The role of Capability and Commitment enhancing HR practices regarding the effects of sustainability efforts on firm performance

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I, R. van Aken, declare that this master thesis has been, entirely, elaborated and written by me. I have acknowledged all the sources that I have used in this paper.

Abstract

Sustainability has become a growing topic of interest for operations management scholars and practitioners (Porter, 2011; Magon, Thomé, Ferrer & Scavarda, 2018) and businesses have started to realize the importance of ecological and social systems in creating a competitive advantage (Magon et al., 2018). This has been a specifically important topic for the manufacturing industry, as the pressure to be sustainable due to energy and resource intensive manufacturing processes (Schrettle, Hinz, Scherrer-Rathje & Friedli, 2014). Moreover, previous research found contradictory results and more research is needed as to under what circumstances the sustainability-performance relationship occurs (Magon et al. 2018). HRM is crucial for establishing innovation (Becker & Huselid, 1998) and plays a significant role in a firm's ability to achieve sustainability and effects on firm performance (Ashford, 2001).Capability and commitment enhancing HR practices (CCEP's) could be one of the factors affecting the sustainability - firm performance relationship.

This research is focused on the effects of pollution prevention measures (PPM's) in Dutch manufacturing companies on firm performance, and the role of CCEP's in this relationship. By looking into the effects of sustainability measures on firm performance and the circumstances under which these occur, this study aims to clarify this relationship and identify causal relationships. By using the data gathered by the EMS (2015), this study used quantitative analyses to find results. A post-hoc analysis was conducted with the aim to find further explanations for the results found in the main analysis.

It was found that PPM's increase environmental performance, and CCEP's do affect the relationship between some PPM's and financial- operational and environmental performance. However, these relationships can be weaker or stronger based on whether pollution prevention technologies (PPT's), pollution prevention practices (PPP's) or both are implemented.

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Chapter 1 Introduction

Sustainability has become a growing topic of interest for operations management scholars and practitioners (Porter, 2011; Magon, Thomé, Ferrer & Scavarda, 2018). Businesses have started to realize the importance of ecological and social systems in creating a competitive advantage (Magon et al., 2018). The manufacturing industry has become the focus of low-carbon development and the majority of the enterprises in that industry face the plight of technology, capital and knowledge in the process of low-carbon transformation. Hence sustainability nowadays plays a key role in firm development.

Sustainability is also referred to as the 'triple bottom line'. This can be defined as contributing to sustainable development by delivering simultaneously economic, social and environmental benefits (Hart & Milstein, 2003, p.56). Hart & Milstein (2003) argue sustainability can be achieved through sustainable value creation, which is driven by four strategies: Clean Technology, Pollution Prevention, Sustainability Vision and Product Stewardship. Sustainability can also be split in internal and external sustainability. Internal sustainability consists of sustainable manufacturing practices (PPM's) within the organization like sustainable new product development, remanufacturing, production, and others. External sustainability is consistent with the definition of external Green Supply Chain Management (GSCM) and Sustainable Supply Chain Management (SSCM); including suppliers and customers in joint initiatives linked with environmental and social management practices (Magon et al., 2018, p. 106). Survey research investigating the effects of internal sustainability, external sustainability or both on firm performance could enrich the understanding of the direct effects of sustainability on performance (Magon et al., 2018). The manufacturing industry has mainly been affected by the pressure to be sustainable as manufacturing processes are energy intensive and consume a significant amount of resources (Schrettle, Hinz, Scherrer-Rathje & Friedli, 2014). Therefore, an answer on how to integrate, innovate and implement environmentally sustainable measures to relieve the pressure of sustainability on the manufacturing industry is important to have (Cai et al., 2019). This study is focused on pollution prevention measures (PPM's) within Dutch manufacturing companies.

In scientific research, there is yet to develop an agreement on the effects of sustainability on firm performance. Magon et al. (2018) found mixed results in the 231 studies analyzed considering the effects of sustainability on firm performance and the circumstances under which these occur. The majority of these studies found direct positive effects on measurements of firm performance, but negative and non-significant effects were found as well in some cases. Studies including mediating relationships mostly used composite measures to measure firm performance and found mediated positive effects. Moderating variables seem largely absent in studies involving the sustainability-performance relationship (Magon et al., 2018). One of the moderators studied are HRM-related practices (or HR practices). HR practices are practices implemented by an organization in order to organize and manage employees. Examples of HR practices studied are behaviors, ethical incentives, person-CSR fit and entrepreneurial orientation (Magon et al., 2018). A mediating relationship would mean that the relationship between sustainability and firm performance works through the implementation of HR practices (f.i. PPM's lead to training of employees, which affects firm performance). A moderating relationship means that the relationship between sustainability and firm performance is affected by HR practices (f.i. employee training enhances the performance impact of PPM's). Whilst the absence of moderators in studies in line with emerging research fields (Sousa and Voss, 2008), explaining the circumstances under which sustainability results in firm performance should be a goal for future studies (Magon et al., 2018).

HRM is a crucial element in establishing sustainable innovation (Becker & Huselid, 1998). Li, Zhao & Liu (2006) state that HRM also plays a significant role regarding the effect of technological innovation on firm performance and innovation is necessary to achieve sustainability (Ashford, 2001). Hence, it can be expected that well-developed HR practices yield a better effect of PPM's on firm performance, and poorly developed practices could decrease that effect. However, HR practices are only present as a moderator in five of the 231 studies analyzed by Magon et al. (2018) as opposed to 20 studies including HR practices and systems as mediating components in the relationship, with no effects mentioned.

Despite the growing interest in sustainability by practitioners and scholars, the antecedents and drivers of sustainability and their relationship to performance remains unclear (Magon et al., 2018). Previous literature intended to find support for a positive relationship between sustainability and firm performance, but the difference in operationalization of the variables, disparity in measurements of firm performance, diversity of theories, measurement scales and firm sizes often lead to contradicting results (Magon et al., 2018). HR practices as a moderator are largely absent in studies, even though previous studies suggest HR practices could well have an effect on the sustainability - performance relationship.

Research should be aimed at explaining how and under which circumstances sustainability results in firm performance, and identify causal relationships (Magon et al., 2018). Also, more research is required regarding the effects of environmental management on manufacturing performance, as outcomes can depend on industry- or company specific characteristics and environmental contexts of a country (Jabbour, da Silva, Paiva, Almada Santor, 2012). Magon et al., (2018) further state that extending the dimensions of firm performance consistent with already tested scales would add to cumulative and comparable knowledge in the field, and survey research analyzing the relationship between either internal or external sustainability and firm performance could contribute to understanding the causal effects of sustainability on firm performance. This research looks at pollution prevention measures as it regards the effects of a set of organizational and technological investments aimed at improving environmental sustainability within an organization. Using separate measurements of performance indicators to measure the financial-, operational- and environmental performance dimensions, the effects of PPM's aimed at reducing waste and emissions are measured. Furthermore, moderation analysis could bring more attention to contextual variables to find out when and under which conditions sustainability influences firm performance (Magon et al., 2018). This notion is strengthened by Wagner (2010), who states that moderation effects matter and should be considered in future studies. Guptha and Singhal (1993) identified four different HRM practice strategies, of which this research will look at the effects of three of them (Human resource planning, career management and reward systems). Hence, the research question (RQ) of this research is: *'To what extent do PPM's affect dimensions of firm performance, and to what extent do HR practices affect this relationship?'*

By focusing on PPM's that are part of a Pollution Prevention strategy as defined by Hart & Milstein (2003) this research aims to identify and clarify a causal pattern between sustainability and firm performance by looking at the effects of the PPM's on financial-, operational- and environmental performance. Moreover, part of the framework developed by Hart & Milstein (2003) can be tested in practice. Besides that, with the addition of HR practices as a moderator, this study aims to add to the understanding of how contextual variables affect the sustainability - firm performance relationship. Also, post-hoc analyses were conducted in order to provide a better understanding of the results. By answering the RQ, managers of manufacturing companies would be able to have a better understanding of the effect of PPM's on firm performance, and how HR practices affect that relationship. As manufacturing companies produce a lot of waste and pollution, this pressurizes them into considering their environmental impact while doing their business (Zailani, Jeyaraman, Vengadasan & Premkumar, 2012). Hence, this information can be of great importance to managers of manufacturing companies.

The following chapters of this research will try to answer the RQ. Chapter 2 is focused on explaining the conceptual model of this research, containing several theories on the relationship described in the RQ. The methods of this study will be elaborated on in chapter 3. In chapter 4 the results of the quantitative main analysis of the study will be analyzed. In chapter 5 the post-hoc results are presented Finally, in chapter 6 the results will be discussed, conclusions will be made and future recommendations will be provided.

Chapter 2 Theoretical Background

2.1 Introduction

Chapter 1 gave a brief insight into the core concepts studied in this research. In this chapter, these concepts are further explained, adjusted to the scope of the study and hypotheses are formed. Firstly, dependent variable firm performance is defined. Secondly, the concept of sustainability in this study (PPM's, independent variable) and its effects on firm performance are examined. Then, HRM and the moderating variable HR practices are elaborated on and hypotheses are formed regarding its effects on the relationship between PPM's and firm performance. Finally, a conceptual model is presented.

2.2.1 Firm Performance

In this paragraph, the dependent variable of this study (firm performance) is defined.

Firm performance not only consists of a number of business performance factors like operational-, financial- and market performance, but needs to take into account environmental and sustainability factors as well. (Magon et al., 2018; Pagell & Dobeli, 2009). However, not all studies consistently use this way of measuring firm performance. Magon et al. (2018) conducted a meta-analysis of 231 papers, trying to find synthesis in the sustainability and firm performance relationship. The studies analyzed by Magon et al. (2018) mainly take into account operational and financial performance factors like delivery, flexibility, quality and costs when looking at a direct relationship between sustainability and firm performance. Profitability and environmental/sustainability factors are often not taken into account. Studies don't consistently measure the same indicators when measuring firm performance, which leads to disparity. (Magon et al., 2018).

Measuring commonly used performance indicators like flexibility, quality, costs, delivery, customer satisfaction, etc. could add to the cumulative knowledge in this field (Magon et al., 2018). Environmental/sustainability factors should be included when measuring firm performance, however often aren't. Moreover, as Zailani et al. (2012) stated, it is important for manufacturing companies to reduce their environmental impact. Hence it is important to take into account the environmental performance of a firm as well as the operational and financial performance when measuring firm performance. Including environmental performance indicators like waste or energy usage could therefore provide a more complete measurement of firm performance and be of great value for manufacturing companies as they need to reduce their environmental impact (Schrettle et al., 2014).

Hence, as firm performance should contain a financial, operational and environmental component, this study measures the dependent variable of firm performance by measuring three firm performance dimensions, namely: operational performance, financial performance and environmental performance. A further operationalization of the dependent variable firm performance is presented in chapter 3. The next paragraphs are centered around sustainability.

2.3 Sustainability

In the following paragraphs the concept of sustainability is explained. First, the antecedents of sustainability are presented and it is explained how sustainability is used and conceptualized in this study. Second, the relationship between sustainability and innovation is laid out in order to consider more information on how PPM's (independent variable) are developed and implemented, so a more complete definition of sustainability can be formed. Then, the concept of sustainability is defined for this study. Finally, the relationship between PPM's and firm performance is analyzed according to prior research and hypothesis 1 is formulated.

2.3.1 Sustainability and PPM's

Sustainability is a broad concept and there are multiple ways to define and conceptualize it. This paragraph looks at the concept of sustainability, how sustainability can be implemented through PPM's and how it is defined in this study.

The definition of sustainability is slightly problematic (Starik & Rands, 1995). The various definitions and terminologies used cause confusion, since some of them are sloppily described, too similar, or only slightly different from one another. Also, most of the terms are multiword units and, therefore, the definitions are unavailable in dictionaries (Glavic & Lukman, 2006). Different terminologies are used, such as: sustainable development, corporate citizenship, sustainable entrepreneurship, Triple Bottom Line, business ethics and corporate social responsibility (van Marrewijk, 2002). Also, the definition of sustainability can differ depending on the context it is used in (Brown, Hanson, Liverman & Merideth, 1987). Sustainable development is defined by the World Commission on Environment and Development (1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Starik & Rands, 1995). This is a vague definition as it leaves question marks over what those 'needs' are. It fails to mention that sustainability is a multi-level and multi-dimensional concept and leaves out the specific notion of economic, social and environmental components (Starik & Rands, 1995; Elkington, 1998). Starik & Rands (1995, p.909) suggest the following definition for ecological sustainability: 'ecological sustainability is the ability of one or more entities, either individually or collectively, to exist and flourish (either unchanged or in evolved forms) for lengthy time frames, in such a manner that the existence and flourishing of other collectivities of entities is permitted at related levels and in related systems.' The ecological sustainability is the degree to which an organization can continue its activities indefinitely without having a negative impact on limiting factors that allow for the existence and flourishing of other groups of entities and organizations (Starik & Rands, 1995).

Sustainability is also referred to as the 'triple bottom line' (Elkington, 1998). As discussed in chapter one, the triple bottom line is about delivering economic, social and environmental benefits simultaneously (Hart & Milstein, 2003), also referred to as global sustainability by Hart & Milstein (2003). The economic dimension is about being able to generate enough income and profit to ensure a long term sustainable return (Vachon & Mao, 2008; Steurer and Konrad, 2009). The environmental dimension is about consuming resources at a lesser pace than the natural regeneration of those resources and generating limited waste and emissions (Vachon & Mao, 2008). Social sustainability is about actively supporting the preservation and creation of skills as well as the capabilities of current and future generations. Promoting health and supporting equal and democratic treatments within and outside the borders of the organization are also part of this definition (Magon et al., 2018, p. 105). Meeting this triple bottom line results in sustainable value. Hart & Milstein (2003) stress the importance of creating sustainable value for the long-term survival of an organization. They argue four dimensions of sustainable value creation are necessary to drive shareholder value and ensure long-term sustainability of an organization, which can be found in figure 1.

Their model is based on the tension between long-term growth and short-term results, and the tension between keeping internal capabilities within the firm and infusing the firm with external perspectives and knowledge. This can be compared to the concept of internal vs. external sustainability.

The horizontal axis represents the difference between internal and external capabilities and the vertical axis represents the tension between long-term and short-term benefits. So the left half of figure 1 corresponds to internal sustainability, and the right half to external sustainability.

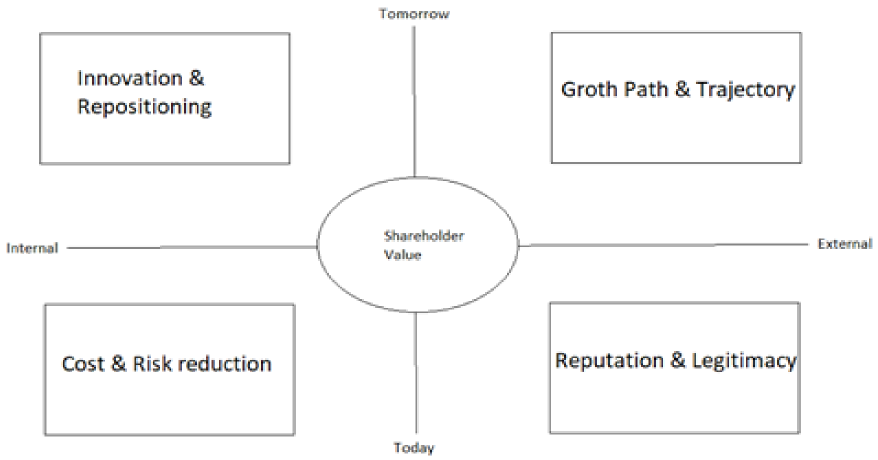

Figure 1; Key Dimensions of Shareholder Value (Hart & Milstein, 2003)

This leads to four forms of corporate payoff: Innovation & Repositioning, Growth Path & Trajectory, Cost & Risk Reduction and Reputation & Legitimacy. Each of these dimensions is driven by a strategy (see figure 2).

Figure 2; Sustainability framework (Hart & Milstein, 2003)

Hart & Milstein (2003) identify four strategies for sustainable value that each yield their own corporate payoff as described in figure 1. These strategies are: Clean Technology, Pollution Prevention, Sustainability Vision, and Product Stewardship. In figure 2 more information about these strategies is presented. Each strategy has its own drivers, its own corporate payoff and sustainable value creation. An organization must encompass each of these strategies into its portfolio to ensure long-term success. With this framework it can be tested whether there is a portfolio imbalance and whether an organization is creating enough sustainable value to ensure long-term success. This can be very helpful as most organizations focus on the bottom half of the framework and hence miss opportunities (Hart & Milstein, 2003).

According to Hart & Milstein (2003) internal sustainability corresponds to strategies of Pollution Prevention and Clean Technology. Pollution Prevention concerns reducing waste and emissions from current operations, and improving environmental efficiency of current operations and has Cost & Risk reduction as corporate payoff. Clean technology is about more radical measures and innovations than Pollution Prevention, leapfrogging standard routines and knowledge and has Innovation & Repositioning as corporate payoff. So Pollution Prevention is more about incremental innovations to current processes and operations that are not that disruptive to the organization, Clean Technology is more about long-term investments that generate a much more radical organizational and/or technological change and leapfrog current technologies. To achieve the goals of these strategies, manufacturing companies can implement sustainable manufacturing practices (in SMP's). SMP's are organizational management practices that integrate environmental, social and economic concerns into operational activities, looking at the complete life cycle of a product (Golini, Longoni & Cagliano, 2014). SMP's have an internal and external dimension, comparable to internal and external sustainability. The internal dimension is about the implementation of SMP's within an organization, the external dimension includes suppliers and customers in joint initiatives linked with environmental and social management practices (Magon et al., 2018, p. 106). Examples of SMP's are sustainable new product development, activities related to procurement, production/manufacturing and remanufacturing (Magon et al., 2018).

As discussed in Chapter 1, there is a pressure on the manufacturing industry to reduce the energy and resource intensiveness of its processes. Therefore this study is focused on more internal and short-term measures to respond to this pressure and reduce pollution, waste and consumption. These measures correspond to the Pollution Prevention strategy as defined by Hart & Milstein (2003). The measures and technologies part of this strategy are referred to as PPM's, and will be explained in paragraph 2.3.3. In the next paragraph the role of innovation in sustainability and PPM's is laid out.

2.3.2 Sustainability and innovation

In this paragraph the role of innovation in relation to sustainability or PPM's is explained. Doing this, a more complete definition of the independent variable of this study can be provided in the next paragraph.

Ashford (2001) uses a similar concept as the triple bottom line, namely 'triple sustainability'; emphasizing improvements in competitiveness and long-term dynamic cohesion, social cohesion and environment (resource productivity and environmental pollution). He states that there are three types of innovations that are necessary for transformations of the industrial state to sustainability. These types of innovations are: technological innovations, organizational innovations and social innovations. Technological innovation is the first commercially successful application of a new technical idea (f.e. a brand new product) (Ashford, 2001, p. 2). Organizational innovation is about changes in and among various organizational aspects of functions of an organization (f.e. marketing, R&D, HRM, etc.) (Ashford, 2001). Social innovation is about changes in preferences of the environment and workers, and changes in the processes that influence these changes (f.e. the usage of social media to call for improved working conditions or environmental performance of a company) (Ashford, 2001).

These types of innovations can drive sustainability. For example, a new cleaner production technology can reduce pollution, a new HRM policy can ensure better motivation and worker health and changes in the social environment of an organization can alter demand and drive an organization to different or more sustainable solutions. However, too much focus on one of the three types of innovations can lead to less potential for sustainability and they need to be used in a coordinated fashion to achieve triple sustainability (Ashford, 2001). Also, Hart & Milstein (2003) argue that the pollution prevention strategy is driven by incremental innovations. Thus, innovation plays a key role in the creation and implementation of PPM's. In the next paragraph, PPM's are defined.

2.3.3 PPM's

As discussed in the previous two paragraphs, there are many ways to define and capture sustainability. It is clear that the concept of sustainability should contain a social, environmental and economic factor, so in that regard the triple bottom line would suffice. A definition of sustainability should contain the following elements: The continued support of human life on earth, long-term maintenance of the stock of biological resources and the productivity of agricultural systems, stable human populations, limited growth economies, an emphasis on small-scale and self-reliance, continued quality in the environment and ecosystems (Brown et al., 1987). Hart & Milstein (2003) present a framework that includes every component mentioned in the triple bottom line and builds upon this concept, of which this study uses PPM's to measure the degree to which a firm is implementing the Pollution Prevention strategy. Ashford (2001) makes a valid point about the importance of innovation to sustainability. So in order to capture the requirements for a definition of sustainability, PPM's are described as: ‘’practices or technologies that integrate environmental, social and/or economic concerns into operational activities with the aim of creating sustainable value’’. By looking at PPM's, the requirements of a definition for sustainability can be satisfied as PPM's contain a social, environmental and economic component and are driven by incremental innovations. In the next paragraph, existing literature on the relationship between sustainability and firm performance is examined.

2.3.4 Sustainability and Firm Performance

Early literature suggested that sustainability hinders firm performance. Porter (1991) stated that investments into greening of companies would pay off in the long term, however other studies that followed found contradictory results (Magon et al., 2018). Wagner (2010) found that only the environmental component of sustainability has a direct positive effect on performance.

Studies researching the relationship between an organization's environmental efforts and its performance measured in stock price found positive results, whilst other studies found a negative relationship when researching the relationship between an organization's sustainability efforts and consumers' willingness to pay (WTP) (Schrettle et al., 2014). González-Benito & González-Benito (2005) conducted a questionnaire among the production and operations managers of 428 Spanish companies and found that environmental practices related to the transformation of logistic processes contribute to lean operation performance and practices related to product design enhance marketing performance. González-Benito & González-Benito (2005) state that the implementation of environmental practices and clean equipment may trigger innovation and renovation processes which could improve the quality and reliability of recycled and reused products/materials and therefore enhance lean operation performance. However some environmental practices such as installation of emission filters and waste separation and preparation systems, the use of renewable energy resources or the contemplation of environmental criteria for planning and programming production are not compatible with operational objectives as cost, speed, and design and mix flexibility (González-Benito & González-Benito, 2005, p. 11). They conceptualize sustainability as 'environmental proactivity': a number of practices and initiatives that can be implemented by a company to reduce its impact on the environment (González-Benito & González-Benito, 2005, p. 1). Proactivity in environmental management can be positively related to financial performance (Darnall, Henriques & Sadorsky, 2008), but also to operational efficiency (Ahmad & Schroeder, 2003). Outcomes of environmental proactivity depend on the portfolio of practices and measures of business performance that are considered (González-Benito & González-Benito, 2005). So, for example minimizing waste and emissions can lead to better firm performance, but the outcomes depend on what PPM's or what combination of PPM's are implemented and the dimensions and indicators used to measure the firm performance. Azevedo, Carvalho & Machado (2011) found a positive effect of green practices on quality and customer satisfaction, and a negative effect on costs. Examples of the green practices adopted by the companies in their study are: ISO 14001 certification, minimizing waste, decreasing the consumption of hazardous and toxic materials and reverse logistics. Yu et al. (2014) conducted a survey among 126 automotive manufacturers in China, looking at the relationship between Green Supply Chain Management (GSCM) and operational performance. They define internal green supply chain management as: 'the implementation of environmental management practices within a company' (Yu et al., 2014, p. 684). They found support for a positive effect of internal green supply chain management on delivery, flexibility and quality, and a negative effect on (decrease in) costs. Yu et al. (2014) state that the sharing of information across functional areas in order to improve green operations and process designs lead to reduced costs and improved quality. Moreover, implementing GCSM initiatives can lead to enhanced coordination of operational activities, which improves flexibility and delivery.

Zailani et al. (2012) state that considering environmental issues when designing new products and engaging suppliers can lead to better OP and increased profitability. Jabbour et al. (2012, p. 19) found in a study among 63 Brazilian manufacturing companies that innovative practices related to environmental management, such as the inclusion of this issue in product development, may improve environmental management proactiveness. They also found that environmental management relates to performance indicators as cost, quality, flexibility and delivery. Costs are reduced as the consumption of raw materials is less (Hunt & Auster, 1990). The search for environmental management in manufacturing leads to innovation (Wagner, 2007). Through innovation quality increases as products are strengthened and improved (Montabon, Sroufe & Narasimhan, 2007) and flexibility increases due to process innovation (Wagner, 2007). As environmental management reduces the risk of an environmental accident, delivery is also improved (Hunt & Auster, 1990). Customer satisfaction increases as green practices have an effect on environmental collaboration with customers and quality increases. Also reverse logistics help explain the positive effect on customer satisfaction (Azevedo et al., 2011).

Even though early literature contradicts that sustainability measures would improve firm performance indicators, more recent literature did find positive effects depending on the combination of PPM's implemented and measures of performance used. So, by implementing PPM's indicators of financial, operational and environmental firm performance can be improved. Hence, H1 is as follows:

H1a: PPM's improve financial performance indicators
H1b: PPM's improve operational performance indicators
H1c: PPM's improve environmental performance indicators

2.4 HR practices

The following paragraphs are centered around HRM and HR practices. In the first two paragraphs, HRM and HR practices are defined, and some of its direct effects on firm performance are mentioned. Then, the expected moderation effect of HR practices on the relationship between PPM's and firm performance is explained and hypotheses are formed.

2.4.1 Human Resource Management (HRM)

HRM is concerned with all aspects of how people are employed and managed in organizations (Armstrong, 2006, p.20). HRM comprises a set of policies designed to maximize organizational integration, employee commitment, flexibility and quality of work (Guest, 1987). Goals of HRM are: integrating HR strategies with the business strategy to support the organization in achieving its objectives, developing a high-performance culture, to ensure the employment of talented, skilled and engaged people and to create a positive employment relationship and a climate of mutual trust between management and employees (Armstrong, 2006). Outcomes of a successful HRM policy on a personal level are: motivation, commitment, cooperation, involvement, flexibility, organizational citizenship turnover and conflict. Outcomes on an organizational level are: productivity, quality, profit, customer satisfaction and return on investment (Guest, 1997). Furthermore, literature agrees there is a strong relationship between a company's HRM systems and its financial performance (Becker & Huselid, 1998).

Literature identifies two forms of HRM, namely 'hard' and 'soft' HRM (Edgar & Geare, 2005). Soft HRM is about considering fulfilling employee needs as an end itself, using appropriate HRM practices to generate favorable attitudes (Guest, 1997). Combining this with communication, motivation and leadership it will result in commitment to the organization and improved performance (Storey, 1987). Hard HRM is only concerned about the effective utilization of employees (Guest, 2002). It emphasizes the quantitative, calculative and business strategic aspects of managing the headcount resource (Storey, 1987).

2.4.2 HRM systems, HR practices and Strategic Human Resource Management (SHRM)

HRM uses the HR architecture of an organization to achieve its goals (Armstrong, 2006). The HR architecture includes HR systems and processes and employee behaviors as well as the structure of the HR function (Armstrong, 2006, p.21). HRM systems are systems of HRM practices rather than individual HRM policies (Becker & Huselid, 1998). Becker & Huselid (1998) add that systems should be the unit of analysis as they better reflect the paths used by policies that influence successful strategy implementation. The HR system consists of the interrelated HR practices (Armstrong, 2006). The entire system needs to be aligned, so both internal (among HRM policies) and external (with other organizational policies and goals) need to fit to help achieve the organization's goals. However, the synergies between the HR systems can be both positive and negative (Becker & Huselid, 1998). Besides HRM, there is also SHRM. SHRM focuses on several issues, including the fit between human resource (HR) practices and organizational strategic goals, the integration of HRM in organizational strategic management, the involvement of the HR function in senior management teams, the devolvement of HR practices to line managers, and the value that is added to organizational performance by HRM (Anderson, Cooper & Zhu, 2007, p.168). SHRM can be defined as the extent to which HRM is considered during corporate/business strategy formulation (Brewster & Larsen, 1992). Another definition of SHRM is: 'the pattern of planned human resource deployments and activities intended to enable an organization to achieve its goals' (Wright and McMahan 1999, p. 52). So SHRM can be compared to HR systems as they both require internal and external fit to the organization. Moreover, SHRM seems to take into account the HR practices that make up the HR systems and how they fit to the organizational strategy. Integration of HRM into strategy can lead to enhanced competence, congruence and cost effectiveness (Andersen et al., 2007).

Gupta & Singhal (1993) identify four strategies of HR practices: (1) human resource planning: f.e. recruiting the right people; (2) performance appraisal: f.e. encouraging risk taking; (3) reward systems: f.e. pay bonuses, promotions, job freedom; (4) career management, f.e. empowering people and continued education.

Human resource planning helps to analyze and determine personnel needs in order to create effective innovation teams (Gupta & Singhal, 1993) and help achieve better knowledge-related outcomes due to retaining personnel, building their expertise into the organizational routines through learning processes, and establishing mechanisms for the distribution of benefits arising from the utilization of this expertise (Kamoche and Mueller, 1998, p. 1036). An effective knowledge management system is critical to the long-term survival of an organization as it underpins the development of other capabilities (Darroch, 2005).

Performance appraisal is appraising individual and team performance in order to link innovativeness to profitability (Gupta & Singhal, 1993). By choosing what kind of behavior will be rewarded, firms are able to assess employee performance. This strategy is linked to an organization's reward systems. Examples of performance appraisal is the encouragement of risk taking and innovation in order to create more innovative products which increase profitability.

Career management is about matching employees' long-term career goals with the organization's goals through continuous training and education (Gupta & Singhal, 1993). Training has been found to have a positive relationship on firm performance (Harel & Tzafrir (1999). Training can affect performance in two ways (Harel & Tzafrir, 1999), namely improving skills and abilities relevant to employees' tasks and development and increasing employees' satisfaction with their jobs and workplace. Also, training supervisors to create a supportive environment can help them establish the value of safety, and therefore be beneficial to the organization (Nahrang et al., 2011).

Reward systems use rewards to motivate personnel to achieve an organization's goals of productivity, innovation and profitability (Gupta & Singhal, 1993). Financial participation of employees can have a positive effect on financial performance of the organization (McNabb & Whitfield, 1998), enhance firm survival and increase productivity (Park, Kruse & Sesil, 2004). Employees need to feel in control of their work and receive accurate and useful feedback (Benson & Lawler III, 2003). Employee involvement can improve firm performance (Addison, Siebert, Wagner, Wei, 2000; Jones & Kato, 2003) and can negatively influence the effectiveness of employees if they are not motivated to perform (Huselid, 1995). Festing, Groening, Kabst, Weber (1999) state that employee share ownership and profit sharing can increase financial performance and increase HRM efficiency.

As stated above, the performance appraisal strategy is closely linked to reward systems. Moreover, performance appraisal is used as an instrument to encourage the creation and adoption of innovations to increase profitability. As PPM's are more about incremental measures and innovations, performance appraisal is closely linked to reward systems and it is focused only on financial performance, the HR practice strategy performance appraisal is excluded from this research. Human resource planning, Career management and Reward systems all focus on enhancing the capabilities and commitment of employees. They are therefore referred to by this study as ‘’Capability and Commitment enhancing HR Practices’’ or CCEP’s.

2.4.3 The moderating role of HR practices

In paragraphs 2.4.1 and 2.4.2. the direct relationship between HRM and firm performance was briefly discussed. In this chapter previous research regarding the moderating effects of HR practices on the relationship between sustainability and firm performance indicators is examined.

Environmental management can create synergy with other management practices within the firm, like HR practices (Wagner, 2007) and there is a positive relationship between human resource policies/practices and environmental management (Wagner, 2010). Implementing specific management practices are important for the successful adoption of activities (Damanpour, 1991). Prerequisites for environmental management practices like HR practices turns the adoption of environmental management practices by organizations into socio-technical processes (Boiral, 2009). These processes make both technological and human aspects relevant for organizational change (Mumford, 2000). Support of HR practices is considered to be fundamental to the adoption of environmental management practices (Jabbour, de Sousa Jabbour, Govindan, Teixeira & de Sousa Freitas, 2013). In order for environmental management to be effective, human aspects must be supported (Jabbour, Jugend, de Sousa Jabbour, Gunasekaran & Latan, 2015) and employee dedication is necessary for organizational sustainability (Milliman, 2013). Jabbour et al., (2015) consider the following HR practices as relevant for environmental management: environmental training, providing autonomy to employees, environmental performance assessment, reward systems, support from senior management and interfunctional/cross-functional integration of environmental management that favors the formation of green teams. Presentation of strict recruitment strategies, appraisal and reward systems and training and empowerment programs enable the skills and competencies needed by employees in order to develop a framework for the development of tools and initiatives of environmental management that impact sustainability and create a competitive advantage (Cherian & Jacob, 2012). Cherian & Jacob (2012) further found that actively involving employees in environmental management principles may lead to better environmental strategies to be implemented, greener products and green savings from waste elimination as employees may feel empowered to adopt these principles as a result of HR policies.

Moreover, environmental management practices and PPM’s may require a certain degree of change to organizational and technological processes and commitment to these changes and practices is needed. It is vital for organizations implementing change to have HR practices in place like supportive-collegial climates, reward systems, information technology, and structures in order to create openness to change and ensure the change is implemented successfully (Fugate, 2012). Strategies such as training, empowerment and participation are likely to impact support for organizational change (Herscovitch & Meyer, 2002). HR practices relating to rewards and performance management may contribute to the development of continuance commitment (Conway & Monks, 2008).

So, HR Practices are proved to be vital to the implementation and adoption of environmental management practices (or PPM's) and can foster support and commitment towards organizational change and practices. Hence, adapting and enhancing the capabilities and commitment of employees required to fit the implementation of PPM's may lead to a more effective implementation. This means capability and commitment enhancing HR practices (CCEP's) could improve the sustainability - performance relationship.This leads to the following hypotheses:

H2a: CCEP's improve the relationship between PPM's and financial performance indicators
H2b: CCEP's improve the relationship between PPM's and operational performance indicators
H2c: CCEP's improve the relationship between PPM's and environmental performance indicators

2.5 Conceptual model

This research focuses on the effects of PPM's on dimensions of firm performance. Firm performance is measured by three dimensions, namely: operational, financial and environmental performance. In the preceding paragraphs the way these relationships are expected to work were explained and hypotheses were formed. PPM's can be found to the left of the model, representing the independent variable. CCEP's are located on the upper side of the model, representing the moderating variable. Finally, the dependent variable firm performance is represented by three firm performance dimensions, leading to the dependent variables Operational Performance, Financial Performance and Environmental Performance. This leads to the following conceptual model (see figure 3, next page).

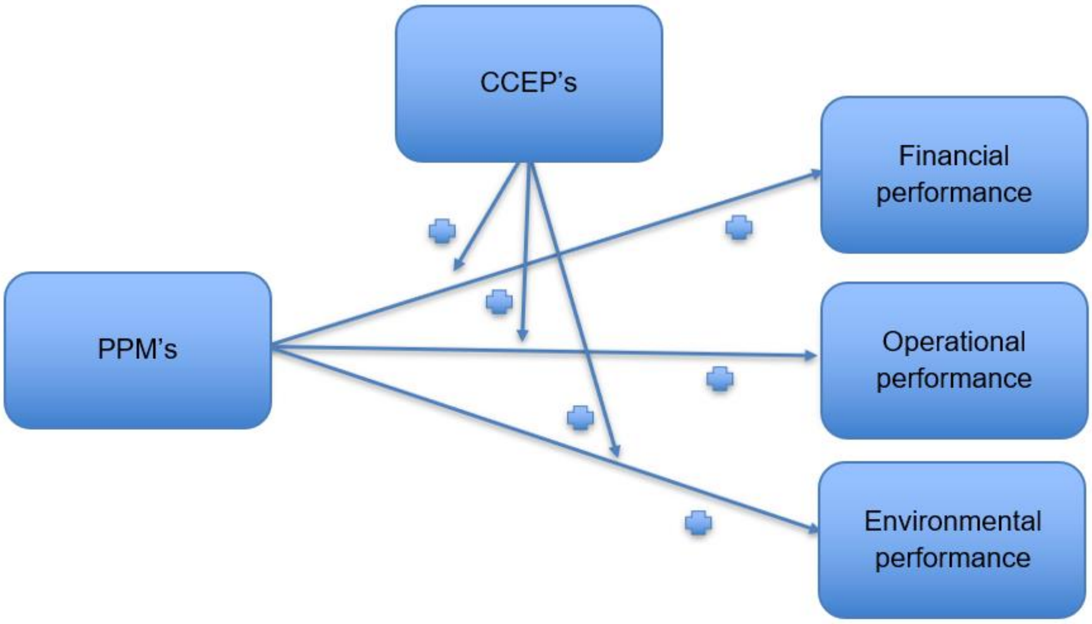

Figure 3: Conceptual model

Chapter 3 Methodology

3.1 Introduction

In the previous chapter the theoretical concepts, hypotheses and conceptual model of the study have been outlined. The following chapter will concern the methodology of this study. First, the chosen research method will be elaborated on. Second, the sample and instruments will be addressed. Then, the operationalization of the variables will be explained in detail. Finally, the validity, reliability and reliability of the study will be discussed.

3.2 Research method

There is a need for research identifying causal relationships and underlying mechanisms under which sustainability measures result in firm performance (Magon et al., 2018). As this study tries to find a causal relationship and aims to explain the mechanisms through which this relationship works, a holistic view of an organization is taken.

Using the quantitative data, the hypotheses stated in chapter 2 can be analyzed and tested. Multiple regression analysis and logistic regression analysis are used to analyze the data. Post-hoc analyses are included to add to the understanding of the results and identify causes for the results, which is appropriate considering the goal of this study. The results of the main analyses form the basis for the post-hoc analysis. The data from the post-hoc analysis therefore complement the quantitative test results and add to the explanatory power of the study.

3.3 Sample and instruments

For this research, the data from the EMS 2015-2016 will be used. This survey was carried out in over 3000 organizations, spread over 9 European countries. This study will draw from this dataset, with its interest being Dutch manufacturing companies. The European Manufacturing Survey (EMS) covers a core of indicators on the innovation fields “technical modernization of value adding processes“, “introduction of innovative organizational concepts and processes“ and “new business models for complementing the product portfolio with innovative services“ (Fraunhofer Institute). The EMS includes several variables, including variables related to sustainability, HRM and firm performance. This makes it possible to use for this research, as the survey can be operationalized for the constructs used in this study.

3.4 Operationalization and Research Design

In this paragraph, the variables are operationalized for the analysis. Constructs from EMS (2015) are used to make up the variables for this study. This operationalization consists of the following variables: Firm Performance (dependent variable), Explanatory variables (PPM's and control variables) and CCEP's (moderating variable). An overview of these operationalizations can be found in tables 1,2,3 and 4. First, the construction of the dependent variables of the study are explained.

3.4.1 Dependent variable (Firm Performance)

As explained in paragraph 2.2.1, firm performance should contain a financial, operational and environmental component. Therefore, in this research, firm performance is measured by financial performance, operational performance and environmental performance.

Financial performance. Financial measures can be used to measure the financial performance of an organization. Therefore the percentage change in annual turnover from 2012-2014 (turnover change) and percentage change in production costs (costs change) represent the financial dimensions to measure financial performance. The variable turnover change is measured by calculating the percentage difference in annual turnover between 2012 and 2014. The variable costs change is measured using a seven-point likert scale. The exact values of which the scale consists can be found in table 1.

Operational performance. Operational performance refers to the measurable aspects of an organization's operational processes such as reliability and production cycle time (Voss, Åhlström & Blackmon, 1997). Therefore, three dimensions of operational performance are measured, namely: lead time, delivery and quality. Lead time is measured by the average amount of days it takes to produce the main product. Delivery is measured by the percentage of orders delivered on time. Quality is measured by the percentage of products having to be scrapped or reworked (scrap rate).

Environmental performance. In this study, environmental performance is measured by the efficiency of resource usage by organizations. Indicators like waste and energy usage need to be included in performance measurements (Schrettle et al., 2014). Therefore the development of electricity usage and development of oil- and gas usage are used to measure environmental performance. Both these variables are measured using a seven-point likert scale ranging from a 15% decrease in usage or consumption to an increase of 15%, with steps of 5% in between points. These 2 variables were combined to create the variable Energy and Resource consumption. The average was taken to create a score for the variable Energy and Resource consumption. See table 1 for an overview of all the dependent variables.

Variable Name	Items	Corresponding item in EMS (see appendix I)
Financial Performance	1. Δ Turnover 2012-2014 (%)	21.1, 21.2
	2. Δ Production costs (1=<-10%, 2=-5 to -10%, 3=-5% to 0, 4=stable, 5= 0 to 5%, 6=5% to 10%, 7= >10%)	12
Operational Performance	1. Manufacturing lead time (days)	20.1
	2. Orders delivered on time (%)	20.2
	3. Scrap rate (%)	20.3
Environmental Performance	Δ Energy and Resource consumption (1=<-10%, 2=-5 to -10%, 3=-5% to 0, 4=stable, 5= 0 to 5%, 6=5% to 10%, 7= >10%)	22.2 & 22.3

Table 1: Dependent variables Financial Performance, Operational performance and Environmental performance and corresponding items from EMS (2015).

3.4.2 Explanatory variables

In this paragraph the construction of the explanatory variables is explained. These explanatory variables are PPM's, Firm Size, Industry Type and Other Technologies and Practices (OTP's). The variables Firm Size, Industry and OTP's are used as control variables.

As defined in chapter 2, PPM's are practices or technologies that integrate environmental, social and/or economic concerns into operational activities with the aim of creating sustainable value. The items used by EMS that correspond to PPM's are used to make up this variable. These are items 1-10 in table 1. All of these items have to do with incremental innovations or practices aimed at minimizing waste, emissions and energy consumption from operations and embrace the complete life cycle of the product. Doing this, organizations integrate social, environmental and economic concerns into their operational activities. Therefore they can be considered PPM's and are used to measure the degree to which an organization is using PPM's by counting the amount of PPM's implemented. This leads to the following operationalization (see table 2, next page):

Total number of PPM's implemented by the organization, 10 items (index)	Corresponding item in EMS (see appendix)
1. Certified energy management system	3.12
2. Instruments of life-cycle assessment	3.13
3. Impact and performance measurements of social and environmental corporate activities	3.14
4. Control system for shut down of machines in off-peak periods	8.1.3
5. Control-automation systems for an energy efficient production	8.1.4
6. Technologies for recuperation of kinetic and process energy	8.1.5
7. Technologies for generating energy and or heat	8.1.6
8. Switching off components, machinery or equipment measures to reduce energy consumption	8.2.1
9. Upgrading existing machinery or equipment measures to reduce energy consumption	8.2.2
10. Premature substitution by new machinery or equipment measures to reduce energy consumption	8.2.3

Table 2: Explanatory variable PPM's and corresponding items from EMS (2015).

In addition to PPM's, five control variables are measured to measure any side-effects or effects on firm performance indicators not explained by the model. These control variables are Firm Size, measured by the number of employees (temps excluded), Industry, measuring the type of industry an organization does its business in within the manufacturing industry and OTP's, measuring to what degree organizations integrate other technologies and practices into their operational activities. Also, an interacting variable between CCEP's and OTP's was created in order to measure a possible moderating effects CCEP's may have on the implementation of OTP's.

Firm size and industry type can lead to different organizational characteristics (Chen & Huang, 2009). Firm size influences the support for behavior towards sustainability (Gallo & Christensen, 2011). One of the reasons for this could be that larger firms have more control mechanisms in place and are therefore able to generate more sustainable development. Moreover, smaller firms could suffer from the 'liability of smallness', meaning that they are more limited in their resources and capabilities than larger firms and suffer from increased environmental vulnerability (Andries & Stephan, 2019). They could therefore be less able or less willing to spend these resources on PPM's or lack the capability to implement them correctly. Furthermore, OTP's (Automation and robotics, Manufacturing technologies for new materials, Additive production technologies and Digital technologies) were included in the model to ensure the measured effects of PPM's on firm performance were due to those PPM's, and not the effect of other technologies and practices implemented by the company. The same goes for the moderating effect of this variable, therefore a moderating variable between OTP's and CCEP's was included. The variable OTP's is constructed as an index variable, using the sum of all five other technologies an practices implemented. These five other technologies and practices are made up of items included by the EMS (2015). These individual items can be found in appendix II, as referred to by table 4.

Hence, as Firm Size, Industry and OTP's (including the moderating effect) could affect the results of the model, these variables are used as control variables. See table 3 for an overview. An overview of the items used from EMS (2015) to construct the OTP's variable can be found in appendix I. The corresponding item numbers are presented in table 3.

Variable Name	**Items**	**Corresponding item in EMS (see appendix I)**
Firm Size	Number of employees 2014	21.3
Industry	1. Metal	
	2. Food	
	3. Textile	
	4. Construction	1.2
	5. Chemical	
	6. Machinery	
	7. Electronic	
OTP's	1. Automation and robotics	8.1.1, 8.1.2
	2. Manufacturing technologies for new materials	8.1.7 – 8.1.11
	3. Additive production technologies	8.1.12 – 8.1.15
	4. Digital technologies	8.1.16 – 8.1.23
OTP's × CCEP's		n/a

Table 3: Control variables Firm Size, Industry, OTP's and OTP's × CCEP's and corresponding items from EMS (2015)

3.4.3 Moderating variable (CCEP's)

This study takes into account the following CCEP's, used from the EMS (2015): retainment of experienced employees and knowledge management, promotion of employee involvement, improvement of health- and safety conditions, financial participation for all employee groups, existence of separate policy for competence-development and training of production-staff and determined number of training days for production-staff. Moreover, EMS (2015) measures the existence of six specific activities for further development and training for production-staff. These are items 7-12 in table 2.

Human resource planning. Measures for retainment of older employees or their knowledge for your company and Standardized methods of function-design to improve health-and safety circumstances at work fit into the human resource planning dimension as it involves the needs of people and how they are employed and managed within an organization. Moreover, health- and safety conditions can be important for organizations as risks and hazards, physical demands, job demands, and complexity relate to burnout, engagement, and safety outcomes (Nahrang, Morgeson & Hofmann, 2011). Nahrang et al. (2011) further state that providing job resources can create employee engagement and mitigate burnout.

Reward systems. Reward systems use rewards to motivate personnel to achieve an organization's goals of productivity, innovation and profitability (Gupta & Singhal, 1993). Effective employee involvement requires a solid power and information sharing system, creating incentive rewards and making sure employees possess the knowledge and skill needed to make decisions. Hence, Instruments to improve employee involvement and Financial participation access for all employee groups fit reward systems as CCEP.

Career management. Career management is about matching employees' long-term career goals with the organization's goals through continuous training and education (Gupta & Singhal, 1993). Hence, Existence of separate policy for competence-development and training of production-staff, Determined number of training days for production-staff and Specific activities for further development and training for production-staff are linked to career management as CCEP. These items together make up the composite variable CCEP's. See table 4 for an overview (next page).

Total number of CCEP's implemented by the organization, 12 items (index)	**Corresponding item in EMS (see appendix I)**
1. Instruments to maintain elderly employees or their knowledge in the factory	3.15
2. Instruments for promoting staff commitment	3.16
3. Standardized methods of job design for improving health or safety conditions at work	3.17
4. Broad-based employee financial participation schemes	3.18
5. Separate area of responsibility for competence development and training	4.3
6. Yes/no days per year designated for qualification and continuing education of employees in production	5.2
7. Activity-specific training applied in your establishment to the employees in production	5.2.1
8. Interdisciplinary focus training applied in your establishment to the employees in production	5.2.2
9. IT-based self-learning programs training applied in your establishment to the employees in production	5.2.3
10. On-the-job training applied in your establishment to the employees in production	5.2.4
11. Information offers training applied in your establishment to the employees in production	5.2.5
12. Continual quality improvement training applied in your establishment to the employees in production	5.2.6

Table 4: Moderating Variable CCEP's and corresponding items from EMS (2015).

3.5 Variable construction and Research Design

In this paragraph, the previous paragraphs are summarized to present an overall research design. The variables in this study are operationalized based on literature and constructed from an existing and proven survey (EMS 2015). These variables are analyzed in SPSS using regression analysis. Logarithmic transformations were made for the variables firm size (LnFirmSize), lead time (LnLeadTime) and scrap rate (LnScrapRate) as their respective distributions were skewed. The same was done for the variable delivery, however this did not improve the distribution. Hence, in order to improve the distribution for analysis this variable was recoded into a binomial variable. A score below 98% meant orders were not delivered on time (score=0), a score of 98% or above meant orders were delivered on time (score=1). See table 5 (next page) for an overview of the research design.

Type of variable	Variable names and units of measurement	Measurement level	min	max
Dependent	Financial performance			
	Δ Turnover 2012-2014 (%)	Ratio	-∞	∞
	Δ Production costs (%) 2012-2014	Ordinal	1	7
	Operational performance			
	Manufacturing lead time (days, ln)	Ratio	0	∞
	Orders delivered on time (no/yes)	Nominal	0	1
	Scrap rate (%, ln)	Ratio	0	100
	Environmental performance			
	Δ Energy and Resource consumption (%)	Ordinal	1	7
Explanatory	PPM's	Ratio	0	10
Moderating	CCEP's	Ratio	0	12
Control	Firm Size (number of employees, ln)	Ratio	10	∞
	Industry type			
	Metal	Nominal	0	1
	Food	Nominal	0	1
	Textile	Nominal	0	1
	Construction	Nominal	0	1
	Chemical	Nominal	0	1
	Machinery	Nominal	0	1
	Electronic	Nominal	0	1
	OTP's	Ratio	0	32

Table 5: analysis variables overview

3.6 Validity, Reliability & Ethics

The validity and reliability of the study need to be accounted for. Validity concerns the guarantee that the instrument is measuring what it's supposed to measure. Reliability is the ability of the instrument to produce the same results consistently under equal conditions (Field, 2009). This research builds upon the constructs of a proven survey (EMS, 2015), which adds to the construct validity of the study. The EMS is taken every four years, with a variety of manufacturing companies from seven different industries and varying sizes taking part, which adds to the external validity of the survey. In order to improve the internal validity of the EMS, trial surveys were conducted. Moreover, representatives were invited to a gathering to discuss the questions included in the survey, and it was made sure that the questions were formulated as detailed as possible. Also a translation check was conducted. Only objective data was gathered by the survey in order to improve reliability. The data was gathered and processed anonymously. Participants were made aware of the goals of the research and were given the possibility to ask questions via phone and email. To test the reliability of the constructs built from items in the survey, reliability checks were conducted for variables PPM's, CCEP's and OTP's. The variable PPM's yielded an Cronbach's alpha of .666, which is a little low according to Field (2013). By deleting the item technologies for regeneration energy/heat from the scale the alpha could be improved to .682. The variable CCEP's yielded a Cronbach's alpha of .715, which is acceptable (Field, 2013). By excluding the item broad-based employee financial participation schemes from the scale, alpha could be improved to .727. The variable Other technologies and practices yielded a Cronbach's alpha of .828, which is good (Field, 2013). This variable could have been improved to .830 by deleting the item processing techniques for alloy construction materials. As the potential improvements were minor and respective items were of theoretical and practical relevance to the variable (Kock, 2015), it was chosen not to delete the items and include them in the scale.

Chapter 4 Results

4.1 Introduction

In this chapter the results of the main analysis is presented. Firstly, the results of the quantitative analysis are elaborated on. Then, the hypotheses formed in chapter 2 are compared to the quantitative results and statements are made regarding the relationships researched. After the quantitative analysis, new hypotheses are formed based on the result. These hypotheses are tested in order to find underlying causes for the results of the quantitative analysis. Finally, the results from the quantitative are concluded.

4.2 Quantitative analysis

In this part the quantitative results are examined. First, the descriptives of the variables are presented. Second, the results of the multiple regression analyses are elaborated on. Finally, the results of the binomial logistic regression analyses are stated. Initially only the main findings of the analyses are explained. Other findings are discussed in a separate paragraph at the end of this chapter.

4.2.1 Sample descriptives and univariate analyses

In this section the characteristics of the sample are further examined. Data from EMS (2015) is used for the quantitative part of the analysis. Dutch manufacturing companies with a minimum of 10 employees were included. The sample size ranges from (N=144) to (N=177) manufacturing firms. Specific sample sizes can be found in the table of the corresponding analysis. As discussed in the previous chapter, from some variables the natural logarithm was taken in order to improve the distribution for the regression. However, their initial values were used in the descriptives for the purpose of better interpretation.

Percentage change in Annual Turnover ranges from -100.00% to 146.67%, with most firms (82.5%) having a change in Annual Turnover between -17.68% and 40.50% (M=11.4117, SD=29.08813). Costs remained stable on average (M=3.86, SD=1.28), as answer 4 corresponds to no change in production costs. Ranging from <-10% to >10% change in costs, most companies reported a -5% to 5% change in costs (78.5%). On average, companies have a lead time of 26 days (M=26.2848, SD=52.92912), ranging from 0 to 450 days, with most companies (93.7%) having a lead time between 0 and 79 days. Delivery ranges from 30% to 100%, with most companies (89.8%) delivering between 83% and 100% of their orders on time (M=92.1356, SD=9.13122). Because of the distribution of the delivery variable, it was transformed into a binary variable. The new variable measured if orders were delivered on time, with a percentage of 98% or above accepted as delivered on time, and anything below as not on time. This lead to 29.7% of orders delivered on time. In terms of quality, companies had to scrap or rework 5% of their products due to quality issues on average. Responses ranged from 0% to 94% with most companies (95.5%) scrapping or reworking between 0% and 15% of their products due to quality issues (M=5.0226, SD=9.68947). Finally, on average Energy and Resource consumption remained stable (M=3.80, SD=.96). Ranging from <-10% to >10%, most firms have a change in Energy and Resource consumption of -5% to 5% (83.6%). An overview of the descriptives of the dependent variables can be found in table 6.

Determinant	Description	Frequency (%)	Mean	SD
Turnover change	Δ Turnover 2012-2014 (%)		11.41	29.09
Production costs change	Δ change in Production Costs (1=<-10%, 2=-5 to -10%, 3=-5% to 0, 4=stable, 5= 0 to 5%, 6=5% to 10%, 7= >10%)		3.86	1.28
Lead Time	Days-average production time of main product group (days)		26.28	52.93
Delivery	Orders delivered on time (yes/no)	29.7		
Scrap Rate	Products having to be scrapped or reworked due to quality problems (%)		5.02	9.69
Energy and resource consumption	Δ Energy and Resource consumption (1=<-10%, 2=-5 to -10%, 3=-5% to 0, 4=stable, 5= 0 to 5%, 6=5% to 10%, 7= >10%)		3.80	.96

Table 6: Sample descriptives dependent variables

PPM's were measured using an index scale, with a maximum of 10 PPM's. The range of PPM's implemented by the companies goes from 0 to 9, with most of the firms (88.1%) implementing between 0 and 4 practices (M=2.1412, SD=1.91209). CCEP's were also measured using an index scale, with a maximum of 12 practices. The range of CCEP's implemented by the firms goes from 0 to 12, with most firms (70%) implementing between 3 and 8 practices (M=5.5876, SD=2.71035).

On average the companies have 104 employees (M=104.0395, SD=591.00253), ranging from 10 to 7800 employees (mode=20, median=38). Seven categories of industries were included in the survey: 1) metal; 2) food; 3) textile; 4) construction; 5) chemical; 6) machinery; 7) electronic. Of these industries, the metal (21.1%), machinery (17.7%) and electronic (18.3%) are most represented. The textile (12.6%), chemical (12.6%) and food industry (10.3%) make up for about a third of the data. The construction industry is least represented with 7.4%. Automation and robotics, Manufacturing technologies for new materials, Additive production technologies and Digital technologies are other technologies and practices used by organizations and are measured on an index scale, to measure how many of these companies are using in total. This leads to a maximum of 32 practices/technologies, with most companies (76.2%) implementing in between 6 and 16 practices/technologies (M=11.1229, SD=5.33748). An overview of the sample descriptives of the explanatory variables can be found in table 7.

Determinant	Description	Frequency (%)	Mean	SD
PPM's	Total number of PPM's implemented		2.14	1.91
CCEP's	Total number of CCEP's implemented		5.59	2.71
Firm size	Number of employees 2014		104.04	591
Industry	Industry type			
Metal		21.2		
Food		10.3		
Textile		12.6		
Construction		7.4		
Chemical		12.6		
Machinery		17.7		
Electronic		18.3		
OTP's			11.13	5.34

Table 7: Sample descriptives Explanatory variables

4.2.2 Financial effects of PPM's and their interaction with CCEP's

In this section the results of the analysis regarding financial performance indicators are presented. Stepwise multiple regression analyses (MRA) were conducted on the variables Turnover change and Production costs change. As the variable Industry is a dummy variable, one category needed to be excluded from the analysis. Therefore the category 'Food' was excluded from the Industry variable. Two analyses were conducted per dependent variable, resulting in two models (model 1, model 2). In model 1, the variables Firm Size, Industry, OTP's and PPM's were included as independent variables. In model 2 the interaction effects of PPM's and CCEP's (PPM's × CCEP's) and OTP's (OTP's × CCEP's) were added. An overview of the model and variable statistics for Turnover change can be found in table 8 (next page). Significant beta scores for variables are shown in bold.

Variables	Model 1 Δ Turnover	Model 2 Δ Turnover	Model 1 Δ Production costs	Model 2 Δ Production costs
	beta	**beta**	**beta**	**beta**
Control variables				
LnFirmSize	-.026	-.007	.056	.063
Industry[a]				
Metal	-.093	-.042	.060	-.002
Textile	**-.253***	**-.216****	-.063	-.121
Construction	-.147	-.134	.056	.026
Chemical	.024	.027	-.080	-.096
Machinery	-.100	-.075	.042	.003
Electronic	.003	.044	.058	.025
OTP's	.095	.036	**-.254***	**-.221****
CCEP's		.105		-.098
CCEP's × OTP's		-.159		**.281***
Explanatory variables				
PPM's	-.049	-.036	.080	.155
CCEP's × PPM's		.006		**-.284***
Model statistics				
Analysis technique		Linear regression		
F-Change	1.376	1.482	1.170	2.408
Significance F-Change	.204	.222	.317	.069
R^2	.080	.109	.060	.100
Adjusted R^2	.022	.032	.009	.033
N	152	152	174	174

Table 8: Model summaries turnover change and production costs change

1. [a] *Reference category for Industry is Food*
2. * *On 95% confidence level*
3. * *On 90% confidence level*

Table 8 shows no statistically significant models for Turnover change (model 1; F(9,151)=1.376, p>.1, R^2=.080, model 2: F(12,151)=1.482, p>.1, R^2=.109). Moreover, no significant effects of PPM's (beta=-.049, p>.1) or CCEP's × PPM's (beta=.006, p>.1) on turnover change were found. Both models for production costs change were found to be insignificant on a 95% confidence level, however model 2 was found to significant at a 90% confidence level (model 1: F(9,165)=1.170, p>.1, R^2=.060, model 2: F(3,162)=2.408, p<.1, R^2=.100). Moreover, model 2 was significantly improved by the addition of the interaction variables (R^2_{change}=.040, p<.1). Explaining an additional 4% of variance, adding up to a total of 10% (R^2=.100) of the variance in production costs change explained. A significant effect of CCEP's × PPM's (beta=-.284) was found. This means implementing more CCEP's to support PPM's moderately decreases production costs. Notable however is, that even though the effect of PPM's was found to be insignificant, the beta score was .155, indicating that PPM's would increase production costs, as opposed to decreasing them. As the moderating effect of CCEP's was found to be significant, it could be that firms have to adapt production processes to implement PPM's, which leads to increased production costs.

This study hypothesized that the implementation of PPM's would improve the financial performance dimensions turnover change and production costs (H1a). Due to increased customer satisfaction, lean operational performance and marketing performance turnover would increase. Moreover, due to implementation of green practices as explained in chapter 2 and reduced consumption of raw materials, production costs would decrease. As presented in table 8 and discussed above, no significant effects of PPM's on financial performance indicators were found. Therefore H1a was not confirmed.

This study also hypothesized CCEP's improves the relationship between PPM's and financial performance indicators (H2a). Due to synergy between HR practices and environmental management, enhanced adoption of technologies and practices, enhanced employee capabilities and recruitment and better green strategies CCEP's can contribute to the implementation of PPM's and therefore increase turnover and decrease production costs. No significant effects were found on turnover change, but a significant negative effect of moderate size on production costs change was found (beta=-.284). Therefore H2a can be confirmed for production costs and not confirmed for turnover change. Hence, H2a is partially confirmed. Some other significant beta scores were found, these however are discussed in the paragraph regarding other findings later on in this chapter. In the next paragraph, the effects on operational performance indicators are analyzed.

4.2.3 Operational effects of PPM's and their interaction with CCEP's

In this section the results of the analysis regarding operational performance are presented. Stepwise multiple regression analyses were conducted on the variables LnLeadTime and LnScrapRate. Two analyses were conducted per dependent variable, resulting in two models (model 1, model 2). In model 1, the variables LnFirmSize, Industry, OTP's and PPM's were included as independent variables. In model 2 the interaction effects of PPM's and CCEP's (PPM's × CCEP's) and OTP's (OTP's × CCEP's) were added. A binary logistic regression analysis (BRA) was conducted on the variable Delivery as its distribution was not suited for MRA. As discussed in Chapter 3, the ordinal scale of the variable delivery was recoded into a binary one for the BRA. Values below 98% orders delivered on time were coded as '0', being not on time. Values from 98% orders delivered on time and above were coded as ‘1’, being on time. Three models were created by the BRA (model 0, model 1, model 2). Model 0 is the base model for the BRA, in model 1, the variables LnFirmSize, Industry, OTP’s and PPM’s were included as independent variables. In model 2 the interaction effects of PPM’s and CCEP’s (PPM’s × CCEP’s) and OTP’s (OTP’s × CCEP’s) were added. The same reference category for Industry was used for these analyses as for the analyses in the previous paragraph; Food. An overview of the model and variable statistics for LnLeadTime and LnScrapRate can be found in table 9 (next page), an overview for the BRA on Delivery can be found in table 9. Significant beta scores for variables are shown in bold.

Variables	**Model 1 LnLeadTime**	**Model 2 LnLeadTime**	**Model 1 LnScrapRate**	**Model 2 LnScrapRate**
	beta	**beta**	**beta**	**beta**
Control variables				
LnFirmSize	.030	-.048	.038	.029
Industry[a]				
Metal	**.351***	**.387***	.091	.053
Textile	.068	.100	-.007	-.039
Construction	**.181***	**.196***	.103	.091
Chemical	**.249***	**.256***	.065	.061
Machinery	**.595***	**.619***	**.296***	**.277***
Electronic	**.336***	**.358***	-.029	-.055
OTP’s	-.017	-.028	**-.194****	-.154
CCEP’s		.024		-.071
CCEP’s × OTP’s		-.136		-.137
Explanatory variables				
PPM’s	-.070	-.080	-.008	.003
CCEP’s × PPM’s		.077		-.065
Model statistics				
Analysis technique		**Linear regression**		
F-Change	5.424	.945	2.239	.751
Significance F-Change	.001	.420	.022	.523
R^2	.230	.244	.109	.121
Adjusted R^2	.188	.187	.060	.056
N	172	172	174	174

Table 9: Model summaries LnLeadTime and LnScrapRate

1. [a] *Reference category for Industry is Food*
2. [*] *On 95% confidence level*
3. [*] *On 90% confidence level*

For LnLeadTime, model 1 was found to be significant, explaining 23% of the variance: $F(9,163)=5.424$, $p<.05$, $R^2=.230$. Model 2 was found to be insignificant: $F(3,160)=.945$, $p>.1$, $R^2=.244$. No significant effects of PPM's (beta=-.070, $p>.1$), nor CCEP's × PPM's (beta=.077, $p>.1$) were found on LnLeadTime. The models for LnScrapRate showed the same trend, with model 1 explaining 11% in the variance and being significant ($F(9,165)=2.239$, $p<.05$, $R^2=.109$) and model 2 ($F(3,162)=.751$, $p>.1$, $R^2=.121$) being insignificant. No significant effects of PPM's (beta=-.008, $p>.1$), nor CCEP's × PPM's (beta=-.065, $p>.1$) were found on LnScrapRate. Other significant effects of control variables were found, however these are discussed in a separate paragraph later on in the chapter. In the next table (table 10, next page), the results for the BRA on Delivery are presented.

Determinant	Model 0 Delivery [a]	Model 1 Delivery [b]		Model 2 Delivery [c]	
Control variables		**B**	**Exp(B)**	**B**	**Exp(B)**
LnFirmSize		.284	-1.329	.277	1.319
Industry[d]					
Metal		**-1.959***	**.141***	**-.2.052***	**.128***
Textile		**-1.156****	**.315****	**-1.346****	**.260****
Construction		-1.011	.364	-1.233	.291
Chemical		-.343	.709	-.485	.616
Machinery		**-1.604***	**.201***	**-1.817***	**.163***
Electronic		-.675	.509	-.582	.559
OTP's		-.025	1.058	-.079	.924
CCEP's				.128	1.137
CCEP's × OTP's				**.404****	**1.489****
Explanatory Variables					
PPM's		.056	.466	.144	1.155
CCEP's × PPM's				**-.477***	**.621***
Model Statistics					
Analysis technique		Logistic regression			
Exp. (B)	.423				
Sig.	.001	.043		.154	
-2 Log likelihood		195.541		190.280	
Chi-Square		17.407		5.262	
df		9		3	
Cox&Snell R^2		.095		.121	
Nagelkerke R^2		.135		.173	

Table 10: Model summaries delivery

1. [a] *Base model, no determinants*
2. [b] *Added LnFirmSize, Industry, OTP's and PPM's*
3. [c] *Added Interaction variables and CCEP's*
4. [d] *Reference category for Industry is Food*
5. [*] *On 95% confidence level*
6. [**] *On 90% confidence level*

As can be found in table 10, model 0 has a significant odds ratio of .423 ($p<.05$), meaning the chance of having orders delivered on time is .43 times smaller without including the explanatory variables in the model compared to including the explanatory variables. In model 1 the explanatory variables LnFirmSize, Industry, OTP's and PPM's were added. These variables improved the model significantly, (chi-square=17.407, $p<.05$, df=9), with between 9.5% and 13.5% of the variation in delivery explained by model 1 (Cox & Snell R^2=.095, Nagelkerke R^2=.135). No significant effect of PPM's on Delivery was found (B=.056, OR=.466). In model 2 the moderating variables CCEP's × PPM's and CCEP's × OTP's were added. The model was improved, but not significantly so (chi-square=5.262, p>.1, df=3). However, this was not reflected by a significant coefficient for CCEP's × PPM's (OR=.621), meaning implementing more CCEP's to support the implementation of PPM's would actually decrease the chance of having orders delivered on time. Again, this could be due to firms not adequately implementing the CCEP's, leading to sub-optimal results in delivery, or it could actually be that implementing more CCEP's to support PPM's disrupts the delivery processes.

This research hypothesized PPM's would improve operational performance dimensions (H1b). PPM's can enhance lean operational performance, lead to better operational efficiency, enhanced information sharing, better coordination of operational activities, more innovation and customer collaboration and hence lead to improved lead times, quality and delivery. No significant effects of PPM's were found on lead time, scrap rate or delivery. Therefore hypothesis 1b is not confirmed.

This study also hypothesized implementing more CCEP's to support the implementation of PPM's would improve the relationship between PPM's and operational performance indicators (H2b). Again, due to synergy between HR practices and environmental management, enhanced adoption of technologies and practices, enhanced employee capabilities and recruitment and better green strategies CCEP's can contribute to the implementation of PPM's and therefore improve lead times, quality and delivery. No significant effects on lead time or quality were found as their models 2 were found to be insignificant. However, contrary to the hypothesis, CCEP's × PPM's decrease the chance of having orders delivered on time. Hypothesis 2b is not confirmed. Other significant scores are discussed later on in this chapter. In the next paragraph, the effects on energy and resource consumption are analyzed.

4.2.4 Environmental effects of PPM's and their interaction with CCEP's

In this section the results of the analysis regarding environmental performance are presented. Stepwise multiple regression analysis was conducted on the variable Energy and Resource consumption. Two models were created (model 1, model 2). In model 1, the variables LnFirmSize, Industry, OTP's and PPM's were included as independent variables. In model 2 the interaction effects of PPM's and CCEP's (PPM's × CCEP's) and OTP's (OTP's × CCEP's) were added. For the control variable Industry the same reference category was used as for the other analyses; Food. An overview of the models can be found in table 11 (next page). Significant beta scores for variables are shown in bold.

Variables	Model 1 Δ Energy and Resource consumption	Model 2 Δ Energy and Resource consumption
	beta	**beta**
Control variables		
LnFirmSize	.003	.010
Industry[a]		
Metal	**-.220****	**-.276***
Textile	-.115	-.167
Construction	**-.196***	**-.211***
Chemical	.055	.055
Machinery	-.108	-.129
Electronic	**-.215****	**-.234***
OTP's	**-.188****	-.139
CCEP's		-.106
CCEP's × OTP's		**.254***
Explanatory variables		
PPM's	**-.164****	-.121
CCEP's × PPM's		**-.227****
Model statistics		
Analysis technique	**Linear regression**	
F-Change	2.729	2.000
Significance F-Change	.006	.117
R^2	.154	.191
Adjusted R^2	.098	.117
N	144	144

Table 11: Model summaries energy and resource consumption

1. [a] *Reference category for Industry is Food*
2. [*] *On 95% confidence level*
3. [**] *On 90% confidence level*

For Energy and Resource consumption, model 1 was found to be significant explaining 15% of the variance ($F(9,135)=2.729$, $p<.05$, $R^2=.154$). Adding the interacting variables to model 2 did improve the variance explained by 3.7% ($R^2_{change}=.037$), however the model was found to be insignificant ($F(3,132)=2.000$, $p>.1$, $R^2=.191$). Notable is that model 2 is not far off of being significant ($p=.117$). A significant beta score for PPM's was found (beta=-.164), meaning a small effect on energy and resource consumption. This means implementing PPM's slightly decreases the energy and resource consumption. Moreover, CCEP's × PPM's were found to be significant (beta=-.227), meaning implementing CCEP’s to aid the implementation of PPM’s moderately decreases energy and resource consumption.

This research hypothesized PPM’s improve environmental performance indicators (H1c). PPM’s can lead to reduced usage of raw materials and hence lead to reduced energy and resource consumption. A significant small effect of PPM’s on energy and resource consumption was found (beta=-.164). This means implementing PPM’s leads to a slight reduction in energy and resource consumption, which leads to increased environmental performance. Hypothesis H1c was confirmed.

This study also hypothesized adapting CCEP’s to PPM’s would improve the relationship between PPM’s and operational performance indicators (H2c). Again, due to synergy between HR practices and environmental management, enhanced adoption of technologies and practices, enhanced employee capabilities and recruitment and better green strategies, CCEP’s can contribute to the implementation of PPM’s. Hence CCEP’s could reduce energy and resource consumption and thus increase environmental performance.

A moderate effect of this moderating effect was found (beta=-.227), which means adapting CCEP’s to aid the implementation of PPM’s moderately decreases energy and resource consumption, hence increasing environmental performance. However, the overall model was found to be insignificant. H2c was partially confirmed. In the next paragraph, the other findings of the analyses are elaborated on.

4.2.5 Other findings

In this paragraph other significant effects found in the analyses are discussed. Regarding financial performance indicators it was found that the implementation of OTP’s (beta=-.221) moderately decreases production costs. However, implementing more CCEP’s to support OTP’s actually moderately increases production costs (beta=.281). An explanation for this may be that even though OTP’s decrease production costs, they are not necessarily designed to have that effect. They may also target new product development or innovations. In that case, the moderating effect of CCEP’s would also include firms which use complex technologies or practices in combination with a progressive use of CCEP’s. This then could lead to a production cost increase for these firms, as they make investments in CCEP’s to support these technologies or practices and therefore increase production costs, which would explain the outcome of the moderation effect found in the analysis.

Regarding operational performance indicators, some significant effects were found for Industry on LnLeadTime. The Metal (beta=.351), Construction (beta=.181), Chemical (beta=.249), Machinery (beta=.595) and Electronic (beta=.336) industries all have higher lead times than the food industry. This is not surprising, as the food industry would have to have low lead times in order to counter food going bad. Moreover, the Machinery industry has a moderately higher scrap rate than the food industry (beta=.296). OTP's have a small negative effect on LnScrapRate (beta=-.194). This means implementing OTP's decreases the percentage of products that have to be scrapped or reworked. This makes sense, as OTP's may target product characteristics and production processes that aim to improve product quality. Furthermore, the Metal (OR=.141), Textile (OR=.315) and Machinery (OR=.201) industries all have decreased chances of having their orders delivered on time compared to the Food industry. Moreover, even though the model was found to be non-significant (p=.154), a significant interaction effect was found for CCEP's and OTP's (OR=1.489), meaning increasing the amount of CCEP's that support OTP's increases the chance of having orders delivered on time. This could be due to the nature of the OTP's implemented in combination with the selected CCEP's to support them. For example: training staff to operate new and/or quicker production technologies such as additive manufacturing could decrease the chances of delayed production and therefore increase the chances of having orders delivered on time.

Finally, regarding environmental performance indicators, significant effects were found for the Metal (beta=-.220), Construction (-.196) and Electronic (-.215) industries, meaning these industries had a greater decrease in energy and resource consumption compared to the Food industry. Moreover, OTP's have a small negative effect (beta=-.188), meaning implementing OTP's lead to a greater decrease in energy and resource consumption. Interestingly, applying CCEP's in order to aid the implementation of OTP's increased the change in energy and resource consumption. An explanation for this may be that even though OTP's by themselves decrease the change in energy and resource consumption, combining them with supportive CCEP's leads to a more effective usage of OTP's. OTP's include alternative production technologies and new products. As employees are more capable and committed to use the OTP's, these might be used more frequently or severely, consuming more energy and resources. Analyzing the other findings, some interesting results were found. In the next paragraph a conclusion is drawn from the results from the main analysis, but also compared to other results found in this paragraph.

4.2.5 Conclusion main analyses

In this paragraph the main findings are concluded briefly and compared to other results found in this study. H1c was confirmed. H2a and H2c were partially confirmed. H1a, H1b and H2b were not confirmed. This means that implementing PPM's increases environmental performance. Moreover, implementing CCEP's aimed to aid the implementation of PPM's partially improves financial performance. Additionally, implementing CCEP's aimed to aid the implementation of PPM's improves environmental performance, this can be stated with lower certainty due to an insignificant model. Other interesting findings are that OTP's decrease energy and resource consumption, production costs and scrap rate. Moreover, increasing the amount of CCEP's to support OTP's decreases production costs. Interestingly, increasing the amount of CCEP's to support OTP's increases production costs and energy and resource consumption.

So, PPM's only improve environmental performance autonomously, while OTP's improve financial-, operational- and environmental performance. This could be due to the complexity and novelty of PPM's when compared to OTP's, which leads to a higher need of support from CCEP's. This notion is supported by Barbieri, Marzucchi and Rizzo (2020), who state that green technologies bring additional complexity and novelty, and handling and adopting them requires difficult knowledge-sourcing efforts and radically new competences. This is supported by the partial confirmation of H2a and H2c, meaning that supporting PPM's by CCEP's can improve the effects on financial and environmental performance.

As the main findings of this study are mixed in their relations to the hypotheses, a post-hoc analysis was conducted. The set-up and results of this analysis are presented in the next chapter.

Chapter 5 Post-hoc analysis

5.1 Post-hoc analyses

In order to clarify and build upon the results found in the previous analyses, several post-hoc analyses were conducted. The results found were mixed and most of the hypotheses of this study were not confirmed. Therefore, it would be valuable to find causes for these unexpected results. The goal of the post-hoc analysis is to clarify the results found in the main analyses. An explanation for the results found in the previous paragraphs could be that an investment in PPM’s yields results in the longer term, as discussed by Porter (1991). Barbieri et al. (2020) state green technologies are more complex, and therefore require greater organizational efforts in terms of knowledge-sourcing and new competences. Moreover, outcomes of practices and initiatives implemented by a company to reduce its impact on the environment depend on the portfolio of practices and measures of business performance that are considered (González-Benito & González-Benito, 2005). Hence, it could be valuable to take a more detailed approach when examining the portfolio of practices and technologies used, as this could affect the results.

Therefore in the post-hoc analysis the variables PPM’s and OTP’s were both split into 2 variables. As green technologies are more complex from non-green ones, technologies and practices were distinguished in both variables, resulting in four new variables. PPM’s was split into Pollution Prevention Technologies (PPT’s) and Pollution Prevention Practices (PPP’s). OTP’s was split into Other Technologies (OT’s) and Other Practices (OP’s). A separate interaction variable was created for each of these new variables in order to measure the moderating effect of CCEP’s. By doing this, this study can evaluate the portfolio of sustainability measures in more detail and analyze to what degree technologies and practices affect firm performance individually. This can help in making a comparison between the implementation of green and non-green technologies and their synergy with CCEP’s and therefore aid in finding a clarification for the results found in the previous chapter. The measures of business performance considered were identical to those in the main analysis in order to create a more consequent comparison. Therefore the analysis techniques used also remain the same. In the next paragraph, the univariate analysis of the new variables is presented.

5.2 Sample descriptives and univariate analysis of new variables

The new variables created for the post-hoc analyses are PPT’s and PPP’s (created from PPM’s) and OT’s and OP’s (created from OTP’s). These variables are also measured on an index scale. PPT’s range from 0 to 6, with most firms (55.4%) implementing between 0 and 3 PPT’s (M=1.6158, SD=1.51484). PPP’s range from 0 to 3, with most firms (89.8%) implementing 0 and 1 PPP’s

(M=.5254, SD=.72353). OT's range from 0 to 14, with most firms (80.3%) implementing between 1 and 6 OT's. Finally, OP's range from 0 to 15, with most firms (72.3%) implementing between 4 and 11 OP's. Their sample descriptives can be found in table 12.

Determinant	**Description**	**Mean**	**SD**
PPT's	Total number of pollution prevention technologies implemented	1.62	1.51
PPP's	Total number of pollution prevention practices implemented	.53	.72
OT's	Total number of other technologies implemented	3.65	2.61
OP's	Total number of other practices implemented	7.5	3.5

Table 12: Sample descriptives new variables

The next paragraph contains the analysis of the effects of PPT's and PPP's on financial performance indicators.

5.3 Financial effects of PPT's and PPP's

Table 13 (next page) contains the results found in the post-hoc analysis regarding financial performance indicators and can be found below. Both models regarding turnover change were found to be insignificant (model 1: $F(11,140)=1.284$, $p>.1$, $R^2=.092$), model 2: $F(5,135)=.861$, $p>.1$, $R^2=.120$). For production costs change, model 1 was found to be not significant ($F(11,163)=1.447$, $p>.1$, $R^2=.089$), model 2 was found to be significant ($F(5,158)=1.888$, $p<.1$, $R^2=.140$), meaning model 2 explains 14% of variance. So adding the interacting variables explains an extra 5.1% of variance compared to model 1. However, no significant of PPT's (beta=.112), PPP's (.008) or CCEP's × PPP's (beta=.033) on production costs were found. However, it was found that CCEP's × PPT's significantly decreases the production costs (beta=-.331).

Variables	Post-hoc Model 1 Δ Turnover	Post-hoc Model 2 Δ Turnover	Post-hoc Model 1 Δ Production costs	Post-hoc Model 2 Δ Production costs
	beta	**beta**	**beta**	**beta**
Control variables				
LnFirmSize	-.028	-.011	.040	.063
Industry[a]				
Metal	-.068	-.044	-.022	-.066
Textile	**-.250***	**-.217****	-.064	-.110
Construction	-.142	-.144	.010	-.015
Chemical	.042	.046	-.094	-.083
Machinery	-.088	-.086	.031	-.061
Electronic	.021	.043	-.017	-.023
OT's	-.007	.010	.087	.060
OP's	.125	.018	**-.331***	**-.367***
CCEP's		.123		-.019
CCEP's × OT's		-.001		**.256***
CCEP's × OP's		-.156		.033
Explanatory variables				
PPT's	.042	.025	.059	.112
PPP's	-.130	-.119	.002	.008
CCEP's × PPT's		-.032		**--.331***
CCEP's × PPP's		.050		.032
Model statistics				
Analysis technique	**Linear regression**			
F-Change	1.284	.861	1.447	1.888
Significance F-Change	.240	.509	.157	.099
R^2	.092	.120	.089	.140
Adjusted R^2	.020	.015	.027	.053
N	152	152	174	174

Table 13: Model summaries post-hoc analysis turnover change and production costs change

1. [a] *Reference category for Industry is Food*
2. ** On 95% confidence level*
3. ** On 90% confidence level*

Notable here is the - although insignificant - small increasing effect of PPT’s. As the moderating effect of CCEP’s however was found to be significant, this confirms the notion that supportive CCEP’s for PPT’s can decrease production costs. Moreover, comparing these results to those found in chapter 4, CCEP’s × PPT’s are mainly responsible for the significant effect of CCEP’s × PPM’s on change in production costs. So it seems that PPT’s benefit more from CCEP’s than PPP’s. This supports the results found by Barbieri et al. (2020), who state that green technologies require knowledge-sourcing efforts and radically new competences to be adopted optimally. Finally, some other significant effects were found, these however are discussed in a separate paragraph later on in this chapter. In the next paragraph the results of the post-hoc analyses regarding operational performance indicators are explained.

5.4 Operational effects of PPT’s and PPP’s

For operational performance indicators, model 1 for LnLeadTime ($F(11,161)=4.489$, $p<.05$, $R^2=.235$) was found to be significant, explaining 23.5% of the variance. Model 2 was found to be insignificant ($F(5,156)=1.477$, $p>.1$, $R^2=.269$). Model 1 for LnScrapRate was found to be significant ($F(11,163)=2.156$, $p<.05$, $R^2=.127$), explaining 12.7% of the variance. Model 2 was found to be insignificant ($F(5,158)=1.237$, $p>.1$, $R^2=.160$). No significant effects of PPT’s, PPP’s, CCEP’s × PPT’s or CCEP’s × PPP’s were found in both analyses. Comparing these results to those found in chapter 4, no significantly different results or additional insights can be found. See table 14 for an overview (next page).

Variables	Post-hoc Model 1 LnLeadTime	Post-hoc Model 2 LnLeadTime	Post-hoc Model 1 LnScrapRate	Post-hoc Model 2 LnScrapRate
	beta	**beta**	**beta**	**beta**
Control variables				
LnFirmSize	.022	.048	.040	.017
Industry[a]				
Metal	**.342***	**.368***	.155	127
Textile	.068	.102	-.005	-.049
Construction	**.172****	**.179***	.133	.131
Chemical	**.252***	**.284***	.083	.065
Machinery	**.580***	**.596***	**.342***	**.336***
Electronic	**.322***	**.342***	.018	-.008
OT's	-.028	.008	**-.241***	**-.259***
OP's	.027	-.098	.011	.140
CCEP's		.068		-.133
CCEP's × OT's		.109		-.002
CCEP's × OP's		**-.276***		.184
Explanatory variables				
PPT's	-.018	-.061	.059	.077
PPP's	-.089	-.092	.002	.065
CCEP's × PPT's		-.006		.056
CCEP's × PPP's		.107		-.124
Model statistics				
Analysis technique		**Linear regression**		
F-Change	4.489	1.477	2.156	1.237
Significance F-Change	.001	.200	.019	.294
R^2	.235	.269	.127	.160
Adjusted R^2	.182	.194	.068	.075
N	172	172	174	174

Table 14: Model summaries post-hoc analysis LnLeadTime and LnScrapRate

1. [a] *Reference category for Industry is Food*
2. ** On 95% confidence level*
3. ***On 90% confidence level*

A logistic regression analysis was conducted on the delivery variable (see table 15), in an identical manner as in chapter 4. Model 0 has a significant odds ratio of .423 (p<.05), meaning the chance of having orders delivered on time is .43 times smaller without including the explanatory variables in the model compared to including the explanatory variables. In model 1 the explanatory variables LnFirmSize, Industry, PPT's, PPP's, OT's and OP's were added. These variables improved the model significantly, (chi-square=17.427, $p<.1$, df=11), with between 9.5% and 13.5% of the variation in delivery explained by model 1 (Cox & Snell $R^2=.095$, Nagelkerke $R^2=.135$). In model 2 the moderating variables CCEP's × PPT's, CCEP's × PPP's, CCEP's × OT's and CCEP's × OP's were added. The model was improved, but not significantly so (chi-square=7.292, $p>.1$, df=5). No significant effects of PPT's, PPP's, CCEP's × PPT's or CCEP's × PPP's were found in both models. See table 15 for an overview (next page).

Determinant	Post-hoc Model 0 Delivery [a]	Post-hoc Model 1 Delivery [b]		Post-hoc Model 2 Delivery [c]	
Control variables		**B**	**Exp(B)**	**B**	**Exp(B)**
LnFirmSize		.287	1.332	.272	1.313
Industry[d]					
Metal		**-1.930***	**.145***	-2.181	.113
Textile		**–1.155****	**.315****	-1.326	.266
Construction		-.985	.374	-1.327	.265
Chemical		-.337	.714	-.636	.529
Machinery		**-1.576***	**.207***	-1.928	.145
Electronic		-.647	.524	-.673	.510
OT's		-.037	.964	.006	1.006
OP's		.069	.982	-.118	.888
CCEP's				.132	1.142
CCEP's × OT's				-.113	.893
CCEP's × OP's				**.536***	**1.709***
Explanatory Variables					
PPT's		.058	1.059	.179	1.196
PPP's		.059	1.061	.128	1.137
CCEP's × PPT's				-.373	.688
CCEP's × PPP's				-.195	.823
Model Statistics					
Analysis technique		**Logistic regression**			
Exp. (B)	.423				
Sig.	.001	.096		.200	
-2 Log likelihood		195.522		188.229	
Chi-Square		17.427		7.292	
df		11		5	
Cox&Snell R^2		.095		.132	
Nagelkerke R^2		.135		.187	

Table 15: Model summaries post-hoc analysis delivery

1. *[a] Base model, no determinants*
2. *[b] Added Firm size, Industry, OT's, OP's, PPP's and PPT's*
3. *[c] Added Interaction variables and CCEP's*
4. ** On 95% confidence level*
5. ***On 90% confidence level*

Comparing these results to those found in chapter 4, it's interesting to see that separating PPM's into PPT's and PPP's led to insignificant results regarding the interaction variables. So bundling PPT's and PPP's and treating them similarly regarding CCEP's seems to decrease the chance of having orders delivered on time. This could be, because PPT's require more efforts to aid adoption as stated in previous paragraphs and found by Barbieri et al. (2020). Not focusing enough on the technological aspect of PPM's when implementing CCEP's may therefore lead to decreased operational performance. Again, other findings are discussed in a separate paragraph. In the next paragraph the results of the post-hoc analyses regarding environmental performance indicators are presented.

5.5 Environmental effects of PPT's and PPP's

For the environmental performance dimension, model 1 was found to be significant ($F(11,133)=2.504$, $p<.05$, $R^2=.172$), explaining 17.2% of the variance. Model 2 was found to be insignificant ($F(5,128)=1.447$, $p>.1$, $R^2=.216$). A significant result was found PPP's (beta=-.191). Hence, PPP's decrease the change in energy and resource consumption. No significant results were found for PPT's and CCEP's × PPT's. CCEP's × PPP's was found to be significant (beta=-220). Meaning PPP's in combination with fitting CCEP's decrease the change in energy and resource consumption, however the model was found to be insignificant. An overview of the results for this model can be found in table 16 (next page), significant beta scores are shown in bold.

Variables	Post-hoc Model 1 Δ Energy and Resource consumption	Post-hoc Model 2 Δ Energy and Resource consumption
	beta	**beta**
Control variables		
LnFirmSize	-.007	.063
Industry[a]		
Metal	**-.236****	**-.284***
Textile	-.110	-.164
Construction	**-.232***	**-.238***
Chemical	.066	.042
Machinery	-.138	-.153
Electronic	**-.250***	**-.257***
OT's	-.014	-.025
OP's	-.151	-.086
CCEP's		-.091
CCEP's × OT's		.049
CCEP's × OP's		**.253****
Explanatory variables		
PPT's	-.077	-.049
PPP's	**-.191***	-.115
CCEP's × PPT's		-.093
CCEP's × PPP's		**-.220****
Model statistics		
Analysis technique	**Linear regression**	
F-Change	2.504	1.447
Significance F-Change	.007	.212
R^2	.172	.216
Adjusted R^2	.103	.118
N	144	144

Table 16: Model summaries post-hoc analysis energy and resource consumption change

1. [a] *Reference category for Industry is Food*
2. ** On 95% confidence level*
3. *** On 90% confidence level*

Comparing these results to those found in chapter 4, it's interesting to see the decrease in energy and resource consumption change is mainly caused by PPP's. This could be because PPP's might be easier to implement than PPT's and therefore have a greater effect on environmental performance in the short term. Finally, in both analyses the second models were found to be insignificant, however significant effects were found for CCEP's × PPM's and CCEP's × PPP's. So the significant effect of PPM's in combination with fitting CCEP's would mainly be caused by the PPP's in the PPM's. In the next paragraph other interesting results found in the post-hoc analyses are discussed and compared to the results found in previous paragraphs.

5.5 Other post-hoc findings

In this paragraph other interesting results found in the post-hoc analyses are discussed. Regarding financial performance indicators, it was found that OP's significantly reduce production costs (beta=-.367). Moreover, CCEP's × OT's significantly increase production costs (beta=.256). This is in line with the findings from the main analyses. However, it can be stated that the significant effects of OTP's and CCEP's × OTP's are largely explained by these post-hoc findings. So as OP's seem to significantly contribute to an increase in financial performance by lowering production costs, OT's do not. An explanation for this may be that OP's include practices aimed at reducing production costs. Combining OT's with CCEP's decreases financial performance by increasing production costs. It could therefore be that these OT's are not designed to reduce costs, but also target new product development or innovations as explained in chapter 4. This then could lead to a production cost increase for these firms, as they make investments in CCEP's to support these technologies which can not be directly measured in cost savings.

Regarding operational performance, OT's significantly reduce LnScrapRate (beta=-.241). This can be explained by the nature of OT's, which can be designed in order to improve production quality and reduce production errors. Therefore the scrap rate could be reduced and operational performance increased. As was found in chapter 4, OTP's also significantly reduce scrap rate, although this effect was weaker. No significant other findings were found for LnLeadTime or Delivery apart from industry effects.

Finally, regarding environmental performance, no significant other results were found as the second model was found to be insignificant (p=.212). In chapter 4 the results of the insignificant model were interpreted as the p-value was very close to .1 (p=.117). As the post-hoc model is a little more off, it was not interpreted in this study. As OTP's decrease energy and resource consumption as found in chapter 4, splitting OTP's into OT's and OP's results in an insignificant effect. Moreover, as found in the main analysis, applying CCEP's in order to aid the implementation of OTP's increased the change in energy and resource consumption. By distinguishing between OT's and OP's this effect can be nullified. In the next paragraph the results of the post-hoc analyses are briefly concluded and compared to the main analyses.

5.6 Conclusion post-hoc analyses

The goal of the post-hoc analysis was to clarify some of the results found in the main analysis. By splitting the variables PPM's and OTP's in the post-hoc analyses a more detailed insight into the portfolio of practices was created. In the main analysis it was found that PPM's decrease energy and resource consumption. Moreover, implementing CCEP's aimed to aid the implementation of PPM's decreases production costs and energy and resource consumption. In the post-hoc analyses it was found that combining PPT's with supportive CCEP's was mainly responsible for the moderating effect on production costs change found in the main analysis. It was also found that bundling PPT's and PPP's into PPM's interacts with CCEP's and decreases the chance of having orders delivered on time. Moreover, it was found that the decrease in energy and resource consumption found in the main analysis was mainly caused by PPP's. The same can be concluded for the moderating variable CCEP's × PPP's. In terms of additional results, it was found that OP's are responsible for a decrease in production costs, and OT's are not. In fact, combining CCEP's with OT's actually increases production costs, which explains the results of OTP's and supportive CCEP's found in the main analyses. OT's reduce the scrap rate while OP's do not. Finally, distinguishing between OT's and OP's turns the autonomous and interacting effects of OTP's on energy and resource consumption found in the main analyses insignificant . In the next chapter, the overall conclusions of this study are discussed and recommendations are made.

Chapter 6 Discussion

6.1 Introduction

In this chapter the findings of this study are discussed. The conclusions are presented and recommendations are made. Firstly, the results of this research are discussed and conclusions are drawn. Then the theoretical and practical implications are explained and recommendations for future studies are made. Finally, the limitations of this study are discussed.

6.2 Conclusion

This research aimed to find an answer to the following question: *'To what extent do PPM's affect dimensions of firm performance, and to what extent do HR practices affect this relationship?'*. By finding an answer to this question this study aimed to identify and clarify a causal pattern between sustainability and firm performance and add to the understanding of how contextual variables affect the sustainability - firm performance relationship.

To answer this question, existing literature was consulted in order to create a basis for this study by looking at definitions of concepts used by this study, already established relationships and recommendations made by previous literature. The framework of Hart & Milstein (2003) was used as a basis for the sustainability concept, as it encompasses all elements of sustainability and is highly practically usable. This therefore created a basis that is both theoretically and practically relevant. Drawing from this framework, the explanatory variable PPM's was created, referring to the amount of pollution prevention measures taken by firms. For firm performance, performance indicators regarding financial-, operational and environmental performance were used in order to cover all performance dimensions as explained in chapter 2. Financial performance was measured by turnover change and production costs change, operational performance was measured by lead time, quality (scrap rate) and delivery and environmental performance was measured by the change in energy and resource consumption. HR Practices were looked at for their possible moderating influence in the sustainability - firm performance relationship to add to the understanding of the circumstances under which sustainability measures might be effective and rewarding. The HR dimensions as identified by Guptha & Singhal (1993) were used to create CCEP's, referring to the amount of capability and commitment enhancing HR practices implemented by firms. A post-hoc analysis was conducted to get a more detailed understanding of what combination of sustainability measures included in the portfolio of firms actually affect firm performance. This was done by making a distinction between technologies and practices when creating the variable PPM's (resulting in PPT's and PPP's). Multiple and logistic regression analyses were used to test the models.

It was found that there is no benefit to implementing PPM's in terms of improved financial- or operational performance. However, the autonomous implementation of PPM's do decrease energy and resource consumption and therefore increase environmental performance. Some findings change when firms use CCEP's to support PPM's. By supporting PPM's with CCEP's production costs can be decreased, and the autonomous effect of PPM's on energy and resource consumption can be improved. The post-hoc analysis suggests that the moderation effect on production costs is mainly explained by PPT's in combination with supportive CCEP's. This is not the case for energy and resource consumption, which is mainly affected by PPP's. Contrary to hypothesized, it was found that supporting PPM's with CCEP's decreases the chance of having orders delivered on time. The post-hoc analysis indicated that distinguishing between PPT's and PPP's would not have this effect, and in fact treating the two as the same measure when combining them with CCEP's decreases delivery and thus operational performance. Additionally, OTP's decrease production costs and scrap rate. Found in the post-hoc analysis, OP's are responsible for the decrease in production costs, OT's are not. The opposite is true for scrap rate, for which OT's cause the decrease. OTP's decrease energy and resource consumption, however this effect is made insignificant if OTP's are split into OT's and OP's. The same goes for the interaction effects of OTP's and CCEP's. Finally, combining OTP's with supportive CCEP's increases production costs. In the post-hoc analysis it was found this is caused by supporting OT's with CCEP's. In the next paragraph implications and recommendations are made based on these findings.

6.3 Implications & Recommendations

In this paragraph the implications of the results of this research are discussed. Firstly the theoretical implications are discussed, then the practical implications are elaborated on.

This study adds to the cumulative knowledge regarding the sustainability - firm performance relationship. It was found that sustainability efforts such as PPM's can improve environmental performance, but the outcomes depend on the portfolio of technologies or practices used. This is in line with the research of (González-Benito & González-Benito, 2005) mentioned in previous chapters. No direct effects of sustainability efforts on financial- or operational performance were found. Moreover, to add to the context under which circumstances the sustainability - firm performance relationship exists, this study looked at to what extent capability and commitment enhancing HR practices (CCEP's) affect the relationship between sustainability measures and firm performance. It was found that CCEP's can help improve financial- and environmental performance when implemented correctly and used for the right set of technologies or practices. However, when not distinguishing between technologies and practices operational performance could be decreased.

Furthermore, some additional discoveries were made which add to the overall knowledge regarding organizational practices or technologies - firm performance relationship.

According to the results of this study, manufacturing companies should look at implementing sustainable practices, and supporting these with fitting CCEP's in order to improve environmental performance. Moreover, correctly aligning sustainable practices or technologies with CCEP's could benefit financial performance. Adversely, treating sustainable technologies and practices identically when it comes to supportive CCEP's can decrease operational performance. Firms looking to increase operational performance indicators should look at implementing other technologies or practices.

6.4 Limitations

In this paragraph the limitations of this study are discussed. This study made use of the EMS (2015). The EMS (2015) investigates Dutch manufacturing companies and includes numerous variables and concepts, among which variables related to sustainability, HRM and firm performance. This provided this study with a proven instrument. However, this also provided limitations as the survey is not tailored towards this study. The EMS (2015) is neither suited to cover all of the four strategies for sustainable value creation as identified by Hart & Milstein (2003), nor all four HR Practices strategies as identified by Guptha & Singhal (1993). Moreover, each performance indicator was measured by a single variable (f.e. quality by scrap rate). Measuring indicators with multiple variables may increase the reliability and validity of the concepts used, and yield different results. Using an instrument specifically designed for all measuring sustainable value creation strategies as defined by Hart & Milstein (2003) as well as HR Practices could increase the validity of future studies and help achieve this goal. Finally, a mixed-methods approach might have been more suitable to find causes for the results of the analyses as an interview can be tweaked to suit the questions raised by the results. An interview may therefore provide a more in-depth analysis of underlying mechanisms than the post-hoc analysis did. Resuming, even though this research did provide some valuable insight into the sustainability - firm performance relationship, further research could improve upon the design of this research. Using a questionnaire specifically designed for all four value creation strategies (Hart & Milstein, 2003), including more HR practices and using more indicators to measure firm performance dimensions could improve the validity and reliability of future studies. Moreover, as Barbieri et al. (2020) found a difference between green and non-green technologies a suggestion might be to look closer into this difference, its relationship with firm performance and under which circumstances this relationship might occur.

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Appendices

Appendix I EMS 2015

Radboud Universiteit Nijmegen

Institute for Management Research

Modernisering van de productie

Enquête 2015

Deze vragenlijst heeft als doel inzicht te krijgen in de inspanningen van industriële bedrijven in Nederland om hun productie en bedrijfsprocessen te moderniseren. Het onderzoek richt zich op productiebedrijven met een omvang van tenminste 10 werknemers. Bij ondernemingen met meerdere vestigingen hebben de vragen betrekking op de aangeschreven vestiging en niet op de totale onderneming.

Voor het onderzoek is beantwoording van alle vragen van belang. Ook als niet alle genoemde technologieën of organisatieconcepten van toepassing zijn op uw bedrijfsvestiging, verzoeken wij u vriendelijk de vragenlijst toch volledig in te vullen. Bij het invullen van de vragenlijst kunt u zowel de muis als de tab-toets gebruiken.

Voor vragen kunt u terecht bij. dr. Peter Vaessen E-Mail: P.Vaessen @ fm.ru.nl Tel.: 024 3611266 Fax: 024 3611933

1.1 **Is uw bedrijfsvestiging** (kruis slechts één optie aan):

- ☐ Het hoofdkantoor van een onderneming/groep met ook buitenlandse vestigingen
- ☐ Een dochter/divisie van een buitenlandse onderneming/groep
- ☐ Het hoofdkantoor van een onderneming/groep met alleen binnenlandse vestigingen
- ☐ Een dochter/divisie van een onderneming/groep met alleen binnenlandse vestigingen
- ☐ Een zelfstandige onderneming

1.2 Bedrijfstak (bijv. textiel, chemische industrie, machinebouw, enz.): ______ hoofdproductgroep ______ aandeel van hoofd-product (groep) in omzet ca. ____ %

1.3 **Is uw bedrijfsvestiging gelet op uw hoofdproduct(groep) leverancier van eindfabricaten of een toeleverancier van onderdelen/ materialen of bewerkingen?** (Kruis slechts één optie aan)

producent van eindfabricaten: ☐ voor consumenten ☐ voor bedrijven

toeleverancier: ☐ van systemen/ installaties ☐ van halffabricaten/ onderdelen

aanbieder van bewerkingen: ☐ aanbieder van bewerkingen (draaien, coaten, lassen, vermalen, e.a.)

1.4 **Als u uw hoofdproduct(groep) levert aan andere bedrijven (als eindfabrikant of toeleverancier), aan welke bedrijfstak levert u dan hoofdzakelijk?** (Kruis slechts één optie aan)

Machinebouw ☐ Chemische industrie ☐ Automotive industrie ☐ Elektro-techniek ☐ andere bedrijfstak, nl.: ______

1.5 **In hoeverre voert uw bedrijfsvestiging voor het hoofdproduct de volgende activiteiten uit van het waardecreatieproces?**
Kruis voor elke activiteit aan in welke mate die in uw eigen bedrijfsvestiging dan wel elders wordt uitgevoerd.
Kruis ook aan of een activiteit in het geheel geen deel uitmaakt van het waardecreatieproces

Waardecreatie-activiteiten

	Onderzoek en Ontwikkeling	Ontwerp/ Vormgeving	Productie/ Verwerking/Recycling	Assemblage	Onderhoud/ Dienstverlening	Verpakken/ Distributie
grotendeels intern > 85%	☐	☐	☐	☐	☐	☐
relevant deel intern (25%-85%)	☐	☐	☐	☐	☐	☐
klein deel intern (<25%)	☐	☐	☐	☐	☐	☐
niet nodig voor vervaardiging van het hoofdproduct	☐	☐	☐	☐	☐	☐

2 **Hoe belangrijk zijn de volgende factoren voor de concurrentiepositie van uw bedrijfsvestiging?** (geef de volgorde van belangrijkheid aan met een score van 1 tot 6; 1 is het belangrijkst, gebruik elke score slechts één keer)

productprijs	productkwaliteit	innovatieve producten	aanpassing producten aan klantenwensen	tijdige levering/ korte levertijden	dienstverlening en service
☐	☐	☐	☐	☐	☐

3 Welke van de volgende organisatieconcepten en werkwijzen worden momenteel in uw bedrijfsvestiging toegepast?

Toepassing gepland voor 2018	Nee	Organisatieconcepten	Ja	Voor het eerst toegepast[1]	Omvang van het toegepaste potentieel [2]
		Organisatie van het werk			
☐	☐	Gedetailleerde voorschriften voor de werkplekinrichting van apparatuur en opslag van tussenproducten (bijv. 5-S methode)	☐	19/20	g m h
☐	☐	Gestandaardiseerde en gedetailleerde werkinstructies	☐	19/20	g m h
☐	☐	Taakverrijking productiemedewerker (integratie van planning, uitvoering of controle)	☐	19/20	g m h
		Organisatie van de productie			
☐	☐	Maatregelen ter verbetering van de interne logistiek (Value Stream Mapping/Design, ruimtelijke inrichting van productiestappen)	☐	19/20	g m h
☐	☐	Klant- of productgeoriënteerde inrichting van productie-eenheden (i.t.t. functionele indeling)	☐	19/20	g m h
☐	☐	Vraaggestuurde productie (bijv. KANBAN, afschaffen van tussenvoorraden)	☐	19/20	g m h
☐	☐	Voorgeschreven methoden voor het verkorten van omstel- en aanlooptijden bij productwisseling (bijv. Single Minute Exchange of Die; Quick Change Over)	☐	19/20	g m h
		Productiemanagement/ -beheersing			
☐	☐	Grafische weergave werkprocessen en -status (Visual Management; dashboard)	☐	19/20	g m h
☐	☐	Kwaliteitsmanagement (bijv. preventieve onderhoud, total quality management/TQM, total productie-onderhoud/TPM)	☐	19/20	g m h
☐	☐	Methoden voor operation management o.b.v. wiskundige analyse van productie (bijv. Six Sigma methode)	☐	19/20	g m h
☐	☐	Methoden van continu verbeteren (Kaizen, kwaliteitscirkels e.d.)	☐	19/20	g m h
		Energie- en milieubeheersing			
☐	☐	Gecertificeerd energie-management systeem volgens ISO 50001, voorheen: EN 16001	☐	19/20	g m h
☐	☐	Instrumenten voor productlevenscyclus-analyse (bijv. EU Ecolabel, Cradle-to-Cradle certificaat, ISO-14020)	☐	19/20	g m h
☐	☐	Het opnemen van sociale en duurzaamheidseffecten in het vaststellen van bedrijfsprestaties	☐	19/20	g m h
		Human resource management			
☐	☐	Maatregelen voor het behoud van oudere werknemers of hun kennis voor uw bedrijfsvestiging (bijv. teams met verschillende leeftijdsgroepen, begeleidingsprogramma's, senior-junior tandems)	☐	19/20	g m h
☐	☐	Instrumenten ter bevordering van werknemersbetrokkenheid (bijv. gratis kantine, ondersteuning kinderopvang, gezinsvriendelijke werktijden)	☐	19/20	g m h
☐	☐	Gestandaardiseerde methoden van functie-ontwerp ter verbetering van gezondheids- en veiligheidsomstandigheden op het werk (bijv. Methods-time measurement (MTM))	☐	19/20	g m h
☐	☐	Financiële participatie toegankelijk voor alle werknemersgroepen (bijv. winstdelingsregelingen, aandelen(optie)plannen, enz.)	☐	19/20	g m h

Toelichting:

1 Het jaar waarin deze technologie voor het eerst werd toegepast in uw bedrijfsvestiging (maak een schatting indien u onzeker bent over het exacte jaar)

2 Daadwerkelijke toepassing ten opzichte van maximaal zinvolle toepassingsmogelijkheden: omvang van het gebruikte potentieel is "gering" bij eerste aanzetten, "midden" bij gedeeltelijke toepassing en "hoog" bij omvangrijke toepassing

4.1 Welke van de volgende activiteiten worden uitgevoerd voor uw productiepersoneel in uw bedrijfsvestiging?

Aanwezige competenties van productiewerknemers worden systematisch vastgelegd?	☐ nee	☐ ja
Functiebeschrijvingen zijn ontwikkeld voor specifieke functiegebieden in de productie?	☐ nee	☐ ja
Er bestaan specifieke competentieprogramma's voor bepaalde functies	☐ nee	☐ ja

4.2 Bij welke personeelsgroepen worden deze instrumenten gebruikt?

☐ LBO of ongeschoold personeel ☐ MBO geschoold personeel ☐ Hooggeschoold personeel (HBO+WO)

4.3 Bestaat er afzonderlijk beleid voor competentie-ontwikkeling en training van productiepersoneel?

☐ nee ☐ ja → Is er in uw bedrijf voor dit beleid een vast jaarlijks budget beschikbaar? ☐ nee ☐ ja

5.1 **Is er een vastgesteld aantal dagen per jaar voor verdere kwalificatie, training en ontwikkeling van het productiepersoneel?**

☐ **nee** ☐ **ja** → **Hoeveel dagen per jaar is er per persoon vastgesteld?** ca. ☐ dagen per jaar

5.2 **Zijn de volgende activiteiten voor verdere kwalificatie, training en ontwikkeling toegepast voor het productiepersoneel in uw bedrijfsvestiging?**

	nee	ja	In aanmerking komen de volgende groepen van productiepersoneel: LBO of ongeschoold	MBO technisch geschoold	Hooggeschoold (WO+HBO)
Training voor specifieke vaardigheden (bijv. machine-onderhoud)	☐	☐ →	☐	☐	☐
Training met interdisciplinair oogmerk (bijv. taalcursussen, leiderschapstraining)	☐	☐ →	☐	☐	☐
Digitale zelfscholingprogramma's (e-learning)	☐	☐ →	☐	☐	☐
On-the-job training (bijv. taakrotatie, werkplekinstructie, georganiseerde ervaringsuitwisseling met collega's)	☐	☐ →	☐	☐	☐
Informatie-aanbod (bijv. bedrijfstak specifieke beurzen, externe databases)	☐	☐ →	☐	☐	☐
Deelname aan activiteiten voor continue kwaliteitsverbetering (bijv. kwaliteitscirkels, Kaizen)	☐	☐ →	☐	☐	☐

Werkt uw bedrijfsvestiging samen met andere bedrijven op de volgende terreinen?
(samenwerking = vrijwillige samenwerking die verder gaat dan eenmalige transacties tussen bedrijven)

	nee	ja	Locatie van de partners: regionaal (< 50km)	nationaal (> 50km)	buiten-land
Samenwerking in inkoop	☐	☐ →	☐	☐	☐
Samenwerking in de productie (voor gezamenlijke systeemleveringen of capaciteitsuitbreiding)	☐	☐ →	☐	☐	☐
Samenwerking in distributie/verkoop	☐	☐ →	☐	☐	☐
Samenwerking in service	☐	☐ →	☐	☐	☐
Samenwerking in onderzoek en ontwikkeling met afnemers of leveranciers	☐	☐ →	☐	☐	☐
Samenwerking in onderzoek & ontwikkeling (O&O) met onderzoeksinstituten (bijv. universiteiten, TNO)	☐	☐ →	☐	☐	☐

Indien uw bedrijfsvestiging voor onderzoek en ontwikkeling samenwerkt met andere bedrijven, zijn daarbij bedrijven actief op het gebied van nanotechnologie, micro-elektronica, photonen, nieuwe materialen, of biotechnologie?

☐ **nee** ☐ **ja** → ☐ nanotechnologie ☐ micro-elektronica ☐ photonen ☐ nieuwe materialen ☐ biotechnologie

Welke van de volgende maatregelen zijn genomen om het risico van industriële spionage te vermijden in uw bedrijfsvestiging? Sinds wanneer zijn deze ingevoerd?

	nee	ja	sinds wanneer?
Speciale IT-veiligheidsmaatregelen (bijv. geen gebruik cloud computing, versleutelen van documenten, algemeen verbod op gebruik van draagbare data media)	☐	☐ →	19/20 ☐
Werknemerstrainingen en verhoging van waakzaamheid voor het gevaar van industriële spionage	☐	☐ →	19/20 ☐
Veiligheidsmaatregelen voor toegang tot terrein, gebouwen of kamers	☐	☐ →	19/20 ☐
Veiligheidsinstructies over illegale verspreiding van informatie (bijv. regelingen voor omgaan met gevoelige gegevens in relatie tot derde partijen)	☐	☐ →	19/20 ☐

Heeft uw bedrijfsvestiging te maken gehad met spionage door andere bedrijven, buitenlandse overheidsorganisaties of met verdachte gevallen in de laatste vijf jaar?

concre(e)t(e) geval(len) ☐ **nee** ☐ **ja** → ☐ ander bedrijf ☐ buitenlandse overheidsorganisatie ☐ onbekend

verdacht(e) geval(len) ☐ **nee** ☐ **ja** → ☐ ander bedrijf ☐ buitenlandse overheidsorganisatie ☐ onbekend

7.3 **Indien er sprake was van een verdacht of concreet geval, welke informatie was het doelwit van industriële spionage?**

Informatie over....

☐ Producten (bijv. ideeën, studies, ontwikkeling, ontwerp) ☐ Productie- of fabricageprocessen ☐ Klanten/toeleveranciers (bijv. contracten, prijzen) ☐ Bedrijfsstrategie (bijv. investeringsplannen)

8.1 Welke van de volgende technologieën worden momenteel in uw bedrijfsvestiging toegepast?

Toepassing gepland voor 2018	Nee	Technologieën	Ja	Voor het eerst gebruikt (Jaar)[1]	upgrade sinds 2012 Ja	upgrade sinds 2012 Nee	Omvang van het toegepaste potentieel[2]
		Automatisering en robotisering					
☐	☐	Industriële robots voor bewerking en fabricage (bijv. lassen, coaten, snijden)	☐	19/20	☐	☐	g m h
☐	☐	Industriële robots voor hanteren van gereedschap en werkstukken in productie (bijv. verplaatsen, assemblage, sorteren, verpakken)	☐	19/20	☐	☐	g m h
		Energie- en grondstoffenbesparing					
☐	☐	Controlesystemen die machines stilleggen bij onderbenutting (bijv. PROFI-energy)	☐	19/20	☐	☐	g m h
☐	☐	Geautomatiseerde beheerssystemen voor energie efficiënte productie	☐	19/20	☐	☐	g m h
☐	☐	Systemen t.b.v. terugwinning van kinetische en procesenergie (bijv. terugwinnen afvalwarmte)	☐	19/20	☐	☐	g m h
☐	☐	Technologieën voor energie- en/of warmteopwekking door middel van zon-, wind-, waterkracht, biomassa of geothermische energie	☐	19/20	☐	☐	g m h
		Bewerkingstechnologieën voor nieuwe materialen					
☐	☐	Productietechnologieën voor micromechanische componenten (micromachinale bewerking, lithografie, micro-injectie e.d.)	☐	19/20	☐	☐	g m h
☐	☐	Nanotechnologische productieprocessen (bijv. oppervlaktebewerking)	☐	19/20	☐	☐	g m h
☐	☐	Technieken voor verwerking van composietmateralen (bijv. carbonvezel, glasvezel)	☐	19/20	☐	☐	g m h
☐	☐	Bio- en gentechnologie in fabricageprocessen (bijv. catalysatoren, bioreactoren)	☐	19/20	☐	☐	g m h
☐	☐	Technieken voor verwerking van legeringen (aluminium-, magnesium-, titaniumlegeringen, enz.)	☐	19/20	☐	☐	g m h
		Additieve productietechnologieën					
☐	☐	Additive productietechnologie voor maken van prototypes (bijv. 3D printing, rapid prototyping; Selective Laser Sintering; Stereolithografie, Laser Beam Melting)	☐	19/20	☐	☐	g m h
☐	☐	Productie met additieve productietechnologie (incl. enkelstuksproductie; kleine productieseries; reserveonderdelen)	☐	19/20	☐	☐	g m h
☐	☐	Systemen voor Machine2Machine communicatie, Multi-agent systemen	☐	19/20	☐	☐	g m h
☐	☐	Systemen voor Cyber-Physical systems, cloud-computing	☐	19/20	☐	☐	g m h
		Digitale fabriek / IT netwerken					
☐	☐	Digitale productieplanning en roostering (bijv. ERP-systeem)	☐	19/20	☐	☐	g m h
☐	☐	Bijna real-time productiebeheersingssystemen (bijv. systemen voor gecentraliseerde aansturing en machinegegevensverwerking	☐	19/20	☐	☐	g m h
☐	☐	Digitale uitwisseling van productieplanningsgegevens met toeleveranciers en/of klanten (supply chain management)	☐	19/20	☐	☐	g m h
☐	☐	Systemen voor geautomatiseerd management van interne logistiek en orderverzameling (e.g. RFID, warehouse management system)	☐	19/20	☐	☐	g m h
☐	☐	Mobiele/draadloze apparaten voor programmering en bediening van installaties en machines (e.g. tablets)	☐	19/20	☐	☐	g m h
☐	☐	Product Lifecycle Management (PLM) systemen of Product/Productieproces datamanagement	☐	19/20	☐	☐	g m h
☐	☐	Technologieën voor veilige mens-machine interactie (bijv. coöperatieve robots, open werkstations e.d.)	☐	19/20	☐	☐	g m h
☐	☐	Digitale oplossingen voor het direct beschikbaar maken van tekeningen, werkschemas en -instructies op de werkvloer (e.g. tablets, smartphones)	☐	19/20	☐	☐	g m h

Toelichting:

1 Het jaar waarin deze technologie voor het eerst werd toegepast in uw bedrijfsvestiging (maak een schatting indien u onzeker bent over het exacte jaar)

2 Daadwerkelijke toepassing ten opzichte van maximaal zinvolle toepassingsmogelijkheden: omvang van het gebruikte potentieel is "gering" bij eerste aanzetten, "midden" bij gedeeltelijke toepassing en "hoog" bij omvangrijke toepassing

8.2 **Welke van de volgende maatregelen nam uw bedrijfsvestiging om energieverbruik te verminderen?**

	Toepassing gepland voor 2018	nee	ja
Afschakelsystemen voor onderdelen, machines of installaties indien niet in gebruik (bijv. afschakeling luchttoevoer, aangepaste verlichtingssensoren)	☐	← ☐	☐
Verbeteren van bestaande machines of installaties (bijv. hoogefficiënte motoren (IE3), aanbrengen isolatie, warmtewisselaraar)	☐	← ☐	☐
Voortijdige vervanging van bestaande machines of installaties door nieuwe machines of installaties	☐	← ☐	☐

8.3 **Welke van de volgende redenen en welke van de genoemde barrières zijn van doorslaggevende betekenis voor het wel of niet invoeren van energie en warmte opwekkende technologieën op basis van hernieuwbare energie in uw vestiging?**

Redenen voor invoering	Energie	Warmte
Verwachte ontwikkeling van de energieprijzen	☐	☐
Strategische redenen (bijv. "groen imago")	☐	☐
Terugdringen broeikasgassen	☐	☐
Eigen energie-opwekking ter vergroting aantal energiebronnen	☐	☐
Politieke of wettelijke bepalingen	☐	☐

Belangrijke barrières	Energie	Warmte
Te grote investeringen of voordelen ontbreken	☐	☐
Administratieve last (bijv. goedkeuringsprocedures)	☐	☐
Niet van toepassing in deze bedrijfsvestiging	☐	☐
Vooralsnog geen relevant onderwerp in deze vestiging	☐	☐
Andere barrières	☐	☐

9.1 **Heeft uw bedrijf sinds 2012 producten geïntroduceerd die nieuw waren voor uw bedrijf of die technisch ingrijpend zijn vernieuwd?**
(Bijv. door nieuwe grondstoffen of materialen te gebruiken, veranderingen in productiefuncties of werking e.d.)

☐ nee ☐ ja → Hoe groot was het aandeel van deze producten in de omzet van het jaar 2014? ca. ____ %

→ Hoe lang duurde gemiddeld genomen de ontwikkeling van zo'n product? (van productidee tot en met lancering) ca. ____ maanden

9.2 **Hebben deze productvernieuwingen ook geleid tot betere milieu-effecten bij gebruik of verwijderen van deze nieuwe producten?**

☐ nee ☐ ja → Welke verbeteringen in de milieu-effecten zijn met deze producten bereikt? (Kruis aan wat van toepassing is)

- ☐ Vermindering van gezondheidsrisico's bij gebruik
- ☐ Vermindering van energieverbruik bij gebruik
- ☐ Vereenvoudiging van onderhoud of herstel
- ☐ Verlenging productlevensduur
- ☐ Vermindering van milieuvervuiling bij gebruik (van grond, water, lucht, of geluid)
- ☐ Verbeterde recycling, terugwinning of verwijderingseigenschappen

9.3 **Bevonden zich bij deze nieuwe producten (nieuw sinds 2012) ook producten, die <u>nieuw-voor-de-markt</u> waren en die uw bedrijfsvestiging als eerste op de markt introduceerde?**

☐ nee ☐ ja → Wat was hun aandeel in de omzet van 2014? ca. ____ %

→ Zijn deze producten speciaal ontwikkeld vooral voor (kruis slechts één optie aan):

- ☐ bestaande klanten binnen uw huidige markt
- ☐ aantrekken van nieuwe klanten binnen uw huidige markt
- ☐ toetreding tot markten nieuw voor *uw bedrijfsvestiging*
- ☐ het ontwikkelen van geheel nieuwe markten

9.4 **Heeft uw bedrijfsvestiging producten in het programma die u <u>al langer dan 10 jaar</u> aanbiedt?**

☐ nee ☐ ja → Welk percentage van de omzet hadden deze producten in 2014? ca. ____ %

10.1 **Welke van de volgende productgerelateerde diensten biedt u uw klanten aan?**
Als uw bedrijfsvestiging dergelijke diensten aanbiedt, worden zij dan ook aangeboden voor producten van andere bedrijven?

	nee	ja	Voor producten van andere bedrijven
Installatie, inbedrijfstelling	☐	☐ →	☐
Onderhoud en reparatie	☐	☐ →	☐
Training	☐	☐ →	☐
Ontwerp, technisch advies (incl. testen, simulaties, O&O voor klanten)	☐	☐ →	☐
Software-ontwikkeling (bijv. software-aanpassing)	☐	☐ →	☐
Klantondersteuning op afstand (helpdesk, service hotline, website)	☐	☐ →	☐
Reviseren, vernieuwen (incl. functie opwaardering of software-uitbreidingen)	☐	☐ →	☐
End-of-life dienstverlening (bijv. recycling, opheffen, terugname)	☐	☐ →	☐

10.2 Indien u productgerelateerde diensten aanbiedt, hoe hoog schat u het aandeel daarvan in de totale omzet van 2014?
► In geval van geen omzet, vul in „0".

Aandeel in totale omzet van diensten die u in 2014 direct, d.w.z. apart, in rekening heeft gebracht ca. ☐ %

Aandeel van diensten die u in 2014 indirect in rekening heeft gebracht (via de productprijs) ca. ☐ %

10.3 Heeft uw bedrijfsvestiging vanaf 2012 nieuwe productgerelateerde diensten aangeboden, die geheel nieuw zijn voor uw bedrijfsvestiging of belangrijke verbeteringen bevatten?

☐ nee ☐ ja → Hoe groot was het aandeel in de omzet van 2014 van deze sinds 2012 nieuw aangeboden productgerelateerde diensten, die uw bedrijfsvestiging direct of indirect in rekening heeft gebracht? ca. ☐ %

11 Hoe vaak heeft uw organisatie vanaf 2012 de volgende activiteiten verricht?

		(0=niet; 1=1 keer; 2=vaker)		
Spin-offs	Opstarten van nieuwe organisaties of activiteiten buiten de onderneming	☐	☐	☐
Uitgaand intellectueel eigendom	Verkopen, of aanbieden van licenties/patenten aan andere organisaties	☐	☐	☐
Werknemer-betrokkenheid	Benutten van kennis en initiatieven van niet-O&O medewerkers bij het realiseren van innovaties	☐	☐	☐
Klantbetrokkenheid	Direct betrekken van klanten in uw innovatieprocessen	☐	☐	☐
Extern netwerken	Het samenwerken met andere organisaties (niet klanten) voor innovatie	☐	☐	☐
Externe participatie	Deelnemen (met bijv. vermogen, kennis) in ondernemingen om toegang te krijgen tot hun kennis of om andere synergieën te creëren?	☐	☐	☐
Uitbesteden van O&O	Uitbesteden van O&O (diensten) aan andere organisaties, zoals universiteiten, publieke onderzoeksinstellingen, commerciële ingenieurs of leveranciers?	☐	☐	☐
Inkomend intellectueel eigendom	Kopen of in licentie nemen van intellectueel eigendom van andere organisaties	☐	☐	☐

12 Hoe hebben zich in uw bedrijfsvestiging de productiekosten per eenheid product (eenheidskosten) ontwikkeld in 2014?

Gedaald met 10% of meer	Gedaald 5 - < 10%	Gedaald 0 - < 5%	Gelijk gebleven	Gestegen 0 - < 5%	Gestegen 5 - < 10%	Gestegen met 10% of meer
☐	☐	☐	☐	☐	☐	☐

13 In de voorafgaande vragen heeft u informatie gegeven over verschillende velden van innovatie. Rangorden deze innovatievelden naar mate van belangrijkheid voor uw bedrijfsvestiging.
Geef met een score van 1 tot 4 de volgorde van belangrijkheid aan met 1 als het belangrijkst; gebruik elke score slechts één keer.

Toevoegen van diensten aan uw producten	Organisatie-vernieuwing	Technische vernieuwing in het productieproces	Ontwikkeling van nieuwe producten
○	○	○	○

14 Welke van de onderstaande informatiebronnen zijn het meest relevant voor belangrijke innovatie-impulsen/ideeën in uw bedrijfsvestiging op de volgende gebieden? (Kruis maximaal drie informatiebronnen aan voor elk gebied van innovatie)

	intern				extern			
	O&O, engineering	productie-afdeling	Klanten-service	Leiding bedrijfsvestiging	Klant of gebruiker	Leverancier	Onderzoeks-instellingen, universiteiten	Conferenties, beurzen
Nieuwe producten	☐	☐	☐	☐	☐	☐	☐	☐
Nieuwe proces-technologieën	☐	☐	☐	☐	☐	☐	☐	☐
Nieuwe diensten	☐	☐	☐	☐	☐	☐	☐	☐
Nieuwe organisatie-concepten	☐	☐	☐	☐	☐	☐	☐	☐

15.1 Wat is het opleidingsniveau van het personeel van uw bedrijfsvestiging?

Hoger onderwijs (HBO+WO)	ca. ☐ %	=100%
MBO technische opleiding	ca. ☐ %	
MBO adminstratieve en commerciële opleiding	ca. ☐ %	
LBO of ongeschoold	ca. ☐ %	
Personeel in opleiding (leerlingen, stagiaires)	ca. ☐ %	

15.2 Hoe is het personeel in uw bedrijfsvestiging verdeeld over de volgende werkterreinen:

Onderzoek en ontwikkeling	ca. ☐ %	=100%
Ideevorming, ontwerp en vormgeving	ca. ☐ %	
Fabricage en montage	ca. ☐ %	
Klantenservice	ca. ☐ %	
Overige (administratie, inkoop, logistiek/distributie, onderhoud, productieplanning enz.)	ca. ☐ %	

16

Heeft uw bedrijfsvestiging in de afgelopen twee jaar delen van de productie of delen van onderzoek en ontwikkeling (O&O) overgeheveld naar andere bedrijven (uitbesteding) of eigen vestigingen in het buitenland (verplaatsing) danwel vestigingen vanuit het buitenland teruggeplaatst?

Overheveling:

Ja: (meerdere opties mogelijk)

Redenen: (meerdere opties mogelijk)

nee	Naar andere bedrijven in Nederland	Naar andere bedrijven in het buitenland	naar eigen vestigingen in het buitenland	Naar welk land (landen)?	Arbeidskosten	Ontsluiting nieuwe markten	Nabijheid belangrijke klanten	Toegang tot nieuwe kennis technologieën/clusters	Belasting, heffingen, subsidies	Gebrek aan gekwalificeerd personeel in eigen land	Importbeperkingen	Nabijheid van O&O of productie die reeds is overgeheveld	Toegang tot natuurlijke hulpbronnen leveranciers	Aanwezigheid van concurrenten
Overheveling van **productie-activiteiten** sinds 2013														
Verplaatsing **onderzoeks- en ontwikkelingsactiviteiten** sinds 2013														

Terugplaatsing (repatriëring) vanuit het buitenland naar het thuisland

Nee	Ja	Vanuit andere bedrijven in het buitenland	Vanuit eigen vestigingen in het buitenland	Uit welk land/landen	Kwaliteit	Flexibiliteit, leveranstrouw	Capaciteitsbenutting	Beschikbaarheid gekwalificeerd personeel	Arbeidskosten	Transportkosten/ logistieke kosten	Kosten van coördinatie en toezicht	Nabijheid van binnenlandse O&O	Verlies van kennis/ -kopiëren/piraterij	Infrastructuur
Terugplaatsing van (delen van) de **productie** sinds 2013														
	→													

17

Geef a.u.b. de herkomst van uw toeleveringen (inputs) en de bestemming van uw producten in 2014.
► Toeleveringen zijn gekochte onderdelen, (ruwe) materialen, productiemiddelen en diensten. Geef alleen het aandeel aan van producten gemaakt in uw bedrijfsvestiging.

Toeleveringen afkomstig uit

- binnenland ca ___ %
- buitenland ca ___ %

=100% van de inkoopwaarde

Producten verkocht in:

- binnenland ca ___ %
- buitenland ca ___ %

=100% van de omzet

18.1

Heeft uw bedrijfsvestiging onderzoek en ontwikkelingsactiviteiten (O&O) uitgevoerd of laten uitvoeren door externe partners in 2014?

☐ nee ☐ ja ➔ O&O-uitgaven in procenten van de omzet in 2014 ca. ___ %

18.2

Heeft uw bedrijfsvestiging sinds 2012 continu O&O uitgevoerd of laten uitvoeren door externe partners?

☐ nee ☐ ja

19

Welk van de volgende kenmerken zijn het meest van toepassing op uw hoofdproduct(groep)?

Productontwikkeling (kruis slechts één optie aan)

- Op specificatie van klant ☐
- Voor een standaardprogramma waarbinnen klantspecifieke wensen gerealiseerd kunnen worden ☐
- Voor een standaardprogramma, waaruit de klant kan kiezen ☐
- Niet aanwezig in deze bedrijfsvestiging ☐

Fabricage/montage (kruis slechts één optie aan)

- Na binnenkomst klantorder (make-to-order) ☐
- Eindmontage van het product wordt uitgevoerd na binnenkomst klantorder (assemble-to-order) ☐
- Op voorraad (make-to-stock) ☐
- Niet aanwezig in deze bedrijfsvestiging ☐

Seriegrootte (kruis slechts één optie aan)

- Enkelstuksproductie ☐
- Kleine of middelgrote series (20-1.000 stuks per maand) ☐
- Grote series (meer dan 1.000 stuks per maand) ☐
- Geen discrete productie (procesindustrie) ☐

Productcomplexiteit (kruis slechts één optie aan)

- Eenvoudige producten ☐
- Producten van middelgrote complexiteit ☐
- Complexe producten ☐

20 **Beantwoordt u de volgende vragen over uw hoofdproduct(groep).**

Wat is de gemiddelde productietijd van uw hoofdproduct(groep)? (doorlooptijd vanaf moment dat opdracht binnenkomt bij productie tot product klaar is voor levering) ca. ☐ werkdagen of ☐ uren

Hoeveel procent van de orders wordt op tijd afgeleverd? ca. ☐ %

Hoeveel procent van uw productie moet na kwaliteitscontrole nabewerking ondergaan of geheel worden afgekeurd? ca. ☐ %

Welk percentage van de geleverde bestellingen heeft klachten van klanten opgeleverd vanwege kwaliteitsproblemen? ca. ☐ %

21 **Hier worden enkele gegevens over uw bedrijfsvestiging gevraagd:**

Jaaromzet 2014 ☐ miljoen € 2012 ☐ miljoen €

Aantal werknemers (excl. uitzendkrachten) 2014 ☐ aantal

Aantal werknemers dat is afgevloeid in 2014 2014 ☐ aantal

Had uw bedrijfsvestiging uitzendkrachten in dienst in 2014? ☐ nee ☐ ja → Hoeveel uitzendkrachten waren in 2014 gemiddeld in dienst bij uw bedrijfsvestiging? ca. ☐ aantal

Inkoop 2014 (ingekochte onderdelen, materialen en diensten) ☐ miljoen €

Afschrijvingen op machines en installaties 2014 (zonder grond en gebouwen) ☐ miljoen €

Investeringen in machines en installaties 2014 ☐ miljoen €

Personeelskosten als percentage van de omzet in 2014 (incl. loonnevenkosten) ☐ %

Graad van capaciteitsbenutting (gemiddeld in 2014) ☐ %

Totale energiekosten als percentage omzet 2014 ☐ %

Rendement op de omzet (vóór belasting in 2014) ☐ negatief ☐ 0 tot 2% ☐ > 2 tot 5% ☐ > 5 tot 10% ☐ > 10%

Jaar van oprichting, c.q. inschrijving bij de Kamer van Koophandel jaar: ☐

Heeft uw bedrijfsvestiging een ondernemingsraad? ☐ nee ☐ ja

22.1 **Geef uw energieverbruik aan als volgt:**

Wat was het aandeel groene stroom in het totale stroomverbruik van uw bedrijfsvestiging in 2014? ca ☐ %

Hoe groot is de te verwarmen oppervlakte van uw bedrijfsvestiging? ca. ☐ m^2

22.2 **Hoe heeft het stroomverbruik van uw bedrijfsvestiging zich ontwikkeld in 2014?**

Gedaald met 10% of meer	Gedaald 5 - < 10%	Gedaald 0 - < 5%	Gelijk gebleven	Gestegen 0 - < 5%	Gestegen 5 - < 10%	Gestegen met 10% of meer
☐	☐	☐	☐	☐	☐	☐

22.3 **Hoe heeft het olie- en gasverbruik van uw bedrijfsvestiging zich ontwikkeld in 2014?**

Gedaald met 10% of meer	Gedaald 5 - < 10%	Gedaald 0 - < 5%	Gelijk gebleven	Gestegen 0 - < 5%	Gestegen 5 - < 10%	Gestegen met 10% of meer
☐	☐	☐	☐	☐	☐	☐

23 **Wie is in meerderheid of exclusief eigenaar van het bedrijf waartoe uw bedrijfsvestiging behoort?**

☐ Private eigenaar/ familie ☐ Financiële investeerder (bijv durfkapitaal) ☐ Ander bedrijf (bijv. niet-financiële investeerder) ☐ stichting ☐ overige eigenaren ☐ Geen meerderheidseigenaar

→ Is de familie actief in het management? ☐ Nee ☐ Ja

Hartelijk dank voor uw bijdrage aan dit onderzoek.

Wij verzoeken u de ingevulde vragenlijst terug te sturen per e-mail naar: P.Vaessen@fm.ru.nl

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