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ABSTRACT

In the last decade, business process management (BPM) has become essential for corporations to maintain their control over business processes. Therefore it is highly important for companies to know which factors influence business process performance. Consequently, this study focuses on the relationship between BPM maturity and BPM performance. The paper aims to determine (1) whether BPM maturity has a significant effect on BPM performance and (2) whether there is a significant difference between a country that is in a relatively more mature stadium with regard to BPM practices and one that is still going through an adapting phase. In this case we compared the Netherlands and Portugal, in which Portugal reflects the country that is going through an adoption phase. A total of 138 Dutch and 58 Portuguese companies responded to an online survey about BPM practices. For this research, 29 Dutch and 12 Portuguese commercial companies with at least 1,000 employees were taken into account. Statistical empirical research shows that BPM maturity has a significant positive effect on BPM performance. It also shows that although the effect is positive in both countries there is a significant difference between the Netherlands and Portugal. The effect of BPM maturity on BPM performance is higher in Portugal than in the Netherlands. The research concludes that large commercial companies in both countries can attain a better BPM performance by raising their BPM maturity.

Keywords: Business Process Management, BPM maturity, BPM performance, Dutch, Portugal

INTRODUCTION

Implementing business process management has become more and more popular within the corporate sector. In order to maintain control over one's business processes in an ever-growing digital world, BPM has taken a key position during the last decade and has become indispensable for many companies. With this said, corporate Managers are continuously trying to improve their BPM performance as it increases companies' effectiveness and efficiency. Many Managers do not know where to focus on in improving BPM performance and the demand for answers is rising.

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Prior research has tried to find out which factors influence BPM performance. For example, research by Ravesteyn, Zoet, Spekschoor and Loggen (2012) has found a positive relationship between BPM maturity and BPM performance in the Netherlands. However research on BPM practices lacks empirical studies that compare two or multiple countries. This is a peculiar fact since internationalization has become a widespread phenomenon. Therefore, this paper aims to determine (1) whether BPM maturity has a significant effect on BPM performance and (2) whether there is a significant difference between a country that is in a relatively more mature stadium with regard to BPM practices and one that is still going through an adoption phase.

This research compares the Netherlands and Portugal, in which Portugal reflects a country that is going through an adoption phase and the Netherlands reflects a country that is in a relative mature stadium (Ravesteyn et al., 2012). The following exploratory research question is formulated: "Which differences exist between the BPM maturity and BPM performance between the Netherlands and Portugal?"
This paper is structured as follows. First a review is given of relevant theory regarding BPM practices. It is crucial to identify the dimensions used for BPM maturity and BPM performance. Hereafter, the dataset will be described. All relevant variables will be explained and the filtering process of the dataset will be revealed. The empirical analysis is divided into a bivariate model, a multivariate model and a multivariate model based on country differences. The bivariate model shows the relationship between BPM maturity and BPM performance. For the multivariate model the variables 'Sector' and 'Employees' are added to the equation. In order to compare the results of the Netherlands and Portugal a Chow-test was conducted. Subsequently conclusions are mentioned followed by a discussion section and future research.

LITERATURE REVIEW

Businesses nowadays are becoming ever more complex amongst others due to internationalization, growing amounts of information and the rise of Information Technology. From economics to finance, and from customer relationship management (CRM) to marketing, organizations are constantly searching for improvement of their efficiency and increase of the return on investment (ROI).

This drive for improvement is present throughout all organizations. When looking at an organization there are several aspects, which can be improved, one of these are the processes of an organization. Processes can be seen as 'the way business is done' and are therefore the main assets of a company (Accorsi, Lehmann, & Lohmann, 2014). Numerous techniques and strategies have been created by both organizations, and researchers as to how process performance can be improved.

An example of this is Six Sigma, created by Motorola in 1986. Six Sigma sets out to improve the quality of output by identifying and removing causes for defect and minimizing manufacturing variability; it is widely used in the industrial sector. (Motorola University, 2005)

Another, equally well known example is Lean Manufacturing, which is a 'philosophy' largely created on the basis of Toyota's production system. Here the emphasis is on the parts of the production process that is adding value to the end customer, any aspect that does not add value is considered to be wasteful and thus should be eliminated (Womack, Jones, & Roos, 1991).

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Not only in manufacturing, but also in the financial and services sectors there are many organizations focusing on their process performance. Terms like *continuous improvement* and *business process improvement* are found in almost any large organization, this is shown in an example from South-Korea where a credit card company is optimizing their services by combining customer complaints with business process management (Pyon, Woo, & Park, 2011). Often one can even find departments in organizations with the sole purpose of business process optimization.

With processes being the main assets of a company (Accorsi et al., 2014), Gartner (2005) already identified business process management as the number one business priority during the first decade of this century. Because of this relevance of process performance and process management, this research will focus on business process management in organizations. According to the BPM Institute, a peer-to-peer exchange for BPM professionals, there are literally hundreds of books, articles, white papers and entire conferences on the subject of BPM. The term BPM is used loosely, and the meaning often varies depending on the context. Before elaborating on the research relevance and the research purpose, it should be clear how BPM is defined in the context of this paper. In this research we use the BPM Institute (2012) definition that states that BPM is:

1. A process of managing your business processes;
2. A management discipline;
3. A technology or set of technologies;
4. Rapid application development framework.

Apart from the definition of BPM, it is important to know the purpose of BPM initiatives in organizations. According to Hammer (2010) BPM aims to increase the efficiency and effectiveness of organizational processes through improvement and innovation.

When looking into the history of BPM as a professional domain, one can trace this back to the 19th century. In the early 1880s, it was Frederick Winslow Taylor who first analyzed the manufacturing workflows with the aim to improve them. Based upon this analysis, he wrote a book called *The Principles of Scientific Management* in 1911. Although BPM as a separate field of study started to emerge in the mid- and late-nineties of the past century, the foundations of process oriented analysis of organizations and the support of these by means of IT systems has a longer history starting with Ellis (1979) and Zisman (1977).

To indicate the relevance and popularity of BPM nowadays there are many studies that show how significant the influence of BPM is on businesses. Studies developing models to improve BPM are popular. For example, providing a methodology that can aid project managers make proper BPM investment strategies (Bai & Sarkis, 2013) or providing a comprehensive picture of BPM capabilities in governments (Niehaves, Plattfaut, & Becker, 2013).

Next to the wide range of models for BPM, studies also focus on companies in particular and the experiences with BPM. A research by Nikolova-Alexieva (2012), which includes a survey having 350 respondents from Bulgarian enterprises for over three years (2009-2011), shows that initiatives regarding business processes were present and of a significant level in Bulgarian

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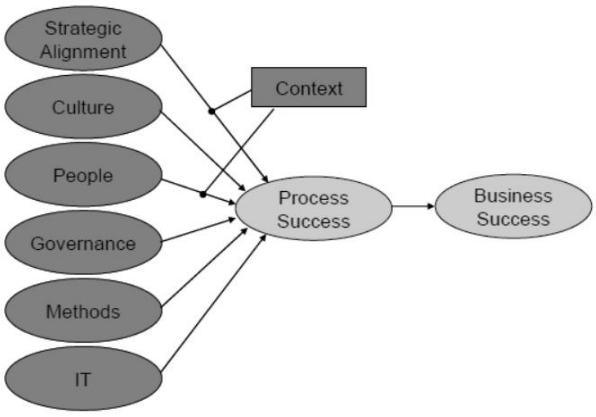
enterprises. Companies are using BPM for growing and saving expenses (Nikolova-Alexieva, 2012). Another research collected empirical data from 368 companies headquartered in Brazil. Business process orientation (BPO) and analytical indicators where proven to be predictors of the performance of an organization, thus showing BPM is significantly relevant for organizations (Bronzo et al., 2013).

A recent quantitative research in Slovakia aims to determine the current status of BPM usage in Slovak enterprises in the wood-processing branch. This study shows how these enterprises focus too little on process management, and if there was more implementation of BPM the enterprise would improve measuring business results and effective costs reduce (Sujova, Rajnoha, & Merková, 2014).

An Australian research project among a small number of Australian firms has made a first approach on developing a BPM maturity model, which facilities the assessment of BPM capabilities (Rosemann & De Bruin, 2005). However this research did not give empirical evidence between the factors of the business process management maturity (BPMM) model and the BPM success. Still this is an important research domain, since process maturity models provide organizations the possibility to evaluate organizational processes and identify opportunities for optimization and thus adding value (Ravesteyn, Zoet, Spekschoor, & Loggen, 2012). The model created by Rosemann & De Bruin (2005) is based upon six core factors, being: strategic alignment, governance, enhancement method, information technology, people and culture. The notion here is that a higher maturity in each of these factors will reflect in higher levels of success in the BPM initiatives of an organization. This *process success* has to be translated into, from a commercial perspective more relevant, business success (Rosemann & De Bruin, 2005). The model that was created is reflected in Figure 1.

Figure 1: BPM maturity model (Rosemann & De Bruin, 2005).



This BPM maturity model from Rosemann and the Bruin (2005) is later combined with research that explains the business process improvement in relation to maturity models (Curtis & Alden, 2006). Combining the latter research and the BPM maturity model, led to a research study from the Netherlands. This quantitative research study among 168 respondents from Dutch organizations studied the correlation between the level of adaptation of BPM and process performance for these organizations. The outcomes show that there is dependence between the

performance of processes within an organization and the BPM maturity of that organization. The research concluded that a positive relationship between BPM maturity and process performance exists. The study has put relatively more effort into measuring performances of processes and to relate this to on-going process improvement initiatives (Ravesteyn et al., 2012).

All of the research previously referred to, show how current studies are done based on a number of organizations limited to the countries origin (Bulgaria, Brazil, Slovakia, Australia and the Netherlands). BPM research lacks empirical studies that compare two or more countries. This could be of interest for all organizations throughout the world since internationalization of companies is a widely spread phenomenon. This raises the question if there could be significant differences between countries in BPM maturity and process performance.

As the European Union aims at uniform business legislation, it is very relevant to compare EU Member States and their BPM maturity. Moreover, the current European Commission has established and reviewed many legislation directives on enterprises. For example, the accounting directives, in particular directive four and seven, establish a uniform system of auditing company accounts (Dimireva, 2009). Study by Ruivo, Oliveira and Neto (2014) shows that some EU member states, are having difficulties with conforming to these EU guidelines. They find that as a consequence of a uniform accounting legislation on EU level "(…) some member states, such as Portugal, are facing a challenge changing from its own national accounting legislation to the accounting principles and guidelines adherent with the IFRS as adopted in the EU and already adopted by other states." (Ruivo, et al, p.4). It must be said that their study is about the adoption of Enterprise Resource Planning (ERP) by Portuguese companies. However, as discussed before, BPM can be defined as a set of technologies, including ERP. With this said, the following hypotheses can be formulated:

Hypothesis 1 - The BPM maturity of companies in the Netherlands is higher than those located in Portugal.

Hypothesis 2 - The BPM performance of companies in the Netherlands is higher than those located in Portugal.

In order to realize this research, we try to answer the following research question: "Which differences exist between the BPM maturity and business processes between the Netherlands and Portugal?" This is a rather exploratory research question and therefore this research has several sub-questions:

1. What is the level of business process maturity of companies in both the Netherlands and Portugal?
2. What is the level of business process performance in both the Netherlands and Portugal?
3. What are the similarities and differences between these two countries?

RESEARCH APPROACH

General Approach

In order to successfully carry out this research, we first performed an extensive literature study to identify the main topics within the existing BPM related scientific research publications. To find these scientific articles and journals we have made use of various sources. Predominantly the Science Direct database is used in combination with Google Scholar and the online library of the University of Utrecht (UU). As a foundation to this research the publication of Ravesteyn et al. (2012) on the dependence between process maturity and process performance is used.

The study described in this paper can be seen as an extension of prior research on BPM in the Netherlands (Ravesteyn et al., 2012), which was in turn part of a broader study on BPM in the Netherlands by Loggen, Havenith, Spekschoor, Versendaal and Ravensteyn (2011). The Research by Ravesteyn et al. (2012) is a longitudinal study for which quantitative research, by means of a structured online survey, was developed and distributed to various business sectors in the Netherlands. This same survey was distributed again a year later in 2013. Additionally, this survey was translated from Dutch to English and consequently from English to Portuguese. In 2013, the online survey was also distributed to 500 commercial companies in Portugal.

The web-survey mentioned above is a structured one with both open and closed questions. The questions can be divided into four different categories:

a) General questions about the organization;
b) Questions about the BPM definition;
c) Questions about the current situation with regard to BPM practices within the organization;
d) Questions about the organization's process performance.

Data Measurement Instrument

The questionnaire used in this research consists of a total of sixteen questions of which some are divided in sub-questions. The questionnaire can be divided into two types of questions and answers: answers based on categorical terms and answers based on a Likert scale.

To be able to analyze the BPM maturity within an organization and consequently, to answer the research question of this paper, specific dimensions for BPM maturity will be used. These dimensions are based on the capability maturity model integrated (CMMI) and research by Rosemann, de Bruin and Hueffner (2004), Rosemann and de Bruin (2005) and Rosemann, de Bruin and Power (2006). The following dimensions will be used for BPM maturity, described in Table 1.

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Table 1: BPM maturity dimensions (Ravesteyn, Zoet, Spekschoor, & Loggen, 2012).

Dimension	Description	No. of Items
Process awareness	Management realizes the importance of a process oriented organization and includes this in its strategy	4
Process description	Process and related information within the organization are identified and captured in process descriptions	6
Measurement of processes	A system to measure and control processes is in place in order to be able to improve processes	5
Management of processes	Process owners are assigned within the organization whom are 'horizontally' responsible for managing processes	5
Process improvement	The organization strives to continually improve processes and there is a system in place to enable this	6
Process resources and knowledge	The organization has adequate resources (such as people with process knowledge) to create a "culture of process orientation"	4
Information Technology	The organization uses IT to design, simulate and execute processes, and to provide real-time measurement information (key performance indicators)	7

Similarly, to determine the level of process performance, twelve statements were developed by Ravesteyn et al. (2012) based on Hueffner (2007) and Rudder (2007). These are described in Table 2.

Table 2: Process performance dimensions (Ravesteyn, Zoet, Spekschoor, & Loggen, 2012).

Process performance characteristic	Statement
Costs	The processes within the organization are executed against acceptable costs
Traceability	Processes within the organizations are easily traceable (thus transparent)
Efficiency	Processes within the organization are efficient
Lead-time	The processes within the organization have an acceptable lead-time
Customer focus	Processes within the organization are customer centric
Continuous improvement	The processes within the organization are continuously being improved
Quality	The results delivered by processes within the organizations are of good quality

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Measurability	Processes within the organization are easily measurable
Employee satisfaction	Processes within the organization contribute to the employee satisfaction
Competitive advantage	The processes within the organization give our organization a competitive advantage
Flexibility	Processes within the organization can easily be changed
Comprehensibility	Processes within the organization can be understood by everybody

The survey results will be empirically tested during this research to identify the actual BPM practices within companies. In the Netherlands, the survey was distributed to the individuals that are member of the Dutch BPM-forum, with the number of responses equaling 225. Out of these 225, 138 individuals actually finished the survey.

In Portugal the survey was distributed to the top 500 commercial organizations of the country with the number of responses being 58. To ensure the validity of the survey results, the Dutch sample was filtered by business sector, as only commercial companies were approached in Portugal.

Furthermore, both samples were filtered by firm size based on the amount of employees. Summarized, this study looks at the top 50 commercial companies (based on the amount of employees) amongst the ones that responded to the survey in Portugal and the Netherlands. This will give a unique comparison between the large organizations of both countries.

DATA ANALYSIS

As mentioned in the previous sector, the survey in Portugal only included commercial companies, thus the Dutch survey had to be filtered by sector. We filtered out the Dutch non-commercial organizations; the results are reflected in Table 3. All responses from organizations within the deleted sectors are not taken into account.

Table 3: Filter by sector in the Dutch sample.

Sector	
Before filtering	**After filtering**
Distribution & transport	Distribution & transport
Financial institutions	Financial institutions
Lower government & provinces	X
Manufacturing	Manufacturing
Education & science	X
Retail & consumer	Retail & consumer
Central government	X
Telecommunication & media	Telecommunication & media
Executive organizations (central government)	X

Utilities	Utilities
Corporate services	Corporate services
Healthcare	X
Other	Other

Furthermore the population sample is filtered by company size based on the amount of employees. Although the data is already filtered on companies with more than 1000 employees, there are still several categories above this level. This was done for both countries and resulted in 29 final observations for the Netherlands and twelve final observations for Portugal, as demonstrated in Table 4.

Table 4: Filter by amount of employees for both countries.

Employees	
Before filtering	**After filtering**
1 – 100	X
101 – 500	X
501 – 1000	X
1001 – 2000	1001 – 2000
2001 – 3000	2001 – 3000
3001 – 5000	3001 – 5000
> 5000	> 5000

Merging the two datasets together was one of the major challenges of this research. A country 'dummy country' was created, which is labeled as 0 for the Netherlands and 1 for Portugal. Moreover, the challenging part of merging the two datasets together was that there was a slight, but problematic difference in the translation of the survey. For questions P2 and P3 – the survey is available upon request to the authors – the Portuguese questions were formulated differently than the Dutch version. In specific, the Portuguese version asked: "Do you agree and if so how much on a scale of 1-5?" While the Dutch survey asked: "Which are the three most important ones according to you?" In order to merge the datasets together we replaced the codes of the Portuguese answers. If there is no response the value is 0 and if the value is on the scale of 1-5, this value is replaced by a value of 1.

Moreover, the Dutch sectors did not match the Portuguese sectors in the existing classification. This research has mapped the sectors from Portugal to the sectors in the Netherlands in order to make a more precise comparison. The procedure can be seen in Table 5. After mapping out each sector, we have decided to change all the Portuguese 'S' codes to the Dutch ones to make a more precise comparison between the two survey results.

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Table 5: Mapping out sectors.

	Portugal	Mapped to NL
S0	Other	13 (Other)
S1	Food, drinks & tobacco	6 (Retail & consumer)
S2	Financial & insurance activities	2 (Financial institutions)
S3	Press and information activities	8 (Telecommunication & media)
S4	Commerce	6 (Retail & consumer)
S5	Construction	10 (Corporate services)
S6	Hotel, restaurant & tourism	6 (Retail & consumer)
S7	Electronics industry, machinery & other	4 (Manufacturing)
S8	Chemical industry	4 (Manufacturing)
S9	Metallurgical industry & metal products	4 (Manufacturing)
S10	Pulp, paper, cardboard & products, publishing & printing	10 (Corporate services)
S11	Non-metallic mineral products	4 (Manufacturing)
S12	Health & medical activities	12 (Healthcare)
S13	Energy sector	10 (Utilities)
S14	Primary sector, extractive and various industries	6 (Retail & consumer)
S15	Transport, communications / tele-communications & distribution services	1 (Distribution & transport)

Lastly, we were forced to make some alternations in the dataset. In Stata we generated several new variables and renamed them. These actions can be seen in Table 6 including the specific formulas.

Table 6: Stata actions.

Action	Formula
gen BPMAwareness	(S2a + S2b + S2c + S2d) / 4
gen BPMDescription	(S3a + S3b + S3c + S3d + S3e + S3f) / 6
gen BPMMeasurement	(S4a + S4b + S4c + S4d + S4e) / 5
gen BPMStearing	(S5a + S5b + S5c + S5d + S5e) / 5
gen BPMImprovement	(S6a + S6b + S6c + S6d + S6e + S6f) / 6
gen BPMMeans	(S7a + S7b + S7c + S7d) / 4
gen ProcITStatement	(S8a + S8b + S8c + S8d + S8e + S8f + S8g) / 7
gen ProcessPerformance	(P1a + P1b + P1c + P1d + P1e + P1f + P1g + P1h + P1i + P1j + P1k + P1l) / 12
gen ProcessBarriers	(P2a + P2b + P2c + P2d + P2e + P2f + P2g + P2h + P2i + P2j + P2k + P2l + P2m + P2n + P2o) / 15
gen ProcessKPI	(P3a + P3b + P3c + P3d + P3e + P3f + P3g + P3h + P3i + P3j) / 10
gen BPMMaturity	(1/7) * (BPMAwareness + BPMDescription + BPMMeasurement + BPMManagement + BPMImprovement + BPMMeans + BPMIT)
gen BPMPerformance	(1/3) * ProcessPerformance + ProcessBarriers + ProcessKPI)

RESULTS

Bivariate Model

The bivariate model consists of a regression of only one dependent variable onto an independent variable. The dependent variable used in the research is BPM performance, with the independent variable being BPM maturity. The regression will be made for both the Netherlands and Portugal. Two separate population models will therefore be created from the next equation (1):

$$BPM\_Performance_i = \beta_0 + \beta_1 BPM\_Maturity_i + \varepsilon_i \quad (1)$$
$$(+)$$

From equation (1) the following sample equation was set up (2):

$$BPM\_Performance = \beta_0 + \beta_1 BPM\_Maturity + e \quad (2)$$

To run the bivariate regression the following hypothesis is created:
H_A: $\beta_1 > 0$

In order to see if the results of the regression can be interpreted significantly one can look at the P-value of the independent variable. The regression in table 7 shows a P-value of 0.000. This means that the chance that the null hypothesis can be accepted is lower than 0.000. This value is also lower than the significance level of 5%.

As the results from the regression are significant these can also be interpreted and the null hypothesis can be rejected. Looking at the coefficient of BPM maturity it can be concluded that an increase of one in the Likert scale of BPM maturity leads to an increase of 0.284 in the probability that there is BPM performance, as shown in table 7. This positive relationship was also expected.

Table 7: Bivariate OLS regression output.

	BPM performance	**P-value**
BPM maturity	0.284	0.000
Constant	0.314	0.056
Observations	41	
R-squared	0.4724	

In order to check whether these results also hold when just examining the Dutch organizations a new bivariate regression is created with an additional condition for country.

In Table 8 it is shown that for the Netherlands, this bivariate regression also results in BPM maturity having a significance influence on the BPM performance, as the P-value is lower than the 5% significance level. The impact of a change of one on the Likert scale of BPM maturity here leads to an increase of 0.230 in the probability that there is BPM performance. Therefore the null hypothesis can also be rejected for the Dutch organizations.

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After checking for the Dutch organizations, the following regression shows the results for the Portuguese firms. Here too, an additional condition has been made, this time excluding the Dutch firms.

For the Portuguese firms, the same conclusion can be made as for the Dutch firms: the BPM maturity is of significant influence on the BPM performance as the P-value is below 5%. The impact of an increase of one on the Likert scale of BPM maturity would lead to an increase of 0.255 in the probability that there is BPM performance. The null hypothesis can also be rejected here. These results are shown in Table 8.

Table 8: Bivariate OLS regression output per country.

	The Netherlands		*Portugal*	
	BPM performance	**P-value**	**BPM performance**	**P-value**
BPM maturity	0.230	0.000	0.255	0.001
Constant	0.388	0.013	0.644	0.011
Observations	29		12	
R-squared	0.4836		0.6589	

Multivariate Model

The multivariate model is an expansion of the bivariate model in which BPM performance is the dependent variable and where BPM maturity is the independent variable. In order to make the analysis of the relation between BPM maturity and BPM performance more reliable a series of independent variables must be added.

Based on the literature research, one factor that comes back continuously is sector. Some sectors tend to have more developed BPM programs because they started using it in an early phase, such as the manufacturing sector, the financial sector and the corporate services sector. Although the dataset is already filtered on only commercial companies, these companies can still be categorized in several industries as can been seen from table 3. Therefore, the second independent variable in the multivariate model is: 'sector'. This variable is expected to have a positive relationship with BPM performance.

Adding 'employees' to the equation completes the multivariate model. Literature research has shown that there is controversy whether relatively big companies have an advantage in BPM over smaller companies. Due to missing information on companies' revenues, this research defines the size of a company based on the number of employees. Although there is controversy whether bigger companies have an advantage in BPM over smaller companies, the results show how there is a positive relationship between the amount of employees and BPM performance.

Next we will present the multivariate model used to determine the impact of BPM maturity as well as the sector and the amount of employees of an organization on the BPM performance of the organization. The multivariate population model for both the Netherlands and Portugal looks as follows:

$$BPM\_Performance_i = \beta_0 + \beta_1 BPM\_Maturity_i + \beta_2 Sector_i + \beta_3 Employees_i + \varepsilon_i \quad (3)$$

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(+) (+) (+)

The estimated regression of equation (3) can be seen in in Table 9.

Table 9: Multivariate OLS regression output.

	BPM performance	**P-Value**
BPM maturity	0.287	0.000
Sector	0.012	0.105
Employees	-0.062	0.020
Constant	0.583	
Observations	41	
R-squared	0.5949	

Firstly, a test for heteroskedasticity was performed to see whether the error term had a constant variance. As this was not the case, it was confirmed that the error term was homoscedastic. Further details on this can be found in appendix I.

As the independent variables maturity and employees both have a P-value of below 0.05, they can both be considered to have a significant effect on the dependent variable BPM performance. The impact of BPM maturity on BPM performance can be interpreted as follows: an increase of one in the Likert scale of BPM maturity leads to an increase of 0.287 in the probability that there is BPM performance, ceteris paribus. However, an increase of one in the ordinal category of employees leads to a decrease of 0.062 in the probability that there is BPM performance. Since 'sector' has a P-value of 0.105, which is above the significance border, we can conclude it does not have a significant effect on BPM performance in the current dataset.

In order to answer the research question whether there is a significant difference between the Netherlands and Portugal, we need to regress the multivariate equation separately for the Netherlands and Portugal. The regression output can be seen in Table 10.

Table 10: Multivariate OLS regression output per country.

	The Netherlands		*Portugal*	
	BPM performance	**P-Value**	**BPM performance**	**P-Value**
BPM maturity	0.256	0.000	0.261	0.004
Sector	0.110	0.065	-0.008	0.632
Employees	-0.028	0.264	0.158	0.748
Constant	0.410	0.054	0.605	0.089
Observations	29		12	
R-squared	0.5969		0.6712	

As shown in the result, for the Netherlands, both Sector and Employees do not have a significant effect on BPM performance as their P-values are higher than 0.05, respectively 0.065 and 0.264. BPM maturity does have a significant effect on BPM performance, meaning that if BPM

maturity increases by one on the Likert scale, it has an additional positive effect of 0.256 in the probability that there is BPM performance.

For Portugal, BPM maturity has a significant effect on BMP performance as its P-value of 0.004 is below 0.05. This means that, just like in the Netherlands, BPM maturity has a positive effect on BPM performance. More specifically, if BPM maturity increases by one on the Likert scale than there is an increase of 0.261 in the probability that there is BPM performance. Similarly to the Netherlands, the P-value of sector and employees is above 0.05, meaning that these variables do not have a significant effect on BPM performance. For this reason, these are not included into further analyses of our models.

In the previous section, the output for the Netherlands and Portugal were compared. In order to confirm the validity of the results, a Chow test is applied. We included the dummy 'country' as the interaction term, this is considered important because literature research has shown that there could be a significant difference on the relationship between BPM maturity and BPM performance between countries that are in a relative more mature stadium of adopting IT systems and countries that are still in an adoption process. The country dummy is labeled as 0 for the Netherlands and 1 if it is Portugal. Next to the normal multivariate regression equation or restricted model, two unrestricted models are created: one for the Netherlands and one for Portugal.

Restricted model:

$$BPM\_Performance_i = \beta_0 + \beta_1 BPM\_Maturity_i + \beta_2 Sector_i + \beta_3 Employees_i + \varepsilon_i \quad (4)$$

Unrestricted models:

For the Netherlands:

$$BPM\_Performance_i = \beta_0^{NL} + \beta_1^{NL} BPM\_Maturity_i + \beta_2^{NL} Sector_i + \beta_3^{NL} Employees_i + \varepsilon_i \quad (5)$$

For Portugal:

$$BPM\_Performance_i = \beta_0^{PT} + \beta_1^{PT} BPM\_Maturity_i + \beta_2^{PT} Sector_i + \beta_3^{PT} Employees_i + \varepsilon_i \quad (6)$$

The null hypothesis, which states that there is no difference between the coefficients of the Netherlands and Portugal, will be tested against the alternative hypothesis, which states that the null hypothesis is not true. The following hypothesis was constructed with a significance level of 0.05:

H_0: $\beta_0^{NL} = \beta_0^{PT}$, $\beta_1^{NL} = \beta_1^{PT}$, $\beta_2^{NL} = \beta_2^{PT}$, $\beta_3^{NL} = \beta_3^{PT}$
H_a: H_0 not true
α: 0.05

The F-stat formula is used to calculate the F-statistic.

$$F = \frac{(RSS_M - RSS_1 - RSS_2) / (k + 1)}{(RSS_1 + RSS_2) / (n1 + n2 - 2(k + 1))}$$

However, all three models must first be estimated. The results are reflected in Table 11.

Table 11: F-statistic.

	Restricted (M)	Unrestricted NL (1)	Unrestricted PT (2)
RSS	1.37	0.41	0.32
Observations (*n*)	41	29	12
Parameters (*k*)	3	3	3

$$= \frac{(1.37 - 0.41 - 0.32) / (3 + 1)}{(0.41 + 0.32) / (29 + 12 - 2\,(3 + 1))} = 7.23287741 \approx 7.23$$

The critical F-stat can be derived from the critical values of the F-statistics table.

$F_C = F_{4,33,0.05} = 2.61$

The F-statistic calculated from the restricted and unrestricted models with regard to country is 7.23. At a 5% significance level, this is larger than the critical F-statistic of 2.61, hence: $F > F_C$ since $7.23 > 2.61$.

Thus, we reject H_0; we accept the unrestricted models in favor of the restricted model. In conclusion, the Netherlands and Portugal have a significant different regression equation. In other words, the country (the Netherlands or Portugal) has a significant influence on the regression results.

By checking for multicollinearity we try to confirm that each of the variables are not perfectly correlated with one another. This must be done separately for the bivariate and multivariate case. Regarding the bivariate case, the independent variable cannot be constant (derived from the OLS solution for β_1). The OLS solution for β_1 is as follows:

$$\frac{\text{Cov}(X_i, Y_i)}{\text{Var}(X_i)}$$

As a result of the above calculation, the Var (X_i) will never be zero. For that reason multicollinearity cannot exist in the bivariate model.

Considering the multivariate model, Table 12 shows the correlations between the variables used:

Table 12: Multicollinearity.

	Employees	Sector	BPM maturity	BPM performance	Country	Sector * Employees
Employees	1.000					
Sector	-0.2294	1.000				
BPM maturity	0.0367	0.0125	1.000			
BPM performance	-0.2782	0.2477	0.6873	1.000		

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Country	-0.4187	0.2271	0.1856	0.6421	1.000	
Sector * Employees	0.0866	0.9274	-0.0089	0.1723	0.1280	1.000

What can be seen from this table is that the correlation between the variables is never one. As a result of this we can confirm that the variables used are not perfectly correlated with each other and the outcomes of the research are not affected.
To be able to test whether for each value of 'employee' there is a different marginal effect of 'sector' on BPM performance, the interaction term Sector*Employee was included in the regressions.

$$BPM\_Performance_i = \beta_0 + \beta_1 BPM\_Maturity_i + \beta_2 Sector_i + \beta_3 Employees_i + Sector*Employee + \varepsilon_i \quad (7)$$

The result of the regression shows the significance of the interaction term Sector*Employees, these are shown in Table 13:

Table 13: results of multivariate regression including interaction term.

	Coefficient	**Significance**
BPM maturity	0.30	0.00
Employees	-0.04	0.22
Sector	-0.12	0.01
Sector * Employees	0.01	0.11

To test the significance of the interaction term, an F-test has to be performed, combining Employees and the interaction term, the result of this is shown is Table 14.

Table 14: Results of F-statistic on significance of the interaction term.

F-test Employees - Interaction term	
Significance level	0.02

The F-statistic of the variables showed a significance level of 0.02, which is lower than the significance level of 0.05. Therefore it can be concluded that the interaction term is in fact significant.

CONCLUSION

By using a dataset filled in by companies from both the Netherlands and Portugal we tried to answer the question: "Which differences exist between the BPM maturity and BPM performance between the Netherlands and Portugal?"

Firstly, this research checked the relationship between BPM performance and BPM maturity. We have shown that the BPM performance, taken as the dependent variable, is significantly and positively influenced by the level of BPM maturity. This dependence was already found by a

previous research (Ravesteyn et al., 2012), however this research only focused on the Netherlands.

Using weighted averages, we have found that the positive relationship between BPM maturity and BPM performance is present in both the Netherlands and in Portugal. Thus there is a similarity in BPM within these countries. The dependence of BPM performance on BPM maturity is proven by the statistical analyses.

By checking for multicollinearity in both the bivariate and multivariate model we conclude that the regression has no perfectly correlated variables. Furthermore, this research shows no constant variance in the error term, and thus no heteroskedasticity was found. Estimated variances are unbiased and the research confirms the presence of homoscedastic error terms of the independent variables.

By checking with statistical analyses techniques for the relationship between BPM performance and BPM maturity and incorporating econometric methods, such as the interaction term and checks on heteroskedasticity and multicollinearity, we are positive that the results are significant and true.

Not only has this research added significant new findings to the already existing literature, this research is also one of the first comparing BPM maturity in two countries. That being said, by using a Chow-test we found a difference between Portugal and the Netherlands, as the variable 'country' appeared to have a significant influence on the dependent variable.

The actual difference in coefficients is rather small, however BPM maturity still has a larger influence on BPM performance for a company in Portugal than for a company in the Netherlands. The difference can be explained by the difference in BPM maturity phases in the countries, the Netherlands is more developed in business process management than Portugal is (Ruivo, et al, p.4). Since Portugal is still at the beginning of implementing BPM, it is likely that increasing BPM maturity will have a larger influence on BPM performance, because the concept of BPM in Portugal is still in an early phase with a relatively low level of BPM maturity.

In conclusion, raising the BPM maturity of an organization can improve the BPM performance in both countries. However, this positive influence of BPM maturity on BPM performance will be larger in Portugal.

DISCUSSION AND FUTURE RESEARCH

A survey was sent to the top 500 commercial companies in Portugal from which 58 actually responded. Within the Netherlands, the survey was distributed to members of the Dutch BPM-Forum, with the number of responses equaling 225. Out of these 225, 138 individuals actually finished the survey. However it could be the case that the answers given are biased because of an error in the filled-in surveys by respondents or due to the length of the survey. Although this might be the case, no indication of this has been found.

The Portuguese survey has only been sent to, and therefore only covers, the top 500 commercial companies in Portugal, while the Dutch survey also covered some governmental, healthcare and

educational organizations. Thus, these are left out for this research and since the research of Portugal was sent to the top 500 commercial companies, only the commercial companies with over 500 employees are considered in this research for both the Netherlands and Portugal. Taking the larger commercial companies of both countries was done in order to avoid bias, however we cannot fully ensure this. For future research both surveys should be send to the top 500 commercial companies of both countries, this will clear out the possibility of a bias.

Because of the controlling for larger commercial companies in both Portugal and the Netherlands, the observations were respectively 29 for the Netherlands and twelve for Portugal. The research has checked for normal distribution of Portuguese companies and their respective variables, thus this research believes the findings are correct and significant. By incorporating checks such as an interaction term, heteroskedasticity and multicollinearity, we are positive that the results found are trustworthy. However, future research should check if the same conclusions could be made when a larger sample is taken into account.

The translation of the survey from Dutch to English and thereafter from English to Portuguese is not expected to give a bias in this research. Nonetheless, the survey has had some slight changes since the possible industry sectors in the survey for Portugal differ from those of the Netherlands. This research has mapped the sectors of the Portuguese companies to the Dutch sectors. For future research it might be helpful to start with a similar English survey to be entirely sure the results in sector are not biased.

Employees have answered the surveys with regard to BPM maturity and BPM performance. Therefore it is his or her own perception of the level of BPM. Since this research has not done any case studies to check the development of BPM within an organization, this research is not entirely sure all perceptions on BPM given in the survey are correct. Case studies on organizations could be applied in further research to check whether the perception of employees on their own BPM development is indeed correct.

Lastly, the survey covers numerous aspects that create the variables BPM maturity and BPM performance. Even though 37 and twelve items/statements are covered to create the variables, it could still very well be that the survey did not cover every influencer on this matter. Next to this it could be the case that there is an omitted variable bias in the regression, options such as experienced BPM manager or total revenue of the company are not incorporated in the survey and thus this research. It could be the case that these influence the BPM performance and therefore future research should incorporate questions such as these to check if there is any omitted variable bias in this research.

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APPENDIX 1

HETEROSKEDASTICITY

Heteroskedasticity testing

In checking for heteroskedasticity we test whether the error term does not have a constant variance. If heteroskedasticity is found, the estimated variances are biased, and since both the T-statistic and the F-statistic depend on the variances the model would not be trustworthy.
This would result in the both the hypothesis testing and conclusions not being reliable anymore and we would not be able to perform inference about the population from a sample.

The test for heteroskedasticity was done based upon the Breusch-Pagan test. Here we regressed independent variables onto the square founded residuals of the original regression. The following hypotheses were defined:

H_0: $\delta_1 = \delta_2 = \delta_3$
H_a: H_0 not true
$\alpha = 0.05$

The results of the F-test show that Prob > F = 0.946. As this result is higher than the significance level of 5% we can reject the null hypothesis of heteroskedasticity and can confirm the presence of homoscedastic error terms of the independent variables.