000 – 6799	Finance, Insurance and Real Estate
7000 – 8999	Services
9100 – 9729	Public Administration
9900 – 9999	Nonclassifiable

Table 16: Industries based on SIC codes (U.S. Securities and Exchange Commission, 2018)

Distress

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Definitely not	43	61.4	61.4	61.4
	Probably not	14	20.0	20.0	81.4
	Might or might not	7	10.0	10.0	91.4
	Probably yes	5	7.1	7.1	98.6
	Definitely yes	1	1.4	1.4	100.0
	Total	70	100.0	100.0	

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
RPA production	58	1	5	3.36	1.038
RPA supplychain	55	1	5	3.15	.970
RPA marketing	62	1	5	2.95	.982
RPA HRM	64	1	5	3.16	1.057
RPA finance	64	2	5	3.66	.821
RPA IT	64	2	5	3.73	.821
RPA R&D	54	1	5	2.96	1.149
Valid N (listwise)	47				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
After-tax income	49	-1800	100000	8313.95	18862.900
Return on Assets	49	-.72	10.00	.6217	1.61836
Return on Sales	48	-6.00	20.00	.5051	3.07043
Market share gains	47	1	5	3.30	1.366
Sales growth	48	1	5	3.44	1.183
Overall performance	49	1	5	3.57	1.155
Valid N (listwise)	34				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Size	62	15	3500	491.61	764.750
Age	61	2	100	44.64	32.797
Industry Control | Competitors	64	1	5	4.03	1.154
Industry Control | Suppliers, Business Partners	64	1	5	3.81	1.220
Industry Control | IT critical means	64	1	5	3.84	1.336
Valid N (listwise)	60				

Function

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Financial Professional (senior level up to CFO)	47	73.4	73.4	73.4
	Financial Young Professional (junior)	9	14.1	14.1	87.5
	Technology Professional (senior level up to CTO)	8	12.5	12.5	100.0
	Total	64	100.0	100.0	

Industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Resource winning (agriculture; forestry and fishing; mining; construction)	4	6.3	6.3	6.3
	Manufacturing	18	28.1	28.1	34.4
	Services (transportation; communications; electric, gas and sanitary service; services)	18	28.1	28.1	62.5
	Retail (wholesale trade; retail trade)	8	12.5	12.5	75.0
	Financial services (finance, insurance and real trade)	8	12.5	12.5	87.5
	Public administration	8	12.5	12.5	100.0
	Total	64	100.0	100.0	

Thesis

Start of Block: Default Question Block

Info

The purpose of this survey is to test how Robotic Process Automation (RPA) influences firm financial performance in The Netherlands. First of all, some general questions are asked, such as size, age and industry related. Subsequently, questions regarding the financial performance of the firm are being asked. Followed by a question about the automation levels active in the firm and the last questions are statements regarding a few aspects of the firm.

This survey is written in two languages: English and Dutch. Please choose a language that suits you best and that makes you most comfortable. This survey will take approximately around 10 minutes of your time (on top of the page, you will see a progress bar) . In advance, I would like to thank you for participating in this survey and to thank for your time.

This survey will be conducted anonymously, sensitive information will not be made public. The main focus of this survey is to confirm or invalidate suggested relationships. This survey will therefore not harm the respondents. By answering this survey, you voluntarily consent to take this survey. You can withdraw from the research at any time without explanation/justification.

Page Break

Q1 Is the threat of financial distress imminent for your firm?

If answered probably yes or definitely yes, survey will not applicable for you

◯ Definitely not (1)

◯ Probably not (2)

◯ Might or might not (3)

◯ Probably yes (4)

◯ Definitely yes (5)

Skip To: End of Survey If Is the threat of financial distress imminent for your firm? If answered probably yes or definitel... = Probably yes

Skip To: End of Survey If Is the threat of financial distress imminent for your firm? If answered probably yes or definitel... = Definitely yes

Q2 What is your function level in the organisation?

◯ Financial Professional (senior level up to CFO) (1)

◯ Financial Young Professional (junior) (2)

◯ Technology Professional (senior level up to CTO) (3)

◯ Technology Young Professional (junior) (4)

Q3 How many employees (FTE) do work in the firm?

____

Q4 For how many years is the firm incorporated in business?

____

Q5 In what industry is the firm operating in?

- ◯ Resource winning (agriculture; forestry and fishing; mining; construction) (1)
- ◯ Manufacturing (2)
- ◯ Services (transportation; communications; electric, gas and sanitary service; services) (3)
- ◯ Retail (wholesale trade; retail trade) (4)
- ◯ Financial services (finance, insurance and real trade) (5)
- ◯ Public administration (6)

Page Break

Q6

Please indicate to what extent you agree to the following statements for your firm's industry.

Where IT stands for Information Technology

	Strongly disagree (1)	(2)	Neutral (3)	(4)	Strongly agree (5)
IT is used extensively by our competitors in this industry (1)	○	○	○	○	○
IT is used extensively by our suppliers and business partners in this industry (2)	○	○	○	○	○
IT is a critical means to interact with customers in this industry (3)	○	○	○	○	○

Q7 What is the trend of overall firm performance over the last 10 years? (for newly incorporated firms: from begin)

Where overall firm performance can be seen as an combination of:

- *After-tax return on total assets (ROA)*
- *After-tax return on total sales (ROS)*
- *Net profit position*
- *Market share gains relative to competition*
- *Sales growth position relative to competition*

◯ Strong decreased (1)

◯ Slightly decreased (2)

◯ More or less the same (3)

◯ Slightly increased (4)

◯ Strong increased (5)

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*

Q8 What is the amount of after-tax income (net income) (in €) on 01-01-2019?

Please answer in thousands! (x1,000)

____

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*

Q9 What is the average amount of total assets (in €) on 01-01-2019?

Please answer in thousands! (x1,000)

____

Q10 What is the amount of total sales revenue (in €) on 01-01-2019?
Please answer in thousands! (x1,000)

____

Page Break

Q11 Please indicate to the following statements to what category the firm belongs.

These questions are all in comparison to competition. So, for example, for market share gains, if answered lowest 20% it will mean that at least 80% of competitors are experiencing more market share gains than you.

	Lowest 20% (1)	21-40% (2)	Average 41-60% (3)	61-80% (4)	Top 20% (5)	Unknown (8)
Market share gains relative to competition (1)	○	○	○	○	○	○
Sales growth position relative to competition (2)	○	○	○	○	○	○
Overall firm performance/success (3)	○	○	○	○	○	○

Q12info

For the next question, information about the automation levels is needed in order to be able to answer it correctly.

1. Null to low level of automation (0-5%)

Employee is completely in charge and performs all the tasks or employee is almost completely in charge and system provide some assistance in what to do.

Example: physically process orders in folders based on the system.

2. Low to medium level of automation (5-20%) *Employee and/or system generates and selects what to do and system will execute the action. Employee still retains full control and can easily intervene. Mainly rule-based including scripts, macros and other.*

Example: generating tables in Excel based on the input of employee.

3. Medium level of automation (up to 60%) *Computer generates a list of decision options and selects one and carries it out if employee consents or employee selects one. This level involves complex rules and includes cross-application and system workflow automation.*

Example: computer generates a list of options (e.g., calculate revenue for month) based on date (system sees it is time for month-end) and executes this action. Data is gathered through multiple applications (ERP-system).

4. Medium to high level of automation (up to 80%) *System presents a limited amount of possible actions, user can only select one of these presented or system selects the best option and carries it out. Employee can still intervene and monitor. From this stage on, dealing with cognitive robotics such as natural language processing, voice recognition and cognitive computer vision.*

Example: system knows inventory is running low, provides two options: buy inventory or produce inventory itself. Based on selected option, system will initiate the process. Employee can still cancel or adjust the selected option. 5. High level of automation (up to 100%) *System is completly in charge and will carry out all actions, employee is out of control and cannot intervene. This level is self-learning and programming, programmed robots can learn and are able to held a conversation.*

Example: system knows inventory is running low, it will initiate a machine to produce more items, subsequently another machine provides the delivery to the place where inventory is held.

Q12 To what extent is automation active in the firm's several departments?

Please answer 6 if a given department does not exist in your firm.

	1. Null to low level of automation (0-5%) (1)	2. Low to medium level of automation (5-20%) (2)	3. Medium level of automation (up to 60%) (3)	4. Medium to high level of automation (up to 80%) (4)	5. High level of automation (up to 100%) (5)	6. Not applicable (6)
Production (when not manufacturing firm: responsible for the turnover) (1)	○	○	○	○	○	○
Supply chain (export, import, delivering, planning) (2)	○	○	○	○	○	○
Marketing (3)	○	○	○	○	○	○
Human Resource Management (HRM) (4)	○	○	○	○	○	○
Finance & Accounting (control) (5)	○	○	○	○	○	○
Information Technology (IT) (6)	○	○	○	○	○	○

Research & Development (R&D) (7)	○	○	○	○	○	○

Page Break

Info **The following statements are the last questions of this survey**

Q13 Please indicate to what extent you agree to the following statements for your firm.

Where IS stands for Information System

	Strongly disagree (1)	(2)	Neutral (3)	(4)	Strongly agree (5)
IS planning is an ongoing process in our organization; planning is not a once-a-year activity. (1)	○	○	○	○	○
Business units' participation in the IS planning process is very high. (2)	○	○	○	○	○
IS planning is initiated by senior management; senior management participation in IS planning is very high. (3)	○	○	○	○	○
We have a formalized methodology for IS planning. (4)	○	○	○	○	○

Our planning methodology has many guidelines to ensure that critical business, organizational, and technological issues are addressed in evolving a IS plan. (5)	○	○	○	○	○
We try to be very comprehensive in our planning, every facet is covered. (6)	○	○	○	○	○
Our systems development process can be easily adapted to different types of development projects. (7)	○	○	○	○	○

The systems development is continuously improved using formal measurement and feedback systems. (8)	○	○	○	○	○
Our systems development process has adequate controls to achieve development outcomes in a predictable manner. (9)	○	○	○	○	○
Our systems development process is flexible to allow quick infusion of new development methodology, tools, and techniques. (10)	○	○	○	○	○

Our systems development process facilitates reuse of software assets such as programs, design, and requirement specifications. (11)	○	○	○	○	○
We have a mature systems development process, the process is well defined and documented. (12)	○	○	○	○	○

Q14 Please indicate to what extent you agree to the following statements for your firm.

	Strongly disagree (1)	(2)	Neutral (3)	(4)	Strongly agree (5)
Our IS staff has very good technical knowledge; they are one of the best technical groups an IS department could have. (1)	○	○	○	○	○
Our IS staff has the ability to quickly learn and apply new technologies as they become available. (2)	○	○	○	○	○
Our IS staff has the skills and knowledge to manage IT projects in the current business environment. (3)	○	○	○	○	○

Our IS staff has the ability to work closely with customers and maintain productive user or client relationships. (4)	○	○	○	○	○
Our IS staff has excellent business knowledge; they have a deep understanding of the business priorities and goals of our organization. (5)	○	○	○	○	○
Our IS staff understands our firm's technologies and business processes very well. (6)	○	○	○	○	○
Our IS staff understands our firm's procedures and policies very well. (7)	○	○	○	○	○

Our IS staff is aware of the core beliefs and values of our organization. (8)	○	○	○	○	○
Our IS staff often do know who are responsible for the important tasks in this organization. (9)	○	○	○	○	○
Our IS staff is are familiar with the routines and methods used in the IS department. (10)	○	○	○	○	○

Q15 Please indicate to what extent you agree to the following statements for your firm.

	Strongly disagree (1)	(2)	Neutral (3)	(4)	Strongly agree (5)
The technology infrastructure needed to electronically link our business units is present and in place today. (1)	○	○	○	○	○
The technology infrastructure needed to electronically link our firm with external business partners is present and in place today. (2)	○	○	○	○	○
The technology infrastructure needed for current business operations is present and in place today. (3)	○	○	○	○	○

The capacity of our network infrastructure adequately meets our current business needs. (4)	○	○	○	○	○
The speed of our network infrastructure adequately meets our current business needs. (5)	○	○	○	○	○
Corporate data is currently sharable across business units and organizational boundaries. (6)	○	○	○	○	○

The complexity of our current application systems seriously restricts our ability to develop modular systems with reusable software components. (7)	○	○	○	○	○
Our application systems are very modular; most program modules can be easily reused in other business applications. (8)	○	○	○	○	○
We have standardized the various components of our technology infrastructure (e.g. hardware, network, database) (9)	○	○	○	○	○

Q16 Please write the name of your company.

(Not required and will not be disclosed if answered!)

____

Q17 In case you would like to receive a summary of the research results, please write your e-mail address.

____

End of Block: Default Question Block

6. Calculation sheet for discriminant validity

PLS	Loadings	^2					NPS	Loadings	^2			
	0,702	0,492804		n	4			0,85	0,7225		n	5
	0,848	0,719104		AVE	0,62			0,704	0,495616		AVE	0,65
	0,83	0,6889		Correlation between PLS & SYD	0,512			0,879	0,772641		Correlation between PLS & SYD	0,439
	0,76	0,5776		^2 correlation	0,262144			0,876	0,767376		^2 correlation	0,192721
								0,709	0,502681			
	Sum	2,478408		AVE PLS & SYD	0,62439158			Sum	3,260814		AVE NPS & DCS	0,54202465
				AVE > correlation square, hence discriminant validity							AVE > correlation square, hence discriminant validity	
SYD	Loadings	^2					DCS	Loadings	^2			
	0,776	0,602176		n	6			0,802	0,643204		n	4
	0,733	0,537289		AVE	0,63			0,066	0,004356		AVE	0,43
	0,819	0,670761						0,681	0,463761			
	0,851	0,724201						0,785	0,616225			
	0,818	0,669124										
	0,756	0,571536										
	Sum	3,775087						Sum	1,727546			
PES	Loadings	^2					IND_CNTRL	Loadings	^2			
	0,862	0,743044		n	4			0,906	0,820836		n	3
	0,869	0,755161		AVE	0,78			0,926	0,857476		AVE	0,79
	0,916	0,839056		Correlation between PLS & SYD	0,573			0,835	0,697225			
	0,876	0,767376		^2 correlation	0,328329							
	Sum	3,104637		AVE PES & HRS	0,69567121			Sum	2,375537			
				AVE > correlation square, hence discriminant validity								
HRS	Loadings	^2					FIRM PERF	Loadings	^2			
	0,732	0,535824		n	6			0,864	0,746496		n	3
	0,789	0,622521		AVE	0,62			0,941	0,885481		AVE	0,84
	0,852	0,725904						0,941	0,885481			
	0,765	0,585225										
	0,723	0,522729										
	0,836	0,698896										
	Sum	3,691099						Sum	2,517458			

Figure 8: calculation sheet for discriminant validity