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FERNANDO GONÇALVES PICASSO

OPERATIONS STRATEGY IN PERSPECTIVE: THE MEANS FOR ACHIEVING SUPERIOR PERFORMANCE

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Campo de Conhecimento: Gestão de Operações e Competitividade

Orientador: Prof. Dr. Ely Laureano Paiva
Co-orientadora: Profa. PhD Barbara Bechler Flynn

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ABSTRACT

Manufacturing strategy has been widely studied and it is increasingly gaining attention. It has a fundamental role that is to translate the business strategy to the operations by developing the capabilities that are needed by the company in order to accomplish the desired performance. More precisely, manufacturing strategy comprises the decisions that managers take during a certain period of time in order to achieve a desire result. These decisions are related to which operational practices and resources are implemented. Our goal was to identify the relationship between these two decisions with operational performance. We based our arguments on the resource-based view for identifying sources of competitive advantage. Hence, we argued that operational practices and resources affect positively the operational performances. Additionally, we proposed that in the presence of some resources the implementation of operational practices would lead to a greater performance. We used previous scales for measuring operational practices and performance, and developed new constructs for resources. The data used is part of the High Performance Manufacturing project and the sample is composed by 291 plants. Through confirmatory factor analysis and multiple regressions we found that operational practices to a certain extant are positively related to operational performance. More specifically, the results show that JIT and custo orientation practices have a positive relationship with quality, delivery, flexibility, performances. Moreover, we found that resources like technology and people explai variance of operational performance.

Key-words: manufacturing strategy; operational practices; resources; operational performance.

RESUMO

Estratégia de operações tem sido cada vez mais estudada e tem ganhado importância nos últimos anos. Seu papel principal é traduzir a estratégia do negócio para a área operacional desenvolvendo as competências necessárias para que o negócio atinja seus objetivos. Mais especificamente, estratégia de operações compreende as decisões que gestores tomam em um determinado período de tempo para atingir o desempenho esperado. Essas decisões estão relacionadas à quais práticas operacionais e recursos serão implementados. O objetivo desta pesquisa é identificar a relação entre práticas e recursos com o desempenho operacional. A teoria usada para explicar essa relação é a visão baseada em recursos, que ajuda a identificar fontes de vantagens competitivas. Com isso, argumenta-se que práticas operacionais e recursos impactam positivamente o desempenho operacional. Adicionalmente, propõe-se que na presença de alguns recursos a implementação de práticas operacionais levaria a um maior desempenho operacional. Para esta pesquisa, usa-se escalas validadas em estudos prévios para medir práticas operacionais e desempenho, e para a mensuração dos recursos uma nova escala é desenvolvida. Os dados utilizados são parte do projeto chamado *High Performance Manufacturing* com uma amostra de 291 plantas. Os métodos utilizados para a análise de dados foram: análise fatorial confirmatória e regressão múltipla. Os resultados advindos dessas análises mostraram que há uma relação positiva entre práticas operacionais e desempenho operacional. Mais especificamente, práticas como JIT e orientação para o cliente relacionaram-se positivamente com desempenho em qualidade, entrega, flexibilidade e custo. Ademais, recursos como tecnologia e pessoas explicam uma grande parte da variação do desempenho operacional.

Palavras-chave: estratégia de operações; práticas operacionais; recursos; desempenho operacional.

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Summary

1. INTRODUCTION

Operations strategy concerns the pattern of decisions that managers take during a certain period of time (Wheelwright, 1984). More specifically, operations strategy comprises the establishment of priorities that denote the desired performance to be pursued by the business (Hayes & Pisano, 1994; Wheelwright, 1984) and the means by which the plant will achieve such priorities (Boyer & Mcdermott, 1999). These decisions, in part, are related to which operational practices and resources will be employed to achieve a desired plant performance (Hayes & Pisano, 1994).

It follows then that operations strategy is crucial for the overall business. The decisions taken by the operational managers denote the aims of the business and set how operations will support such needs, transforming operations into a competitive weapon for the firm (Skinner, 1969). Generally, such decisions are related to quality, costs, flexibility, and delivery (Boyer & Lewis, 2002; Größler & Grübner, 2006; Ward, Peter T.; McCreery, Jhon K.; Ritzman, Larry P.; Sharma, 1998; Wheelwright, 1984). According to Boyer and Mcdermott (1999), what makes a successful operations strategy is how the decisions are translated into a consistent set of activities that will support the needs of the company (Boyer & Mcdermott, 1999). Many authors argue that operational practices and resources are crucial (Dean & Snell, 1996; Jayaram et al., 1999; Ketokivi & Schroeder, 2004; Morita & Flynn, 1997; Wu et al., 2012; Boyer & Lewis, 2002; Boyer & Mcdermott, 1999) in supporting the operational performance pursued by the company (Barney, 1991; Jayaram et al., 1999; Kaynak, 2003).

This work deals with the role of operational practices and resources in supporting operational performance. Operational practices involve specific tasks aimed at achieving a desired result (Flynn, Sakakibara, & Schroeder, 1995). Herewith, definite practices would be implemented according to the competitive priorities set with the aim of improving the overall performance (Boyer & Lewis, 2002). By the same token, resources involve tangible assets (workforce, equipment, etc.) as well as intangible ones (technology, skills, etc.) that support the needs of the company (Boyer & Lewis, 2002; Wheelwright, 1984). As noted by Boyer & Lewis (2002) and Boyer & Mcdermott (1999), matching the resources with the competitive priorities are vital for an effective operations strategy. Thus, we propose the following research question:

What is the relationship of operational practices and resources with operational performance?

The theory used as a backdrop to this work is the resource-based view (Barney, 1991). This theory analyzes the firm through an internal perspective and states that assets meeting some criteria (rare, valuable, non-imitable, and non-substitutable) can create competitive advantage for the company. Therefore, operational practices and resources will be analyzed through this perspective, and those that meet the above mentioned conditions will be considered sources of competitive advantage for the firm. It is noteworthy that competitive advantage will be assessed through operational performance (i.e.: Schroeder, Bates, & Junttila, 2002).

To answer the research question, we use the data collected in the third round of the High Performance Manufacturing project (Schroeder & Flynn, 2001). The main aim of this project is to understand the operations practices and routines and their impact on performance. The sample is composed of companies in three sectors: transportation, machinery and equipment, and electronics. The choice of these sectors was based upon the variability of practices and the operational performance they provide (Flynn, Schroeder, Flynn, Sakakibara, & Bates, 1997). The companies that comprise the sample have more than one hundred employees, and are located in eleven countries (USA, Brazil, Germany, Italy, Spain, Finland, Sweden, Austria, Japan, China, and Korea).

Following this, we present the literature review, which discuss the operational practices, resources, operational performance, and theory that was used as the basis for this work. Next, we show the methodology that describes the data in detail, and the methods and software used for analyzing them. Afterwards, we present the results that discuss the relationship among operational practices, resources and operational performance. We then conclude the work by presenting the main findings, contributions, limitations, and suggestions for future research.

2. LITERATURE REVIEW

This topic is dedicated to reviewing previous literature related to operations strategy that includes operational practices, resources, and operational performance; as well as the theory that is used for supporting the research model.

2.1. Theory

The backdrop theory for this work is the Resource-Based View (RBV). This theory takes an internal perspective approach of companies to analyze competitive advantage created through their own resources (Barney, 1991; Barney, Ketchen, & Wright, 2011; Wernerfelt, 1984). According to Barney (1991), this theory presents two assumptions: (i) companies control different strategic resources; and (ii) these resources are imperfectly mobile across firms.

For a resource to be a source of competitive advantage, it has to have four characteristics (Barney, 1991): it must be valuable, rare, imperfectly mobile, and there cannot be substitutes or equivalent resources possessed by other companies. Each of these characteristics is detailed below:

- Valuable: A resource is valuable when through its use a company is able to implement strategies that improve effectiveness and efficiency. Here firms separate what can be considered a resource and what is not.
- Rare: An important resource possessed by only one firm can generate competitive advantage because this firm will be able to create a strategy that none of the others will have. If all or most of the competing firms have this resource, it is not rare because any firm can use it in the same way.
- Imperfectly imitable resources: Value and rareness are sources of competitive advantage for first-movers. However, a resource will enable a company to create sustained competitive advantage only if it is difficult for other competing firms to imitate it.
- Non-available, strategically equivalent substitutes: Even if a firm has valuable, rare, and imperfectly imitable resources, it will not be able to implement strategies that generate competitive and sustained advantage, if other firms possess resources that create equivalent strategies.

Even though some companies try to copy successful strategies from competitors, they may be unable to do so because some resources characteristics make them difficult to imitate or acquire. As Barney (2001) pointed out, the development of resources presents: (i) path dependency, which means that some resources are developed inside the company over a long period of time; (ii) casual ambiguity, which happens when a company cannot fully understand the relationship between its resources and competitive advantage; and (iii) social complexity, that is, the fact that some resources just cannot be sold or bought. Since resource heterogeneity is maintained, some companies are then able to implement strategies that lead to sustained competitive advantage.

The prominence of RBV is demonstrated by Crook, Ketchen, Combs, and Todd (2008) and Barney et al. (2011). The former presented a meta-analysis based on data from over 29,000 firms (Crook et al., 2008). In this study, the authors found that strategic resources are related to performance and, moreover, resources that possess certain characteristics (valuable, rare, non-imitable, and non-substitutable) explain, to a greater extant the increase in performance than resources that do not meet the RBV conditions. The latter carried out a study 20 years after of the article written by Barney (1991). In this study, the authors argue that RBV reached its maturity as a theory for four reasons: (i) increasingly, authors are using the term RBT (resource-based theory) instead of RBV (resource-based view); (ii) RBV has influenced other perspectives, like the knowledge-based view and natural-based view; (iii) RBV has been integrated with other perspectives like institutional theory and economics; and (iv) RBV has provided retrospective assessments that produced reliable results (Barney et al., 2011).

In operations management, the RBV has been used for explaining sources of greater operational performances. For example, Schroeder et al. (2002), based on RBV assumptions, argued that proprietary processes and equipment might be difficult to copy when they result from an iterative process and can lead to better performance. Likewise, Paiva, Roth, and Fensterseifer (2008) stated that manufacturing cross-functional integration is positively related to the RBV. The authors argued that the integration of different functional areas permits the creation of product characteristics that are valued by clients and not easily found elsewhere. By the same token, Coates and McDermott (2002) argued that using the RBV perspective to study manufacturing competencies helps to better understand production capabilities. In doing so, RBV provides a basis for examining methods and skills that support companies in establishing their competitive priorities (Coates & McDermott, 2002).

Then, we use RBV in this study to understand the competitive advantages that operational practices and resources can bring to a company. Therefore, we state that practices and resources that meet RBV criteria are considered sources of superior operational performance. It follows then that companies possessing these assets are able to create above normal returns, thereby outperforming competitors.

2.2. Operational practices

Operational practices are standard sets of activities that are transferred across companies (Wu, Melnyk, & Flynn, 2010; Wu et al., 2012). For example, just in time (JIT) involves activities like the minimization of inventory, increase flexibility, scheduling daily production etc. (Flynn, Sakakibara, & Schroeder, 1995); human resource practices embrace activities such as allowing employees to decide how to do their work, ensuring that employees' suggestions are taken into account, etc. (Jayaram et al., 1999). Since operational practices are standard activities, they are observable and tend to be copied by other companies (Wu et al., 2012).

Moreover, operational practices are employed for achieving a desired specific performance (Flynn et al., 1995). For example, total quality management (TQM) is used for improving the quality of products and services (Flynn et al., 1995), JIT is aimed at the elimination of waste (Wu et al., 2012). Jayaram et al. (1999) found that human resource practices, such as top management commitment, communication of goals, employee training, and cross-functional teams are directly linked to specific operational performance, which means that practices are set to attain certain types of results. Therefore, we define operational practices as standard sets of activities in order to achieve a desired specific performance, which can be copied by other companies.

We use the scale developed by Wu et al. (2012) for measuring operational practices. In the literature, the authors found seven common practices for operations: quality management, just in time (JIT), customer orientation practices, supplier relationship, integrated product development, workforce development, and leadership practices. In the following sections we discuss each one in more detail and develop the hypotheses accordingly.

2.2.1. Quality management practices

Quality management was influenced by zero-defect practices in the military area, more precisely in the production of missiles in which flawless processes were imperative. In doing so, many benefits accrued to the operations, for example faster and more reliable production (Garvin, 1987). Afterward, companies started to implement quality management practices in their operations, and their diffusion happened when Japanese companies were outperforming their American competitors by offering products with higher quality. Garvin (1987) showed that in a comparison between Japanese and American semiconductor companies, the latter were far behind in terms of quality. It follows then that American companies recognized quality as a strategic weapon that would allow them to create more value in their products and services.

Quality management is defined as an approach or philosophy for improving and sustaining quality products and processes to meet or exceed customer expectations (Cua, McKone, & Schroeder, 2001; Flynn et al., 1995). Its basis is the continuous improvement of all processes, customer-driven quality, production without defects, and data-based decision making (Flynn et al., 1995) from the acquisition of resources to after-sales customer service (Kaynak, 2003); and it requires the involvement of the management, the workforce, the suppliers, and the customers (Cua et al., 2001). According to Cua et al. (2001) all quality management programs highlight the significance of management commitment and a well-established strategy. The management commitment is crucial to validate the program among other employees, and a well-defined strategy helps the company to direct its efforts for improving quality towards its goals and market (Garvin, 1987).

According to Sousa & Voss (2002), quality management is supported by practices and techniques. Practices commonly found in the literature are: the use of statistical process control, the use of quality control policies and plans, supplier certification for quality, customer focus, interfunctional design effort, process management, measurement and communication, and rewards for quality. Table 2.1 shows more details of quality management practices. Flynn et al. (1995) divide management practices into three dimensions: (a) statistical process control, that is, the use of charts to provide feedback, permitting actions to be based on the variability of the manufacturing process; (b) product design for quality that includes improvements in design characteristics through manufacturability and reliability, interfunctional design efforts, and new product quality efforts for extensive prototyping and design modifications prior to release for manufacture; and (c) customer focus, that is, practices that help a company to understand customer needs and the effectiveness of the company in meeting them.

Table 2.1 – Quality management practices

Study	Quality management practices	Performance operationalization	Main findings
(Flynn et al., 1995)	Use of statistical process control, customer focus, and interfunctional design effort	Quality performance (4-item scale measuring superior quality, customer satisfaction, level of quality, and customer relations) JIT performance (was measured as cycle time, defined as the total time from the receipt of raw materials by the plant until the product is received by the customer, in days, averaged across products)	- Positive relationship between TQM and JIT practices and performance - The combination of TQM and JIT practices leads to synergies that lead to further performance improvement - Infrastructure practices were found to form a strong foundation for both JIT performance and quality performance
(Sakakibara et al., 1997)	Process control, feedback, rewards for quality, top management quality leadership, and supplier quality involvement	Manufacturing performance measured by four objective (quantitative) variables: - Inventory turnover: ratio of cost of goods sold to aggregate inventory - Cycle time: average time from raw materials procurement to customer delivery - Lead time: average length of time to fill an order - On-time delivery: percentage of on-time deliveries to customers - Competitive advantage (perceptual variables): unit cost of manufacturing, quality of product and service, fast delivery, and flexibility to change volume. Relative to competition	- There is an incremental effect of infrastructure practices (including quality management) on manufacturing performance - The practices most strongly related to manufacturing performance were manufacturing strategy and quality management
(Choi & Eboch, 1998)	Process quality, human resources, strategic quality planning, and information and analysis	- Quality: Production down time, external reject, and internal reject - Delivery (Dropped): On-time delivery, flow time, and machine cycle time - Cost (Dropped): Costs per units produced, work-in-process inventory, weeks of raw materials supply, and inventory turnover ratio	- TQM practices are significantly correlated with customer satisfaction - TQM practices are significantly correlated with plant performance at a weaker level than that TQM and customer satisfaction
(Samson & Terziovski, 1999)	Leadership, people management, customer focus, strategic planning, information and analysis, and process management	Organizational performance: Customer satisfaction, employee morale, productivity, defect as % of product volume, warranty claims as a % of total sales, cost of quality (error, scrap, rework and inspection) as a % of total sales, and delivery in full on-time to customers	- Human Resource Management, leadership and customer focus proved to be strongly significant and positively related to performance - Variance in performance explained by 21.4%
(Cua et al., 2001)	Cross-functional product design, process management, supplier quality management, and customer involvement	Manufacturing performance measured by four variables separately and weighted performance: - Conformance quality (P1): Quality of product conformance - Cost efficiency (P2): Unit cost of manufacturing - On-time delivery (P3): Delivery performance - Volume flexibility (P4): Flexibility to change volume - Weighted manufacturing performance	- Cost efficiency and on-time delivery are positively associated with a greater number of practices spanning the three programs of TQM, JIT, and TPM - Conformance quality is more strongly associated with the implementation of common practices and TQM techniques than JIT and TPM practices - Volume flexibility has a significant positive relation with

		(Rank): Consistent quality (W1), low unit cost (W2), dependable delivery (W3), and ability to make rapid volume changes (W4) Weighted performance = W1 x P1 + W2 x P2 + W3 x P3 + W4 x P4	committed leadership, customer involvement, and technology emphasis - Simultaneous implementation of TQM, JIT, and TPM will result in higher performance than implementation of practices and techniques from only one of either TQM, JIT or TPM.
(Kaynak, 2003)	Management leadership, training, employee relations, quality data and reporting, supplier quality management, product/service design, and process management.	- Inventory management performance (purchase material turnover, and total inventory turnover) - Quality performance (productivity/service quality, productivity, cost of scrap and rework, delivery lead-time of purchased materials, and delivery lead-time to customers) - Financial and market performance (ROI, sales growth, profit growth, market share, and market share growth)	- There is a positive relationship between the extent to which companies implement TQM and firm performance - There is an interdependence of TQM practices - There is an indirect relationship between leadership and training and firm performance - Management leadership is directly related to training, employee relations, supplier quality management, and product design - Training and employee relations are directly related to quality data and reporting - Supplier quality management directly and positively affects product/service design, process management, and inventory management performance - Product/service design positively contributes to quality performance directly - Process management is directly and positively related to quality performance
(Swink et al., 2005)	Focus on quality performance, measurement, and communication (i.e., feedback) of quality related data for improvement and control purposes, and statistical quality control techniques	Market-based performance measured by a 3-item scale: profitability, market share of major product/product line, and unit growth rate in sales	- Process quality management practices are associated with both process and new product flexibilities, but only when strategy integration is present - Supplier relationship management coupled with strategy integration was the only practice found to be significantly associated with cost efficiency, and with an indirect effect on improved quality performance

Source: Elaborate by the author

Some authors have shown the benefits of quality management practices, either related directly to operational performance or to other practices. For example, Sakakibara, Flynn, Schroeder, & Morris (1997) argued that quality management practices are related to JIT through the establishment of control processes. Sousa and Voss (2002) claimed that improved process quality which means fewer defects, scrap and rework, leads to better operational performance, like reduced costs and more dependable processes. Moreover, Sousa and Voss (2002), reviewing studies of quality management, found a significant effect of quality practices on operational performance. Additionally, some researchers have demonstrated the effect of quality management practices on specific operational performance. For example, Choi and Eboch (1998) found a positive relationship between quality practices and quality performance. Cua et al. (2001) found a significant relationship between quality practices and cost, delivery and quality performances. Therefore, we state the following:

H1. There is a positive relationship between quality management practices and quality performance.

H2. There is a positive relationship between quality management practices and delivery performance.

H3. There is a positive relationship between quality management practices and flexibility performance.

H4. There is a positive relationship between quality management practices and cost performance.

2.2.2. Just-in-Time

JIT is a set of practices whose primary goal is to eliminate all forms of waste (Cua et al., 2001; Flynn et al., 1995; Shah & Ward, 2003; Swink, Narasimhan, & Kim, 2005) in order to reduce lead time and inventory (Snell & Dean, 1992). According to Shah and Ward (2003), Cua et al. (2001), and Swink et al. (2005), three main forms of waste are material movements, work in process inventory and unnecessary delays in flow time. JIT acts exactly against these forms of waste, because it receives and produces each raw material or subcomponent just in time for it to be used in the next step of production (Snell & Dean, 1992). By doing so, the practices that compose JIT are aimed at matching production with customer demand (Flynn et al., 1995).

The most common JIT practices found in the literature review were: set-up time reduction, scheduling flexibility, maintenance, equipment layout, kanban or pull system, supplier relationship, small batch size, product simplification, and quality improvements. According to Flynn et al. (1995) JIT practices can be divided into four dimensions: (a) kanban that controls the movements of orders on the shop floor; (b) lot size reduction to minimize inventory and increase flexibility; (c) JIT scheduling activities that direct practices in order to meet demand; (d) and set-up time reduction that minimizes the time required to change machines over to work on different parts. Table 2.2 shows more details of the literature review for JIT studies.

Table 2.2 – JIT practices

Study	JIT practices	Performance operationalization	Main findings
(Snell & Dean, 1992)	Product simplification through parts reduction, frequent deliveries from a limited numbers of suppliers, small lot sizes, set-up time reduction, factory layout by product families, and consistence preventive maintenance	Human resource management: - Selective staffing: a 7-item scale measuring the extensiveness of a firm's selection process - Comprehensive training: an 8-item scale measuring the extensiveness of training and development opportunities - Developmental appraisal: a 9-item scale measuring whether performance appraisal was used for developing employees - Equitable rewards: an 8-item scale measuring the degree to which pay was competitive for the industry and based on individual performance	- Advanced manufacturing technology is positively related to selective staffing, comprehensive training, developmental appraisal, and externally equitable rewards for operations employees and it is also positively related to selective staffing for employees in quality - JIT is positively related to selective staffing in quality, and it is negatively related to selective staffing in operations. In addition, JIT is negatively related to performance appraisal in both quality and operations
(Flynn et al., 1995)	Set-up time reduction practices, schedule flexibility, and the use of Kanban	- Quality performance: 4-item scale measuring superior quality, customer satisfaction, level of quality, and customer relations - JIT performance: Measured as cycle time, defined as the total time from the receipt of raw materials by the plant until the product is received by the customer, in days, averaged across products	- Positive relationship between TQM and JIT practices and performance - The combination of TQM and JIT practices leads to synergies that lead to further performance improvement - Infrastructure practices were found to form a strong foundation for both JIT performance and quality performance
(Sakakibara et al., 1997)	Set-up time reduction, scheduling flexibility, maintenance, equipment layout, Kanban, and JIT supplier relationships	Manufacturing performance measured by four objective (quantitative) variables: - Inventory turnover: ratio of cost of goods sold to aggregate inventory - Cycle time: average time from raw materials procurement to customer delivery - Lead time: average length of time to fill an order - On-time delivery: percentage of on-time deliveries to customers - Competitive advantage (perceptual variables): unit cost of manufacturing, quality of product and service, fast delivery, and flexibility to change volume. Relative to competition	- JIT practices have value only when they are used to build infrastructure, and have no direct effect on performance - JIT practices generate an indirect effect that works through improvement of manufacturing infrastructure by providing a set of targets and discipline for the organization - Manufacturing performance enhances competitive advantage at the plant level

(Koufteros, Vonderembse, & Doll, 1998)	Shop-floor employee involvement in problem solving, reengineering set-up, cellular manufacturing, quality improvement efforts, preventive maintenance, dependable suppliers, pull production	Pull production as a dependent variable. 3-item scale: - Pull production through shipment - Pull production at stations - Pull production system	- Shop-floor employee involvement in problem solving is a catalyst for reengineering set-ups, cellular manufacturing, quality improvement efforts, preventive maintenance, and dependable suppliers - Three time-based manufacturing practices (reengineering set-ups, cellular manufacturing, and preventive maintenance) have a significant relationship with pull production
(Cua et al., 2001)	Setup time reduction, pull system production, JIT delivery by supplier, functional equipment layout, daily schedule adherence, committed leadership, strategic planning, cross-functional training, and employee involvement	Manufacturing performance measured by four variables separately and weighted performance: - Conformance quality (P1): Quality of product conformance - Cost efficiency (P2): Unit cost of manufacturing - On-time delivery (P3): Delivery performance - Volume flexibility (P4): Flexibility to change volume - Weighted manufacturing performance (Rank): Consistent quality (W1), low unit cost (W2), dependable delivery (W3), and ability to make rapid volume changes (W4) Weighted performance = W1 x P1 + W2 x P2 + W3 x P3 + W4 x P4	- Cost efficiency and on-time delivery are positively associated with a greater number of practices spanning the three programs of TQM, JIT, and TPM - Conformance quality is more strongly associated with the implementation of common practices and TQM techniques than JIT and TPM practices - Volume flexibility has a significant positive relation with committed leadership, customer involvement, and technology emphasis only - Simultaneous implementation of TQM, JIT, and TPM will result in higher performance than implementation of practices and techniques from only one of them.
(Shah & Ward, 2003)	Lot size reduction, cycle time reduction, quick changeover techniques, cellular layout, reengineering production processes, and bottleneck removal	Operational performance measured by a 6-item scale. The items include 5-year changes in manufacturing cycle time, scrap and rework costs, labor productivity, unit manufacturing costs, first pass yield, and customer lead time	- Organizational context, i.e. plant size, unionization and plant age, matters with regard to implementation of lean practices - Combined JIT practices are associated with higher performance. They explain 23% of the variation of operational performance
(Swink et al., 2005)	Lot-size reduction, set-up time reduction, facility layouts to promote smooth flow, and pull or kanban-based production systems	Market-based performance measured by a 3-item scale: profitability, market share of major product/product line, and unit growth rate in sales	- JIT flow practice is significantly associated with process flexibility and with new product flexibility, but only when strategy integration is strong - Strategy integration and enhanced manufacturing cost efficiency and flexibility serve as means by which practices affect market performance - Manufacturing practices are mostly effective only when high levels of strategy integration complement them - Strategy integration serves as a basis for improved cost efficiency and new product flexibility, which in turn lead to better performance in the marketplace

Source: Author

JIT impacts a company positively because its practices allow companies to increase their flexibility and deliver faster, which generate competitive advantage (Koufteros, Vonderembse, & Doll, 1998). For example, small batch sizes reduce the number of defects by allowing close control of the production, which consequently reduces the costs of scraps and rework (Sakakibara et al., 1997). Furthermore, set-up time reduction leads to small batch sizes, which, in turn increases flexibility and reduces the need for inventories (Koufteros et al., 1998). It follows then that companies with greater flexibility respond better to change in demand, which impacts their market share and decreases the need for inventories. The latter makes the storage costs go down, improving the overall company performance.

Studies have shown the positive impact of JIT practices on performance. For example, Flynn et al. (1995) found a positive relationship between JIT and performance. Cua et al. (2001) found that JIT practices are positively associated with cost and delivery performances and to a lesser degree, with quality performance. Likewise, Shah and Ward (2003) argued that combined JIT practices are associated with higher performance. Taking the aforementioned into account; we argue that there is a positive relationship between JIT practices and operational performance. Below, the hypothesis for each operational performance is stated.

H5. There is a positive relationship between JIT practices and quality performance.

H6. There is a positive relationship between JIT practices and delivery performance.

H7. There is a positive relationship between JIT practices and flexibility performance.

H8. There is a positive relationship between JIT practices and cost performance.

2.2.3. Customer orientation

Customer orientation is defined as the practice of putting customers' interests first (Deshpandé, Farley, & Jr, 1993) in order to create superior value (Slater & Narver, 2000). More specifically, customer orientation deals with the understanding of the current and future customer needs and the company's ability to respond to them (Ellis, 2006). Kohli & Jaworski (1990) divided customer orientation into three parts: (1) generation of information concerning current and future customer needs; (2) dissemination of this information throughout the organization; and (3) responsiveness to customer requirements. According to Kohli &

Jaworski (1990), the generation of information is the first step for customer orientation in the way that it brings to the company the exogenous factors that affect customer desires. Afterward, the dissemination of information through different areas of the organization share the basis for actions, and responsiveness is the actions the company takes by, for example, designing and offering products/services corresponding to the current or anticipated customer desires.

Some customer orientation practices found in the literature are: awareness of customer requirements, dissemination of customer information, measure customer satisfaction, quick response to complaints, timely information to customers, and so on. Table 2.3 shows more details about customer orientated practices. A noteworthy point is that the prevalent literature concerning customer orientation is from marketing research. As pointed out by Deshpandé et al. (1993), customer orientation can be viewed as synonymous with market orientation.

Table 2.3 – Customer orientated practices

Study	Customer orientation practices	Performance operationalization	Main findings
(Samson & Ford, 2000)	- Know our customer requirements - Customer requirements disseminated - Use domestic customer requirements in design - Use overseas customer requirements in design - Design products to match our capabilities - Have a process to resolve customer complaints - Use complaints to initiate improvements - Measure customer satisfaction	Cost performance, lead times, teamwork, quality, overall performance	New Zealand, that presented higher levels of implementation of manufacturing practices like customer orientation, also presented better results for cost performance, defect rates, and overall performance
(Yusuff, 2004)	- Customers are provided with timely information - Complaints are answered quickly - Corporate goal to reduce number of complaints and all successful efforts in providing outstanding services are recognized.	Annual sales, annual exports, product variety, annual expenses, R&D investment, market share, investment in new technologies, overall performance, and annual profit and loss	The authors did not find any impact of best practices on organizational performance due to the small sample size
(Deshpandé, Farley, & Jr, 1993)	- Measurements of customer service - Products based on customer information - Knowledge of competitors - Company's aware of customer evaluation of products and services - More customer oriented than competitors - Competition based on product	Market share, profitability, growth rate, and size of a business in relation to its most significant competitors	- The marketers' customer orientation as reported by customers is related positively to business performance - the customers perceptions are significantly more important than the marketers' own perceptions

	or service differentiation - Customer's interest comes first - Company's products/services are the best in the business - The business exists primarily for serving customers		
(Pelham & Wilson, 1995)	- All functions are responsive to serving target markets - Customer understanding orientation - Managers' understanding for creating customer value - Customer satisfaction orientation - Market strategy directed to creating value for customers - Communication of customers, marketing success, and marketing failures - Strengths and weaknesses discussed by top managers - Competitor orientation	**New product success:** - New product/service development - Market development **Growth/share:** - Sales growth rate - Employment growth rate - Market share **Profitability:** - Operating profits - Profit to sales ratio - Cash flow from operations - Return on investment - Return on assets **Relative product quality (single measurement):** - Rate of relative product quality	- Market orientation is the only variable to significantly influence the perceived level of relative product quality - Marketing orientation significantly and positively influences increases in new product success - Market orientation is also a significant positive influence on current levels of new product success, with other independent variables - The impact of market orientation on growth share is indirect through new product success - Market orientation significantly and positively influences increases in profitability for small firms
(Slater & Narver, 2000)	- Customer orientation: customer commitment, create customer value, understand customer needs, customer satisfaction objectives, measure customer satisfaction, after-sales service - Competitor orientation: share of competitor information, respond rapidly to competitors' actions, top managers discuss competitors' strategies, target opportunities for competitive advantage - Interfunctional coordination: information shared among functions, functional integration in strategy, all functions contribute to customer value	Return on investment of the business over the past 3 years relative to the primary competitors in the principal market	- Market orientation and business profitability are positively related - Robustness of the results because the relationships remained at the same level as in the study conducted by the same authors in 1990
(Ellis, 2006)	- Narver and Slater’s (1990) MKTOR scale - Kohli et al.’s (1993) MARKOR scale	- Business-level performance was defined as any generic, financial indicator applicable at the level of the firm (e.g. profits, ROI/A, sales growth, cash-flow) - Market-specific performance was defined with reference to specific product markets (e.g. market share, new product performance, brand awareness, customer satisfaction or loyalty)	The study corroborates the relationship between market orientation and performance. Moreover, it is found that market orientation is significantly affected by the cultural and economic characteristics depending on the country in which it is implemented
(Kohli & Jaworski, 1990)	Related to intelligence generation, intelligence dissemination, and responsiveness	Not developed	Virtually all the executives interviewed noted that a market orientation enhances the

	performance of an organization

Source: Author

The benefits of implementing customer orientation practices are pointed out by Pelham & Wilson (1995). They argue that companies with a good understanding of their customers are more likely to reduce the incidence of new product failures, and retain their customers by monitoring their satisfaction and reactions. Moreover, the authors found that a high level of customer orientation can create competitive advantage for small firms.

Indeed, many studies have shown the relationship between customer orientation and performance. For example, Samson and Ford (2000) found that higher levels of practices, like customer orientation, lead to better cost performance. Slater and Narver (2000), in a replication study, found that customer orientation is positively related to business profitability. The exception is the study by Yusuff (2004) that did not find a relationship between best practices (including customer orientation) and performance, but, as the author noted, it was probably because of the small sample. In general, the results point out that there is a positive effect for companies that use customer orientation practices. Since customer orientation is a practice based on marketing, few studies have shown a relationship between customer orientation and operational performance (i.e. Pelham & Wilson, 1995; Samson & Ford, 2000). We then extend some previous works by testing the relationship between customer orientation practices and operational performance. Taking the aforementioned into account, we develop the following hypotheses:

H9. There is a positive relationship between customer orientation practices and quality performance.

H10. There is a positive relationship between customer orientation practices and delivery performance.

H11. There is a positive relationship between customer orientation practices and flexibility performance.

H12. There is a positive relationship between customer orientation practices and cost performance.

2.2.4. Integrated product development practices

Integrated product development is defined as a managerial approach for developing new products through the overlapping of activities and exchange of information among different areas involved in the new product development process (NPD) (Gerwin & Barrowman, 2002). According to Koufteros, Vonderembse, and Doll (2002), successful firms assign heavyweight product development manager, who is responsible for reorganizing the development of products from a sequential process to a concurrent process in which marketing, product engineering, process engineering, manufacturing planning, and sourcing activities overlap.

The overlapping activities are accomplished through integrated product development practices. For example, Koufteros, Vonderembse, and Jayaram (2005) argue that concurrent engineering is a practice that involves cross functional teams for planning process design, product design, and manufacturing activities simultaneously. Other integrated product development practices are supplier involvement in product development, customer integration and so on. Table 2.4 shows more details regarding these practices.

Table 2.4 – Integrated product development practices

Study	Integrated product development practices	Performance operationalization	Main findings
(Gerwin & Barrowman, 2002)	- NPD process: overlap and interaction tools; formal methods; development time; goal failure - Product definitions: incremental approach; development time; goal failure - Organizational context: broad tasks; development time - Teaming: cross-functional team; development time; goal failure; team head's influence	Project performance: development time and goal failure	- Overlap and/or interaction appears to be a very efficacious characteristic - Integrated tools and formal methods improve both performance measurements - Broadening tasks does not seem to reduce development time - The teaming category suggests that using cross-functional teams may reduce goal failure - The team leader's organizational influence is effective in reducing both performance measurements in a broad range of situations
(Koufteros, Vonderembse, & Doll, 2002)	- Heavyweight product development managers - Concurrent engineering - Computer use	- Product innovation: unique features; developing new products and features; developing a number of “new” features - Quality: offering products that function according to customer needs over a reasonable lifetime; offering a high-value product to customers; offering safe-to-use products that meet customer needs; offering reliable products that meet	- There is a significant impact of concurrent engineering on quality - Higher computer use was associated with higher levels of product innovation - There is a negative relationship between the use of computers and quality - Product innovation presented a statistically significant negative effects on quality

		customer needs; offering durable products that meet customer needs; offering quality products that meet customer expectations; offering high performance products that meet customer needs - Premium price: selling at price premiums; selling at prices above average; selling at high prices that only a few firms can achieve	
(Koufteros, Vonderembse, & Jayaram, 2005)	- Concurrent engineering - Customer integration - Supplier product integration - Supplier product integration	- Product innovation: developing unique features; developing new products and features; developing a number of new features; developing a number of new products - Quality: offering products that function according to customer needs over a reasonable lifetime; offering a high value product to the customers; offering safe-to-use products that meet customer needs; offering reliable products that meet customer needs; offering durable products that meet customer needs etc. - Profitability: profitability relative to the average in the industry	- Higher levels of concurrent engineering were associated with higher levels of customer integration and higher levels of both supplier product integration and supplier process integration - Customer integration had a statistically significant positive relationship with product innovation - Customer integration exhibited a statistically moderate effect on quality - Supplier product integration showed a statistically moderate effect on quality - Higher levels of product innovation were associated with higher levels of quality - There is a positive relationship between quality and profitability

Source: Author

The literature pointed out many benefits of implementing integrated product development practices. Sakakibara et al. (1997) argue that design for manufacturability and reliability engineering practices are practices crucial for reduction of inventory buffers and to shortening throughput time. More generally, Koufteros et al. (2002) pointed out that integrated product development practices allow firms to attend customer demands faster through innovative products, and it also help firms in creating cross-functional competencies, enhancing flexibility, and share knowledge.

Empirical results pointed in the same direction. Koufteros et al. (2002) found that concurrent engineering had a significant impact on quality performance, and that the use of the computer is associated with higher product innovation. Koufteros et al. (2005) found that supplier product integration and customer integration had a moderate impact on quality performance. Therefore, we state that integrated product development practices have a positive impact on operational performance according to the following hypotheses:

H13. There is a positive relationship between integrated product development practices and quality performance.

H14. There is a positive relationship between integrated product development practices and delivery performance.

H15. There is a positive relationship between integrated product development practices and flexibility performance.

H16. There is a positive relationship between integrated product development practices and cost performance.

2.2.5. Supplier relationship practices

Supply chain management is defined as the strategic co-ordination within or across organizations for enhancing the long term performance of the company as well as the entire supply chain (Mentzer et al., 2001). More specifically, supply management shows how a company co-ordinates its manufacturing, logistics, materials, distribution and transportation function from the source to customer through supply processes, technologies and capabilities (Tan, Kannan, Handfield, & Ghosh, 1999).

The activities involved in the co-ordination of the supply chain are accomplished through supply chain management practices (Li, Rao, Ragunathan, & Ragunathan, 2005). Such practices stimulate a closer relationship with selected suppliers by information sharing, long-term relationships, certification and training, and co-operative investments (Swink et al., 2005). According to Krause, Scannell, & Calantone (2000) some of these practices are: supplier assessment, rewards for suppliers for improved performance, stimulating competition among suppliers, and direct involvement in suppliers, such as personnel training. Table 2.5 presents more details regarding supply chain practices.

Table 2.5 – Supplier relationship practices

Study	Supplier relationship management practices	Performance operationalization	Main findings
(Choi & Hartley, 1996)	- Finances: Financial conditions, profitability of supplier, financial records disclosure, performance awards - Consistency: Conformance quality, consistent delivery, quality philosophy, prompt response - Relationship: Long-term relationship, relationship closeness, communication openness, reputation for integrity	Not developed	- In selecting suppliers based on the potential for a co-operative, long-term relationship, it is important to have ones that are direct and indirect suppliers - Price is one of the least important selection items, regardless of position in the supply chain

	- Flexibility: Product volume changes, short set-up time, short delivery lead time, conflict resolution - Technological capability: Design capability, technical capability Service: After-sales support, sales rep competence - Reliability: Incremental improvement, product liability - Price: Low initial price		- Quality and delivery in the context of supplier selection are part of the same underlying construct - Auto assemblers place a higher level of importance on technological capability and financial considerations than indirect suppliers when selecting suppliers
(Tan, Kannan, Handfield, & Ghosh, 1999)	- Commodity management teams set the level of cost, quality and lead time for the supplier - Local plant managers are given authority to execute purchase orders and daily supply flows - Low volume, low-cost materials are handled by individual plant staff based on local needs - The company has a quality-assurance (certified) program for our supplier's specific product - The company has a quality-assurance program for our supplier's manufacturing process - The company takes advantage of supplier-provided technical support and test capabilities - Manufacturing personnel regularly visit our supplier's facility - Suppliers receive changes to our specification after we develop a new product design - Share of sensitive information with company's suppliers - There are annual negotiations to establish the price for key-input items from the company's suppliers	- Market share - Return on total assets (ROA) - Average annual market share growth (over the past three years) - Average annual market sales growth (over the past three years) - Average annual growth in return on total assets (over the past three years) - Average production cost - Overall customer service levels - Overall product quality - Overall competitive position	- There is evidence that competitiveness can be compromised if management fails to adequately analyze the competitive environment - Industry competitiveness correlates positively with overall performance - Managing the supply base has a significant impact on growth, but not on overall performance - Evaluating suppliers and involving them in the decision-making process are both positively related to growth and ROA
(Krause, Scannell, & Calantone, 2000)	- Direct involvement: Site visits by the company to supplier's premises to help supplier improve its performance, training/education of the supplier's personnel - Supplier incentives: Promise of current benefits, promise of future business - Competitive pressure: Use of more than one supplier for creating competition among suppliers, quality is the first priority, but, when necessary, the suppliers have to cut costs - Supplier assessment: Assessment of supplier's performance, providing supplier with feedback	Performance improvement: the supplier development effort has contributed to increasing the company's product/service sales, expectation of supplier's improvement to help the company, supplier development effort has helped improve the company's product/service quality	- The supplier incentives strategy has a direct and positive impact on direct involvement - The supplier incentives strategy has an indirect and positive impact on performance improvement mediated by direct involvement - The supplier assessment strategy has a direct and positive impact on direct involvement - The supplier assessment strategy has an indirect positive impact on performance improvement mediated by direct involvement
(Li, Rao, Ragunathan, & Ragunathan, 2005)	- Strategic supplier partnership: quality as the number one criterion in selecting suppliers, solve problems jointly with suppliers, help suppliers to improve their product quality etc. - Customer relationship: frequent interaction with customers to set reliability, responsiveness, and other standards for the company, frequently measure and evaluate customer satisfaction etc. - Information sharing: inform trading partners in advance of changing needs,	- Delivery dependability: deliver the kind of products needed, deliver customer order on time, provide dependable delivery - Time to market: deliver product to market quickly, first in the market in introducing new products, time-to-market lower than industry average, fast product development	- Organizations with high level of supply chain practices have better performance in term of delivery performance to commit date, supply chain response time, cash-to-cash cycle time, inventory days of supply, and net asset turns - Moreover, supply chain practices are associated with a 2% increase in fill rate, a 4% increase in perfect order fulfillment, a 27% decrease in

	trading partners share proprietary information etc. - Information quality: information exchange among company's trading partners and the company is timely, accurate, complete, adequate, and reliable - Internal lean practices: reduce set-up time, continuous quality improvement, pull production system, require shorter lead times from suppliers, and streamline ordering - Postponement: products are designed for modular assembly, production process modules can be re-arranged, delay final product assembly activities for customer orders and last possible position, and goods are stored at appropriate distribution points		order fulfillment lead time, and an 83% increase in product flexibility
(Li et al., 2006)	Same scale of (Li, Rao, Ragunathan, & Ragunathan, 2005)	**- Competitive advantage:** - Price/cost - Quality - Delivery dependability - Product innovation - Time to market - **Organizational performance:** - Market share, return on investment, growth of market share, growth of sales, growth on return of investment, profit margin on sales, overall competitive position	- Organizations with high levels of supply chain practices have high levels of organizational performance - Supply chain practices have a direct impact on competitive advantage - Higher levels of competitive advantage may lead to improved organizational performance - Supply chain practices had a greater direct impact on competitive advantage than on organizational performance
(Kim, 2006)	- Technical initiative: advanced management and manufacturing technology, nationwide information network - Structural initiative: formalization of supply chain organization, executive program for supply chain management, human resource management - Logistical initiative: logistics infrastructure, close location to suppliers and customers	**- Competition capability:** - Cost leadership - Customer service - Innovative marketing technology - Differentiation **- Firm performance:** - Market performance - Financial performance - Customer satisfaction	- The results indicated that supply chain practices had a significant influence on competition capability - Supply chain practices and competition capability have statistically significant influences on supply chain integration, and supply chain integration had a significant effect on firm performance - For large firms, supply chain practices and competition capability have significant direct effects on firm performance
(Zhou & Benton jr, 2007)	- Supply chain planning: the use of historical data in the development of forecasts; ‘‘what-if’’ analysis has been implemented for supply/demand balancing; a change in the demand information instantaneously ‘‘reconfigures’’ the production and supply plans etc. - Just-in- time (JIT) production: pull system; cellular manufacturing; cycle time reduction; agile manufacturing strategy; bottleneck/constraint removal - Delivery practice: delivery of products to major customer on a just-in-time basis; single point of contact for all order inquiries; real time visibilities of order tracking; consolidation of orders by	Delivery performance: on-time delivery, perfect order fulfillment rate, and delivery reliability/dependability	- Effective information sharing enhances effective supply chain practice - Supply chain dynamism does have positive influence on supply chain practice - Effective information sharing mediates the impact of supply chain dynamism on supply chain practice - Among the three groups of supply chain practice, only delivery practice has a significant positive influence on delivery performance

	customers; sources, carriers, etc.; usage of automatic identification during the delivery process to track order status

Source: Author

Suppliers can have either a negative or positive impact (Krause et al., 2000). According to Krause et al. (2000), if a company is able to select and/or develop good suppliers, it can create competitive advantage. For example, Zhou & Benton jr (2007) argued that supply chain planning gives accuracy to the forecast demand, the company being able to attend customer needs in a timely manner. Likewise, Li et al. (2005) mentioned that strategic supplier partnerships can reduce time to market and customer responsiveness, information sharing can improve deliveries and help in the introduction of new products, and postponement can increase flexibility and balance the global efficiency of the supply chain.

Some researchers have showed positive relations between supply chain practices and performance. Tan et al. (1999) found that evaluating suppliers and involving them in the process made them have a positive impact on growth and on the return on assets. Li et al. (2005) showed that companies with higher levels of supply chain practices presented better delivery performance. By the same token, Zhou & Benton jr (2007) found that delivery practice, one component of supply chain practices, has a significant positive influence on delivery performance. This research extends the previous literature by testing the relationship of supply chain practices and the common operational performance separately (quality, delivery, flexibility, and cost). Therefore, based on the aforementioned, we develop the following hypothesis:

H17. There is a positive relationship between supplier relationship practices and quality performance.

H18. There is a positive relationship between supplier relationship practices and delivery performance.

H19. There is a positive relationship between supplier relationship practices and flexibility performance.

H20. There is a positive relationship between supplier relationship practices and cost performance.

2.2.6. Workforce development practices

Workforce practices deal with the development of human resources, which are the most important asset of an organization (Ahmad & Schroeder, 2003). These practices are aimed at improving employees' skills through the development and acquisition of the company's human capital (Huselid, 1995; Swink et al., 2005). According to Flynn, Sakakibara, and Schroeder (1995) workforce management comprises the investments in selective hiring, training and development, and retention. For Youndt, Snell, Dean, and Lepak (1996) this investment is justified only when improving employees' skills brings greater returns through productivity. Then, according to the authors, "the higher the potential for employee contribution in a firm, the more likely it is that the firm will invest in human capital" and this investment will increase productivity leading to higher organizational performance.

Some workforce practices are related to the development of other practices like JIT (Flynn et al., 1995; Sakakibara et al., 1997), and total quality management (TQM) (Flynn et al., 1995). In this work, we focus more on researches that treat workforce practices separately. Practices commonly found in the literature are: selection, training, performance appraisal and so on. Table 2.6 shows more details of the operationalization of workforce practices.

Table 2.6 – Workforce development practices

Study	Workforce development practices	Performance operationalization	Main findings
(Huselid, 1995)	- Employee skills and organizational structures: proportion of the workforce included in a formal information sharing program; proportion of the workforce whose jobs have been subjected to formal job analysis; proportion of non-entry level jobs have been filled from within in recent years etc. - Employee motivation: proportion of the workforce whose performance appraisals are used to determine their remuneration; proportion of the workforce that receives formal performance appraisals; promotion decision rules; qualified applicants per position	- Turnover: average annual rate of turnover - Productivity: sales per employee - Corporate financial performance: market-based measurement; gross rate of return on capital	- Employee skills and organizational structures scale was negatively related to turnover, while both scales were positively related to productivity and corporate financial performance - Companies with high performance work practices showed shorter rates of turnover - There is a reasonable increment of productivity for increasing the level of work practices - Employee skills and organizational structures were positive and significantly related to gross rate of return on capital but not with employee motivation
(Youndt, Snell, Dean, & Lepak, 1996)	- Staffing practices: selectivity in hiring; selection for manual and physical skills; selection for technical skills; and selection for problem-solving skills - Training practices: comprehensiveness; policies and procedural training; training for technical skills; and training for	- Machine efficiency: equipment utilization; scrap minimization - Customer alignment: product quality; on-time delivery - Employee productivity: employee morale; employee productivity	- Human resource system focused on enhancing human capital is a valuable approach for strengthening operational performance in manufacturing - Greater performance appears to depend on properly aligning HR systems with manufacturing strategy

	problem-solving skills - Performance appraisal practices: developmental focus; results-based appraisal; and behavior-based appraisal - Compensation systems: hourly pay; salary; skill-based pay; individual incentives; group incentives; individual equity; and external equity		
(Jayaram, Droge, & Vickery, 1999)	- Top level management commitment - Communication of goals - Employee training - Cross-functional teams - Cross training - Employee autonomy - Employee impact - Broad jobs - Open organizations - Effective labor management relations	Cost reduction, quality, flexibility, and time-based competition	- Top management commitment was significantly correlated to time - Communication of goals was significantly correlated to flexibility - Employee training was significantly correlated to flexibility - Human management practices are grouped according to the strategic dimensions they are meant to support - For cost, flexibility and time, each human resource factor was consistently related to performance in its respective performance dimension - The generic human resource factor was only related to time-based performance
(Kathuria & Partovi, 1999)	- Relationship-oriented practices: e.g.: networking; team building; supporting; mentoring; inspiring; recognizing; and rewarding - Participative leadership and delegation practices such as: consulting and delegating - Work-oriented practices: planning, clarifying, problem solving, monitoring and informing	- Accuracy of work - Quality of work - Productivity of the group - Customer Satisfaction - Operating Efficiency - Quantity of work - Timeliness in meeting delivery schedules	- There is a significant positive relationship between relation-oriented practices and managerial performance in the sample with high emphasis on flexibility - A significant positive relationship was found between participative leadership and delegation practices and managerial performance in the sample with high emphasis on flexibility
(Ahmad & Schroeder, 2003)	- Employment insecurity - Selective hiring: 1. Manufacturing and human resources fit 2. Behavior and attitude - Use of teams and decentralization: 1. Team activities 2. Interaction facilitation - Compensation/incentive contingent on performance: 1. Contingent compensation 2. Incentives to meet objectives - Extensive training: 1. Training on job skills 2. Training in multiple functions - Status differences - Sharing information: 1. Communication of strategy 2. Feedback on performance	- Cost: unit cost of manufacturing - Quality: quality of product conformance - Delivery: on-time delivery performance - Flexibility: flexibility to change volume - NPD speed: speed of new product introduction	- Human resource practices vary widely by country and to some extent by industry - Employment insecurity and status difference seem to hinder the development of other human resources practices - Operational performance is significantly related to selective hiring, use of self-managed teams and decentralization, use of compensation contingent on organizational performance, the extent of training, and sharing of information
(Collins & Clark, 2003)	**- Incentive pay:** - Top management team (TMT) members' variable pay is based on how well the company as a whole is performing - The use of multiple incentives to attract top candidates for the TMT - The majority of TMT members'	Sales growth and stock performance	- A positive significant relationship was found between the set of network-building human resource practices and sales growth and stock performance - Human resource practices for TMT network development appear to affect firm performance through

	pay is based on variable remuneration - Incentive-based pay for the TMT is based on how well the company is performing as a whole **- Network-building HR practices:** - TMT members are provided expense accounts for developing job-related personal contacts - TMT members have received training to develop personal relationships with key internal stakeholders - TMT members are evaluated on their ability to develop relationships with employees across different areas of the firm - The TMT frequently discusses strategies for developing personal relationships with key external stakeholders and others	TMT external and internal social networks

Source: Author

Many authors recognized the benefits of implementing workforce practices. For example, Sakakibara et al. (1997) found that small group problem-solving activities support production-related problems, improving cycle time and reducing waste. By the same token, Swink et al. (2005) stated that problem-solving capabilities are likely to increase work flexibility, which, in turn, increases process flexibility. Youndt et al. (1996) argued that continuous improvement requires practices, like employee feedback, and Huselid (1995) showed that recruiting and selective hiring practices have a considerable impact on the quality of skills new employees will possess.

Since the focus of this study is to assess the relationship between workforce practices and specific operational performance, we also analyze the results of previous researches. According to table 2.6, Huselid (1995) found that the workforce levels positively impacts productivity. Youndt et al. (1996) showed that greater performance is accomplished as long as workforce practices are aligned to manufacturing strategy. In other words, companies that are, for example, seeking to reduce costs, should implement the right workforce practices. Indeed, some studies showed the specific relationship between workforce practices and operational performance. For example, Jayaram, Droge, and Vickery (1999) found that communication of goals and employee training were significantly correlated to flexibility performance. In order to extend this line of research, we state the following:

H21. There is a positive relationship between workforce development practices and quality performance.

H22. There is a positive relationship between workforce development practices and delivery performance.

H23. There is a positive relationship between workforce development practices and flexibility performance.

H24. There is a positive relationship between quality workforce development and cost performance.

2.2.7. Leadership practices

Leadership is defined by specific characteristics of a leader. More specifically, Horner (1997) argued that leadership is related not only to traits, qualities and behaviors, but also stated that there is no consistent definition due to the breadth of the subject. For some authors, leadership is crucial for implementing quality management practices (Kaynak, 2003; Samson & Terziovski, 1999). For example, Samson and Terziovski (1999) pointed out that leadership helps in enhancing individual performance and organizational learning.

Practices related to leadership deal mostly with the involvement of management teams in the strategic activities, motivating employees to accomplish company goals, and interacting with the team, receiving suggestions and ideas to improve productivity. Table 2.7 shows more details of the leadership practices.

Table 2.7 – Leadership practices

Study	Leadership practices	Operationalization of performance	Main findings
(Samson & Terziovski, 1999)	- Senior managers actively encourage change and implement a culture of trust, involvement and commitment in moving towards 'Best Practice' - There is a high degree of unity of purpose throughout our site, and we have eliminated barriers between individuals and/or departments - 'Champions of change' are effectively used to drive 'Best Practice' at the plant - The company proactively pursues continuous improvement rather than reacting to crisis' 'fire-fighting' - Ideas from production operators are actively used in assisting management - Environmental 'green' protection issues are proactively managed at the plant	Organizational performance: Customer satisfaction, employee morale, productivity, defect as % of product volume, warranty claims as a % of total sales, cost of quality (error, scrap, rework and inspection) as a % of total sales, and delivery in full on-time to customers	Leadership practices had a positive significant effect on performance
(Samson & Ford, 2000)	- Management encourages trust and involvement - The elimination of barriers - Uses champions of change - Proactively pursues continuous improvement - Shop floor ideas used by management	Cost performance, lead times, teamwork, quality, overall performance	New Zealand, that presented higher levels of implementation of manufacturing practices, like leadership, also presented better results for cost performance, defect

			rates, and overall performance
(Kaynak, 2003)	- Extent to which the top business unit/organization executive assumes responsibility for quality performance - Acceptance of responsibility for quality by major department heads within the organization - Degree to which the organization's top management is assessed for quality performance - Extent to which the organization's top management supports long-term quality improvement processes - Degree of participation by major department heads in the quality improvement process - Extent to which the organizational top management has objectives for quality performance - Specificity of quality goals within the organization - Comprehensiveness of the goal-setting process for quality within the organization - The understanding of quality goals and policy Importance attached to quality by the organizational top management in relation to cost and schedule objectives - Amount of review of quality issues in organizational top management meetings - Degree to which the organization's top management considers quality improvement as a way to increase profit - Degree of comprehensiveness of the quality plan within the organization	- Inventory management performance (purchase material turnover, and total inventory turnover) - Quality performance (productivity/service quality, productivity, cost of scrap and rework, delivery lead-time of purchased materials, and delivery lead-time to customers) - Financial and market performance (ROI, sales growth, profit growth, market share, and market share growth)	- A direct effect of leadership practices on performance was not found but it was directly related to other practices, like training, employee relations, supplier quality management, and product design, and indirectly related to quality data and reporting, and process management - Moreover, leadership by management also indirectly affects firm performance through the mediating effects of the other practices of TQM

Source: Author

The literature has shown contrasting results. On the one hand, Samson & Terziovski (1999) found that leadership practices, like trust, commitment, and involvement, were positively related to organizational performance. By the same token, Samson and Terziovski (1999) showed that leadership practices had a positive impact on cost performance. On the other hand, Kaynak (2003) did not find a direct effect of leadership practices on performance. In order to shed some light on this topic, we test hypotheses that relate leadership practices to specific operational performance. In doing so, this research illustrates the contingency effect of this kind of practices. Thus, the following is hypothesized:

H25. There is a positive relationship between leadership practices and quality performance.

H26. There is a positive relationship between leadership practices and delivery performance.

H27. There is a positive relationship between leadership practices and flexibility performance.

H28. There is a positive relationship between leadership practices and cost performance.

2.3. Resources

Resources are all assets (intangible and tangible) controlled by a company that enable it to implement its strategies (Barney, 1991; Wernerfelt, 1995). Barney, (1991) divides a company’s resources into three categories: (1) physical resources comprising the plant and equipment, location, physical technology, and access to raw material; (2) human resources that are related to training, experience, intelligence, judgment, relationships, and insight of individual managers and workers in the company; and (3) organizational resources that are the formal reporting structure of the company: its planning, control and co-ordinating systems; and the relationships among groups within the company, between it and other companies and with the environment.

For operations management, resources must be properly used, otherwise they will be wasted in activities that do not strengthen the company’s position in the market (Hayes & Wheelwright, 1984). Thus, the ability of managing resources in operations becomes crucial. Indeed, the success of operations can be measured by “the effectiveness with which it utilizes the various kinds of assets entrusted to it: facilities, technologies and skills” (Hayes & Wheelwright, 1984). Companies that are leaders in their market treat resources as opportunities to strengthen their competitive advantage. Such companies develop proprietary equipment, make efforts to anticipate new manufacturing practices and technologies, and pursue capabilities in advance of their needs (Hayes & Wheelwright, 1984). For this work, the resources are: proprietary equipment, technology and human resources.

Proprietary equipment means the development of equipment by the plant, which could be patented or not, that helps the company to increase its performance (Schroeder et al., 2002). Moreover, proprietary equipment is developed to meet the specific needs of the plant (Hayes & Wheelwright, 1984). For example, Hayes and Wheelwright (1984) found that Japanese companies have modified their machines by making them smaller and more flexible in order to better meet the market demand. Furthermore, they also state that companies that develop their own equipment have the machines at their disposal, and therefore are not subjected to the constraints of equipment producers. Proprietary equipment can lead to better performance because it is difficult to imitate in the short term, and it is related to casual ambiguity (Schroeder et al., 2002). Therefore, we state the following hypotheses:

H29. There is a positive relationship between proprietary equipment and operational performance.

Technology refers to “the total ‘system’ of resources and organizational capabilities that are brought to bear to produce the firm’s products and services” (Hayes & Wheelwright, 1984). Manufacturing technology is considered a crucial resource for the success of the company, because it helps to improve performance (Hayes & Wheelwright, 1984). For example, Hayes and Wheelwright (1984) argue that, through technology, companies can develop better production processes and methods that might improve productivity (lower costs of production). Additionally, technology “is viewed as a set of overall capabilities that are vital to the company’s success. They are a valued source of future growth and competitive advantage, equal in importance to marketing and financial capabilities” (Hayes & Wheelwright, 1984). Therefore, we propose the following hypothesis:

H30. There is a positive relationship between technology and operational performance.

Human resources are defined as the organizational commitment that the employees have to the company. Organizational commitment comprises the identification and participation of the employee in a certain company (Mowday, Steers, & Porter, 1979). More specifically, as stated by Mowday, Steers, & Porter (1979), organizational commitment can be characterized by three factors: “(1) a strong belief in and acceptance of the organization’s goals and values; (2) a willingness to exert considerable effort on behalf of the organization; and (3) a strong desire to maintain membership in the organization.”

Organizational commitment was chosen as a human resource because it embraces the definition of resources by Barney (1991) and Wernerfelt (1995). In other words, organizational commitment involves employees who are managed by the company, and their disposition towards participation in the activities that support the company’s strategy. As stated by Hayes and Wheelwright (1984), employees are the link between the strategy and the tactics that are necessary for its implementation. Therefore, we argue that:

H31. There is a positive relationship between human resources and operational performance.

The hypotheses formulated to test the relationship between resources and operational performance, is done using performance as one factor putting together quality, delivery, flexibility and costs. We do this for examining the impact of RBV on the perspective of cumulative capabilities. In other words, we test whether resources that are valuable, non-imitable, rare, and non-substitutable support the development of integrated operational performance.

We also argue that resources alter the relationship between operational practices and performance. For example, companies with cutting-edge technology are more likely to have positive results implementing operational practices than companies with low levels of technology. Tracey, Vonderembse, and Lim (1999) stated that technology enables companies to deal more effectively with practices related to customer orientation, and this leads to better performance. Additionally, Kaynak (2003) argued that committed employees are crucial for implementation of changes in the company; it is by such commitment that workers contribute more to higher productivity. Thus, with some resources, operational practices are more effectively implemented, leading to better performance. Therefore, we propose the following:

Moderating hypothesis: Resources moderate the relationship between operational practices and performance.

2.4. Operational performance

Operational performance is the level of achievement of the competitive priorities set by the company (Schroeder et al., 2011). Neely, Gregory, & Platts (2005) define performance measurement as "the process of quantifying the efficiency and effectiveness of action". Then, the performance of the manufacturing area serves as a measurement of whether the company has realized its intended operations strategy or not. Consequently, the operational performance becomes crucial for assessing how operations are supporting the overall business objectives.

We assess operational performance by quality, delivery, flexibility, and cost according to the scale developed by Schroeder et al. (2011). Quality is measured by conformance to product specifications, performance and capacity (Neely et al., 2005). Delivery is measured by inventory turnover and the cycle time from raw materials to delivery. Flexibility is the capacity of changing the volume and mix of products. Finally, cost is measured by the costs per unit. Thus, operational performance will measure the role of resources and operational practices in supporting the competitive priorities pursued by the firm.

We also assess operational performance by joint performances. According to Ferdows and De Meyer (1990) plants can achieve competitive advantage by focusing on different operational performances simultaneously. Indeed, some authors found that, companies that pursue the strategy of multiple performances develop greater results than only focusing on one performance (Corbett & Whybark, 2001; Kathuria, 2000; Mapes, Szwejczewski, & New, 2000; Noble, 1995). Thus, as aforementioned, we use the cumulative performance model to test its relationship with strategic resources.

3. METHODOLOGY

The methods employed include confirmatory factor analysis and multiple regressions. We use SPSS version 20 for the descriptive statistics and multiple regressions. Confirmatory factor analysis was carried out using AMOS 15. In this section, we present the research model, discuss the procedures used for data collection, how the constructs were measured, validation of the model and so on.

3.1. Research model

According to the aforementioned hypotheses, figure 3.1 illustrates the research model. We argue that operational practices are positively related to operational performance and that this relation is altered in the presence of resources. Moreover, we argue that resources have a positive direct relationship with operational performance. For each operational performance, all operational practices and resources measurements are regressed. In doing so, we are able to specifically identify the practices that are related to each operational performance and the impact of resources on operational performance. Reasonably, for the moderator effect, we only present the hypotheses that are confirmed.

In the appendixes, we show the details regarding the items composing the operational practices and performance, and resources.

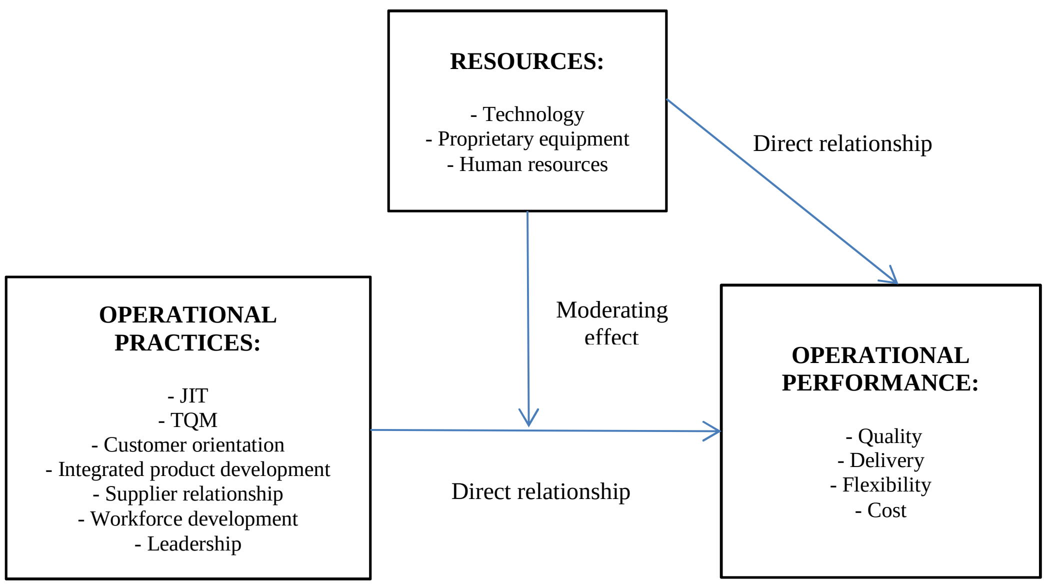

Figure 3.1 – Research model

Source: Author

3.2. Data collection

The data was collected via written questionnaires of the High Performance Manufacturing project (HPM). The HPM was initiated in 1989 with the objective of comparing companies from the USA and Japan (Schroeder & Flynn, 2001), and, nowadays, it includes more than 10 countries. The HPM is co-ordinated by the researchers, Barbara Flynn (Indiana University) and Roger Schroeder (Minnesota University). The main purpose of this project is to compare the operational performance of different plants by identifying the factors that lead a plant to achieve above normal performance.

For this study, we use the third round, which covered 11 countries (USA, Brazil, Germany, Italy, Spain, Finland, Sweden, Austria, Japan, China, and Korea) with a total of 291 manufacturing plants. In order to participate, companies were required to have more than 100 employees, as well as be part of one of the following sectors: electronics, machinery and equipment, or transport components. Table 3.1 shows the details of the sample.

Table 3.1 – Number of plants by country and sector

Country	Electronic		Machinery and Equipment		Transport components		Total Country	
	n	%	N	%	n	%	n	%
Australia	9	50.0%	5	27.8%	4	22.2%	18	6.2%
Brazil	4	23.5%	6	35.3%	7	41.2%	17	5.8%
China	19	44.2%	14	32.6%	10	23.3%	43	14.8%
Finland	11	44.0%	6	24.0%	8	32.0%	25	8.6%
Germany	9	23.7%	11	28.9%	18	47.4%	38	13.1%
Italy	10	40.0%	9	36.0%	6	24.0%	25	8.6%
Japan	10	33.3%	11	36.7%	9	30.0%	30	10.3%
Korea	8	34.8%	7	30.4%	8	34.8%	23	7.9%
Spain	8	32.0%	8	32.0%	9	36.0%	25	8.6%
Sweden	7	30.4%	9	39.1%	7	30.4%	23	7.9%
USA	6	25.0%	10	41.7%	8	33.3%	24	8.2%
	101	34.7%	96	33.0%	94	32.3%	291	100.0%

Source: Author

The survey questionnaires and instructions for administering the research instrument were equally distributed for the global research team. Questionnaires were translated from English to the native languages of each country. In order to assure reliability, questionnaires were carefully translated back to English by different researchers. In order to compose the database, a total of 13 different questionnaires were applied in each plant. The survey has a percentage of 65% of return.

3.3. Descriptive statistics

In this section we analyze the minimum, maximum and mean of the variables, and also if there is any unusual observation as well as the normality of the data.

The scales of the items range from 1 to 5 in some cases and from 1 to 7 in others. For one variable (hsesn01), one case presented a maximum value of 9.1, representing either an error of imputation or in answering the questionnaire. We decided to delete this case, the sample remaining with 291 valid cases.

Table 3.2 presents the descriptive statistics for the variables. Note that the values for the minimum, maximum and mean are not exact numbers because more than one respondent answered the same questions for the same case; then these values are a mean among the respondents for the same item. The variation coefficient represents the standard deviation relative to the mean (Anderson, Sweeney, & Williams, 2005). Its values range from 0.35 to 0.08, which means that, for some variables the standard deviation represents 35% of the mean and, for others, the deviation is 8% of the mean.

Table 3.2 – Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. Deviation	Coefficient of variation	Skewness	Kurtosis
grcpn01	291	1.0	6.0	3.3	0.90	0.28	0.0	-0.3
grcpn02	291	2.0	5.0	3.9	0.69	0.18	-0.1	-0.2
grcpn03	291	1.0	6.0	3.8	0.85	0.22	-0.2	-0.3
grcpn04	291	2.0	6.0	3.7	0.84	0.22	0.0	-0.6
grcpn05	291	2.0	5.0	3.8	0.80	0.21	-0.4	-0.2
grcpn06	291	1.0	6.0	3.7	0.82	0.22	-0.3	0.0
grcpn07	291	1.0	5.0	3.3	0.86	0.26	-0.1	-0.1
grcpn08	291	1.0	5.0	3.4	0.80	0.23	0.0	0.0
grcpn09	291	1.0	5.0	3.3	0.92	0.28	-0.4	-0.3
grcpn10	291	2.0	5.0	3.9	0.75	0.19	-0.2	-0.3
hsesn01	291	2.0	7.0	5.2	0.70	0.13	-0.7	1.5

hslyn02	291	2.6	7.0	5.3	0.79	0.15	-0.5	0.3
hslyn04	291	3.0	6.7	5.0	0.67	0.13	-0.2	0.1
hslyn06	291	3.0	6.9	5.1	0.72	0.14	-0.2	0.0
hslyn07	291	3.0	6.8	5.3	0.70	0.13	-0.3	-0.3
hslyn09	291	3.0	6.9	4.8	0.72	0.15	0.0	-0.1
hsmfn03	291	2.5	7.0	5.2	0.78	0.15	-0.6	0.3
hspcn01	291	1.3	7.0	4.5	1.13	0.25	-0.3	-0.1
hstmn03	291	0.0	7.0	5.3	0.90	0.17	-1.1	3.3
hstwn10	291	2.7	7.0	5.1	0.89	0.18	-0.4	-0.3
hsvcn02	291	3.9	7.0	5.8	0.60	0.10	-0.7	0.6
jsmhn08	291	1.5	7.0	4.7	1.01	0.22	-0.5	-0.2
jspln06	291	1.0	7.0	4.0	1.38	0.35	0.1	-0.8
jssun04	291	1.8	7.0	4.8	0.99	0.21	-0.4	0.1
jssun11	291	1.0	7.0	4.7	1.08	0.23	-0.4	0.1
mspmn02	291	2.0	7.0	5.0	0.90	0.18	-0.4	0.0
pstrn03	291	4.5	7.0	6.0	0.50	0.08	-0.5	0.1
qscon01	291	1.7	7.0	5.4	0.77	0.14	-0.8	1.8
qscsn02	291	3.0	6.7	5.2	0.66	0.13	-0.6	0.3
qspsn09	291	1.7	7.0	4.8	1.14	0.24	-0.5	-0.1
qsspn02	291	1.9	6.3	4.6	0.79	0.17	-0.5	0.1
qsspn03	291	2.0	6.9	5.1	0.86	0.17	-0.6	0.1
qssun03	291	2.6	6.9	5.4	0.67	0.12	-0.6	1.0
qsvcn03	291	4.0	6.9	5.8	0.52	0.09	-0.7	0.6
qsvcn06	291	2.3	6.9	5.1	0.74	0.15	-0.6	0.6
qsvmn01	291	2.5	6.9	5.0	0.87	0.17	-0.6	0.1
ssatn06	291	2.0	7.0	5.1	1.02	0.20	-0.4	-0.2
ssatn07	291	1.5	7.0	5.2	0.98	0.19	-0.6	0.2
sspen04	291	1.0	7.0	3.9	1.34	0.35	0.1	-0.6
sspen05	291	1.0	7.0	4.8	1.19	0.25	-0.8	0.4
sspen07	291	2.0	7.0	4.7	0.92	0.19	-0.3	-0.1
ssr3n02	291	3.0	7.0	5.5	0.80	0.15	-0.6	0.2
ssr4n01	291	1.0	7.0	4.7	1.10	0.23	-0.3	-0.2
ssr4n04	291	1.5	7.0	4.9	1.03	0.21	-0.5	0.0
ssr4n05	291	2.7	7.0	5.5	0.81	0.15	-0.7	0.7
tsnpn03	291	2.0	6.5	4.3	0.97	0.23	-0.2	-0.3

Source: Author

The analysis of data normality is based on the skew and kurtosis index. According to Kline (2011) a rule of thumb for these indexes is values less than 3 for skewness and values less than 10 for kurtosis. The maximum values for skewness and kurtosis are -1.1 and 3.3 respectively, which do not demonstrate any trouble with the normality of the data.

3.4. Missing value analysis

The importance of analyzing missing values is to identify the extent to which it is a problem, and guarantee the original distribution of the data when a method is applied to treat the issue (Hair, Black, Babin, Anderson, & Tatham, 2009). Hair et al. (2009) suggest four steps to deal with missing values: (a) to determine its type, (b) to determine its extent, (c) to identify its randomness, and (d) to select the method for its treatment.

The types of missing values are divided into ignorable and non-ignorable missing values. For this study, we consider missing values non-ignorable because they happened mostly due to sensitive questions (Hair et al., 2009). Then, the next step is to determine the extent of missing values. Table 3.3 shows that, of the 46 variables used in the study, 25 (54%) have at least one missing value. For the cases, the missing values embody 14%. Overall, the missing values represent 2% of the data.

Table 3.3 – Summary of missing values

	Variables		Cases		Values	
	Qty	%	Qty	%	Qty	%
Complete	21	46%	292	86%	15,256	98%
Missing values	25	54%	47	14%	338	2%
Total	46	100%	339	100%	15,594	100%

Source: Author

Next, we perform a statistical test to verify the randomness of the data in order to determine whether the missing values are missing at random (MAR) or missing completely at random (MCAR). The Little's MCAR test resulted in a p-value less than 0.05 (0.024), showing that it is significant, and the null hypothesis, that the values are missing completely at random, is rejected. Therefore, we conclude that the data is missing at random.

According to Hair et al. (2009), missing at random (MAR) means that the values are missing randomly within subgroups, but differ in levels among subgroups. Therefore, we have to identify how these missing values are distributed throughout the sample. Table 3.4 shows the missing values by variable and country, and table 3.5 shows the missing values by variable and sector.

In table 3.4, a pattern is found. The variables from GRCPN10 to GRCPN01 represent 93% of the missing values. Although some countries like Korea and China present 25% and 17% missing values respectively, the issue is due to the aforementioned variables.

Table 3.4 – Missing values by country and variable

Variables	**Australia**	**Brazil**	**China**	**Finland**	**Germany**	**Italy**	**Japan**	**Korea**	**Spain**	**Sweden**	**USA**	**Total Variables**
QSPSN09	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSVMN01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSSPN03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
JSSUN11	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
JSSUN04	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
JSPLN06	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
JSMHN08	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSVCN03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSCON01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSVCN06	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSCSN02	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSSUN03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
PSTRN03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
MSPMN02	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
QSSPN02	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
TSNPN03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
HSMFN03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
HSVCN02	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
HSTWN10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
HSTMN03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
HSESN01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
HSPCN01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
SSR3N02	0%	0%	2%	0%	0%	0%	0%	6%	0%	0%	0%	**1%**
HSLYN02	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
HSLYN04	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
HSLYN06	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
HSLYN07	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
HSLYN09	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
SSR4N04	0%	0%	2%	0%	0%	0%	0%	6%	0%	0%	0%	**1%**
SSR4N05	0%	0%	2%	0%	0%	0%	0%	6%	0%	0%	0%	**1%**
SSATN06	0%	0%	2%	0%	0%	0%	0%	6%	0%	0%	0%	**1%**
SSATN07	0%	0%	2%	0%	0%	0%	0%	6%	0%	0%	0%	**1%**
SSR4N01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
SSPEN04	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
SSPEN05	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
SSPEN07	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
GRCPN10	14%	9%	10%	10%	5%	0%	6%	26%	7%	4%	10%	**9%**
GRCPN02	14%	9%	10%	7%	7%	0%	6%	23%	7%	0%	10%	**9%**
GRCPN04	14%	9%	10%	7%	7%	0%	6%	23%	4%	0%	10%	**8%**
GRCPN03	14%	9%	10%	10%	7%	0%	6%	23%	4%	0%	10%	**9%**
GRCPN06	14%	9%	10%	7%	7%	0%	6%	23%	4%	0%	10%	**8%**
GRCPN05	14%	14%	10%	7%	7%	0%	11%	26%	4%	0%	10%	**9%**
GRCPN09	14%	18%	10%	13%	7%	4%	6%	26%	4%	0%	10%	**10%**
GRCPN07	14%	9%	12%	13%	7%	4%	9%	26%	7%	0%	10%	**10%**
GRCPN08	14%	14%	10%	13%	7%	4%	6%	26%	7%	0%	14%	**10%**
GRCPN01	14%	9%	12%	10%	7%	4%	9%	23%	4%	0%	10%	**9%**
Total Cases	**9%**	**7%**	**17%**	**9%**	**9%**	**1%**	**7%**	**25%**	**4%**	**0%**	**12%**	**100%**

Source: Author

Table 3.5 illustrates that the missing values across sectors are evenly distributed, which means that there is no pattern of missing data by sector. Therefore, we conclude that a pattern of missing values lies on the variables.

Table 3.5 – Missing values by sector and variable

Variables	Electronic	Machinery and Equipment	Transport components	Total Variables
QSPSN09	0%	0%	0%	**0%**
QSVMN01	0%	0%	0%	**0%**
QSSPN03	0%	0%	0%	**0%**
JSSUN11	0%	0%	0%	**0%**
JSSUN04	0%	0%	0%	**0%**
JSPLN06	0%	0%	1%	**0%**
JSMHN08	0%	0%	0%	**0%**
QSVCN03	0%	0%	0%	**0%**
QSCON01	0%	0%	0%	**0%**
QSVCN06	0%	0%	0%	**0%**
QSCSN02	0%	0%	0%	**0%**
QSSUN03	0%	0%	0%	**0%**
PSTRN03	0%	0%	0%	**0%**
MSPMN02	0%	0%	0%	**0%**
QSSPN02	0%	0%	0%	**0%**
TSNPN03	0%	0%	0%	**0%**
HSMFN03	0%	0%	0%	**0%**
HSVCN02	1%	0%	0%	**0%**
HSTWN10	0%	0%	0%	**0%**
HSTMN03	0%	0%	0%	**0%**
HSESN01	1%	0%	0%	**0%**
HSPCN01	0%	0%	0%	**0%**
SSR3N02	0%	1%	2%	**1%**
HSLYN02	1%	0%	0%	**0%**
HSLYN04	1%	0%	0%	**0%**
HSLYN06	1%	0%	0%	**0%**
HSLYN07	1%	0%	0%	**0%**
HSLYN09	1%	0%	0%	**0%**
SSR4N04	0%	1%	2%	**1%**
SSR4N05	0%	1%	2%	**1%**
SSATN06	0%	1%	2%	**1%**
SSATN07	0%	1%	2%	**1%**
SSR4N01	0%	0%	0%	**0%**
SSPEN04	0%	0%	0%	**0%**
SSPEN05	0%	0%	1%	**0%**
SSPEN07	0%	0%	1%	**0%**
GRCPN10	9%	10%	9%	**9%**
GRCPN02	9%	9%	8%	**9%**
GRCPN04	8%	9%	8%	**8%**
GRCPN03	8%	9%	9%	**9%**
GRCPN06	8%	9%	8%	**8%**
GRCPN05	8%	10%	11%	**9%**
GRCPN09	9%	12%	10%	**10%**
GRCPN07	9%	11%	12%	**10%**
GRCPN08	9%	11%	12%	**10%**
GRCPN01	8%	9%	12%	**9%**
Total Cases	**30%**	**34%**	**36%**	**100%**

Source: Author

The final step is to define a method to deal with the missing values. We choose the listwise deletion in which all cases that have at least one missing value is deleted (Hair et al., 2009; Kline, 2011). We perform this method because, in doing so, we guarantee the original distribution of the data without compromising the sample size significantly (Hair et al., 2009). Whereas the original sample was composed of 339 cases, after the listwise deletion, the sample resulted in 291 cases.

3.5. Confirmatory Factor Analysis

Confirmatory factor analysis is a technique using part of a structural equation modeling method that allows researchers to define “a priori measurement models in which both the number of factors and their correspondence with the indicators are explicitly specified” (Kline, 2011, p. 112). Afterwards, the researcher analyzes how well the pre specified models fit the data in order to either confirm or reject the hypothesis that the model fits the data well (Hair et al., 2009).

According to Hair et al. (2009), the validity of the model depends on the quality of its fit and the construct validity. For analyzing the model’s fit, the indicators used are the Comparative Fit Index (CFI), the Standardized Root Mean Residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA). Following Hair et al. (2009), it is only necessary to have an index of incremental fit (CFI), and an absolute fit (SRMSR and RMSEA) in order to verify the fit of the model. In addition, we analyze the General Fit Index (GFI), Adjusted General Fit Index (AGFI), Normed Fit Index (NFI), and Tucker Lewis Index (TLI). We assess the construct validity by analyzing convergent and discriminant validities (Hair et al., 2009).

The following sections show in detail the results of the confirmatory factor analysis. We perform analyses of model fit and construct validity for each measurement (operational practices, resources and operational performance). In addition, we perform common method bias analyses to verify whether the variance due to the method represents a great concern (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

3.5.1. The overall model fit

The first measurement analyzed is the chi-square (x^2), which tests whether the covariance matrixes of the sample and model are equal (Hair et al., 2009). The null hypothesis tested is that there is no difference between the covariance matrix of the sample and the covariance matrix of the model. Once the x^2 is known, it is possible to determine the probability of equality of both matrixes; this probability is the p-value. The lower the p-value, the higher the chance that the two matrixes are different, which means that the model does not fit the data well (Hair et al., 2009). However, as pointed out by Hair et al. (2009), the x^2 statistics have problems because they are affected by the sample size. In other words, the larger the sample or the quantity of variables, the lower the p-value, even without differences between the covariance matrixes. Therefore, other indexes, like the General Fit Index (GFI), the Comparative Fit Index (CFI), the Standardized Root Mean Residual (SRMR), and the Root Square Error of Approximation (RMSEA), are used because they are not affected by sample size.

The General Fit Index (GFI) is less sensitive to sample sizes, although N is not included in its calculation. Its value ranges from 0 to 1 with higher values showing better fit. GFI values equal to or greater than 0.90 are indications of good fit (Hair et al., 2009).

The Comparative Fit Index (CFI) is an incremental fit index. The CFI is normed and its values range from 0 to 1. It is relatively insensitive to the model complexity, which makes CFI commonly used by researchers (Hair et al., 2009). CFI values equal to or greater than 0.90 indicate that the model fits well.

The Adjusted General Fit Index (AGFI) takes into account the model complexity, adjusting the GFI by the proportion of degrees of freedom used in the model and the total number of degrees of freedom available (Hair et al., 2009). The AGFI penalizes more complex models and favors those more simple. This index presents values less than the GFI relative to the model complexity (Hair et al., 2009).

The Normed Fit Index (NFI) is an incremental fit index that is calculated by the difference between the x^2 of the adjusted model and the null model; then, this value is divided by the x^2 of the null model (Hair et al., 2009). Its values range from 0 to 1, and the closer to 1, the better the model fit (Hair et al., 2009).

The Tucker Lewis Index (TLI) is a mathematical comparison between the specified theoretical model and a null model of reference (Hair et al., 2009). The TLI is not normed; then, its values can be either less than 0 or greater than 1, with values closer to 1 indicating good fit. Generally, the TLI and CFI present similar values.

The Standardized Root Mean Residual (SRMR) is an index of poor fit whose high values indicate that the model does not fit well. The SRMR is a measurement of the root square of the mean between the standardized covariance of observed and estimated individual terms (Hair et al., 2009). For this index, values close to zero are signs of good fit (Hair et al., 2009).

Lastly, the Root Mean Square Error of Approximation (RMSEA) illustrates how well the data fit the population. Moreover, it also attempts to correct the model complexity and sample size (Hair et al., 2009). Like the SRMR, the RMSEA is an index of poor fit whose lower values are preferable. For Hair et al. (2009), values less than 0.10 are considered acceptable.

In order to assess goodness-of-fit, we analyze the aforementioned indexes for each research model (operational practice, resources, and operational performance).

Operational practices: Table 3.6 shows the measurements of goodness-of-fit for operational practices. The p-value for the x^2 is significant ($p < 0.000$) which means that the model does not fit the data well. However, as mentioned above, this measurement is impacted by the sample size. Then, the analyses rely on other indexes. The GFI and CFI are slightly below 0.90, which indicate a reasonable fit. For the indexes of poor fit, SRMR is close to zero, which shows a good fit as well as an RMSEA value below 0.10. Based on the results, we can conclude that the indexes for operational practices provide support for the model.

Table 3.6 – Model fit indexes for operational practices

$x^2 = 498.063$	$p < 0.000$
CMIN/DF	*2.38*
GFI	0.87
AGFI	0.83
CFI	0.85
NFI	0.77
TLI	0.82
SRMR	0.07
RMSEA	0.07

Source: Author

Resources: Table 3.7 shows a significant x^2 that is affected by the sample size. The other indexes, like the GFI and CFI, show a good fit; both are above the threshold of 0.90. The

SRMR is close to zero and the RMSEA is below 0.10. According to the indexes, the model presents good fit.

Table 3.7 – Model fit indexes for resources

$x^2 = 136.221$	*$p < 0.000$*
CMIN/DF	*2.20*
GFI	0.93
AGFI	0.90
CFI	0.96
NFI	0.93
TLI	0.95
SRMR	0.05
RMSEA	0.06

Source: Author

Operational performance: Like the previous models the x^2 has a significant p-value; therefore, we rely on the other indexes. For GFI and CFI, the model shows a good fit (values above 0.90) according to table 3.8. The SRMR is close to zero and the RMSEA is below 0.10. Therefore, the indexes indicate a good model fit.

Table 3.8 – Model fit for operational performance

$x^2 = 79.899$	*$p < 0.000$*
CMIN/DF	*2.755*
GFI	0.952
AGFI	0.909
CFI	0.941
NFI	0.911
TLI	0.908
SRMR	0.057
RMSEA	0.072

Source: Author

3.5.2. Construct validity

According to Hair et al. (2009), construct validity is the extent to which a group of items reflect a latent construct that they should measure. Construct validity is assessed through convergent and discriminant validity. The former is used to analyze the validity of the constructs and the latter is performed to show the difference of the constructs.

3.5.2.1. Convergent validity

Convergent validity means that a group of items from the same construct share a high degree of variance (Hair et al., 2009). According to Hair et al. (2009), there are three ways to assess convergent validity: (a) factor loadings, (b) extracted variance (EV), and (c) reliability. Each one is discussed in detail.

Factor loadings: The standardized factor loadings are the variance that a latent construct accounts for an item. Following Hair et al. (2009), for convergent validity, the standardized factor loadings should show values higher than 0.50. This is because, with values above 0.50, more variance is accounted for the construct than the error.

Extracted variance (EV): The EV is the variance accounted for the latent factor structure and it is calculated for each construct (Hair et al., 2009). The figure below shows its calculation.

$$EV = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}$$

Figure 3.2 – Calculation of variance extracted

λ is the standardized factor loading and *i* is the number of items. Therefore, for n items, EV is calculated as the total of all squared standardized factor loadings (Hair et al., 2009). For Hair et al. (2009), values equal to or greater than 0.50 are a good indication of convergent validity.

Reliability: Hair et al. (2009) argue that reliability is also a measurement of convergent validity. For the authors, a measurement of reliability commonly used is the composite reliability, which is calculated by the squared sum of the standardized factor loadings (λ_i) divided by the sum of this calculation plus the sum of the errors (δ_i). Figure 3.3 shows the calculation:

$$CR = \frac{\left(\sum_{i=1}^{n} \lambda_i\right)^2}{\left(\sum_{i=1}^{n} \lambda_i\right)^2 + \left(\sum_{i=1}^{n} \delta_i\right)}$$

Figure 3.3 – Calculation of composite reliability

A good value for this measurement is above 0.70. However, values between 0.60 and 0.70 can also be acceptable since other indicators of construct validity show good values.

In order to assess convergent validity, we perform the aforementioned measurements for each research model (operational practice, resources, and operational performance).

Operational practices: Table 3.9 shows the loadings for each factor, the extracted variance, and the composite reliability for the constructs. Analyzing the factor loadings, there are few variables with values below 0.50 (highlighted), but close to the threshold. For all of them except integrated product development, the values of extracted variance and composite reliability are above the threshold pointed out by Hair et al. (2009) (except for the extracted variance of JIT flow that is very close to 0.50).

Table 3.9 – Convergent validity for operational practices

Construct	Variables	Loadings	Extracted variance (%)	Composite reliability
Quality Management	QSVMN01	0.85	62.24	0.71
	QSSPN03	0.54		
	QSPSN09	0.60		
JIT Flow	JSSUN11	0.45	49.59	0.65
	JSSUN04	0.73		
	JSPLN06	0.43		
	JSMHN08	0.61		
Customer Orientation	QSVCN03	0.49	54.23	0.73
	QSCON01	0.56		
	QSVCN06	0.71		
	QSCSN02	0.76		
Supplier Relationship	QSSUN03	0.77	68.45	0.57
	PSTRN03	0.48		
Integrated Product Development	MSPMN02	0.44	47.57	0.45
	QSSPN02	0.52		
	TSNPN03	0.42		
Workforce	HSMFN03	0.56	51.16	0.68

Development	HSVCN02	0.45		
	HSTWN10	0.73		
	HSTMN03	0.62		
Leadership	HSESN01	0.68	59.05	0.66
	HSPCN01	0.60		
	SSR3N02	0.60		

Source: Author

Resources: Table 3.10 shows that all loadings of items are above 0.50, the least extracted variance is 57.49, and the composite reliability ranges from 0.75 to 0.90. Therefore, the results found indicate convergent validity.

Table 3.10 – Convergent validity for resources

Construct	Variables	Loadings	Extracted variance (%)	Composite reliability
Human Resources	HSLYN02	0.84	71.87	0.90
	HSLYN04	0.74		
	HSLYN06	0.78		
	HSLYN07	0.84		
	HSLYN09	0.81		
Technology	SSR4N04	0.65	66.54	0.84
	SSR4N05	0.83		
	SSATN06	0.66		
	SSATN07	0.85		
Proprietary Equipment	SSR4N01	0.68	58.38	0.76
	SSPEN04	0.57		
	SSPEN05	0.76		
	SSPEN07	0.66		

Source: Author

Operational performance: Table 3.11 shows the results of convergent validity for operational performance. All loadings of items except two (highlighted) are above 0.50, the extracted variances are also above 0.50, and the composite reliability figures range from 0.65 to 0.76. Therefore, the results indicate a good level of convergent validity for the constructs.

Table 3.11 – Convergent validity for operational practices

Construct	Variables	Loadings	Extracted variance (%)	Composite reliability
Quality	GRCPN10	0.65	73.54	0.64
	GRCPN02	0.72		
Delivery	GRCPN04	0.74	80.31	0.76
	GRCPN03	0.82		
Flexibility	GRCPN06	0.77	59.87	0.68
	GRCPN05	0.73		
	GRCPN09	0.41		
Cost	GRCPN07	0.65	59.02	0.67
	GRCPN08	0.80		

GRCPN01	0.43

Source: Author

3.5.2.2. Discriminant validity

Discriminant validity is the extent to which a construct is different from the others (Hair et al., 2009). According to Hair et al. (2009), evidence of discriminant validity shows that a construct is unique and captures some phenomena that others cannot. We assess discriminant validity by running two models with a pair of constructs. The first one is performed with a free covariation between constructs, and, in the second, the variables are loaded on only one construct. The logic behind this is that the former should present a better fit than the latter in order to illustrate that the constructs are measuring different things (Hair et al., 2009). If the test fails, it follows that there are more constructs than necessary. The test is performed by the statistical significance of the difference of the chi-square between an unconstrained model and a constrained one.

We test discriminant validity for each measurement (operational practices, resources, and operational performance) in order to assess the difference among the constructs.

Operational practices: Table 3.12 shows the difference of chi-square between an unconstrained and a constrained model. For some cases there is no significant difference, which means that the constructs are measuring the same thing. The constructs that should be reviewed are: Supplier Relationship, Integrated Product Development, Leadership, and Workforce Development.

Table 3.12 – Discriminant validity for operational practices

Construct scale pairs		Unconstrained		Constrained		
		x^2	*d.f*	*x^2*	*d.f*	*x^2 difference*
Quality Management	JIT Flow	42.9	13	148.3	14	105.4*
Quality Management	Customer Orientation	36.7	13	113	14	76.3*
Quality Management	Supplier Relationship	18.9	4	46	5	27.1*
Quality Management	Integrated Product Development	25.9	8	32.1	9	6.2*
Quality Management	Workforce Development	36.4	13	88	14	51.6*
Quality Management	Leadership	6.5	8	32.5	9	26.0*
JIT Flow	Customer Orientation	70.3	19	170.4	20	100.1*
JIT Flow	Supplier	24.6	8	44.1	9	19.5*

	Relationship					
JIT Flow	Integrated Product Development	43.1	13	50.7	14	7.6*
JIT Flow	Workforce Development	49.3	19	98.3	20	49.0*
JIT Flow	Leadership	38.1	13	76.9	14	38.8*
Customer Orientation	Supplier Relationship	22.9	8	38.3	9	15.4*
Customer Orientation	Integrated Product Development	27.6	13	37.8	14	10.2*
Customer Orientation	Workforce Development	73.7	19	105.8	20	32.1*
Customer Orientation	Leadership	41.1	13	92.5	14	51.4*
Supplier Relationship	Integrated Product Development	19.2	4	21.1	5	1.9
Supplier Relationship	Workforce Development	41.2	8	44.3	9	3.1
Supplier Relationship	Leadership	2.2	4	12.30	5	10.1*
Integrated Product Development	Workforce Development	24.4	13	29.5	14	5.1*
Integrated Product Development	Leadership	7.7	8	10.2	9	2.5
Workforce Development	Leadership	53.1	13	53.2	14	0.1

* Significant at $p < 0.05$
Source: Author

As some constructs are not statistically different from others, we analyze the items and either deleted or merged those that are conceptually similar. After this procedure, we perform all the steps of construct validity again for operational practices. For matter of clarity we present the new model and the details in the next section.

Resources: Table 3.13 shows the results of discriminant validity for resources. All the differences of the chi-square are statistically significant. Thus, the results suggest evidence that the constructs are different from each other.

Table 3.13 – Discriminant validity for resources

Construct scale pairs		Unconstrained		Constrained		
		x^2	*d.f*	*x^2*	*d.f*	*x^2 difference*
Human Resources	Technology	41.3	26	429	27	387.7*
	Proprietary Equipment	74.8	26	320.7	26	245.9*
Technology	Proprietary Equipment	61.3	19	212.5	20	151.2*

* Significant at $p < 0.05$
Source: Author

Operational performance: Table 3.14 presents the results for operational performance. All the differences of the chi-square are statistically significant, and so the figures show evidence of discriminant validity for the constructs.

Table 3.14 – Discriminant validity for operational performance

Construct scale pairs		Unconstrained		Constrained		
		x^2	*d.f*	*x^2*	*d.f*	*x^2 difference*
Quality	Delivery	0.2	1	47.0	2	46.8*
	Flexibility	19.4	4	74.7	5	55.3*
	Cost	4.2	4	46.8	5	42.6*
Delivery	Flexibility	7.8	4	63.1	5	55.3*
	Cost	9.0	4	89.3	5	80.3*
Flexibility	Cost	17.1	8	81.7	9	64.6*

* Significant at $p < 0.05$
Source: Author

3.5.3. Treatment for operational practices

After the analysis of discriminant validity for operational practices, we find out that it would not be prudent to carry on with the original scale. Therefore, based on the confirmatory factor analysis for each item, we deleted two constructs (Integrated Product Development and Leadership) and put some items that are conceptually similar into other constructs. Table 3.15 shows the original scale of the modifications. Next, we perform the analysis of construct validity for the new model.

Table 3.15 – Modifications for operational practices

Constructs	Variables	
	Before	After
Quality Management	QSVMN01	QSVMN01
	QSSPN03	QSSPN03
	QSPSN09	QSPSN09
JIT Flow	JSSUN11	JSSUN11
	JSSUN04	JSSUN04
	JSPLN06	JSPLN06
	JSMHN08	JSMHN08
Customer Orientation	QSVCN03	QSVCN03
	QSCON01	QSCON01
	QSVCN06	QSVCN06
	QSCSN02	QSCSN02
Supplier Relationship	QSSUN03	QSSUN03
	PSTRN03	QSSPN02

Integrated Product Development	MSPMN02	Deleted	Construct deleted
	QSSPN02	Supplier Relationship	
	TSNPN03	Deleted	
Workforce Development	HSMFN03	HSMFN03	
	HSVCN02	Deleted	
	HSTWN10	HSTWN10	
	HSTMN03	HSTMN03	
Leadership	HSESN01	Workforce Development	Construct deleted
	HSPCN01	Workforce Development	
	SSR3N02	Deleted	

Source: Author

Table 3.16 shows the measurements of goodness-of-fit for the original model and after the modifications. All indexes are above the first model, which indicates a better fit. Furthermore, we compare the difference of chi-square between both models ($x^2 = 197.748$, d.f. = 84), and the result illustrates that the difference is statistically significant (p-value < 0.005), which confirms a better fit of the second model.

Table 3.16 – Overall model fit for operational practices after modifications

Original model		After Modifications	
$x^2 = 498.063$	$p < 0.000$	$x^2 = 300.315$	$p < 0.000$
CMIN/DF	*2.38*	*CMIN/DF*	*2.40*
GFI	0.87	GFI	0.90
AGFI	0.83	AGFI	0.86
CFI	0.85	CFI	0.88
NFI	0.77	NFI	0.82
TLI	0.82	TLI	0.86
SRMR	0.07	SRMR	0.07
RMSEA	0.07	RMSEA	0.07

Source: Author

We assess convergent validity for the new model as shown in table 3.17. All the indexes support convergent validity after modifications. The noteworthy point is the indexes for Supplier Relationship and Workforce Development practices that were modified. Both present good figures with all values above the required level (Hair et al., 2009).

Table 3.17 – Convergent validity for operational practices after modifications

Construct	Variables	Loadings	Extracted variance (%)	Composite reliability
Quality Management	QSVMN01	0.82	62.24	0.71
	QSSPN03	0.56		
	QSPSN09	0.61		
JIT Flow	JSSUN11	0.47	49.59	0.66
	JSSUN04	0.70		
	JSPLN06	0.45		
	JSMHN08	0.64		
Customer Orientation	QSVCN03	0.49	54.23	0.73
	QSCON01	0.57		
	QSVCN06	0.70		
	QSCSN02	0.75		
Supplier Relationship	QSSUN03	0.71	70.14	0.58
	QSSPN02	0.56		
Workforce Development	HSMFN03	0.53	52.83	0.78
	HSTWN10	0.74		
	HSTMN03	0.64		
	HSESN01	0.69		
	HSPCN01	0.62		

Source: Author

Table 3.18 shows the analysis of discriminant validity after the modifications. The results indicate that all the constructs are statistically different; thereby giving support for carrying on with this model.

Table 3.18 – Discriminant validity for Operational Practices after modifications

Construct scale pairs		Unconstrained		Constrained		
		x^2	d.f	x^2	d.f	x^2 difference
Quality Management	JIT Flow	42.9	13	148.3	14	105.4**
Quality Management	Customer Orientation	36.7	13	113.0	14	76.3**
Quality Management	Supplier Relationship	11.7	4	20.4	5	8.7**
Quality Management	Workforce Development	67.2	19	121.4	20	54.2**
JIT Flow	Customer Orientation	70.3	19	170.4	20	100.1**
JIT Flow	Supplier Relationship	27.7	8	47.6	9	19.9**
JIT Flow	Workforce Development	79.9	26	143.1	27	63.2**
Customer Orientation	Supplier Relationship	21.1	8	41.5	9	20.4**
Customer Orientation	Workforce Development	118.0	26	177.4	27	59.4**
Supplier Relationship	Workforce Development	46.5	13	70.2	14	23.7**

**p-value < 0.005
Source: Author

3.5.4. Common method variance

Common method variance (CMV) refers to the variance that is attributable to the measurement method rather than the constructs the measurements represent (Podsakoff et al., 2003). According to Podsakoff et al. (2003), CMV is considered an issue because it is one of the main sources of measurement error. There are many causes of CMV, some are related to the respondents and others to the measurement item itself. For more details, see Podsakoff et al. (2003) .

Following Podsakoff et al. (2003), there are two ways to tackle the issue of common method variance, through: (a) the design of the research instrument, or (b) statistical control. We use both in order to mitigate and identify the potential problems of CMV.

The data were collected from different sources per firm in order to mitigate effects of consistency motives, implicit theories, social desirability tendencies, mood states, and the tendency of the participants to respond inaccurately (Podsakoff et al., 2003). Second, participant anonymity was allowed to increase the veracity of answers, as stated by Podsakoff et al. (2003): “these procedures should reduce people’s evaluation apprehension and make them less likely to edit their responses to be more socially desirable, lenient, acquiescent, and consistent with how they think the researcher wants them to respond”. Lastly, it is also possible to diminish CMV by improving scale items (Podsakoff et al., 2003). Accordingly, the research instrument was carefully designed in order to: (a) eliminate ambiguous terms, (b) make terms as clear and simple as possible, and (c) keep questions simple, specific, and concise.

Furthermore, we perform a statistical control analysis: the Harman’s single-factor test. In this technique, the researcher loads all variables of a model into an exploratory factor analysis in order to determine the number of factors necessary to explain the variance of the model. If either (a) only a single factor emerges, or (b) one single factor accounts for the majority of the covariance among the variables, then common method variance is considered a great concern (Podsakoff et al., 2003). For each model, we apply the Harman’s single-factor test.

Operational practices: Table 3.19 shows the results of the Harman’s single-factor test for operational practices. Four factors with eigenvalues greater than one emerged from the exploratory factor analysis. Moreover, one factor accounts for 31.8% of the variance, four factors being necessary to explain the majority of variance. Therefore, the results suggest that common method bias is not a great concern for this model.

Table 3.19 – Harman's single-factor test for operational practices

Component	Eigenvalue	% Variance	Cumulative %
1	5.73	31.83%	31.83%
2	1.69	9.37%	41.20%
3	1.31	7.27%	48.47%
4	1.21	6.70%	55.17%

Source: Author

Resources: Table 3.20 presents the results of the Harman's single-factor test for resources. Three factors with eigenvalues above one emerged from the test. Additionally, a single factor explains 37% of the variance. Since more than one factor emerged from the analysis and a single factor cannot explain the majority of variance, we conclude that common method variance is not an issue for resources.

Table 3.20 – Harman's single-factor test for resources

Component	Eigenvalue	% Variance	Cumulative %
1	4.89	37.59%	37.59%
2	2.40	18.45%	56.04%
3	1.37	10.55%	66.59%

Source: Author

Operational performance: The results for operational performance are shown in table 3.21. According to the figures, three factors with eigenvalues above one emerged from the analysis. Additionally, a single factor accounts for 36% of the variance of the model. Because more than one factor arose from the exploratory factor analysis, and three factors are necessary to explain the majority of variance, the results suggest that common method bias is not a problem for operational performance.

Table 3.21 – Harman's single-factor test for operational performance

Component	Eigenvalue	% Variance	Cumulative %
1	3.60	35.97%	35.97%
2	1.27	12.66%	48.64%
3	1.08	10.82%	59.46%

Source: Author

4. RESULTS

The hypotheses proposed are tested using multiple regressions. The method utilized was stepwise in order to identify the incremental impact of each variable (Hair et al., 2009). The dependent variables are quality, delivery, flexibility and cost. The others (operational practices and resources) are used as independent variables. Moreover, we controll for types of industry effects.

The scale was obtained through the mean of the items that compose the construct. Table 4.1 shows the correlations for the constructs as well as the descriptive statistics for the summed scale.

Table 4.1 – Correlation matrix

	Constructs	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1	Quality management practices	4.96	0.75	1											
2	JIT practices	4.54	0.78	.25**	1										
3	Customer orientation practices	5.37	0.50	.43**	.30**	1									
4	Supplier relationship practices	4.99	0.61	-.06	-.04	-.03	1								
5	Workforce development practices	5.18	0.67	.02	.04	.09	.43**	1							
6	HRM - resources	5.13	0.61	.23**	.30**	.51**	-.04	.01	1						
7	Technology - resources	5.15	0.78	.54**	.33**	.40**	-.06	.03	.32**	1					
8	Proprietary equipment - resources	4.53	0.87	.25**	.18**	.30**	.02	-.06	.25**	.45**	1				
9	Quality performance	3.87	0.62	.07	.17**	.20**	-.04	.03	.24**	.31**	.17**	1			
10	Delivery performance	3.77	0.76	.13*	.26**	.25**	-.01	.11*	.19**	.34**	.26**	.37**	1		
11	Flexibility performance	3.62	0.65	.10*	.22**	.18**	-.10*	.01	.17**	.37**	.23**	.34**	.45**	1	
12	Cost performance	3.34	0.65	.13*	.26**	.20**	.00	.07	.22**	.38**	.26**	.35**	.36**	.41**	1

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Source: Author

Since the regression contends interaction terms, the factors are mean-centered in order to reduce problems with multicolinearity (Jaccard, Wan, & Turrisi, 1990). The sections in this topic are divided according to dependent variables (quality, delivery, flexibility, and cost). Each section presents the hypotheses testing for its respective performance.

4.1. Quality

Table 4.2 shows the results of the multiple regressions for quality performance. The variables shown are the ones that were significant in predicting the dependent variable. The results show that there is no impact on quality performance of the sector in which the company takes part. We find that customer orientation and JIT practices are positively associated with quality, even though they explain a small part of its variance (4.8%).

Table 4.2 – Stepwise regression for quality performance

Variables	Model 1			Model 2		
	β	t	p-value	β	t	p-value
Customer orientation practices	0.202 (0.72)	3.507	0.001	0.167 (0.75)	2.778	0.006
JIT practices				0.119 (0.48)	1.984	0.048
R^2	0.041			0.054		
R^2 adjusted	0.038			0.048		
P-value for the change				0.047		
Overall F (p-value)				8.181 (0.000)		

Numbers in parentheses in β represent the standard error.

Source: Author

The result of the analysis, a positive relationship between customer orientation practices and quality performance, corroborated the literature. Pelham and Wilson (1995) found that customer orientation significantly influence the perceived level of product quality. Accordingly, customer orientation has as its basis the understanding of customers' needs and the response to them; it follows that a company that does a good job of understanding its customers are more likely to deliver according to their desires. By doing so, the perception of quality by its customers is greater than otherwise.

The positive relation between JIT practices and quality performance may be due to the fact that JIT, for example, emphasizes small batch sizes, which, in turn, reduce the number of problems with the products owing to closer control. As the items composing the quality scale are product performance, capacity and conformance to specifications, reducing the defects of products would increase both measurements because products free of defects are more likely to do what they are made for. For example, Koufteros et al. (1998) argued that JIT activities are a promoter of quality improvements. Likewise, Shah & Ward (2003) found that combined JIT practices lead to higher performance.

Therefore, from the hypotheses proposed previously, two are supported. Table 4.3 shows a summary of the relationships tested between operational practices and quality performance as well as the results.

Table 4.3 – Summary of hypotheses results for quality performance

#	Hypothesis	Results
H1	There is a positive relationship between quality management practices and quality	Not supported
H5	There is a positive relationship between JIT flow practices and quality	Supported
H9	There is a positive relationship between customer orientation practices and quality	Supported
H17	There is a positive relationship between supplier relationship practices and quality	Not supported
H21	There is a positive relationship between workforce development practices and quality	Not supported

Source: Author

A counterintuitive result is the lack of relationship between quality management practices and quality performance. Many authors (Cua et al., 2001; Flynn et al., 1995; Kaynak, 2003; Sakakibara et al., 1997; Swink et al., 2005) found a positive impact of quality management practices on performance. A possible reason we do not find it may be due to our scale that is slightly different from previous studies. For example, while some authors measured quality practice by using items, like customer focus (Flynn et al., 1995) and leadership (Kaynak, 2003; Samson & Terziovski, 1999), we used these items for other practices.

4.2. Delivery

Table 4.4 shows the results of the multiple regressions for delivery performance. The variables shown are the ones with a significant coefficient. The control variable (sector) was not significant, which means that the sector does not impact the results.

We find that JIT practices and customer orientation practices are significantly positively associated with delivery performance. Both practices account for 9% of the delivery variation. Moreover, the results show that some resources moderate the relationship between operational practices and delivery. More specifically, technology moderates the relationship between supplier relationship practices and delivery, and the relationship between workforce development practices and delivery. We discuss the details of our results below.

Table 4.4 – Stepwise regression for delivery performance

Variables	Model 1			Model 2			Model 3			Model 4		
	β	t	p-value	B	t	p-value	β	T	p-value	B	t	p-value
Direct effects												
JIT practices	0.262 (0.05)	4.61	0.000	0.207 (0.05)	3.53	0.000	0.212 (0.05)	3.68	0.000	0.196 (0.05)	3.40	0.001
Customer orientation practices				0.185 (0.08)	3.15	0.002	0.193 (0.08)	3.35	0.001	0.221 (0.08)	3.75	0.000
Moderating effects												
Workforce x Technology							-0.181 (0.07)	-3.28	0.001	-0.139 (0.08)	-2.39	0.017
Supplier practices x Technology										-0.126 (0.09)	-2.11	0.036
R^2	0.069			0.10			0.132			0.146		
R^2 adjusted	0.065			0.093			0.123			0.134		
P-value for the change	0.000			0.002			0.001			0.036		
Overall F (p-value)										12.194 (0.000)		

Source: Author

JIT practices comprise reducing the set up time and optimizing plant layout, to name a few, thereby increasing the flow of materials and products from suppliers to customers. Since delivery performance was measured by fast delivery and on-time delivery, we argue that companies implementing JIT practices will be able to shorten lead times, which is directly related to fast and on-time deliveries. Although some authors found a significant impact of JIT practices on performance (Cua et al., 2001; Koufteros et al., 1998; Shah & Ward, 2003), only Cua et al. (2001) pointed out a positive association between JIT and delivery performance.

Customer orientation practices consist of activities, such as, satisfying and exceeding customer expectations, and close contact with customers. It follows that a company that has implemented such practices is more likely to understand its overall customers’ expectations, including when products are needed. Then, a company can make improvements in its productivity process in order to respond to customers’ requirements, for instance, delivery fine-tuning the current company’s delivery performance and customers’ expectations. Our finds are novel in the sense that, albeit the literature pointed out a positive relationship between customer orientation and performance (Deshpandé et al., 1993; Pelham & Wilson, 1995; Samson & Ford, 2000; Slater & Narver, 2000), it did not show the impact of this practice on specific operational practices.

Regarding the moderating effects, we find that, when technology is present, there is a negative relationship between workforce practices and delivery. One reasonable explanation is that when a company is investing in technology with high-tech equipment, for example, there is a less need for the involvement of employees in the productivity process. It follows then that a company with developed technology implementing workforce practices will decrease its operations capacity because its technology does not require such practices. By the same token, in the presence of technology, there is a negative relationship between supplier practices and delivery. Companies possessing developed technology do not depend on their suppliers to increase delivery performance. If these companies start to implement supplier practices, they can harm their delivery performance; it might be due to the fact that suppliers do not have the same technology, and so an attempt to develop joint activities will not bring benefits for the company. According to the aforementioned discussion, table 4.5 shows the results for the hypothesis testing.

Table 4.5 – Summary of hypotheses results for delivery performance

#	Hypothesis	Results
H2	There is a positive relationship between quality management practices and delivery	Not supported
H6	There is a positive relationship between JIT flow practices and delivery	Supported
H10	There is a positive relationship between customer orientation practices and delivery	Supported
H18	There is a positive relationship between supplier relationship practices and delivery	Not supported
H18a	Technology moderates the relationship between supplier relationship practices and delivery	Supported

H22	There is a positive relationship between workforce development practices and delivery	Not supported
H22a	Technology moderates the relationship between workforce development practices and delivery	Supported

Source: Author

4.3. Flexibility

Table 4.6 shows the results for the multiple regressions for flexibility performance. We present only the variables that were significantly related to a dependent variable. Moreover, the sector in which the company takes part did not exert an influence on the results.

The practices that are significantly associated to flexibility are JIT and customer orientation practices. Both were positively significantly related to flexibility, accounting for 5.9% of its variance. Below, we discuss the results in further detail.

Table 4.6 – Stepwise regression for flexibility performance

Variables	Model 1			Model 2		
	β	t	p-value	β	T	p-value
JIT practices	0.224 (0.037)	3.909	0.000	0.185 (0.05)	3.11	0.002
Customer orientation practices				0.130 (0.078)	2.184	0.03
R^2	0.05			0.066		
R^2 adjusted	0.047			0.059		
P-value for the change				0.03		
Overall F (p-value)				10.125 (0.000)		

Source: Author

JIT practices improve the productivity process in the sense that they reduce all forms of waste, thereby enhancing lead time and eliminating inventories. Once a company implements such practices, it will create buffers that will enable it to change the volume and variety of products more effectively, thus improving flexibility performance. Previous studies showed the importance of JIT practices to flexibility. Cua et al. (2001) found that activities like set-up time reduction and others had a significant positive relationship with volume flexibility. Likewise, Swink et al. (2005) pointed out that the significant association between JIT practices with process and new product flexibility.

Companies that implement customer orientation practices are the ones that are really interested in what customers want. These companies, in an attempt to respond to customers' demand have developed a good capacity to change volume and/or mix of products that are measurements of flexibility. Hence, the positive relationship between customer orientation practices and flexibility. Table 4.7 shows the results of hypothesis testing for flexibility performance.

Table 4.7 – Summary of hypotheses results for flexibility performance

#	Hypothesis	Results
H3	There is a positive relationship between quality management practices and flexibility	Not supported
H7	There is a positive relationship between JIT flow practices and flexibility	Supported
H11	There is a positive relationship between customer orientation practices and flexibility	Supported
H19	There is a positive relationship between supplier relationship practices and flexibility	Not supported
H23	There is a positive relationship between workforce development practices and flexibility	Not supported

Source: Author

4.4. Cost

Table 4.8 shows the results for the multiple regressions for cost performance. We do not find any influence of the sector in which the company takes part on the results. Only the significant variables are shown in the table.

JIT practices and customer orientation practices were significantly positively related to cost performance. Both variables account for 8% of the variance of the dependent variable. We discuss the results in more details below.

Table 4.8 – Stepwise regression for cost performance

Variables	Model 1			Model 2		
	B	t	p-value	β	t	p-value
JIT practices	0.263 (0.048)	4.637	0.000	0.223 (0.049)	3.776	0.000
Customer orientation practices				0.136 (0.077)	2.314	0.021

R^2	0.069	0.086
R^2 adjusted	0.066	0.08
P-value for the change		0.021
Overall F (p-value)		13.588 (0.000)

Source: Author

As mentioned before, JIT practices are aimed at reducing waste, which comprise material movements, work in process inventories, and unnecessary delays in lead times. These forms of waste might have a direct impact on costs. For example, inventories can increase operational costs enormously as well as delays in lead time. Thus, by implementing JIT practices, companies are able to reduce operational costs by improving their overall operations. Indeed, Cua et al. (2001) found a positive relationship between cost efficiency and JIT practices.

Likewise, customer orientation practices were positively related to cost performance. It might be that companies that know their customers well develop more efficient operational processes to attend them better. More specifically, knowing their customers well, companies put their effort only into those operations that really matter in order to satisfy them. In doing so, companies are able to improve their operational costs. Table 4.9 shows the results for the hypothesis testing for cost performance.

Table 4.9 – Summary of hypotheses results for cost performance

#	Hypothesis	Results
H4	There is a positive relationship between quality management practices and cost	Not supported
H8	There is a positive relationship between JIT flow practices and cost	Supported
H12	There is a positive relationship between customer orientation practices and cost	Supported
H20	There is a positive relationship between supplier relationship practices and cost	Not supported
H24	There is a positive relationship between workforce development practices and cost	Not supported

Source: Author

4.5. Cumulative performances and resources

In testing the hypotheses regarding the relationship between joint performances and resources, we found that almost 25% of the model is explained by two resources: technology and human resources. Table 4.10 shows the results for the multiple regressions. We do not find any effect of the sector in which the company takes part.

Table 4.10 – Stepwise regression for joint performances

Variables	Model 1			Model 2		
	β	t	p-value	β	t	p-value
Technology	0.481 (0.025)	144.315	0.000	0.436 (0.034)	8.085	0.000
Human resources				0.138 (0.043)	2.55	0.011
R^2	0.231			0.248		
R^2 adjusted	0.228			0.243		
P-value for the change				0.000		
Overall F (p-value)				47.496 (0.000)		

Source: Author

Technology is a resource that helps companies to improve their overall productivity. In doing so, companies that develop this resource are more able to implement more efficient processes that lead to enhance operational performances. Moreover, technology is viewed as a set of capabilities that might not be easily observable by competitors and since it supports the pursuit of simultaneously performances, it is considered a source of competitive advantage.

Human resource was measured by the commitment that employees have to the company goals. How a company makes people willing to put a great effort on its objectives might be not easily copied or observable by competitors; thus we consider committed people a resource that brings competitive advantage. Furthermore, once these employees believe in the company's strategy, they will do what is needed in order to accomplish the goals. It follows then that, cumulative performance are more likely to succeed in this situation. Table 4.11 shows hypotheses tested and their results.

Table 4.11 – Summary of hypotheses results for joint performances and resources

#	Hypothesis	Results

H29	There is a positive relationship between proprietary equipment and operational performance	Not supported
H30	There is a positive relationship between technology and operational performance	Supported
H31	There is a positive relationship between human resources and operational performance	Supported

Source: Author

It is noteworthy to mention that we test a model for the operational performance factors together and the results did not show a good fit to the data. Indexes like CFI (0,75) and RMSEA (0,15) were far from the recommended.

5. CONCLUSION

This research dealt with the decisions that managers take in operations in order to achieve better operational performance. For this work, such decisions are related to operational practices and resources. We argue that practices like quality management, JIT, customer orientation, supplier relationship, and workforce development along with resources like, workers, technology, and proprietary equipment are means to achieve better quality, delivery, flexibility and cost performance. Our goal with this research was to understand the impact of strategic operational decisions on operational performance. We use a previous scale for operational practices and developed a new one for resources, proposing a model in which resources moderate the relationship between operational practices and operational performance.

Our results show that two operational practices were consistently positively related to operational performance. JIT and customer orientation practices were positively related to the four measurements of operational performance (quality, delivery, flexibility, and cost). The results are of interest in the sense that they can provide a route for companies with poor performance and do not know how to initiate a turnaround. By starting to focus on customer orientation and JIT practices, these companies can find an answer. Both practices propose initiatives that help the operational area to achieve its goals. It is worth mentioning that the greatest variance explained by both practices was 9.3% for delivery performance. Table 5.1 shows a summary of the hypotheses proposed in this study and the testing results.

Table 5.1 – Summary of the overall hypotheses results

#	Hypothesis	Results

H1	There is a positive relationship between quality management practices and quality	Not supported
H2	There is a positive relationship between quality management practices and delivery	Not supported
H3	There is a positive relationship between quality management practices and flexibility	Not supported
H4	There is a positive relationship between quality management practices and cost	Not supported
H5	There is a positive relationship between JIT flow practices and quality	Supported
H6	There is a positive relationship between JIT flow practices and delivery	Supported
H7	There is a positive relationship between JIT flow practices and flexibility	Supported
H8	There is a positive relationship between JIT flow practices and cost	Supported
H9	There is a positive relationship between customer orientation practices and quality	Supported
H10	There is a positive relationship between customer orientation practices and delivery	Supported
H11	There is a positive relationship between customer orientation practices and flexibility	Supported
H12	There is a positive relationship between customer orientation practices and cost	Supported
H17	There is a positive relationship between supplier relationship practices and quality	Not supported
H18	There is a positive relationship between supplier relationship practices and delivery	Not supported
H18a	Technology moderates the relationship between supplier relationship practices and delivery	Supported
H19	There is a positive relationship between supplier relationship practices and flexibility	Not supported
H20	There is a positive relationship between supplier relationship practices and cost	Not supported
H21	There is a positive relationship between workforce development practices and quality	Not supported
H22	There is a positive relationship between workforce development practices and delivery	Not supported
H22a	Technology moderates the relationship between workforce development practices and delivery	Supported
H23	There is a positive relationship between workforce development practices and flexibility	Not supported
H24	There is a positive relationship between workforce development practices and cost	Not supported
H29	There is a positive relationship between proprietary equipment and operational performance	Not supported
H30	There is a positive relationship between technology and operational performance	Supported
H31	There is a positive relationship between human resources and operational performance	Supported

Source: Author

More specifically, we find that quality performance is positively impacted by customer orientation and JIT practices. We argue that the positive relationship between customer orientation practices and quality performance is due to the understanding that a company has of its customers and the ability to respond to it; it follows then that a company that implements customer practices are more likely to develop products with the quality desired by their customers. The positive relationship between quality and JIT practices might be due to the fact that the latter give emphasis to small batch sizes that help to reduce the number of product problems, thereby improving quality.

Delivery is positively related to customer orientation and JIT practices. Since customer orientation practices comprise the understanding of when a certain product is needed, we argue that a company that implements these practices is more likely to have a better match between its productivity process and customer needs, thus improving delivery performance. JIT practices encompass shorter lead times and the optimization of plant layout for improving the production flow. Such activities help to reduce the time that a product takes to reach the customers, consequently impacting the company's delivery performance.

Flexibility performance is also positively related to customer orientation and JIT practices. For the former, we argue that customer orientated companies understand changes of customer needs well, and so develop a more flexible productive system. For the latter, the positive relationship might be due to the fact that JIT practices are aimed at eliminating all forms of waste, which helps to create buffers that give companies more flexibility to change product mix or volume as required.

Cost performance is positively related to customer orientation and JIT practices. It follows that customer-orientated companies are more likely to develop more efficient productive processes once they know their customers well. These companies focus only on the operations that matter to customers and get rid of processes that are costly and do not add value to the products; thereby, improving cost performance. By the same token, JIT practices are implemented to improve overall operations performance. Consequently, initiatives, like improving material movements, reducing inventories and shortening lead time, directly affect the operational costs such that a productive is developed capable of doing more using less resources.

Moreover, we find two moderating effects, albeit negatively related to operational practices and performance. In the first case, we find that technology moderates the relationship between supplier relationship practices and delivery. It follows that, in the presence of more advanced technology, a company with supplier practices will witness reduced delivery times. It could be that this company with developed technology does not need a close relationship with its suppliers to improve its delivery. An attempt to implement supplier relationship practices could even harm delivery performance when suppliers are at a different level of technology. Thus, it could, for example, be very difficult to join systems and processes. Secondly, we find that technology also moderates the relationship between workforce development practices and delivery performance. In the presence of technology, workforce practices affect delivery negatively. We argue that companies with developed technology need less involvement of their employees in processes like supply. Therefore, an attempt to develop workforce practices for improving delivery will not only be usefulness, but it will decrease the level of deliveries.

Testing the relationship between RBV perspectives and cumulative performances, we find that some resources that meet RBV criteria support the development of simultaneously operational performances. By one hand, RBV premises state that when a resource is rare, valuable, difficult to copy, and there is no substitutable, it is a source of competitive advantage. On the other hand, the literature points out that companies pursuing simultaneously operational performances achieve better results than pursuing one operational performance. When bringing these perspectives together, we find that competitive resources might be an important basis for the development of joint performances. Indeed, we find that almost 25% of the variance of joint performances. This result shed light on the precedent factors that are significant when a company is implementing its strategies.

The contribution of this work is twofold. First we extend previous researches by testing the relationship between separately operational practices and independently operational performance. By doing so, we are able to identify the specific patterns concerning both factors. And secondly, we develop a new scale of resources and put it into the operational context. This was an attempt to highlight the importance that resources have for operations, and, moreover, to bring this discussion for empiric terms.

This study is limited by many factors. The sample encompasses a reduced number of respondents by country, which does not permit a closer analysis, for example, contrasting one country to another. Secondly, the data is transversal, which does not permit viewing of effects of the implementation of practices over time. Additionally, the responses to the questionnaire are subjective for the respondents, even though with common method analyses.

Clearly, there are other factors accounting for operational performance. Future research should focus on the identification of such factors and develop measurements that help to understand further how companies achieve greater performance. Methods other than quantitative research might be the way to tackle this issue. For example, case studies might be an effective way of deepening understanding of the underlying operational processes. Moreover, operations researchers should increasingly focus on the development of longitudinal data.

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APPENDIX A – SCALES FOR OPERATIONAL PRACTICES

Item code	Quality management practices
QSPSN09	We monitor our processes using statistical process control
QSVMN01	Our plant focus on the prevention of problems instead of solving them after they occurred
QSSPN03	Quality is our first criterion to choose suppliers
*SRBNN05	Extent of benchmarking for quality management

Item code	JIT flow practices
JSSUN11	We emphasize small lot sizes, to increase manufacturing flexibility
JSSUN04	We have low setup times of equipment in our plant
JSPLN06	We use a kanban pull system for production control
JSMHN08	We have located our machines to support JIT production flow

Item code	Customer orientation practices
QSVCN03	We believe that organizations should be pro-active regarding customers' needs
QSCON01	We are frequently in contact with our customers
QSVCN06	Our plant satisfies or exceeds the requirements and expectations of our customers
QSCSN02	Our customers seem happy with our responsiveness to their problems

Item code	Supplier relationship management practices
QSSUN03	We help our suppliers to improve their quality
*PSTRN03	We believe that cooperating with our suppliers is beneficial
*PSSPN04	We monitor the performance of members of our supply chains, in order to adjust supply chain plans
*PSSPN03	We strive to manage each of our supply chains as a whole

Item code	Integrated product development practice
*MSPMN02	In order to improve equipment performance, we sometimes redesign equipment
**QSSPN02	Our suppliers are actively involved in our processes of new product development
*TSNPN03	Direct labor employees are involved to a great extent before introducing new products or making product changes

Item code	Workforce development practices
HSMFN03	Our employees receive cross training for replacing others when necessary
*HSVCN02	We encourage our employees to work together for achieving common goals
HSTWN10	Our employees regularly receive training to improve their skills
HSTMN03	Our plant forms teams to solve problems

Item code	Leadership practices
***HSESN01	Management takes all product and process improvement suggestions seriously
***HSPCN01	Our incentive system encourages us to vigorously pursue plant objectives
*SSR3N02	We have a manufacturing strategy that is actively pursued

* Items dropped from the measurement model
** Items moved to supplier relationship practices
*** Items moved to workforce development practices

APPENDIX B – SCALES FOR RESOURCES

Item code	Human resources management
HSLYN02	I talk up this organization to my friends as a great organization to work for.
HSLYN04	I find that my values and this organization's values are very similar.
HSLYN06	This organization really inspires the best in me in the way of job performance.
HSLYN07	I am extremely glad that i chose this organization to work for, over others i was considering at the time i joined.
HSLYN09	For me, this is the best of all organizations for which to work.
*HSLYN03	I would accept almost any type of job assignment in order to keep working for this organization.

Item code	Technology
SSR4N04	We pursue long-range programs, in order to acquire manufacturing capabilities in advance of our needs.
SSR4N05	We make an effort to anticipate the potential of new manufacturing practices and technologies.
SSATN06	Our plant stays on the leading edge of new technology in our industry.
SSATN07	We are constantly thinking of the next generation of manufacturing technology.

Item code	Proprietary equipment
SSR4N01	We actively develop proprietary equipment.
SSPEN04	We have equipment that is protected by our firm's patents.
SSPEN05	Proprietary equipment helps us gain a competitive advantage.
SSPEN07	We frequently modify equipment to meet our specific needs.
*SSPER06	We rely on vendors for most of our manufacturing equipment.

* Items dropped from the measurement model

APPENDIX C – SCALES FOR OPERATIONAL PERFORMANCE

Item code	Quality
GRCPN10	Performance and capacity of products
GRCPN02	Conformance to product specifications

Item code	Delivery
GRCPN04	Fast delivery

GRCPN03	On time delivery

Item code	**Flexibility**
GRCPN06	Flexibility to change volume
GRCPN05	Flexibility to change variety of products
GRCPN09	Fast introduction of new products

Item code	**Cost**
GRCPN07	Inventory turnover
GRCPN08	Cycle time from raw materials to delivery
GRCPN01	Unit production cost