

# The link between configurations of lean bundles and operational performance

A Qualitative Comparative Analysis of small- and medium-sized manufacturing enterprises



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## **Abstract**

This research addresses the different perspectives associated with the development of lean bundles by identifying pathways to develop a lean organization. It requires a focus on lean bundles that is important for the organization. This focus concentrates on how an organization tries to distinguish itself and the context in which the organization operates. Previous research on lean bundles identified complementarities between lean bundles as well as their link with operational performance. This research identifies strategy-related configurations of lean bundles linked to substantive operational performance. A fuzzy-set qualitative comparative analysis (fsQCA) was performed on data of 44 manufacturing SME's. Data on operational performance and on the lean bundles of supplier integration, customer involvement, just-in-time, total productive maintenance, and human resource management were collected by the Research Group Lean / World Class performance at HAN University of Applied sciences. The findings of this research confirm that the development of lean bundles are strategy related. Three different pathways to substantive operational performance were identified based on the strategies of Treacy and Wiersema: operational excellence, product leadership and customer intimacy. This research provides an alternative explanation for the relationship between lean bundles and operational performance and therefore provides guidance for lean practitioners that seek to develop lean bundles in manufacturing SMEs. Moreover, this research opens new ways for lean theory development as it provides focus and a more nuanced understanding of the relationship between lean bundles and operational performance.

**Keywords:** lean bundles, business strategy, fsQCA, SMEs, operational performance

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# 1. Introduction

Today's fast changing, dynamic business environment forces SME's to deliver high performance in order to reduce their costs and provide products of higher quality in shorter lead times (Ariyachandra & Frolick, 2008; Belekoukias, Garza-Reyes, & Kumar, 2014; Bennet & Bennet, 2004). SME's can turn to lean management to improve their operational performance and enhance their competitiveness (Keitany & Riwo-Abudho, 2014; Womack & Jones, 1996). However, developing lean management is not easy, even though the link between different lean bundles as well as their link with operational performance are well established by many scholars (like Bortolotti, Boscari, & Danese, 2015; Danese & Bortolotti, 2014; Fullerton, McWatters, & Fawson, 2003; Negrão, Godinho Filho, & Marodin, 2017). Still, a lot of manufacturing SMEs struggle to identify which lean bundles they should develop (McGovern, Small, & Hicks, 2017; Netland, 2016; Netland, Schloetzer, & Ferdows, 2015). It requires a focus on lean bundles that are important for their organization. This focus is often strategically informed, because it aligns operational activities and offers guidance (Slack, Alistair, & Johnston, 2013). In essence, a business strategy should lead to strategic decisions regarding the development of lean bundles that are necessary to achieve the desired competitive position of the organization as a whole (Laseter, 2009). Yet, little attention is paid to this focus in the literature. This research goes deeper into the strategically informed focus and will in this way provide guidance for SMEs when developing lean management, by exploring strategy-related configurations of lean bundles that are linked to substantive operational performance.

Lean manufacturing is widely embraced to enhance customer value and reduce waste and variability (Shah & Ward, 2003) through just-in-time production and respect for employees (Sugimori, Kusunoki, Cho, & Uchikawa, 1977). Lean management is generally envisioned as a philosophy (guiding principles and overarching goals) or as a set of management practices, tools and techniques (Shah & Ward, 2007). Usually, a company is considered to be "lean" when it pursues and develops the five key principles of Womack and Jones (1996). Lean, however, constitutes a diversity of lean practices that are merged into the following five lean bundles: supplier related practices (SRP), customer related practices (CRP), just-in-time (JIT), total productive maintenance (TPM) and human resource management (HRM) (Shah & Ward, 2003, 2007). This diversity contributes to the difficulty in developing a lean organization (Hines, 2010). In fact, the way in which the five principles of Womack and Jones (1996) are arranged can differ with regard to the characteristics of the organization. For instance, TPM might be

more important for operational-excellence driven organizations, JIT might be more important for product leaders and a customer link might be more important for customer intimacy driven organizations. It might be not important to develop all lean bundles together, because several combinations of lean bundles are possible that lead to substantive operational performance. Thus, not all lean bundles are equally important for every organization (Brown, Squire, & Blackmon, 2007; Cua, McKone, & Schroeder, 2001; Ketokivi & Schroeder, 2004).

All of the above asks for a different approach on how to develop a lean organization. Rather than being equally important, lean bundles can best be developed in configurations (Ward, Bickford, & Leong, 1996). Configurations are “multidimensional constellations of conceptually distinct characteristics (elements) that commonly occur together” (Meyer, Tsui, & Hinings, 1993, p. 1175). Related concepts are types (Mintzberg, 1990), typologies (Miles & Snow, 1978), gestalts (Miller, 1981) or forms (Short, Payne, & Ketchen, 2008). The basic premise of a configurational approach is that it identifies dominant types of observable characteristics of behaviour which appear to lead to a particular performance (Ketchen Jr et al., 1997; Miles & Snow, 1978; Miller, 1996; Payne & Pharm, 2019). A configurational approach therefore provides a more comprehensive understanding, since it highlights clusters of interconnected bundles, rather than loosely coupled entities whose components can be understood in isolation (Fiss, 2007). A cluster of configurations can be made up of numerous dimensions, like environments, industries, strategies, processes, practices and outcomes (Meyer et al., 1993). The configurational approach in this research focuses especially on configurations of strategy-related lean bundles.

Given the configurational approach, it is proposed that configurations of lean bundles can be developed depending on how an organization strives to distinguish itself (Filippini, Forza, & Vinelli, 1996; Galeazzo & Furlan, 2018; Swink, Narasimhan, & Kim, 2005). Strategic decisions related to these distinctions determine what, when, where and how the lack of financial resources of SMEs are invested (Assarlind & Gremyr, 2014; Laseter, 2009). To tackle this, strategists thoughtfully select lean bundles that will produce a competitive advantage. Thus, the development of lean bundles is not an isolated event, but is part of a strategic activity and therefore it requires alignment with the strategy of the organization and important business objectives (Achanga, Shehab, Roy, & Nelder, 2006; Jadhav, Mantha, & Rane, 2014).

Over the past decades, support for a positive relationship between internal and external lean practices and operational performance has been found by several studies (e.g. Cua et al., 2001; Flynn, Sakakibara, & Schroeder, 1995; Jayaram, Das, & Nicolae, 2010; Negrão et al., 2017; Shah & Ward, 2003, 2007). Moreover, the complementarity of lean bundles has also been found in various studies (Furlan, Vinelli, & Dal Pont, 2011; Hofer, Eroglu, & Hofer, 2012; Sohal, Keller, & Fouad, 1989; Willmott, 1994). However, these researchers could only make suggestions about complex causality of lean bundles, because of their method of analysis. Within multivariate analyses, the interpretation of an interaction of more than two variables is a challenge, as well as the investigation of multiple paths (Vis, 2012). This research therefore continues with a configurational approach, a novel method in the field of lean management. Only two studies explored configurations of lean bundles in relation to (financial) performance with a qualitative comparative analysis (QCA) (Galeazzo & Furlan, 2018; Hallavo, Kuula, & Putkiranta, 2018). Galeazzo and Furlan (2018) found configurations of lean bundles that were linked to successful financial performance. However, their study focussed on financial performance and internally related lean bundles only. Hallavo et al. (2018) explored the evolution among lean bundles and found that a certain maturation effect takes place within lean bundle use. All things considered, various research has been done, however the relation between strategy and lean bundles has never been explored extensively. Therefore, this study tries to fill this gap by aiming to *explore strategy-related configurations of lean bundles that are linked to substantive operational performance*. In this way, this research provides SMEs with insights in which configurations of lean bundles enhance operational performance. Understanding these relationships will help practitioners to make better decisions about which lean bundles they should develop in order to accomplish the organizational strategy. Moreover, this research opens new ways for lean theory development as it provides focus and a more nuanced understanding of the relationship between lean bundles and operational performance.

The research paper is structured as follows. In the next section, first an overview of business strategies, operational performance, lean bundles and related configurations of lean bundles is given. At the end of the section, some hypotheses will be presented. In section three characteristics of the data sample are described and why a qualitative comparative analysis is the best way to analyse the relationship between strategy-related configurations of lean bundles and operational performance. This is followed by the results, presented in section four. Finally, section five contains the contributions of this study.

## **2. Configurations of lean bundles to achieve substantive operational performance**

This section outlines the theoretical background and the relevant findings of preceding studies on configurations of lean bundles. The first three paragraphs are intended to enlarge the reader's understanding of different business strategies, performance objectives and lean bundles. Paragraph four links the different business strategies to the different lean bundles to conceptualize configurations that are linked to substantive operational performance. In this way, this research specifies configurations of lean bundles into three strategically related pathways to realize a lean organization. Finally, a conceptual model summarizes all previous paragraphs to achieve the research objective.

### **2.1 Generic business strategies**

Manufacturing plants link lean bundles to business strategies (Brown et al., 2007; Ketokivi & Schroeder, 2004). Many scholars have tried to associate strategic choices with their corresponding type of strategies (like Miles & Snow, 1978; Porter, 1985). Treacy and Wiersema (1995) discriminated between strategies aiming for operational excellence, product leadership and customer intimacy. Since Treacy and Wiersema (1995) focus specifically on customer value (Zacharias, Nijssen, & Stock, 2016) and as their strategies are still used in recently published studies in leading academic journals (Nandakumar, Ghobadian, & O'Regan, 2011), these strategies are used in this research.

Treacy and Wiersema (1995) distinguished three different business strategies. First, operational excellence is about an excellent production process with superior operations and execution. The focus is on operating efficiency, streamlined operations and supply chain management as the organization tries to deliver products and services to customers at competitive prices with minimal inconvenience (Treacy & Wiersema, 1993). In fact, this strategy focuses on a high price-quality ratio, or so called best total cost for the customer. Second, product leadership is about excelling on product quality and innovation in order to offer customers state-of-the-art products and services (Roodt & Potgieter, 2004). The focus is on research and development, short time to market and high margins in a short time frame (Treacy & Wiersema, 1993). This strategy can be summarized as striving to deliver the best product. Third, the customer intimacy strategy excels in excellent customer focus and customer service, by constantly aligning and shaping products and services to customer needs to provide customized solutions (Treacy &

Wiersema, 1993; Zacharias et al., 2016). The focus is on building customer loyalty for the long term, through on time and reliable delivery of products and services that meet customers' expectations (Treacy & Wiersema, 1993). This business strategy can be understood as providing customers with the best total solution. To briefly summarize, three business strategies can be distinguished: operational excellence, product leadership and customer intimacy.

In order to become a market leader, an organization should choose one of these three business strategies and align both strategic decisions and the operating model of the organization accordingly (Habryn, 2014; Treacy & Wiersema, 1995). For instance, an operational-excellence driven organization that therefore tries to excel in quality and costs, is more likely to develop the TPM bundle. This is because TPM leads to high quality and low costs due to the maximization of equipment effectiveness and prevention of unexpected breakdowns (Ahuja & Khamba, 2008a, 2008b). In addition, research has shown that alignment of the chosen business strategy strengthens the connection between lean bundles and operational performance (Brown et al., 2007; Galeazzo, Furlan, & Vinelli, 2017; Swink et al., 2005). However, selecting one business strategy does not imply that the other two business strategies are irrelevant for the organization. According to Treacy and Wiersema (1995) organizations should strive for excellence in one business strategy, and achieve a certain threshold in the other two. For instance, a successful customer intimacy driven organization must keep its prices within reasonable limits for the customers (Habryn, 2014). To sum, the development of lean bundles depends on the business strategy an organization chooses and the related operational performance objectives they try to excel on. So, the development of lean bundles can help to meet business objectives and market demands.

## **2.2 Generic performance objectives**

Manufacturing plants in a competitive environment often adopt lean bundles to improve their operations (Hayes, Pisano, Upton, & Wheelwright, 2005). Given the strategic role of operations, competitive advantages are associated with operational performance objectives (Slack et al., 2013). Competitive priorities link the generic business strategy of organizations with their performance objectives. To this end, organizations try to excel in certain operational performance objectives in order to realize their business strategy. In context of lean management, operational performance can be defined as “the changes happening in the operational metrics after the implementation of lean manufacturing practices in an organization” (Dora, Kumar, Van Goubergen, Molnar, & Gellynck, 2013, p. 159). Slack et al.

(2013) describe five generic operational performance objectives, one of which can be subdivided into three categories. They can be applied to different aspects of operations: quality, speed, dependability, flexibility and cost. Since many scholars used the operational performance objectives from Slack to investigate the relation between lean bundles and operational performance (Batista, 2009; Boaden & Cilliers, 2001; Furlan, Dal Pont, & Vinelli, 2011; González-Benito & Dale, 2001; Gunasekaran, Patel, & Tirtiroglu, 2001; Nyamari, 2017; Tangen, 2003, 2005), these objectives are used in this research.

The first operational performance objective that Slack et al. (2013) distinguishes is quality. Quality is about meeting customers' expectations by consistently producing services and products that meet specifications (Batista, 2009). High-quality operations have stable, efficient and error-free processes (no mistakes, waste and rework), whereby internal customers are not inconvenienced by flawed service (Slack et al., 2013). Second, speed means delivering products and services requested by customers as quickly as possible (Batista, 2009). Fast operations reduce the level of in-process inventory between processes as well as shortening delivery lead time (Slack et al., 2013). Third, dependability is about doing things in time and as promised for customers (Batista, 2009). Dependable operations have reliable processes, which eliminates wasteful disruptions (Slack et al., 2013). Reliable delivery ensures trustworthiness. Fourth, flexibility is about being able to change the operations to fulfil new requirements (Batista, 2009). In this research three types of requirements are taken into account: product- (the ability to introduce new or modified products), volume- (the ability to change volume of output over time), and delivery flexibility (the ability to change delivery time) (Slack et al., 2013). Flexible operations adapt to changing circumstances quickly, without disrupting the rest of the operation. Fifth, costs is about doing things economically (Batista, 2009). Economic operations have a high total productivity which eliminates process wastes, such as excess capacity and process delay's (Slack et al., 2013). Moreover, it allows low prices, high margins or both. To sum, seven operational performance objectives can be distinguished: quality, speed, dependability, product flexibility, volume flexibility, delivery flexibility, and costs.

### **2.3 Lean practices and lean bundles**

Shah and Ward (2003, 2007) identified lean bundles from ten interrelated and internally consistent lean practices. Many scholars use a variety of the lean practices mentioned by Shah and Ward (2007) (see table 1), because of their extensive view that makes it possible to measure lean manufacturing more holistically. They include the people, process and technology

components as well as internal (related to firm) and external components (supplier and customer) (Alsmadi, Almani, & Jerisat, 2012). Following the most recent research on lean bundles (Hallavo et al., 2018; Negrão et al., 2017), this research grouped lean practices into five lean bundles because the research method that has been used. This research method constrained the number of causal conditions that could be included (Fiss, 2011). SRP ensures that suppliers are more involved into the production process of the organization (Shah & Ward, 2007) and consists of supplier feedback, JIT-delivery and developing suppliers. CRP implies customer involvement, whereas HRM ensures employee involvement by means of flexible, cross-functional workforce and self-directed work teams. Both bundles consist of one lean practice. Deviating from Shah and Ward (2007), the internally related group is split into JIT consisting of pull, flow and low setup, and TPM consisting of controlled processes and productive maintenance. JIT's primary goal is continuously reducing and ultimately eliminating all forms of wastes (Sugimori, Kusunoki, Cho, & Uchikawa, 1977), while the TPM bundle is represented by practices that maximize equipment effectiveness and reflects the emphasis on new process equipment or technology acquisition (Cua et al., 2001). In summary, the following five lean bundles are used in the analysis of strategy-related configurations of lean bundles: SRP, CRP, JIT, TPM, and HRM.

*Table 1: Lean bundles and their appearance in key references*

Lean bundle	Lean practices	Sources											
		1	2	3	4	5	6	7	8	9	10	11	12
SRP	Supplier feedback	x								x		x	x
	JIT deliveries	x			x				x	x		x	x
	Supplier development	x								x	x	x	x
CRP	Customer involvement	x			x				x	x	x	x	x
	Pull	x	x	x	x		x	x	x	x		x	x
JIT	Flow	x	x	x	x	x	x	x	x	x		x	x
	Setup	x			x	x		x	x	x		x	x
	SPC					x		x		x	x	x	x
TPM	TPM	x	x	x	x	x	x	x	x	x		x	x
HRM	Employee involvement	x	x			x	x	x	x	x	x	x	x

1) Nordin, Deros, and Wahab (2010); 2) Puvanasvaran, Megat, Hong, and Razali (2009); 3) Wong, Wong, and Ali (2009); 4) Mackelprang and Nair (2010); 5) Furlan, Vinelli, et al. (2011); 6) Stone (2012); 7) Marodin, Saurin, Tortorella, and Denicol (2015); 8) Jasti and Kodali (2015); 9) Dora, Van Goubergen, Kumar, Molnar, and Gellynck (2014); 10) Fotopoulos and Psomas (2009); 11) Lyons, Vidamour, Jain, and Sutherland (2013); 12) Hofer et al. (2012)

## 2.4 Configurations of lean bundles

In light of the above, the lean bundles can be conceptualized in the following three business strategies or configurations. First, to achieve operational excellence the quality of operational processes must be increased (i.e. error free and elimination of wastes) in order to decrease the costs and therefore offer a lower price than competitors (Allen & Helms, 2006; Dess & Davis, 1984; Josiah & Nyagara, 2015). To this end, organizations that follow this strategy try to excel on the operational performance objectives quality and costs (Hallgren & Olhager, 2009). Moreover, they design a low variety and high volume process with low margins (Powell & Strandhagen, 2012). This requires a steady and streamlined production line, which can be achieved by TPM (Cua et al., 2001; McKone, Schroeder, & Cua, 1999). TPM ensures maximum effectiveness of the equipment, improves the level of productivity and daily maintenance prevents unexpected breakdowns and thereby maintains high quality products (Ahuja & Khamba, 2008a, 2008b). Moreover, the JIT bundle seems also important for this strategy as JIT's primary goal is continuously reducing and ultimately eliminating all forms of wastes by means of set-up time reduction, equipment layout and pull systems production (Danese, Romano, & Bortolotti, 2012). This bundle allows for a low and smooth production variety and a decrease in costs. Although authors support the relation between JIT and the operational excellence strategy, others find that JIT can be counterproductive for this strategy (Swink et al., 2005; Ward, McCreery, & Anand, 2007). Although these authors found that JIT can be counterproductive, it is important to realize that organizations driven by operational excellence, excel on the operational performance objectives quality and costs. For this reason it is reasonable that JIT is indeed important for this strategy, because elimination of waste will lead to an increase in quality and decrease in cost. The SRP seems of lesser importance for this bundle as production is done in smaller batches (Swink et al., 2005). The customer-related and HRM bundles may be too expensive for this configuration, because the low variety does not allow constantly changing product requirements. However, also for those bundles some scholars find otherwise (Ketokivi & Schroeder, 2004). Nevertheless, they have used a perceptual measure of operational performance and therefore it is doubtful whether the respondent's answers reflect the true state of affairs. All things considered, operational excellence companies excel in terms of quality and costs of operational performance objectives. As a result, TPM and JIT are of importance, SRP is of lesser importance, and CRP and HRM are counterproductive for this strategy.

Second, to achieve product leadership, it is important to deliver the best product as quickly and dependable as possible (Ahmad & Schroeder, 2002; Treacy & Wiersema, 1993). For this purpose, this organization excels in delivery speed and delivery dependability. JIT seems therefore the most important bundle, since it helps to reduce product lead time (Cua et al., 2001; Danese et al., 2012; Fullerton & McWatters, 2001; Fullerton et al., 2003). Furthermore, a precondition for JIT appears to be TPM as JIT requires a steady and streamlined production process which ensures equipment availability and on time deliveries (Ahuja & Khamba, 2008b; Cua et al., 2001; Swink et al., 2005). Moreover, since JIT implies little or no safety stocks, which means that timing, quality and quantity of deliveries are vital (Manoochchri, 1984; Swink et al., 2005), the SRP bundle seem to be required as well in order to provide customers with short delivery times and dependable deliveries. In addition, the SRP bundle enhances superior product design combined with short development times (Wagner, 2003), which is key for the product leadership strategy as it requires innovation to be able to deliver the best product. Bundles of lesser importance, though not irrelevant, seem CRP (Furlan, Dal Pont, et al., 2011) and HRM (Furlan, Vinelli, et al., 2011). The reason why they still can contribute to this strategy is that integration of customers could spark new opportunities for product improvements, and HRM shapes the organizational environment in which other lean bundles are developed (Cua et al., 2001). To conclude, product leaders excel in delivery speed and delivery dependability. Hence, that is why JIT, TPM and SRP are of importance and CRP and HRM are of less important but not irrelevant.

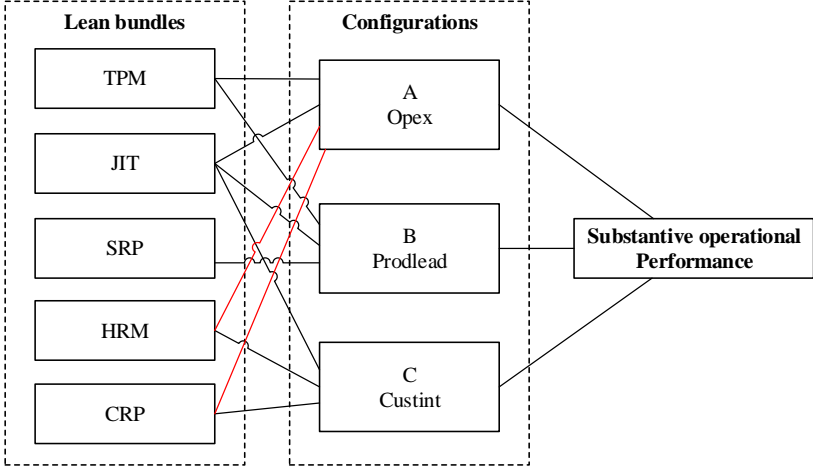
Third, to achieve customer intimacy an individual customer approach and long-term customer relationships are most important, which makes CRP the most important bundle (Bügel, Verhoef, & Buunk, 2011; Kok, Bouwman, & Desiere, 2008). Moreover, due to the complexity in production, the HRM bundle is also required as well as intense training of employees in order to improve employees' behaviour, to increase problem solving skills and to build long-term customer relationships (de Waal & van der Heijden, 2016; Sheppeck & Militello, 2000). Furthermore, JIT is also important because it enables organizations to meet the precise demands of customers and enables them to respond rapidly to market demands (Hartley, 1981; Sohal et al., 1989; Swink et al., 2005). To this end, organizations following the customer intimacy strategy emphasis on the operational performance objectives product-, volume- and delivery flexibility. However, TPM is of lesser importance since the customized products do not demand very high levels of productive maintenance or process control (Swink et al., 2005). Besides that, delivery time is often not important for customers so therefore the

SRP bundle might also be least important (Dal Pont, Furlan, & Vinelli, 2008; Furlan, Dal Pont, et al., 2011; Treacy & Wiersema, 1993). In summary, since customer intimacy driven organizations emphasise product-, volume- and delivery flexibility, CRP, HRM and JIT are of importance, while TPM and SRP are not important.

### 2.5 Conceptual model

The literature exploration reveals strategy-related configurations of lean bundles, as described in the previous paragraph, that are linked to substantive operational performance. The literature study shows evidence that it is likely that organizations with different strategies develop different lean bundles. Moreover, it is generally assumed that the development of lean bundles always leads to an increase in operational performance (Negrão et al., 2017). An empirical study explores the extent to which these conditions (lean bundles) can explain the outcome (substantive operational performance) on its own or in conjunction with each other. How these conditions are explored is described in the next section. From a comprehensive view, the following will be expected (see figure 1). First, the presence of TPM and JIT in combination with the absence of HRM and CRP is associated with organizations that achieve substantive operational performance through operational excellence. Second, the presence of TPM, SRP and JIT is associated with organizations that achieve substantive operational performance through product leadership. Third, the presence of JIT, HRM and CRP is associated with organizations that achieve substantive operational performance through customer intimacy. Finally, the absence of lean bundles is associated with organizations that achieve non-substantive operational performance.

Figure 1: Configurations of lean bundles for substantive operational performance



Note: the black lines shows the link and red lines show an inverse link

### **3. Methodology**

This section describes the justification of the research in terms of methods and data collection. It provides insights in the research design, describes the data sample and measures in detail and explains why and how a qualitative comparative analysis is used to analyse the data in order to come to different configurations to develop a lean organization.

#### **3.1 Research approach**

To explore strategy-related configurations of lean bundles that are linked to (non-)substantive operational performance, a Fuzzy set Qualitative Comparative Analysis (fsQCA) is employed. This technique allows to explore a combination of conditions (here, lean bundles) that eventually produce a phenomenon (here, operational performance) (Ragin, 1987; Rihoux & Lobe, 2009). Yet, with a medium N of about 10 to 40 cases, only four to seven conditions can be included (Berg-Schlosser & Meur, 2009). Each condition is treated as an independent set in which cases (here, SMEs) are assigned a set-membership score according to their membership degree in the condition's set, this process is also called "calibration" (see section 4.2 for details on the calibration) (Schneider & Wagemann, 2012). fsQCA is able to assign membership values to conditions on a scale from 0.0 (non-membership) to 1.0 (full membership), with 0.5 as the cross-over point (Roig-Tierno, Gonzalez-Cruz, & Llopis-Martinez, 2017). Thus, fsQCA is most appropriate since it enables cross-case comparison based on the combinations of conditions and it offers configuring causal conditions based on the degree of membership rather than on categorical memberships (Roig-Tierno, Gonzalez-Cruz, & Llopis-Martinez, 2017).

FsQCA has several advantages over more traditional quantitative methods, due to the underlying epistemological foundation (Vis, 2012). First, by using set theory, fsQCA enables to examine relationships between conditions and outcomes through a set-theoretic analysis of subset relations. In this way, it allows to examine causal complexity in terms of sufficiency and necessity, rather than capturing the net effects of an independent variable on an outcome (Misangyi et al., 2017; Schneider & Wagemann, 2010). In particular, this means that fsQCA is able to identify more than one pathway to a given outcome (Misangyi et al., 2017). As such, fsQCA overcomes the limitation of traditional approaches where the interpretation of an interaction of more than two variables is a challenge, as well as the investigation of multiple paths (Vis, 2012). In addition, by using Boolean algebra instead of linear algebra, researchers can examine the effects of a combination of various conditions, rather than individual

conditions, on the outcomes (Schneider & Wagemann, 2010). Finally, in contrast to the symmetry inherent in linear regression, set relations are asymmetrical (Misangyi et al., 2017). Due to the fact that Boolean algebra is used, the presence as well as the absence of a condition may produce the same outcome, depending on its combination with other conditions (Misangyi et al., 2017). To sum, an fsQCA, as compared to traditional methods, is the most appropriate method. It allows to examine commonalities and differences among combinations of causal conditions to understand how lean bundles act and are connected together to obtain (non-)substantive operational performance (Galeazzo & Furlan, 2018). To this end, fsQCA provides a more comprehensive and nuanced understanding of the phenomena under this study (Fiss, Marx, & Cambré, 2013; Meuer & Rupietta, 2016; Rihoux & Lobe, 2009).

### **3.2 Sample and data collection**

The cases under study are all manufacturing SMEs in the Netherlands, which were recruited by the HAN Lean-QRM centre. The HAN Lean-QRM centre defined “manufacturing” according to the definition of “Level 1, Group C: Manufacturers” stated in the “Statistical classification of economic activities in the European Community” (European Commission, 2010). Organizations that employ 10-250 employees were defined as SMEs (European Commission, 2005). A total of 44 manufacturing SMEs participated in a multiple respondent self-assessments survey. A multiple respondent survey was held, due to the fact that Bowman and Ambrosini (1997) have shown that using single respondents suffer from respondent bias and therefore is unreliable. The survey is conducted among production managers, who were complemented by the owner/director, general manager, managers of different cells, managers from different departments (marketing, sales, R&D, engineering and/or logistics) and/or team leaders. The total number of employees per company was the starting point for the selection of the number of respondents per case. The number of respondents per case varied from two to thirteen, with an average of six respondents per case. The survey was completed during a joint session with all the respondents. The joint session started with an explanation, both orally and in writing, about the different concepts. In this way it was ensured that all respondents had the same understanding of the concepts surveyed. As a result, the idiosyncratic variation was diminished, whereas the construct validity was increased.

### **3.3 Measures**

The design of the questionnaire was based on multiple-item measurement scales that have been validated and found to be reliable in previous research. Lean practices were measured using the questionnaire developed by Shah and Ward (2007), because it is well validated and therefore widely used for measuring this construct and has become more or less a standard (Hofer et al., 2012; Marodin & Saurin, 2013; Overboom, De Haan, & Naus, 2010; Vinodh & Balaji, 2011). The questionnaire consists of 41 questions which covers the following 10 lean practices: 1) supplier feedback, 2) JIT delivery by suppliers, 3) supplier development, 4) customer involvement, 5) pull, 6) continuous flow, 7) set up time reduction, 8) total productive/preventive maintenance, 9) statistical process control and 10) employee involvement. The lean practices were measured by using multiple questions. A five point Likert scale, like Shah and Ward (2007), is used, ranging from 1) no implementation to 5) full implementation. The remaining scores relates to: 2) some implementation, 3) moderate implementation and 4) extensive implementation.

To measure operational performance, the following objectives were used: 1) cost, 2) quality, 3) delivery speed, 4) delivery dependability, 5) delivery flexibility, 6) product flexibility and 7) volume flexibility. Those objectives are often used by different scholars for measuring this construct (Tangen, 2003). Each of these objectives were measured by single questions, such as “How is this organisation’s performance on cost, compared to that of its competitors?”. A nine point Likert scale is used, ranging from 1) very bad to 9) very good performance, in order to increase the ability to discriminate. Scales with more response alternatives have greater reliability and convergent and discriminant validity, because the variance increases with the number of scale points (Felix, 2011; Preston & Colman, 2000). This results in a nuanced and more detailed picture of the results.

### **3.4 Data quality**

This research uses secondary data that has often been criticized for questionable validity and reliability (Hair, William, Babin, & Anderson, 2014). However, content validity is ensured, since the data sample in this case was collected for the same purpose. Moreover, to ensure reliability and validity, a confirmatory factor analysis, and internal correlation and internal consistency analysis are conducted (Heale & Twycross, 2015). Furthermore, the internal reliability is evaluated by calculating the Cronbach’s alpha (Hair et al., 2014). Besides that, the

fsQCA itself also asks for reliability and validity. The robustness of fsQCA is an important point, which is strongly related to the validity and reliability, as the analysis is heavily dependent on decisions that researchers make at different stages of the process of fsQCA (Skaaning, 2011). In order to ensure reliability and validity, the research is presented as transparently as possible and robustness checks were carried out. Transparency is ensured through the verifiability and traceability of the analysis steps and results (Wagemann & Schneider, 2015). By means of exposing and making important data accessible, others are able to replicate the research (Bryman, Becker, & Sempik, 2008; Rihoux & Ragin, 2009). Robustness is checked by means of performing different calibration methods, because it measures the extent to which solutions are sensitive to (small) changes in researchers' decisions (Skaaning, 2011). Last, important to realize is that results are only “modest generalizable”, due to the fact that QCA makes it possible to formulate propositions that can be applied, with appropriate caution, to other similar cases (Berg-Schlosser, De Meur, Rihoux, & Ragin, 2009; Ragin, 1987).

### **3.5 Data analysis**

As mentioned in the theoretical background, various studies already indicated a significant relationship between configurations of lean bundles and operational performance. Additionally, this relationship is expected to be strategically informed. A configurational comparative method; fsQCA, is seen as the most appropriate technique to capture strategy-related configurations of lean bundles that are linked to (non-)substantive operational performance. But, before analysing configurations of lean bundles, two confirmatory factor analysis, one for operational performance and one for lean practices, are performed in order to ensure construct validity. To this end, it is ensured that the conditions representing the construct are included in the fsQCA. If a factor loading is not high enough, it means that this condition may not be included in the fsQCA because this condition does not properly represent the construct.

To explore strategy-related lean bundles that lead to (non-)substantive operational performance, one fsQCA is performed. The choice of conditions and outcome for the analysis must be theoretically informed in order to appropriately apply an fsQCA analysis. The core of the analysis consist of calibrating the sets and the construction of a truth table. Calibration means that you assign set-membership scores of condition to cases. The truth table shows all possible combinations leading to the presence or absence of the outcome. So, first and most importantly

all measures are calibrated into fuzzy sets with values ranging from 0 to 1 (Pappas, Kourouthanassis, Giannakos, & Chrissikopoulos, 2016). In fsQCA the set membership is expressed in degrees, so the cut-off point must be chosen carefully and transparently. This requires calibration, which can be done by theoretical justification or based on the distribution of the cases. General, the following ways are possible to calibrate a fuzzy set: 1) use the average of the collected data, 2) use the average of data from literature, 3) assign a sequence according to theory, 4) assign a sequence according to experts, 5) look at groups in the collected data and 6) use the centre point (median) of the data. Calibration method 1, 2, 5 and 6 are used in this research, because method 3 and 4 are calibrated in a qualitative manner based on the researcher's assumption (Ragin, 2007). Next, the transformation of variables into calibrated set is done by fsQCA program, by setting three meaningful thresholds (full membership, full non-membership, and the cross-over point), which describes whether the case is more in or out of a set (Pappas et al., 2016). After calibration, set membership scores are assigned.

Before conducting the fuzzy truth table, a check for necessary conditions is performed (Ragin, 2009). A condition is necessary if the outcome cannot be produced without the condition. Any condition that passes the test and makes sense as a necessary condition can be omitted from the truth table procedure (a.k.a. analysis of sufficiency). Logically, after the test for necessary conditions a truth table is constructed which shows  $2^k$  rows, with  $k$  representing the number of outcome predictors, and each row representing each possible combination (see appendix 1 for a Venn diagram). As a result, it can be investigated whether conditions are sufficient to produce a certain outcome. Furthermore, for each outcome a consistency and coverage (parameters of fit) is calculated by the fsQCA software (Kane, Lewis, Williams, & Kahwati, 2014). Finally, a robustness test is carried out to enhance confidence of the proposed relationship by checking for substantial differences in the outcome (Emmenegger, Schraff, & Walter, 2014).

### **3.6 Research ethics**

Due to the fact that there is no face to face involvement as the researcher did not participate in the primary data collection (Thorne, 2012), other ethical issues are at stake. Ethical issues raised in this research are related to informed consent, fidelity, confidentiality and non-maleficence (Thorne, 2012). Since the participants of the primary research are connected to the HAN Lean-QRM centre, it is justifiable that they would also contribute to this research. Therefore it is arguable that the scope of the original consent also covers the scope of this research. Furthermore, the fidelity is threatened because there is greater distance between the original

data source and the analyst (Thorne, 2012). Moreover, there is a chance that truth could be replaced by interpretation (Rosen, 2003). Because the researcher is supervised by the researcher who collected the original data, the chance of violating fidelity is expected to be small. Confidentiality is ensured as much as possible by not explicitly mentioning companies by name. However, since HAN Lean-QRM centre is a knowledge network, the companies affiliated with this network know that the knowledge developed through this research will be shared in meetings, publications and in education. So violations of confidentiality are almost zero. Finally, this research is beneficent for the majority of the SME's, because it provides them with insight on which lean bundles are linked to certain strategies.

## 4. Results

This section provides insights in the conducted factor analysis and fsQCA by providing the results from these analysis. First it is shown by a factor analysis that it is allowed to include all conditions in the fsQCA. This is followed by an explanation of the calibration methods that have been used. Then, the necessary and sufficient conditions leading to (non-)substantive operational performance is reported. Finally, the results of the robustness checks are shown.

### 4.1 Factor analysis

To estimate reliability and validity, confirmatory factor analysis were performed for operational performance and lean practices. To conduct a proper Factor Analysis, Hair et al. (2014) are referring to a Factor Analysis decision process, which is used in this research. All relevant assumptions for conducting a factor analysis are met (see appendix 2). All variables are of interval level, sample size is large enough ( $>50$ ;  $=255$ ), the sample is homogeneous and there is sufficient correlation between the items to run the factor analysis (OP: Bartlett's Test of Sphericity is significant at  $\alpha = .05$  ( $p = .000$ ) and  $KMO = .718$ ; LP: Bartlett's Test of Sphericity is significant at  $\alpha = .05$  ( $p = .000$ ) and  $KMO = .629$ ). The relevant outputs of the analyses can be found in Appendix 2.

A component factor analysis is used as factor method, since the researcher already received previous knowledge about the variables (Hair et al., 2014). Different scholars used Slack's operational performance objectives to measure the construct operational performance (Tangen, 2003). Moreover, Shah and Ward (2007) already proved empirically that lean practices is a multi-dimensional construct which consists of the conceptually proposed five-dimensional structure; lean bundles. Therefore, the researcher believe that the specific and error variance represent a relatively small proportion of the total variance. A component analysis will therefore fit best. Based on the evaluation of the correlation matrix, the oblique method ( $cor. >0.30$ ) is used for operational performance and the varimax method ( $cor. <0.30$ ) is used for lean practices. The outputs of both analyses can be found in table 2.

Table 2: Outputs confirmatory factor analysis

Indicator	Factor loading
Price	.601
Quality	.491
Delivery Speed	.880
Delivery Dependability	.938
Product Flexibility	.753
Volume Flexibility	.680
Delivery Flexibility	.538

Bundle	Practices	Factor loading
SRP	Supplier feedback	.657
	JIT Delivery	.656
	Supplier development	.703
CRP	Customer involvement	.663
JIT	Pull	.830
	Continuous flow	.679
	Set up time reduction	.759
TPM	SPC	.771
	TPM	.688
HRM	Employee involvement	.525

Although factor loadings of  $\pm 0.30$  to  $\pm 0.40$  are minimally acceptable, factor loadings should be higher than  $0.50$  and ideally higher than  $0.70$  in order to be practically significant (Hair et al., 2014). As shown in table 2 all items meet the threshold of  $>0.50$ , with exception of Quality which meet the minimal acceptable threshold of  $\pm 0.40$ . Furthermore, to determine the reliability the Cronbach's Alpha is measured. Factor analysis of OP and LP show a sufficient Cronbach's Alpha value of respectively  $0.728$  and  $0.757$ . Also following judgemental criteria (Wieland, Durach, Kembro, & Treiblmaier, 2017) and considering the content of the deflecting items (content validity), it is decided to maintain all items for the fsQCA analysis.

## 4.2 Fuzzy sets

To determine which configurations of lean bundles were linked to substantive operational performance, first both operational performance and bundles of lean practices were calibrated into fuzzy membership scores. The calibration is based on groups identified in the dataset, in which this calibration was informed by theory. Operational performance was measured on a nine-point scale with 1-3 being lower, 4-6 equal and 7-9 better than competition. Therefore,  $6.5$  was chosen as the threshold for cases outperforming competition. Since no cases were above  $7.8$  nor below  $5.3$ , these values were chosen as full and non-membership respectively. Likewise, lean bundles were calibrated in the same way. The full and non-membership threshold of the lean bundles are based respectively on the largest and smallest value of that

particular lean bundle. To ensure robustness of the fsQCA analysis, various ways of data calibration are tested to see whether substantial differences occurred. The various calibrations tested whether the findings were the same for different cross over points. Three robustness tests were performed as shown in table 3. One based on the average in the dataset, one based on the centre point (median) in the dataset and one based on the industry (un)weighted average from 14 studies (Abdallah & Anh, 2007; Alsmadi et al., 2012; Bortolotti et al., 2015; Braunscheidel & Hamister, 2012; Dora et al., 2014; El-Khalil & Farah, 2013; Ghosh, 2013; Godinho Filho, Ganga, & Gunasekaran, 2016; Hofer et al., 2012; Koloszár, 2018; Negrão et al., 2017; Svärd, 2016; Tortorella, Vergara, & Ferreira, 2017; Visser, 2014). The latter calibration, based on industry average, was also subdivided into subgroups based on: 1) size of the organization (SME/LE), 2) country status (developed/developing/mixed), 3) type of sector (manufacturing/service) and 4) sample size ( $\leq 60$ ;  $>60 \leq 200$ ;  $<200 \leq 300$ ;  $>2000$ ).

*Table 3: Calibration of outcome and conditions*

Outcome (1) / Conditions (2-6)	Threshold full- membership	Crossover point				Threshold non- membership
		Groups in data	Data average	Industry average	Linear	
<b>Operational performance (1)</b>	7.8	6.5	6.4	NA	6.3	5.3
<b>Supplier related practices (2)</b>	3.6	2.8	2.7	3.0	2.8	2.0
<b>Customer related practices (3)</b>	4.0	3.15	3.2	3.2	3.2	2.1
<b>JIT (4)</b>	4.1	2.9	2.9	2.7	2.8	2.2
<b>TPM (5)</b>	3.0	2.35	2.3	2.9	2.3	1.6
<b>HRM (6)</b>	4.0	2.55	2.6	2.7	2.5	1.8

### 4.3 Necessary and sufficient conditions leading to (non-) substantive operational performance

Next, by using the fsQCA software, the actual fsQCA was performed. After analysing substantive operational performance, an analysis of negative results (non-substantive operational performance) was also performed. So, for both outcomes, substantive operational performance and non-substantive operational performance, necessary and sufficient conditions were identified. Necessary conditions were first sought before the analysis of sufficient conditions was performed.

#### Necessary conditions leading to substantive operational performance

After constructing the calibrations, a check for necessary conditions was performed (see table 4). The minimum consistency threshold for necessity of 0.9 was not reached by the lean bundles (Schneider & Wagemann, 2012). Analysis of the X-Y plots and consistency levels demonstrated that no bundles were necessary for each configuration

Table 4: Output necessary condition test substantive operational performance

	Outcome: Operational performance	
	Consistency	Coverage
Supplier related practices	0.742138	0.711558
Customer related practices	0.809224	0.668688
JIT	0.756813	0.741654
TPM	0.762579	0.727864
HRM	0.721698	0.661066

#### Sufficient conditions leading to substantive operational performance

The analysis of sufficient conditions starts with the construction of truth tables. So, a truth table algorithm was performed to identify which bundles of lean practices were sufficient for cases to outperform competitors. A truth table shows all possible combination of causal conditions that lead to the desired outcome. The truth table is shown in appendix 3.

Next, a frequency and consistency threshold must be selected. A reasonable frequency threshold is at least one case with greater than 0.5 membership in a combination (Ragin, 2009). Furthermore, this threshold must also reflect the nature of the evidence and the character of the

study. Moreover, the exact location of the consistency threshold is heavily dependent on the specific research context. There is no universal accepted consistency threshold. However, a consistency level below 0.75 is often identified as problematic (Schneider & Wagemann, 2012). Eventually, in this research a frequency threshold and consistency threshold of respectively 1 and >0.80 is used, since this solution explained the phenomena better.

The fsQCA software provides three types of solutions: complex, parsimonious and intermediate solutions. The difference between those three types of solutions is the usage of logical remainders (Ragin, 2009). Within the complex solution no logical remainders are used. The parsimonious solutions may uses all logical remainders, without any evaluation of their plausibility. Finally, the intermediate solutions uses only the logical remainders that “make sense” given the researcher’s substantive and theoretical knowledge are incorporated into the solution. The intermediate solution is superior to the other two types and therefore this solution is used in this research (Ragin, 2009).

Results of the fsQCA based on calibration on groups are given in table 5 and show that there are three configurations of lean bundles with substantive operational performance. First, supplier related practices combined with customer related practices and TPM but with absence of HRM. Second, supplier related practices combined with JIT and TPM. And third customer related practices combined with JIT, TPM and HRM. These configurations of lean bundles show considerable overlap with the configurations identified from the literature.

*Table 5: Configurations of lean bundles sufficient for substantial operational performance*

<b>Configuration</b>	<b>1 Opex</b>	<b>2 Prodlead</b>	<b>3 Custint</b>
<b>Supplier related practices</b>	●	●	
<b>Customer related practices</b>	●		●
<b>JIT</b>		●	●
<b>TPM</b>	●	●	●
<b>HRM</b>	⊗		●
<b>Raw coverage</b>	0.433438	0.556604	0.445493
<b>Unique coverage</b>	0.0408805	0.0592243	0.0183438
<b>Consistency</b>	0.928171	0.845541	0.855992
<b>Overall solution coverage</b>	0.615828		
<b>Overall solution consistency</b>	0.838687		

### **Necessary conditions leading to non-substantive operational performance**

After analysing substantive operational performance, an analysis of negative results (non-substantive operational performance) was also performed. First, after constructing the calibrations, a check for necessary conditions was performed (see table 6). The minimum consistency threshold for necessity of 0.9 was not reached by the lean bundles (Schneider & Wagemann, 2012). Analysis of the X-Y plots and consistency levels demonstrated that no bundles were necessary for each configuration.

*Table 6: Output necessary condition test non-substantive operational performance*

	<b>Outcome: non-substantive Operational performance</b>	
	<b>Consistency</b>	<b>Coverage</b>
<b>Supplier related practices</b>	0.520867	0.652261
<b>Customer related practices</b>	0.579856	0.625812
<b>JIT</b>	0.518459	0.663585
<b>TPM</b>	0.510835	0.636818
<b>HRM</b>	0.605136	0.723956

### **Sufficient conditions leading to non-substantive operational performance**

The sufficient conditions leading to non-substantive operational performance are not the same as those that lead to substantive operational performance (see appendix 4). The results of sufficient conditions leading to non-substantive operational performance show that organizations who not develop lean bundles will not obtain substantive operational performance. This additional analysis suggested that causation is asymmetric (Ragin, 2009). In other words, the negative outcome is not explained by the reverse role of the same conditions as for substantive operational performance. To conclude, SMEs that do not develop lean bundles are likely to give them a performance disadvantage compared to SMEs that develop lean bundles.

## **4.4 Robustness check**

In order to check the robustness of the results, the data operationalization, calibration and the analysis that have been performed are shown as transparent as possible (see appendix 5). Besides, various ways of data calibration are used to see whether substantial differences in the outcome occurs. The results from the recalibrations based on the average in the dataset, on the

centre point (median) in the dataset and on the industry (un)weighted average can be found in appendix 5. First, the recalibration based on the average still resulted in three configurations. Only a small change occurred in the last configuration: customer intimacy. The TPM bundle was no longer present, while the SRP bundle now appeared to be present. However, the solution coverage and –consistency became lower after the recalibration, indicating that the calibration based on groups explained the condition better. Second, the calibration based on literature did not yield corresponding configurations with the calibration based on groups, although various ways of calibrations were used ((un)weighted, size of the organization (SME/LE), 2) country status (developed/developing/mixed), 3) type of sector (manufacturing/service) and 4) sample size ( $\leq 60$ ;  $>60 \leq 200$ ;  $<200 \leq 300$ ;  $>2000$ )). The results of the recalibration based on developing countries, which appeared to be closest related to the dataset in this study, showed that the operational excellence configuration consisted of SRP, CRP and JIT instead of SRP, CRP, TPM and ~HRM. Moreover, within the second configuration, product leadership, it appeared that in addition to SRP, JIT and TPM, HRM was also required. In contrast, the customer intimacy configuration seems most robust since no changes occurred. A possible explanation for the changes that have occurred, is that the value of TPM in our sample is lower than those in literature (2.3 v.s.  $>3.0$ ). Similarly, Shah and Ward (2007) show that TPM often deviates from other lean bundles. Third, the recalibration based on centre point (median) also resulted in three configurations where a slight difference can now be seen in product leadership. The HRM bundle also appeared to be present. However, the coverage and consistency of the solution also decreased here after the recalibration, indicating that the calibration based on groups explained the condition better. To summarize, all recalibrations did not yield any other insights, since small changes did not lead to different results. It can therefore be concluded that the results of the calibration based on groups are robust.

## **5. Discussion**

This paper aimed to determine strategy-related configurations of lean bundles that are linked to substantive operational performance. First, this section elaborates on the results. Next, the theoretical and managerial implications are discussed. Then suggestion for further research are made. The last paragraph includes limitations of this research.

### **Configurations to develop a lean organization**

The results show that configurations of lean bundles are linked to substantive operational performance, which is in line with previous research (Cua et al., 2001; Negrão et al., 2017; Ward et al., 2007). Moreover, this research specifies these configurations into three strategically related pathways in order to develop a lean organization. It appears that for operational excellence the TPM, SRP and CRP bundle are required, whereas the HRM bundle is not required. To this end, there is less agreement in literature about which lean bundles constitute the operational excellence strategy. Although there is agreement that TPM is important for this configuration (McKone et al., 1999; McKone, Schroeder, & Cua, 2001), there are contradictions about the other lean bundles. This research finds that JIT is not important for this configuration, which contradicts other scholars who find that JIT is important (Danese et al., 2012). That JIT is not required in this configuration is interesting, since JIT is associated with cost efficiency and quality improvements. However, Danese et al. (2012) only investigates the relation between JIT production, JIT supply, efficiency and delivery performance. As a matter of fact, other lean bundles are not included in their analysis. Instead, this research focuses specifically on how different lean bundles combine in order to create substantive operational performance. In this way, this research does not capture the net effect of one variable but captures the effects of a combination of various conditions (Misangyi et al., 2017). So, this difference could explain that JIT is not important in this study as it examines lean bundles in conjunction. Although interesting, it is not surprising since other scholars also found that JIT was not important (Swink et al., 2005; Ward et al., 2007). A possible explanation for this contradiction in literature might be that there are fewer setups, pull and flow, because the operational excellence strategy requires a low variety and high volume process with low margins (Powell & Strandhagen, 2012). Furthermore, it appears that SRP is also required for the operational excellence strategy. This is in line with Swink et al. (2005) who also discovered and argued that SRP is positively related to cost reduction and efficiency through reduced uncertainty and disruptions in the production process. Whereas scholars found that the CRP and

HRM bundles might be too expensive for this configuration, this research only found that HRM was counterproductive whereas CRP was required. HRM is counterproductive because a process with low variety and a high volume does not require intense training of employees (de Waal & van der Heijden, 2016; Shepeck & Militello, 2000). It is remarkable that CRP is required for this configuration. Although the operational excellence strategy is more internally oriented, the organization seems to be able to offer efficient and effective solutions to customers by improving their internal processes. In addition, Wallace (1992) shows that the operational excellence strategy requires some degree of coordination with customers. This is in line with the questions that are under the CRP construct, 3 of the 5 questions are about coordination.

The findings show that organizations striving for product leadership must address JIT more extensively, while TPM and SRP should not be forgotten. Moreover, the CRP and HRM bundles are not required in this configuration. In contrast to the findings in the configuration of operational excellence, the findings in the configuration of product leadership are surely in line with findings from earlier research (Ahuja & Khamba, 2008b; Cua et al., 2001; Danese et al., 2012; Fullerton & McWatters, 2001; Fullerton et al., 2003; Ketokivi & Schroeder, 2004; Manoochchri, 1984; Wagner, 2003; Wagner & Hoegl, 2006). These findings are, for example, similar to Cua et al. (2001) who argue that JIT reduces product lead time and that TPM serves as a precondition for JIT, which in turn makes SRP important since it ensures equipment availability and on time deliveries. That the CRP and HRM bundle are not required for this configuration, is similar to the findings of Furlan, Dal Pont, et al. (2011) and Furlan, Dal Pont, et al. (2011). They conclude that those bundles are of lesser importance, since they found no complementarities between CRP and JIT and HRM acts as an enhancer for JIT.

Regarding customer intimacy, the CRP and HRM bundles are of great importance, while TPM and SRP are also required in order to achieve this strategy. In this sense, the findings of this research mostly confirm the findings of preceding research. Bügel et al. (2011) argued that the CRP bundle is of importance since investing in an intimate relationship is viable for initiating and continuing a successful relationship with customers. Furthermore, Shepeck and Militello (2000) argued that the HRM bundle is required to increase skills of employees. Yet, in contradiction to Hartley (1981) and Swink et al. (2005) this research found that JIT was not required for this configuration. Both scholars, however, used a linear regression model that focuses on the unique contribution of a variable and therefore keeps other values constant (Fiss, 2005). This stands in direct opposition to the basic premise of a configurational approach used

in this research, namely that it is the presence or absence of particular other factors that gives a variable meaning or not (Fiss, 2005). As a result, the linear regression model is much less adept at answering under what specific conditions a variable influences an outcome. Hence, that is why the results of this research differs from theirs. Another explanation for the different results might be that customers do not value fast delivery. Although some scholars found that TPM is of lesser importance (Swink et al., 2005), this research found that it is indeed important to develop TPM. This difference potentially occurred due to disparities in the sample. Swink et al. (2005) explicitly included high-performing plants, while in this study SMEs are not selected on their performance. In addition, the difference could also be explained by the fact—that customers want products that meet precise specifications and therefore process control is required. Finally, the findings also contradicts others who argued that SRP is not required for this configuration (Furlan, Dal Pont, et al., 2011; Treacy & Wiersema, 1993). In fact, the results in this study show that SRP is required. Clearly, without supplier involvement, organizations cannot meet the high and specific customer requirements. Moreover, Furlan, Dal Pont, et al. (2011) also used a regression analysis, which cannot capture combination of various conditions. As a result, it is not remarkable that the SRP bundle is required in this configuration.

### **Theoretical implications**

The findings of this research provide three main contributions to the lean management literature. First, findings of this research provide more insights into how lean bundles configure together and confirms that the development of lean bundles are strategy related. The development of lean bundles depends on how an organization tries to distinguish itself and the context in which they operate. This deviates from the prevailing view that all lean bundles are equally important (Shah & Ward, 2003; Thanki, Govindan, & Thakkar, 2016) and that the success of a lean organization depends on the development of the whole set of lean bundles. This study provide a more nuanced understanding of the relationship between lean bundles and operational performance by showing that the pursuit of the five principles of Womack and Jones (1996) can be shaped in different ways depending on the strategy of the organization. So, instead of considering a lean company as lean when it has developed all lean bundles, this study provides a nuanced view because it considers a lean company to be lean when it properly pursues all the principles of lean. To this end, a variety of lean bundles can be developed, with not all lean bundles being equally important.

Second, this research focuses on a broader perspective, since it proposes strategy-related configurations of lean bundles that are linked to substantive operational performance, rather than financial performance. To this end, a broader conceptualization of organizational performance is given, since this research include multiple objectives of operational performance (Venkatraman & Ramanujam, 1986). Moreover, a different composition of lean bundles is used (more focused on supply chain) than in other studies (Galeazzo & Furlan, 2018). Hereby, the entire supply chain is taken into account instead of only internal related practices.

Third, this research continues with a configurational approach, a novel method in the field of lean management. This research therefore provides an alternative explanation of the relationship between lean bundles and operational performance. Most literature has simplified this relationship too much by investigating the effect of lean bundles on operational performance through a regression model (Negrão et al., 2017; Vis, 2012). This research shows that lean bundles indeed lead to improvement of operational performance, however it highlights that this is based on how they are configured together. In this sense, this research complements and advances previous research because it provides a nuanced perspective to explain the relationship of lean bundles and operational performance improvements by demonstrating that lean bundles are not equally important and are strategy related.

### **Managerial implications**

This research offers guidance for lean practitioners that aim to develop a lean organization in three ways. First, it is possible to focus on only few sets of lean bundles to obtain substantive operational performance. Thus, not all lean bundles are equally important. In other words, organizations must emphasize those bundles that are related to their business strategy, while maintaining a certain threshold on the other lean bundles. So, it is not necessary to maximize the development of the whole set of lean bundles. In this sense, managers trying to develop a lean organizations can use the findings of this research to focus their attention depending on their related business strategy. Without a clear focus, SME's fail to transform efforts into an effective improvement of operational performance. Second, as development of lean bundles is costly, managers should focus on lean bundles which fits their business strategy. It helps them to overcome the problem of prioritizing investments in the many practices an organization can develop in order to become more lean (Jordan & Michel, 2001). The findings of this research can serve as arguments for strategic choices that a board of directors need to make with regard to investments related to the development of lean bundles. To this end, managers of SME's can

invest their few available financial resources more wisely. Third, it requires a different way of thinking from managers, because different, equally effective lean bundle configurations are available that lead to substantive operational performance. Managers should first identify the strategy that underlies their business operations and then select the most suitable configuration.

### **Limitations and suggestions for further research**

The results provide some interesting cues for further research. First, as this research focuses specifically on SRP, CRP, JIT, TPM, and HRM bundles, this research omits bundles, e.g. TQM, that can also lead to substantive operational performance. It would be interesting to know how those bundles relate to business strategies. Second, this research uses an overall performance measure that derives from the average of seven individual performance objectives. Future research could explore strategy-related configurations of lean bundles that are linked to single performance areas. This would be a fruitful area of investigation since it could enhance confidence of the proposed relationship between strategy-related lean bundles and operational performance. Third, this research calibrates set membership scores by focusing on three qualitative anchors that structure fuzzy sets: the threshold for full membership, the threshold for full non-membership, and the cross-over point (direct method) (Ragin, 2007). Future research could explore the indirect method which relies on the researcher's broad groupings of cases according to their degree of membership in the target set. This could possibly lead to other pathways to develop a lean organization. Fourth, only a multiple respondent self-assessments survey is used in order to answer the research question. To elaborate on the findings, in-depth interviews could be conducted. Finally, a fifth potential fruitful area of investigation would be to investigate different samples sizes from different industries or countries. As this research included 44 manufacturing SME's, it was constrained in the number of causal conditions that it could include (Fiss, 2005). When enlarging the sample size, future research could add contextual or contingent factors influencing organizations' operational performance. As this research only investigates SME's in the Netherlands, findings can only be generalized to other SME's. Moreover, since fsQCA is designed for more theoretical-driven work results are only "modest generalizable" to similar cases that share a reasonable number of characteristics with those cases under study (Berg-Schlosser et al., 2009; Rihoux, 2006). Future research could explore how strategy-related lean bundles configure for example in the service sector or in other countries or parts of the world. Country characteristics and cultures might influence the relationship between strategy, lean bundles and operational performance, indicating that the same strategy-related configurations of lean bundles do not apply throughout the world.

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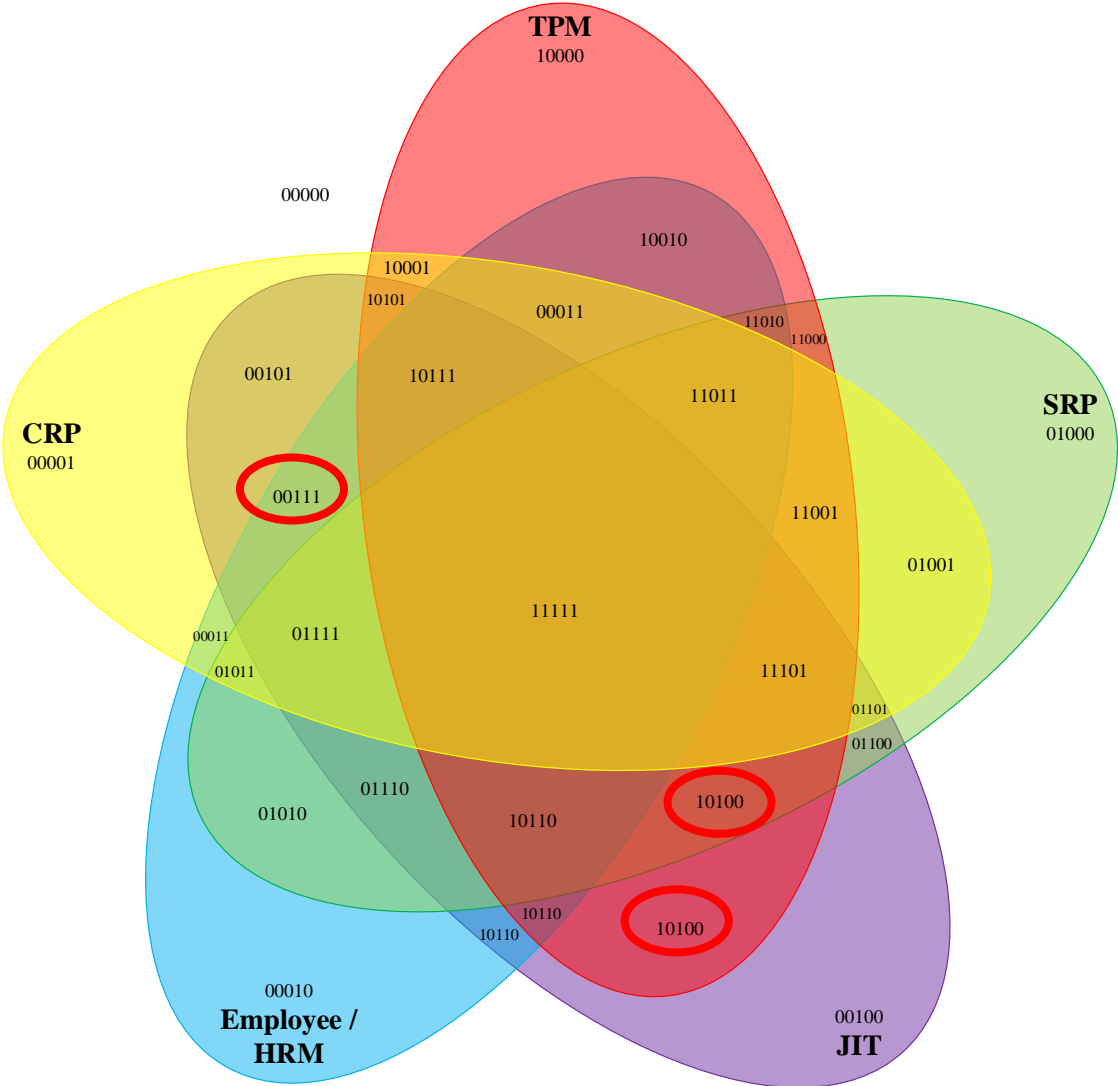
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# Appendixes

## Appendix 1: Venn-diagram

The Venn diagram describes the values of the explanatory variables. The five-set Venn diagram uses congruent ellipses in a radial symmetrical arrangement to illustrate the logical relationships between TPM, SRP, JIT, Employee/HRM and CRP lean bundles. The variable TPM receives the value 0 when it falls outside its ellipse and receives the value 1 when it falls inside ellipse. Thus, the line of the ellipse determines the value for the variable TPM. The variable SRP, JIT, Employee/HRM and CRP are determined in a similar way. In Figure 2, 25 or 32 logical combinations are presented. The red circles show which lean bundles are expected to form a certain configuration (see also the conceptual model).



## Appendix 2 Factor analysis: including assumptions check and Cronbach's Alpha Assumptions (Hair et al., 2014)

First, all variables have to be of interval or ratio level. Because of the Likert scale that is used, the differences between each point is assumed to be equal and therefore the variables are considered of interval level. Second, the sample size must be large enough (variable ratio 5:1 and sample >50). In this sample there are 12 items and 255 respondents. As a result, the ratio is 21.25. So therefore the sample size is large enough for a factor analysis to be carried out. Moreover, the sample is found to be representative for manufacturing SME's in terms of industry, environment, products and number of employees. Third, the sample need to be homogeneous. When analysing the standard deviations, skewness and kurtosis, it can be concluded that the sample is homogeneous and that the sample is normally distributed. Finally, both Bartlett's test of Sphericity and the KMO- test need to be significant. Both test can be found below and shown that a factor analysis can be conducted. This is due to the fact that the Bartlett's Test of Sphericity is significant ( $p < .05$ ) and KMO  $> .50$ . Which indicate that sufficient correlations exist among the variables to proceed.

**Descriptive Statistics**

	N	Mean		Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
Price	44	5,125	,2127	1,4106	,065	,357	-,820	,702
Quality	44	6,875	,1464	,9712	-1,405	,357	1,649	,702
Delivery speed	44	6,364	,1960	1,3001	-,276	,357	,068	,702
Delivery dependability	44	6,455	,1881	1,2474	-,899	,357	1,408	,702
Product flexibility	44	7,034	,1253	,8311	-,400	,357	,577	,702
Volume flexibility	44	6,568	,1556	1,0320	,307	,357	-,629	,702
Delivery flexibility	44	6,250	,1630	1,0810	-,325	,357	,624	,702
Valid N (listwise)	44							

**Descriptive Statistics**

	N	Mean		Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
Supplier feedback	44	3,428	,0548	,3637	,375	,357	,040	,702
JIT delivery	44	2,496	,0852	,5655	,537	,357	,042	,702
Developing suppliers	44	2,305	,0614	,4070	,155	,357	-,394	,702
Involved customers	44	3,161	,0734	,4867	-,121	,357	-,817	,702
Pull	44	3,045	,0916	,6077	,627	,357	1,501	,702
Flow	44	3,114	,1053	,6982	-,175	,357	-,364	,702
Low setup	44	2,549	,0810	,5375	,880	,357	1,445	,702
Controlled processes	44	1,943	,0739	,4901	,704	,357	,004	,702
Productive maintenance	44	2,608	,0701	,4651	,036	,357	-,293	,702
Involved employees	44	2,631	,0780	,5171	,697	,357	,208	,702
Valid N (listwise)	44							

The tables above shows that the standard deviations of the variables are low, which means that the sample is homogeneous. Furthermore, the skewness and kurtosis shows that the sample is normally distributed. Ideally, the kurtosis and the skewness is 0 (Hair et al., 2014). The values for asymmetry and kurtosis between -2 and +2 are considered acceptable in order to prove normal univariate distribution.

**Factor analysis Operational Performance: principle component with oblique rotation**

**KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,718
Bartlett's Test of Sphericity	Approx. Chi-Square	334,712
	df	21
	Sig.	,000

**Communalities**

	Initial	Extraction
P	1,000	,353
Q	1,000	,326
DS	1,000	,753
DD	1,000	,805
PF	1,000	,529
VF	1,000	,597
DF	1,000	,577

Extraction Method: Principal Component Analysis.

**Total Variance Explained**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings <sup>a</sup>
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
1	2,770	39,574	39,574	2,770	39,574	39,574	2,484
2	1,170	16,714	56,289	1,170	16,714	56,289	1,924
3	,889	12,699	68,988				
4	,798	11,405	80,393				
5	,649	9,265	89,658				
6	,436	6,226	95,884				
7	,288	4,116	100,000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

**Pattern Matrix<sup>a</sup>**

	Component	
	1	2
P		,601
Q	,491	,175
DS	,880	
DD	,938	-,186
PF	-,104	,753
VF	,210	,680
DF	,534	,398

Extraction Method: Principal Component Analysis.  
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 6 iterations.

**Component Correlation Matrix**

Component	1	2
1	1,000	,314
2	,314	1,000

Extraction Method: Principal Component Analysis.  
Rotation Method: Oblimin with Kaiser Normalization.

**Reliability Statistics**

Cronbach's Alpha	N of Items
,728	7

The first table of KMO and Bartlett shows that the factor analysis will be useful. There are no communalities below  $<0.20$ , which are shown in the Communalities table. The Total Variance explained is 56,29% with two factors. The eigen value of four factors is above 1. The Pattern Matrix shows that there are no items are double loaders. The Factor Correlation Matrix shows that there is enough correlation ( $>.30$ ) between the factors to complete an Oblique Rotation.

The Cronbach's alpha assesses the consistency of the whole scale. The generally agreed upon lower limit for Cronbach's alpha is .70, although it may decrease to .60 in exploratory research (Hair et al., 2014). The Cronbach's Alpha of Operational Performance is .728. So it can be concluded that the scale used to measure operational performance is internally consistent.

## Factor analysis Lean bundles: principle component with varimax rotation

### KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,629
Bartlett's Test of Sphericity	Approx. Chi-Square	138,536
	df	45
	Sig.	,000

### Communalities

	Initial	Extraction
Supplierfeedbackmean Supplier feedback mean	1,000	,750
JITdeliverymean JIT delivery mean	1,000	,769
Developingsuppliers Developing suppliers	1,000	,555
InvolvedcustomersCustomerrelated Involved customers/Customer related	1,000	,442
Pull	1,000	,811
Flow	1,000	,508
Lowsetup Low setup	1,000	,651
Controlledprocesses Controlled processes	1,000	,628
Productivemaintenance Productive maintenance	1,000	,732
Involvedemployees Involved employees	1,000	,426

Extraction Method: Principal Component Analysis.

### Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,535	35,353	35,353	3,535	35,353	35,353	2,673	26,735	26,735
2	1,512	15,120	50,473	1,512	15,120	50,473	2,086	20,857	47,591
3	1,225	12,250	62,722	1,225	12,250	62,722	1,513	15,131	62,722
4	,919	9,189	71,911						
5	,836	8,361	80,272						
6	,583	5,835	86,107						
7	,515	5,146	91,252						
8	,459	4,592	95,845						
9	,257	2,574	98,419						
10	,158	1,581	100,000						

Extraction Method: Principal Component Analysis.

**Rotated Component Matrix<sup>a</sup>**

	Component		
	1	2	3
Supplierfeedbackmean Supplier feedback mean	,227	,657	,516
JITdeliverymean JIT delivery mean	,553	,656	-,183
Developingsuppliers Developing suppliers	,242	,703	
InvolvedcustomersCustomerrelated Involved customers/Customer related		,663	
Pull	,311	-,160	,830
Flow	,679		,216
Lowsetup Low setup	,759	,271	
Controlledprocesses Controlled processes	,771	,184	
Productivemaintenance Productive maintenance	,504		-,688
Involvedemployees Involved employees	,525	,388	

Extraction Method: Principal Component Analysis.  
 Rotation Method: Varimax with Kaiser Normalization.  
 a. Rotation converged in 4 iterations.

**Component Transformation Matrix**

Component	1	2	3
1	,791	,610	,038
2	-,079	,040	,996
3	,606	-,791	,080

Extraction Method: Principal Component Analysis.  
 Rotation Method: Varimax with Kaiser Normalization.

**Reliability Statistics**

Cronbach's Alpha	N of Items
,757	10

The first table of KMO and Bartlett shows that the factor analysis will be useful. There are no communalities below <0.20, which are shown in the Communalities table. The Total Variance explained is 62,72% with three factors. The eigen value of four factors is above 1. The Factor Correlation Matrix shows that there is not enough correlation (<.30) between the factors to complete an oblique Rotation. Therefore an orthogonal rotation is performed, leading to the above results.

The Cronbach's alpha assesses the consistency of the whole scale. The generally agreed upon lower limit for Cronbach's alpha is .70, although it may decrease to .60 in exploratory research (Hair et al., 2014). The Cronbach's Alpha of Lean is .757. So it can be concluded that the scale used to measure lean management is internally consistent.

### Appendix 3 Truth table

CaliSRP	CaliCRP	CaliJIT	CaliTPM	CaliHRM	number	CaliOP	Cases	Consistency
1	1	1	1	0	3	1		0.937422
1	1	0	1	0	1	1		0.915888
0	1	1	1	1	2	1		0.878082
1	0	1	1	0	1	1		0.871795
1	0	1	1	1	2	1		0.867558
1	1	1	1	1	4	1		0.867021
1	1	1	0	0	2	0		0.850727
0	1	0	1	1	1	0		0.843112
1	0	0	1	0	1	0		0.842818
1	1	1	0	1	1	0		0.831073
0	1	1	0	0	1	0		0.814039
0	1	1	0	1	2	0		0.792258
1	1	0	0	1	3	0		0.789171
0	0	1	0	1	1	0		0.780355
0	0	0	1	1	1	0		0.758085
0	0	0	1	0	2	0		0.729093
0	1	0	0	0	3	0		0.723047
0	0	0	0	1	3	0		0.651109
0	0	0	0	0	10	0		0.542517

#### Appendix 4 Outcome leading to non-substantive performance

Configuration	1 OPEX	2 PRODLEAD	3 CUSTint
<b>Supplier related practices</b>	⊗	⊗	⊗
<b>Customer related practices</b>	⊗		⊗
<b>JIT</b>	⊗	⊗	
<b>TPM</b>		⊗	⊗
<b>HRM</b>		⊗	●
<b>Raw coverage</b>	0.570626	0.540931	0.357544
<b>Unique coverage</b>	0.0718299	0.081862	0.0204655
<b>Consistency</b>	0.933071	0.948628	0.943856
<b>Overall solution coverage</b>	0.672954		
<b>Overall solution consistency</b>	0.903556		

## Appendix 5: Robustness

### Outcome based on average

Configuration	1 OPEX	2 PRODLEAD	3 CUSTint
Supplier related practices	●	●	●
Customer related practices	●		●
JIT		●	●
TPM	●	●	
HRM			●
Raw coverage	0.476456	0.464304	0.351899
Unique coverage	0.0926582	0.0805063	0.0572152
Consistency	0.848512	0.830616	0.79977
Overall solution coverage	0.614177		
Overall solution consistency	0.800132		

### Outcome based on theory (developing countries)

Configuration	1 OPEX	2 PRODLEAD	3 CUSTint
Supplier related practices	●	●	
Customer related practices	●		●
JIT	●	●	●
TPM		●	●
HRM		●	●
Raw coverage	0.56715	0.560386	0.434299
Unique coverage	0.052657	0.0550724	0.010628
Consistency	0.866421	0.892995	0.936458
Overall solution coverage	0.63285		
Overall solution consistency	0.821276		

### Outcome based on centre point (median)

Configuration	1 OPEX	2 PRODLEAD	3 CUSTint
Supplier related practices	●	●	
Customer related practices	●		●
JIT		●	●
TPM	●	●	●
HRM	⊗	●	●
Raw coverage	0.389044	0.480501	0.426648
Unique coverage	0.0896007	0.0752088	0.0213556
Consistency	0.952273	0.871946	0.880268
Overall solution coverage	0.591458		
Overall solution consistency	0.837227		