



The relationship between Leadership style and the success of Lean Six Sigma implementation

by

Daniela Maria Costa Nogueira

Master Dissertation in Management

Faculdade de Economia, Universidade do Porto

Supervised by:

Professor Maria do Rosário Mota Oliveira Alves Moreira

Professor Paulo Sérgio Amaral de Sousa

September, 2017

Biographic Note

Daniela Maria Costa Nogueira was born on 5th September 1994, in Famalicão, Braga, Portugal.

In 2015, Daniela obtained the Bachelor's degree in Economics by School of Economics and Management of University of Porto. In the same year, she decided to join the Master in Management at the same faculty, which allowed her to obtain complementary knowledge in management subjects, such as quality, operations and supply chain, acquiring a more practical perspective about management.

Acknowledgments

To begin with, I would like to thank my supervisors. Firstly, Professor Maria do Rosário Moreira, to the knowledge and experience transmitted but, above all, to the motivation and support, without which this dissertation could not be concluded. Thank also to Professor Paulo Sousa for his fundamental availability and contribution in this research.

To my closest friends, my acknowledgment for the incentives, help and patience.

To my parents, the biggest thank to the opportunity.

Abstract

Purpose – the purpose of this study is to better understand the role that leadership takes in the success of lean six sigma implementation, trying to identify what is the impact of the transactional, transformational, directive and empowering leadership styles in the success of this implementation in Portuguese companies, and what are the most important leaders' attributes concerning this implementation.

Design/methodology/approach – an on-line questionnaire was distributed among 65 manufacturing and services Portuguese organizations that have implemented the LSS.

Findings – The results suggest that empowering leadership has a positive impact in the success of LSS implementation. Even though results do not allow to conclude about the impact of the other styles, several leader's attributes were identified as having an influence: individualized consideration, information sharing, skill development, intellectual stimulation, assigned goals and self-directed decision making

Originality/value – Few studies were addressed to research the role of leadership in the success of adopting lean six sigma and to our best knowledge, only one paper studied the critical attributes of leaders in lean implementation. Moreover, the study will be conducted in Portugal where this theme has been rarely investigated.

Key-words: Lean six sigma; Leadership; Transactional; Transformational; Directive; Empowering

Contents

1. Introduction.....	1
2. Literature Review	3
2.1. Lean Six Sigma	3
2.1.1. Lean.....	3
2.1.2. Six Sigma	4
2.1.3. Lean Six Sigma	6
2.2. Leadership Styles	8
2.3. The Relationship Between Leadership and Lean Six Sigma	11
2.4. Measures of Lean Performance.....	12
2.5. Hypotheses	13
3. Methodology	15
3.1. Methodology of Similar Studies	15
3.2. Methodology Adopted	16
3.3. Measures	17
3.4. Sample.....	20
4. Results.....	22
4.1. Descriptive analysis	22
4.2. Empirical validation of the research hypotheses.....	23
5. Conclusion	32
References.....	34
Annex 1 - Questionnaire	40
Annex 2 – Questionnaire translation	45
Annex 3 – Email example.....	50
Annex 4 – SPSS Outouts (H1.1, H2.1, H3.1 and H4.1)	51
Annex 5 – SPSS Outputs (H1.2, H2.2, H3.2 and H4.2)	52
Annex 6 – SPSS Outputs (Correlations).....	54

List of Tables

Table 1 - Types of Waste	3
Table 2 - Definitions of LSS	6
Table 3 - Critical Success Factors of LSS implementation	7
Table 4 - Leadership styles comparison	10
Table 5 - Results of the similar studies	12
Table 6 - Methodology of the similar studies	15
Table 7 - Questionnaires used in similar studies	16
Table 8 - Questionnaire description	18
Table 9 - Hypotheses to be tested	19
Table 10 - Correspondence between questionnaire items and leaders' attributes	19
Table 11 - Correspondence between questionnaire items and lean dimensions	20
Table 12 - Average value of variables	23
Table 13 - Results of Mann-Whitney tests	24
Table 14 - Results of Mann-Whitney tests	26
Table 15 - Spearman correlation coefficients among leadership styles	27
Table 16 - Confidence intervals of Spearman correlation coefficients	28
Table 17 - <i>p-values</i> of Wilcoxon test	29
Table 18 - Spearman coefficient correlation and confidence interval	29
Table 19 - Spearman correlation coefficient between each leadership dimensions and the success of LSS implementation	30

List of figures

Fig. 1 - Hypotheses validation	27
--------------------------------------	----

1. Introduction

The success of lean six sigma (LSS) implementation in some well-known organizations boosted its implementation in many others around the world (Laureani and Antony, 2017). In addition, the last economic crisis and its consequent recession increased the need for competition and, therefore, the need to implement tools and techniques to improve the competitive level (Alsmadi *et al.*, 2012), such as LSS practices. Despite the popularity and success, there are various cases in which this implementation proved to be unsuccessful (Laureani and Antony, 2017), which may be associated with an increasing concern about the implementation failures (Chakravorty, 2009). As an attempt to better understand those failures, previous studies have identified the critical success factors for the LSS implementation, identifying leadership as one of them (Laureani and Antony, 2017). In fact, leaders' role in an organization is nowadays recognized as critical to support change (Pamfilie *et al.*, 2012); nevertheless, few studies were addressed to the study of the role of this specific factor (Laureani and Antony, 2016).

Consequently, the purpose of this research is to fulfill a gap in the literature and better understand the role that leadership takes in the success of LSS implementation. As few studies were addressed to study the role of leadership in the success of adopting LSS (Snee and Hoerl, 2003) and to our best knowledge, only one paper (Laureani and Antony, 2016) studied the critical characteristics of leaders concerning the lean implementation, this study aims at adding value to the existent literature. To better comprehend the role of leadership, the study aims to identify what is the impact of leadership style in the success of LSS implementation and what are the most important attributes that leaders should have to facilitate this implementation. This information may help organizations that are implementing or thinking about starting to implement LSS to identify if they have the right leadership attributes to facilitate success or if they need to change it. In order to achieve this goal, a survey was developed to Portuguese companies that have implemented LSS to determine the leadership style and attributes of the managers and to assess the success of LSS implementation, directly through the leader answer, and indirectly verifying which lean techniques are in fact implemented.

To achieve the main objective of this research, this dissertation is organized as follows. Firstly, in Section 2, the literature regarding lean six sigma, leadership styles, previous

studies that relate both and measures of lean performance is reviewed. Section 3 presents the methodological considerations, including an analysis of the methodology used by similar studies and the method selected to this research. Later on, Section 4 includes the results of the data analysis, and in the last section the Conclusion is presented.

2. Literature Review

This chapter includes the main literature review about the topics in discussion, and it is divided in four main sections. Section 2.1 is about lean six sigma, containing a first description of both approaches, lean and six sigma. In Section 2.2 a definition of leadership is presented and the most common leadership styles are described. Section 2.3 is related to the relationship between the previous ones, leadership and lean six sigma and presents the results achieved by similar studies. The final section, 2.4, describes the measures of lean performance.

2.1. Lean Six Sigma

2.1.1. Lean

Lean is a “systematic approach to identify and eliminate waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection” (Sunder, 2015, pp. 282). It was introduced in Toyota in the 1950s by Taiichi Ohno, through the Toyota Production System, which objective was to achieve improvements in efficiency by reducing *muda*, the Japanese word that means waste, and that “became one of the most important concepts in quality improvement activities” (Dahlgard and Dahlgard-Park, 2006, pp. 264). The Toyota Production System was later converted into a management philosophy in which waste of all types is reduced through the elimination of inefficient activities (Alsmadi *et al.*, 2012). The waste of “all types” includes seven types of waste according to Ohno (1988), defined in the Table 1.

<i>Wastes</i>	<i>Definition according to Ohno (1988)</i>
Defects	Waste of making defective products
Inventory	Waste of stock at hand (work-in-process and finished goods inventory)
Over processing	Unneeded steps to process the parts
Overproduction	Unnecessary process transformations
Transportation	Unnecessary movements of material or products
Unnecessary movement	Motions that do not increase the value of the product
Waiting	Waste of time at hand, due to delays in the actions that accomplish process transformation

Table 1 - Types of Waste
Source: adapted from Thürier *et al.* (2017)

Along with the removal of waste, lean can be based on other three concepts: lean tools and techniques, the involvement of people and continuous improvement (Assarlind *et al.*, 2013). One of the notable lean tools and techniques is the Value Stream Mapping, used to map and analyze the activities in the process, to allow the identification and elimination of the non-value added ones. “The methodology emphasizes on empowering organizational front-line employees through waste reduction” (Sunder, 2015, pp. 282). Among the benefits of using the Value Stream Mapping it is possible to identify the common language that it provides and the fact that it incorporates all the lean techniques (Rother and Shook, 2003).

In a deeper analysis, Shah and Ward (2007) identify ten components of a lean system, namely: supplier feedback; just-in-time (JIT) delivery by suppliers; supplier development; customer involvement; pull production; continuous flow; set-up time reduction; total productive/preventive maintenance; statistical process control and employee involvement. To reduce the waste of all types, the organizations must reduce or eliminate the variability of supply, demand and processing time simultaneously, otherwise only some of the waste will be eliminated. This means that these ten dimensions are correlated. In order to reduce the variability of the process, products and machines must be grouped to allow a continuous flow and preventive maintenance should be applied to prevent pauses. The products and machines grouped allow employees to identify problems and the cross-training allows a quicker and effective resolution of them. The customer involvement allows a better prediction of customer demand, while the reduction of set-up times and the statistical process control enable a better prediction of process output. To produce on a JIT basis, it is used the Kanban and a pull production system, that requires also a JIT delivery by suppliers. The JIT delivery by suppliers can be improved by providing regular feedback and training (Shah and Ward, 2007).

2.1.2. Six Sigma

Six sigma was first introduced by Bill Smith in Motorola, in the 1980s, being widely responsible for the Motorola quality turnaround achieved in those years. It was then introduced in General Electric, but the first use of the term was made by the company Johnson & Johnson in 1988 (Snee, 2010).

Six sigma can be interpreted in four different ways, as a “set of statistical tools, an operational philosophy of management, a business culture and an analysis methodology that uses the scientific methods” (Tjahjono *et al.*, 2010, pp. 220). As a statistical measure, it counts the probability of defects in a process, allowing the identification of the causes of the problem and permitting improvements in the process through the elimination of the root causes of defects, before they happen (Antony, 2006). Through the emphasis on variation reduction, this approach allows cost reductions and increases in customer satisfaction, at the same time (Bendell, 2006).

One of the most used methodologies is the DMAIC process, consisting of five phases: (1) Define - identify the process/product that needs to be improved; (2) Measure - identify the critical product/process characteristics; (3) Analyze - analyze the key performance metrics, identifying the critical factors of performance; (4) Improve – select the performance characteristics that must be improved; (5) Control - ensure that the improvements are monitored using methods of statistical process control. If the outcome is not the expected, some of the preceding phases may be revisited (Park, 2003). Therefore, six sigma is a process improvement methodology as it improves the understanding of companies about their products and processes, providing then higher quality, efficient development and operating costs (Suresh *et al.*, 2012). This helps to create competitive advantage and achieve long-term goals (Sunder, 2015). In fact, six sigma focuses on the bottom line results (Snee, 2010).

According to Andersson *et al.* (2014), six sigma can be implemented not only in the production phase, but in the whole company, and it includes the following main components: “a clear infrastructure, fact-based decisions, effective and efficient methods and tools, systematic follow-up and feedback on results, comprehensive training programs, and uniform procedures for improvement and design of products, processes, and systems” (Andersson *et al.*, 2014, pp. 906).

2.1.3. Lean Six Sigma

Lean six sigma is an integration of both lean and six sigma, which occurred only in the late 1990s and 2000s (Laureani and Antony, 2012). There are various definitions of LSS, some of them are systematized in the Table 2.

<i>Author</i>	<i>Definition</i>
Laureani and Antony (2012), pp. 275	“LSS is a business improvement methodology that aims to maximize shareholder’s value by improving quality, speed, customer satisfaction and costs: it achieves this by merging tools and principles from both Lean and Six Sigma”.
Salah <i>et al.</i> (2010), pp. 259	“LSS can be described as a methodology that focuses on the elimination of waste and variation, following the DMAIC structure, to achieve customer satisfaction with regards to quality, delivery and cost. It focuses on improving processes, satisfying customers and achieving better financial results for the business with regards to quality, delivery and cost”.
Snee (2010), pp. 10	“LSS is a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom-line results”.
Thomas and Barton (2011), pp. 42	LSS “enables companies to achieve the benefits of waste reduction and responsive manufacturing offered by Lean with developing robust, error free and fault tolerant production offered by Six Sigma”.

Table 2 - Definitions of LSS

Some organizations started to implement one of these methodologies first, and the other one later, in parallel (Bhuiyan and Baghel, 2005). However, evidence shows that they should be used simultaneously, as the parallelism can cause dilemmas such as the choice between the right methodology, the allocation of resources and the initiatives that should be prioritized. In fact, one of the benefits of the integration is that it “enables people to choose the right tools to attack different problems” (Salah *et al.*, 2010, pp. 251). They complete each other, helping to overcome the limitations of both and increasing the potential improvement of the organizations (Bhuiyan and Baghel, 2005).

According to Snee (2010), there are eight key characteristics that LSS has that make it different and more likely to achieve success comparing to other approaches. To begin with, LSS (1) creates bottom line results and it (2) encourages an active senior management leadership. In addition, he also mentioned the fact that it (3) uses the DMAIC approach, which (4) allows a rapid program completion, more specifically in

three-six months; LSS has also a (5) clear definition of success and a (6) clearly specified infrastructure to success; it (7) focuses on customers and processes and (8) uses statistical thinking and methods.

Despite these characteristics that allow LSS to be a successful approach, there are a lot of cases in which this implementation proved to be unsuccessful (Laureani and Antony, 2017). To better understand those failures, previous studies have identified the critical success factors for the LSS implementation. Table 3 presents the most important results of those studies, according to the review of the literature made by Backar *et al.* (2015).

<i>Critical success factor</i>	<i>Description</i>	<i>Authors</i>	<i>Position (Importance)</i>
Leadership	“The ability of an individual to influence, motivate, and enable others to contribute toward the effectiveness and success of the organizations of which they are members”. (House <i>et al.</i> , 2001, pp. 494)	Backar <i>et al.</i> (2015) / Yadav and Desai (2016)	4 th /1 st
Linking LSS to strategy	The change initiative should be linked to the organization’s strategy and should also support it (Näslund, 2013)	Lande <i>et al.</i> (2016) / Laureani and Antony (2012)	9 th /5 th
LSS competency	Includes things such as the understanding of the tools and techniques and the skills of the project leader (Backar <i>et al.</i> , 2015)	Manville <i>et al.</i> (2012) / Yadav and Desai (2016)	5 th /3 rd
Management commitment	It involves the creation of consciousness about improvement needs and increase the chance of success through, for example, obstacles elimination, resources allocation, progresses review and rewards for effort (Snee, 2010)	Jeyaraman and Teo (2010) / Lande <i>et al.</i> (2016)	1 st /2 nd
Organizational infrastructure and project management	It includes the project’s leadership and the formation of the project, including the project team and approach (Näslund, 2013)	Jeyaraman and Teo (2010) / Manville <i>et al.</i> (2012)	5 th /7 th
Training	Consists in training both managers and workers, and can include things from general training to specific tools. It is important to provide education about the tools, knowledge and methods needed to understand the changes (Näslund, 2013)	Lande <i>et al.</i> (2016) / Laureani and Antony (2012)	1 st /2 nd

Table 3 - Critical Success Factors of LSS implementation

Backar *et al.* (2015) concluded that the most critical factors are: management commitment and leadership; LSS competency; training and education; organizational infrastructure and project management; and linking LSS to business strategy.

The leadership factor is one of the factors with highest importance in the LSS success, as it can be seen in Table 3. So, this study will focus on the leadership style, reviewed in detail in the next section.

2.2. Leadership Styles

There are several definitions of leadership in the literature. In the first Global Leadership and Organizational Behavior Effectiveness research conference, in 1994, 54 researchers reach a consensus about it, defining leadership as “the ability of an individual to influence, motivate, and enable others to contribute toward the effectiveness and success of the organizations of which they are members” (House *et al.*, 2001, pp. 494). Related to leadership, it is possible to find various school of thoughts, for example, leadership style, leadership model, leadership index and theories of leadership (Suresh *et al.*, 2012).

In terms of leadership styles, there is a vast tradition of conceptualization. For example, the path-goal theory identifies four styles of leader behaviors: achievement-oriented, directive, participative and supportive leaderships. However, the dominant typology is the Bass’s one (Opoku *et al.*, 2015; Sarti, 2014; Yahaya and Ebrahim, 2016), that defines the transactional and transformational leadership (Bass, 1990). Based on this tradition, Liu *et al.* (2003) suggests four different styles of leadership, integrating two different styles to this well-defined Bass paradigm: directive, transactional, transformational, and empowering. These styles are different from each other and represent distinct characteristics (Pearce *et al.*, 2003).

Transactional leadership

This type of leadership, as the name indicates, is based on transactions between managers and employees, where leaders recognize accomplishments and promise rewards for good performance and effort (Bass, 1990). The transactional leadership has 2 dimensions: contingent reward and management by exception (active and passive). These leadership dimensions are then reflected in the behavior of the leader, being recognized as leaders’ attributes. The first dimension, contingent reward, is characterized by the reward that

leaders give to employees when they achieve a certain level of performance, which means that the leader provides the goals and expectations. The other dimension represent a management by exception, i.e., the leader only makes interventions if something occurs differently than expected. In the passive case, the leader takes actions only if standards are not accomplished, while in an active case, the leader searches for standards deviations and takes corrective actions (Hartog *et al.*, 1997).

Transformational leadership

This style of leadership is present when leaders expand and raise the interests of the employees, creating consciousness of the group mission and giving employees incentives to look for the good of the group instead of looking to the personal good. This may be achieved through one or a combination of the following ways: (1) Leaders may be charismatic, providing vision and sense of mission, instilling pride and gaining respect and trust. A charismatic leader may inspire its employees, promoting the idea that they may accomplish great things if they apply extra effort in doing it. (2) Leaders may meet the emotional needs of each employee, paying attention to the differences among them; (3) Leaders may intellectually stimulate employees, showing new ways of looking to problems, instructing them to see difficulties as problems to solve, and emphasizing rational solutions (Bass, 1990).

According to Rafferty and Griffin (2004, pp. 332-334) there are five dimensions of transformational leadership: (1) vision, defined as “the expression of an idealized picture of the future”; (2) inspirational communication, viewed as “the expression of positive and encouraging messages about the organization, and statements that build motivation and confidence”; (3) intellectual stimulation, that means “enhancing employees’ interest in and awareness of problems, and increasing their ability to think about problems in new ways”; (4) supportive leadership, that means “expressing concern for followers and taking account of their individual needs”; and (5) personal recognition, that can be viewed as “the provision of rewards such as praise and acknowledgement of effort for achievement of specified goals”.

Directive leadership

Directive leaders make decisions single-handedly, which means that the subordinates rarely participate in decision-making (Liu *et al.*, 2003). The directive leader provides direction and command, assigns goals and expectations, and gives intimidation and reprimand (Pearce *et al.*, 2003).

Empowering leadership

Empowering leadership can be defined from two perspectives: the “power-sharing” perspective and the “self-efficacy” perspective. The first one emphasizes the power and responsibility that it gives to the subordinates, while the second one emphasizes the removal of the feeling of helplessness and the raise of the employees’ task-related intrinsic motivation (Li *et al.*, 2016). Zhang and Bartol (2010, pp. 109) integrate these two perspectives and define this leadership style as “the process of implementing conditions that enable sharing power with an employee by delineating the significance of the employee’s job, providing greater decision-making autonomy, expressing confidence in the employee’s capabilities, and removing hindrances to performance”. This leadership type has six different dimensions (Konczak *et al.*, 2000): delegation of authority, accountability, self-directed decision making, information sharing, skill development, and coaching for innovative performance.

A comparison among the styles is presented in the Table 4.

<i>Leadership Styles</i>	<i>Comparison (Pearce et al., 2003, pp. 300)</i>
Transactional	“Establish the conditions of the exchange relationship between leader and follower”
Transformational	“Define and sustain vision, elicit inspiration from followers, and stimulate change”
Directive	“Primarily associated with the leader giving orders on how work has to be done”
Empowering	“Mainly aimed at the development of followers, eventually molding them into effective self-leaders that are capable of initiative, creativity, and acting on their own”

Table 4 - Leadership styles comparison

2.3. The Relationship Between Leadership and Lean Six Sigma

According to Laureani and Antony (2017), there are 10 leadership characteristics that facilitate the success of LSS implementation: visible, communicative, inspirational, consistent, targeted, leading by example, flexible, perceive LSS as a philosophy, clearly define roles and responsibilities, and able to build. However, the leadership attributes identified cannot all be linked to one of the leadership styles, and for this reason they identify the need for a new leadership paradigm. In addition, they noticed that the topics about leadership style were mentioned more by interviewees from small organizations (fewer than 1000 employees) and participants from customer-service-led companies.

Gelei *et al.* (2015) divided the leadership attributes into three groups: contributor, inhibitor and neutral. They concluded that no one of the leadership behaviors (a set of leadership attribute) were inhibitors to the success adaptation of lean techniques. In addition, two of the leadership behaviors were considered as contributors: communicative and micro-manager. The communicative behavior includes five leadership attributes: communicative, motive arouser, improvement oriented, consultative, and inspirational. The micromanager behavior includes micromanager and non-delegator attributes.

Aij *et al.* (2015) identified the importance of going to the *gemba*, that means that the leader should understand the processes by seeing them in practice; employee empowerment and trust; and modesty and openness.

Assen (2016) studied the impact of higher management's leadership styles (transformational, servant and empowering leadership) on lean management (lean practices, and use of lean tools). The results show that empowering leadership is positively related to lean, while servant leadership is negatively related and transformational leadership has no impact. However, he also states that leadership styles are not related to the level of lean practices, and servant leadership is negatively related to the use of lean tools, while empowered leadership is positively related. Taking into account the leadership individual factors: standing back, humility and intellectual stimulation are negatively related to the use of lean tools, while informing and showing concern are positively related.

These conclusions are systematized in Table 5.

Author	Country	Industry	Results	
			Characteristics	Leadership style
Aij <i>et al.</i> (2015)	Netherlands	Healthcare	Going to the <i>gemba</i> ; Employee empowerment; Modesty	
Assen (2016)	Netherlands	Various	Informing and showing concern	Empowering style is positively related to lean, servant style is negatively related to lean, and transformational style has no impact
Gelei <i>et al.</i> (2015)	Hungary	Manufacturing firms	Communicative; Motive arouser; Improvement oriented; Consultative; Inspirational; Micromanager; Non-delegator	
Laureani and Antony (2017)	Various	Various	Visible; Communication; Inspirational; Roles, responsibility and relations; Consistent; Targeted; Philosophy; Leading by example; Flexible; Connection, competence and character	No existing style that comprehends all

Table 5 - Results of the similar studies

None of the authors identify one leadership style as being more conducive to LSS implementation success. Aij *et al.* (2015) and Gelei *et al.* (2015) only studied the leader attributes, not linking them to specific styles. Laureani and Antony (2017) identified the traits and characteristics more conducive to LSS implementation, also not linking them directly to styles, but concluding that there is not an existing style that comprehends all the characteristics identified. Only Assen (2016) made an analysis of both, styles and individual factors, only to senior managers.

2.4. Measures of Lean Performance

Lean aims at eliminating non value-add activities, which means that it might reduce costs and improve productivity. In fact, it is expected that lean increases the company profitability. In addition, as the lean implementation might reduce the number of defects and the production cost, it improves the company competitiveness and performance (Camacho-Miñano *et al.*, 2013). The market performance can also be improved, as the

manufacturing and management productivity are enhanced through the reduction of set-up times and work in process inventory (Yang *et al.*, 2011).

The business performance is commonly used as a measure of accomplishment of a company (Olhager and Prajogo, 2012). According to Büyüközkan *et al.* (2015), it can be divided into operational-competitive performance, market performance and financial performance. The operational performance is measured using the organization processes, such as delivery, flexibility and quality, the market performance is measured through the market share and measures for sales (Yang *et al.*, 2011), while the financial performance is measured using the return on assets, return on sales, return on investment, profits and market value (Büyüközkan *et al.*, 2015; Yang *et al.*, 2011).

2.5. Hypotheses

A transactional leader recognizes accomplishments and promises rewards for performance and effort (Bass, 1990). Laohavichien *et al.* (2009) states that this type of leadership can lead to successful quality performance, as the leader can reward the accomplishment of quality goals and give penalties to the ones that do not meet them. This clarification of leader's expectations builds commitment from employees to achieve the goals, such as innovative activities, and aligns the employees' expectations with the firm improvement needs, which also leads to a higher quality performance. The contingent reward creates employees' awareness about the expectation to develop new ideas and solutions regarding the processes and practices. In addition, through the management by exception, leaders closely monitor employees and give constructive feedback, which allows to identify which processes and practices need to be improved (Prasad and Junni, 2016). Therefore, it is possible to formulate H1.

H1: Transactional leadership is positively related to LSS implementation success

Transformational leaders provide vision, mission awareness, instill pride, respect and trust. They build motivation and confidence and stimulate the employees, increasing their consciousness and capability to look at problems in different ways. They are supportive leaders, showing concern and recognition and looking to individual needs (Rafferty and Griffin, 2004). Jung *et al.* (2003, pp. 528) state that through the vision and sense of mission leaders increase employees' "understanding of the importance and values associated with desired outcomes, raise their performance expectations and increase their

willingness to transcend their self-interests for the sake of the collective entity”; and through the confidence in employees’ skills, leaders increase their commitment to long-term goals, mission and vision. In addition, Pongpearchan (2016) states that transformational leadership has a positive impact on the performance of staffs, as it enhances the cohesiveness, commitment, motivation and trust. Therefore, it is possible to formulate H2.

H2: Transformational leadership is positively related to LSS implementation success

In a directive leadership, the leader makes decisions single-handedly, which means that the employees do not participate in this process (Liu *et al.*, 2003). Instead, the leader provides clear directions, command and expectations (Pearce and Sims, 2002). Directive leaders help followers in task completion and provide monitoring and performance feedback, which reduces process loss and allows quick decisions (Kahai *et al.*, 2004; Lorinkova *et al.*, 2013). Therefore, it is possible to formulate H3.

H3: Directive leadership is positively related to LSS implementation success

Dombrowski and Mielke (2013) identified the culture of improvement and the qualification as the principles of lean leadership, considering that the most adequate way to improve the processes is to continuously challenge them. The improvement culture includes the long-term thinking, considering the failure as an opportunity to improve and learn. To allow the employees to take part in the continuous improvement, their qualification is essential. It must occur not only in classes or training sessions, but essentially on a daily basis, through the solution of problems at the shop floor. The coaching approaches lead to a sustainable continuous improvement process, that is the aim of lean. As we saw before, an empowering leader shares the power with the employees by providing autonomy and encouraging them to make decisions, giving training to allow the necessary skill development and encouraging new ideas (Konczak *et al.*, 2000). Therefore, it is possible to formulate H4.

H4: Empowering leadership is positively related to LSS implementation success

3. Methodology

This chapter includes the description of the methodology that is applied to study the research questions stated. It includes an analysis of the methodology used by similar studies, the method selected to study the questions identified and the source of information that is used.

3.1. Methodology of Similar Studies

The previous studies about the relationship between leadership and LSS cover various industries, such as services, automotive, manufacturing and healthcare, nevertheless the most common studies search this relation to one industry in one country. The source of information is varied, with studies that collect data through interviews (Aij *et al.*, 2015; Laureani and Antony, 2017), but the most used method was the questionnaire (Assen, 2016; Dun and Wilderom, 2016; Gelei *et al.*, 2015; Pamfilie *et al.*, 2012; Sureerattanan *et al.*, 2014;). Netherlands is the country with more studies, one directed to only one industry (Aij *et al.*, 2015) and one to a variety of industries (Assen, 2016), using different methodologies.

When the questionnaire is used, the respondents are generally the top managers and, in some cases, team members. Table 6, presented below, synthetizes this information.

<i>Author</i>	<i>Country</i>	<i>Industry</i>	<i>N</i>	<i>Method</i>	<i>Who answer</i>
Aij <i>et al.</i> (2015)	Netherlands	Healthcare	6	Interview Experiences, observation, and document analysis	Team leaders and members
Assen (2016)		Various	199	Questionnaire	Middle managers
Dun and Wilderom (2016)		Manufacturing and service	429		Lean team- leaders and members
Gelei <i>et al.</i> (2015)	Hungary	Manufacturing	74		(Top) managers
Pamfilie <i>et al.</i> (2012)	Various	Services	28		Project manager and team members
Sureerattanan <i>et al.</i> (2014)	Thailand	Automotive	540		Managers of first-tier suppliers
Laureani and Antony (2017)		Various	21	One-to-one telephone interviews	LSS practitioners

Table 6 - Methodology of the similar studies

It was also relevant to analyze the type of questionnaire used in the studies, taking into consideration the number of questions, the scale used in the answers and the global structure. Table 7 presents this analysis, where it is possible to perceive that questionnaires are usually divided in different parts, one to access the information about lean and the other to access the information about leadership, using the five or/and seven-point Likert scales (Dun and Wilderom, 2016; Pamfilie *et al.*, 2012; Rossum *et al.*, 2016).

<i>Author</i>	<i>n</i>	<i>Scale</i>	<i>Structure</i>
Dun and Wilderom (2016)	12	five and seven-point Likert scales	Two parts: (1) a section on values, completed by the team leaders; (2) a part on work team - level information sharing behavior and team effectiveness, completed by the team members.
Rossum <i>et al.</i> (2016)	69	seven-point Likert scale	Two parts: (1) Assessing the existing organizational lean culture; (2) leader behavior questionnaire
Pamfilie <i>et al.</i> (2012)	17	five-point Likert scale	Three parts: (1) related to leadership and organizational culture and LSS excellence model; (2) identify impediments in organization cultural change; (3) related to employee motivation

Table 7 - Questionnaires used in similar studies

3.2. Methodology Adopted

The method used to study the research question behind this work is the questionnaire. Firstly, because it is the most employed method in the similar studies. Secondly, because it is the most indicated one, as the aim is not to have a detailed perspective, but a high volume of observations.

The questionnaire was distributed among the Portuguese companies that have implemented the LSS, presenting five different parts: 1st part to assess general data; 2nd to determine the leadership characteristics and style; 3rd to assess the success of LSS implementation and 4th and 5th part to assess the perception of the leader about the LSS implementation and leadership style, respectively.

3.3. Measures

To determine the leadership styles and attributes of the leaders (through the correspondent leadership dimensions), the survey was developed adapting three previous questionnaires from literature. Transactional and transformational leadership are measured using the Multifactor Leadership Questionnaire (Avolio and Bass, 2004), form 5X-Short. Transactional leadership is measured by two dimensions, contingent reward and management by exception active, performing a total of 7 items. The transformational leadership is assessed through 5 dimensions: idealized influence – attributed, idealized influence – behavior, inspirational motivation, intellectual stimulation and individualized consideration, reflected in 18 items. Directive leadership was measured using the questionnaire developed by Pearce and Sims (2002), performing a total of 2 items, representing their 2 dimensions (assigned goals, and instruction and command). Empowering leadership is measured using Konczak *et al.*'s (2000) Leader Empowering Behavior Questionnaire. The empowering scale consists of 13 items for the 6 dimensions: delegation of authority, accountability, self-directed decision making, information sharing, skill development, and coaching for innovative performance.

To assess LSS implementation success two different ways were adopted. The first one is an adaptation of the 10 measures of lean manufacturing practices developed by Shah and Ward (2007). These measures are widely adopted by similar studies (Alsmadi *et al.*, 2012; Assen, 2016; Gelei *et al.*, 2015; Sureerattanan *et al.*, 2014) and include 3 measures of supplier involvement (supplier feedback, JIT delivery, developing suppliers), one of customer involvement (involved customers) and 6 measures of internal processes (pull, flow, low set-up, controlled processes, productive maintenance, and involved employee), reflected in 43 items. The second one is through the company performance. According to Büyüközkan *et al.* (2015), business performance can be divided in operational performance, market performance and financial performance. The operational performance is measured using the organization processes, the financial performance is measured using the ROI (return on investment) and the market performance is measured through the market share.

A brief description of each part of the questionnaire can be seen in the Table 8 and the questionnaire is presented in Annex 1. Annex 2 presents its Portuguese translation, as it was delivered to Portuguese companies.

<i>Part</i>	<i>Content</i>	<i>Description</i>
I	General information	5 open questions: job position, activity sector, CAE, sales volume, number of employees
II	Leadership style	5-point Likert scale questions about the leadership styles
III	Lean practices	5-point Likert scale questions about the lean implementation
IV	Lean performance	5 questions
V	Leadership style perception	1 question

Table 8 - Questionnaire description

The dominant leadership style is determined by the arithmetic average of the items of each style's scores, i.e., the scores of each style are added and divided by the number of items corresponding to that style (Sarver and Miller, 2014). The correspondence between the style and the questionnaire items is presented on the table below. The LSS implementation success is determined, on one hand by the score of the items related to the practices implemented, and on the other hand through the score of the items related to the business performance. For this reason, each one of the hypotheses is divided into two different hypotheses, described in the Table 9.

<i>H</i>	<i>Description</i>	<i>Authors</i>	<i>Questionnaire Items (3rd part)</i>
H1.1	Transactional leadership is positively related to LSS implementation success, measured through the practices implemented	Bass (1990); Laohavichien <i>et al.</i> (2009); Prasad	16-18, 22-24, 26
H1.2	Transactional leadership is positively related to LSS implementation success, measured through the business performance	and Junni (2016)	
H2.1	Transformational leadership is positively related to LSS implementation success, measured through the practices implemented	Jung <i>et al.</i> (2003); Pongpearchan	2, 3, 6, 9, 10, 12-14, 19, 25, 31-38
H2.2	Transformational leadership is positively related to LSS implementation success, measured through the business performance	(2016); Rafferty and Griffin (2004)	

(continue next page)

<i>H</i>	<i>Description</i>	<i>Authors</i>	<i>Questionnaire Items (3rd part)</i>
H3.1	Directive leadership is positively related to LSS implementation success, measured through the practices implemented	Kahai <i>et al.</i> (2004); Liu <i>et al.</i> (2003); Lorinkova <i>et al.</i> (2013);	4, 27
H3.2	Directive leadership is positively related to LSS implementation success, measured through the business performance	Pearce and Sims (2002);	
H4.1	Empowering leadership is positively related to LSS implementation success, measured through the practices implemented	Dombrowski and Mielke (2013);	1, 5, 7, 8, 11, 12, 15, 20, 21,
H4.2	Empowering leadership is positively related to LSS implementation success, measured through the business performance	Konczak <i>et al.</i> (2000)	23, 28-30

Table 9 - Hypotheses to be tested

As presented previously, each leadership style comprises several dimensions. Table 10 presents the correspondence between each dimension and the items contained in the questionnaire included to ascertain the attribute of the leader (the dimension of the style).

<i>Style</i>	<i>Total Items</i>	<i>Attribute</i>	<i>Questionnaire Items</i>
Transactional	7	Contingent reward	22-24, 26
		Management by exception active	16-18
Transformational	18	Idealized influence – attributed	12, 19, 37, 38
		Idealized influence – behavior	31-33, 36
		Inspirational motivation	25, 34, 35
		Intellectual stimulation	6, 9, 10, 13
		Individualized consideration	2, 3, 14
Directive	2	Assigned goals	27
		Instruction and command	4
Empowering	13	Delegation of authority	20, 21
		Accountability	23, 28
		Self-directed decision making	7, 8
		Information sharing	29, 30
		Skill development	1, 5
		Coaching for innovative performance	11, 12, 15

Table 10 - Correspondence between questionnaire items and leaders' attributes

Table 11 presents a detailed description of the questionnaire (3rd part) showing the correspondences between the items and the lean dimensions.

<i>Dimensions</i>	<i>Total Items</i>	<i>Factors</i>	<i>Questionnaire Items</i>
Supplier related	14	Supplier feedback	1-5
		JIT delivery	6-8
		Developing suppliers	9-12, 40, 41
Customer related	6	Involved customers	13-18
		Pull	19, 20
		Flow	21-25
Internally related	23	Low set-up	26, 27, 42
		Controlled processes	28-31, 43
		Involved employee	32-35
		Productive maintenance	36-39

Table 11 - Correspondence between questionnaire items and lean dimensions

3.4. Sample

To identify the Portuguese companies that have implemented the LSS, the Kaizen Institute Portugal was contacted by phone. As the Institute does not have a formal and available database with this information, the Marketing and Back Office Manager of Kaizen Institute Portugal suggested searching for the companies that may have implemented the LSS, in various sources. The first source should be the companies included in the pool of winners of the annual Kaizen prize. Moreover, the periodic newsletter of the Kaizen Institute Portugal reports several cases of lean/kaizen implementation. We also search for companies that have potentially implemented LSS in LinkedIn.

After having this list, we started building our own database with information about the company name, sector, project associated to lean and, if available, the name of the project manager. Once the companies' names were collected, they were contacted by phone, one by one, in order to have indication about the name of the manager associated with the lean implementation project and the e-mail contact. To each manager, an initial e-mail was sent to introduce our study, to ascertain the availability to answer the on-line survey and to confirm if the manager in charge of the lean project is/was really the one we were contacting. An example of the e-mail (in Portuguese) is included in Annex 3. Then, after confirming the person and the e-mail address, the link of the on-line survey become

available and was distributed by e-mail. At September 1st, due the low number of responses (11), a new e-mail was sent to create consciousness about the importance of the research and request the fulfillment of the questionnaire. It was open from the 10 of August till the 13 of September (in order to collect the maximum number of answers).

The data collected is analyzed with the IBM SPSS Statistics software (24.0 version), and the results are presented in the chapter below.

4. Results

This chapter includes the description and analysis of the data collected through the questionnaires. Section 4.1 presents a descriptive analysis of the leaders' responses. In Section 4.2 the research hypotheses are empirically validated and an analysis of the correlations is made.

4.1. Descriptive analysis

The questionnaire was sent to 65 leaders from manufacturing and service organizations. However, only 25 responses were received, which means that the response rate was 38%.

Most of the organizations (76%) are manufacturing industries, such as drinks, wood and cork, paper and cardboard, textile and automobiles industries. The remaining 24% includes, for example, construction, consulting, transport and administration organizations.

The number of employees is, on average, 680. Only one organization has less than 50 employees, 54% have less than 250 and 46% above this number. Regarding the sales volume, organizations present average values of 170 million (in euros), with 21% below 10 million and 25% above 200 million.

Concerning the lean tools, organizations started to use them, on average, 7 years ago. The helpfulness of this implementation in the achievement of organizations' goals was recognized by 92% of the leaders, with 96% of those asserting a high or very high impact. In terms of financial profitability, most of the leaders (92%) indicated that LSS implementation had a positive impact, high or very high in 61% of these cases. The LSS impact in market share was only recognized by 68% of leaders, and less than half (41%) indicated a high or very high impact.

In terms of the leadership style that leaders think that describes them better, the responses were almost equally distributed among the four styles. Transactional style was indicated by 20% of leaders, transformational collected 32% of the responses and the remaining percentage was divided by directive and empowering styles, with 24% each.

The average values obtained to each leadership style and Lean are presented in the Table 12.

<i>Variable</i>	<i>Average value</i>
Transactional Leadership	3.75
Transformational Leadership	4.14
Directive Leadership	4.00
Empowering Leadership	4.15
Lean Measures	3.70
Supplier related	3.50
Customer related	4.24
Internally related	3.70

Table 12 - Average value of variables

4.2. Empirical validation of the research hypotheses

This section describes and evaluates the research hypotheses identified. The hypotheses were tested using again the SPSS software. The SPSS outputs are presented in Annex 4.

The analysis is divided into two parts: firstly, the research hypotheses are tested and then an analysis of the correlations is made. In order to test the 4 types of hypothesis (H1 to H4) the Mann-Whitney non-parametric test¹ was employed. This non-parametric test, allows assessing whether there is enough evidence of differences statistically significant between the averages of leadership styles in each of the two groups considered.

For the first type of hypotheses (H1.1, H2.1, H3.1 and H4.1), the groups were defined according to the 3rd part of the questionnaire, related to the implementation of LSS practices. One group corresponds to the companies that have currently implemented at least half of the practices included in the survey (22 practices that is more than half of the 43 items) and the other group was constituted by the companies with a lower number of lean practices (less than 22). Actually, when the company answers ‘never’ (level 1 in Likert scale), ‘rarely’ (level 2) or ‘sometimes’ (3), we considered that the practice is not fully implemented yet. When the answer is ‘fairly often’ (4) or ‘very often, if not always’ (5), we considered it is implemented and part of the company daily practices. We considered statistically significant, the tests with a $p\text{-value} \leq \alpha = 0,05$. The results are presented in Table 13.

¹ It is a non-parametric test that is used to compare two sample means that come from the same population. It tests the null hypothesis that the two samples means are equal in the two defined groups.

<i>Group</i>	<i>H</i>	<i>Mann Whitney U</i>	<i>Exact sig. (2 tailed)</i>	<i>Decision ($\alpha=0,05$)</i>
Implementation of Lean practices	H1.1	57.5	0.759	Not reject H0
	H2.1	44.5	0.273	Not reject H0
	H3.1	55.0	0.663	Not reject H0
	H4.1	20.5	0.008	Reject H0

Table 13 - Results of Mann-Whitney tests

As the tests are considered statistically significant when $p\text{-value} \leq \alpha=5\%$, there is only one null hypothesis that is rejected: the H4.1 (the $p\text{-value}$ is 0.008) related to the empowering leadership style. We reject the hypothesis that the level of empowering leadership is the same in the two defined groups (the ones that have LSS implementation success and the ones that do not have; being the success measured by the intensity and number of practices implemented). We may say that the empowering leadership style presents significant statistical evidence of influencing the success of LSS implementation. Moreover, we may say that the influence is positive as the group of companies that have success in the implementation of LSS have a higher level of empowering attitudes (an average of 4,24 *versus* a mean of 3,90 in the other group).

Concerning the other leadership styles (transactional, transformational and directive), as we can't reject the null hypothesis (H1.1, H2.1 and H3.1) that the two samples means are equal in the two defined groups we, consequently, are not able to conclude nothing about the impact of those leadership styles in the LSS implementation success. There is no evidence that the transactional, transformational and directive leadership style have a positive impact in the success of LSS implementation.

This conclusion is in line with the studies of Aij *et al.* (2015), that recognizes employee empowerment as an important characteristic when implementing LSS and Assen (2016), who concludes that a leadership based in the involvement of employees, by delegating authority and giving accountability, is positively related to the success of lean (and previously JIT) and the use of Lean tools. In the Portuguese case, among the surveyed companies that are in a kaizen, lean or LSS process implementation, the ones whose leader has more empowering attitudes have a higher success in their LSS implementation.

Consequently, we may recommend to companies that are thinking about starting a similar process, to pay attention to the attitudes (dimensions) of this style: delegation of authority, accountability, self-directed decision making, information sharing, skill development, and coaching for innovative performance.

A similar analysis was made to test the other hypotheses (H1.2, H2.2, H3.2 and H4.2). The hypotheses were tested through the Mann-Whitney test, using the leadership styles but with different measures of LSS implementation success. In this case, the groups were defined according to the 4th part of the questionnaire, related to the lean performance.

Concerning the financial profitability (the hypothesis with an “a” next to the name – H1.2a, e.g.) one group corresponds to the companies that report no improvement on the financial profitability due to LSS implementation (when the company answers ‘very low’ (1 in Likert scale), ‘low’ (2) or ‘moderate’ (3)) and the other was constituted by the companies that report an improvement (when the company answers ‘high’ (4) or ‘very high’ (5)). For testing the remaining hypotheses, the groups of companies were sorted among the two groups depending on the intensity of impact on LSS implementation on market share (the hypothesis with an “b” next to the name), and organizations’ goals (the hypothesis with an “c” next to the name).

The results are presented in Table 14 and the SPSS outputs in the Annex 5.

<i>Group</i>	<i>H</i>	<i>Mann Whitney U</i>	<i>Exact sig. (2 tailed)</i>	<i>Decision ($\alpha=0,05$)</i>
Financial profitability	H1.2a	59.5	0.347	Not reject H0
	H2.2a	75.0	0.925	Not reject H0
	H3.2a	57.5	0.289	Not reject H0
	H4.2a	75.0	0.912	Not reject H0
Market share	H1.2b	53.5	0.586	Not reject H0
	H2.2b	61.5	0.942	Not reject H0
	H3.2b	28.5	0.031	Reject H0
	H4.2b	54.5	0.625	Not reject H0

(continue next page)

Organizations' goals	H1.2c	24.0	0.503	Not reject H0
	H2.2c	32.0	0.951	Not reject H0
	H3.2c	15.0	0.140	Not reject H0
	H4.2c	20.5	0.293	Not reject H0

Table 14 - Results of Mann-Whitney tests

Taking into consideration the *p-values*, it is not possible to reject none of the null hypotheses, except in H3.2b case, that presents a *p-value* equal to 0.031. In H3.2b we reject the hypothesis that the level of directive leadership is the same in the two defined groups (the ones that have a market share improvement (success) and the ones that do not have). We may say that the directive leadership style presents significant statistical evidence of influencing the success (when measured by the market share increase) of LSS implementation. Moreover, although surprisingly, we may say that the influence is negative as the group of companies that have an increase in the market share (i.e., have success) have a lower level of directive attitudes (an average of 3,57 *versus* a mean of 4,17 in the other group).

Accordingly, we may infer that in the Portuguese case, among the surveyed companies that are in a kaizen, lean or LSS process implementation, the ones whose leader has less directive attitudes have a higher success in their LSS implementation. Therefore, we suggest companies in some lean or kaizen process, to pay attention to the dimensions of this directive style in order to avoid this kind of attitudes.

Concerning the other leadership styles (transactional, transformational and empowering), we cannot reject the null hypothesis that the two samples means are equal in the two defined groups. Consequently, we are not able to make conclusions about the impact of those leadership styles in the LSS implementation success measured by the financial profitability, market share increase and organizations' goals. There is no evidence that the transactional, transformational and empowering leadership styles have a positive impact in financial profitability, market share increase and organizations' goals.

Figure 1 synthesizes the hypotheses testing results. The dashed red arrows indicate hypotheses that are rejected (the *p-value* is less than 0.05). In all the others, we cannot conclude about the impact.

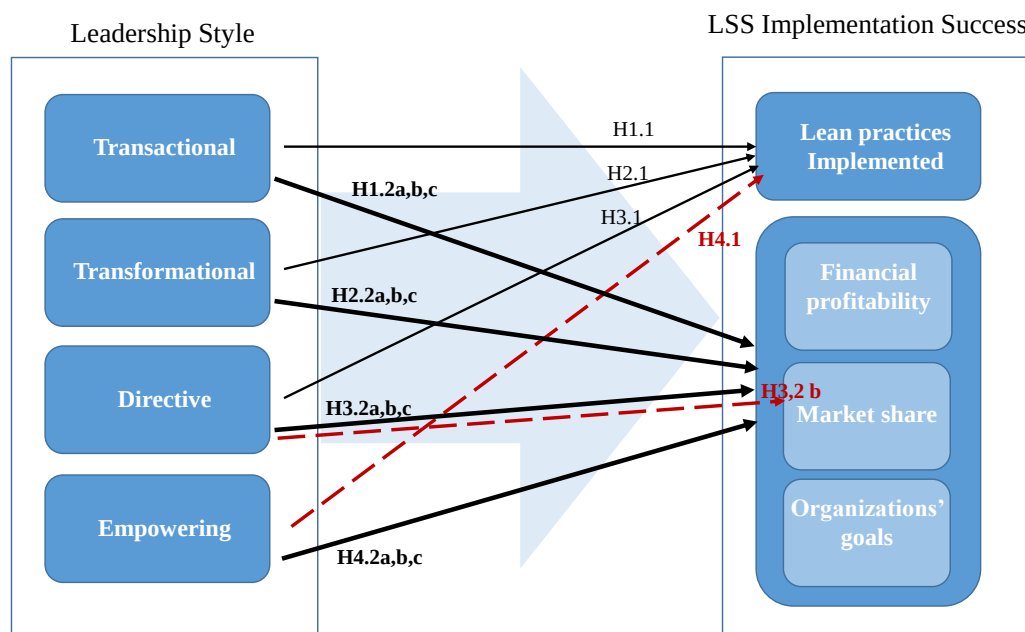


Fig. 1 - Hypotheses validation

The second part of this section includes the analysis of the correlations. Three correlations studies are done: correlation between each pair of the four styles of leadership; correlations between each leadership style and the measure of LSS implementation success; and correlation between each leadership dimension (attribute of the leader) and the measure of LSS implementation success. In order to do that, the Spearman correlation non-parametric test is used, as it allows assessing the correlation between two variables. We considered statistically significant, the tests with a $p\text{-value} \leq \alpha = 0,05$. The SPSS outputs are presented in Annex 6.

The correlation matrix containing the Spearman correlation coefficients of the four styles of leadership as well as the corresponding $p\text{-values}$ (in brackets) are presented in Table 15.

	<i>Transactional</i>	<i>Transformational</i>	<i>Directive</i>	<i>Empowering</i>
Transactional	1	0.544 (0.005)	0.474 (0.017)	0.655 (0.000)
Transformational			0.469 (0.018)	0.687 (0.000)
Directive				0.347 (0.089)
Empowering				1

Table 15 - Spearman correlation coefficients among leadership styles

All the styles are correlated with each other, as the *p-values* assume values lower than 0.05, except in the case of the correlation between the directive and the empowering styles that is only statistically significant at $\alpha=0.10$. Despite being statistically significant, half of the correlation coefficients present values lower than 0.5 (transactional vs. directive, transformational vs. directive and directive vs. empowering), meaning that the correlation is not strong. The strongest correlation is between transformational and empowering leaderships, exhibiting a coefficient of 0.687.

As we can see, no leadership style is dominant, as all correlations are significant. The bootstrapped confidence intervals (confidence level of 95%), presented in Table 16, reinforce this conclusion.

	<i>Lower bound</i>	<i>Upper bound</i>
Transactional-Transformational	0.11	0.84
Transactional -Directive	0.10	0.75
Transactional -Empowering	0.38	0.85
Transformational - Directive	0.09	0.74
Transformational - Empowering	0.39	0.91
Directive - Empowering	0.02	0.65

Table 16 - Confidence intervals of Spearman correlation coefficients

As no leadership style proved to be dominant in the success of LSS implementation, this suggests that despite leadership being considered a critical success factor to LSS implementation (Backar *et al.*, 2015; Yadav and Desai, 2016), there is no leadership style dominance, when Portuguese organizations involved in kaizen or lean programs. This may mean that it is the power of the leadership that influences LSS, instead of the power of the leadership style.

To assess whether there is a leadership style dominating the other ones, we also performed the Wilcoxon test for paired samples², applied to each possible pair of the four leadership styles, allowing to infer whether the medians of the differences are zero.

The results are exhibited in Table 17.

² It is a non-parametric test used when comparing two related samples, to assess whether their population mean ranks differ.

	<i>p-values</i>
Transactional-Transformational	0.00
Transactional -Directive	0.09
Transactional -Empowering	0.00
Transformational - Directive	0.19
Transformational - Empowering	0.75
Directive - Empowering	0.23

Table 17 - *p-values* of Wilcoxon test

This test leads to the same results, proposing that no single leadership style dominates the other ones, since it is suggested that the medians of the differences between variables are zero.

Another possible analysis for assessing the impact (measured by the correlation factor) of the leadership style on the LSS implementation success is to compute the correlation (Spearman coefficient) between each leadership style and the success (measured by the average level of lean practices implemented). Table 18 contains the correlation coefficient as well as the respective bootstrapped confidence intervals (confidence level of 95%).

			<i>Transactional</i>	<i>Transformational</i>	<i>Directive</i>	<i>Empowering</i>
Lean	Correlation coefficient		0.088 (0.674)	0.347 (0.089)	0.154 (0.463)	0.530 (0.006)
	Confidence interval	Lower bound	-0,36	-0,11	-0,23	0,16
		Upper bound	0,59	0,72	0,58	0,78

Table 18 - Spearman coefficient correlation and confidence interval

The correlation between the empowering style and the LSS implementation success is significant, which seems to be confirmed by the respective confidence interval. This is in accordance with the empirical validation of H1.4, presented previously.

With caution, we can conclude the same regarding the correlation between the transformational style and the LSS implementation success, as the *p-value* is somewhat high (9%) and the confidence interval is very wide (high uncertainty) and marginally contains zero. All the remaining correlations are not significant.

The last correlations tested are the correlations (Spearman coefficient) between each leadership dimension (attribute) and the success of LSS implementation. The results are presented in Table 19, and the attribute/dimension cells which correlation is statistically significant are painted in grey. The darkest ones correspond to the dimensions whose correlation with LSS implementation success is significant to $\alpha=5\%$ and the clearest represent the dimensions whose correlation is significant to $\alpha=10\%$.

<i>Attributes</i>	<i>Lean</i>	
	Correlation Coefficient	Sig. (2-tailed)
Contingent reward	0.142	0.498
Management by exception active	0.131	0.534
Idealized influence – attributed	0.186	0.374
Idealized influence – behavior	0.204	0.327
Inspirational motivation	0.199	0.341
Intellectual stimulation	0.337	0.099
Individualized consideration	0.401	0.047
Assigned goals	0.358	0.079
Instruction and command	0.060	0.776
Delegation of authority	0.318	0.121
Accountability	0.259	0.211
Self-directed decision making	0.335	0.100
Information sharing	0.447	0.025
Skill development	0.592	0.002
Coaching for innovative performance	0.171	0.414

Table 19 - Spearman correlation coefficient between each leadership dimensions and the success of LSS implementation

There is no dominant style, which can be explained by the existence of various dimensions (and therefore, leaders' attributes) with a statistically significant correlation coefficient. It is the case of the attributes 'individualized consideration', 'information sharing', 'skill development', 'intellectual stimulation', 'assigned goals', and 'self-directed decision making'.

In the Portuguese case, among the surveyed companies that are in a kaizen, lean or LSS process implementation, the ones attributes of the leaders that have a correlation with the success in their LSS implementation is 'individualized consideration', 'information sharing', and 'skill development'.

Consequently, we may suggest companies that are in a lean or kaizen implementation project, to be aware of the importance of leadership in the success of its implementation and, more than just adopting a single style, adopt attitudes related to the attributes mentioned above.

5. Conclusion

Leadership has been identified as a critical success factor of LSS implementation. this study purpose was to identify what is the impact of leadership style in the success of LSS implementation and find the most important leader' attributes that facilitate it. By this way, this study can be used by companies to help to identify if their leadership is the most adequate when they are thinking in implementing LSS.

To allow the study of these questions, a questionnaire was developed and delivered to Portuguese companies that have implemented LSS. The hypotheses were tested in the SPSS, using the Mann-Whitney non-parametric test; correlations between some variables were also assessed.

The results suggest that empowering leadership has a positive impact in the success of LSS implementation (measured through the implementation of lean practices). Therefore, we can recommend to companies that are thinking about starting a similar process, to pay attention to the attitudes of the leaders related to this style: delegation of authority, accountability, self-directed decision making, information sharing, skill development, and coaching for innovative performance. When the LSS implementation success was measured through the increase in the market shares, the directive leadership presented a negative impact. Consequently, we suggest companies in some lean or kaizen process, to take into consideration the dimensions of this directive style (assigned goals, and instruction and command) in order to avoid this kind of attitudes.

Moreover, we identify that none of the leadership style proved to be dominant. This seems to suggest that it is the power of the leadership that influences LSS, instead of the power of the leadership style. Accordingly, when testing separately which leader's attributes are more important in the success of LSS implementation, various dimensions exhibited statistical significant values: individualized consideration, information sharing, skill development, intellectual stimulation, assigned goals and self-directed decision making. Consequently, organizations that are in the beginning of the LSS implementation process should be aware of the importance of leadership in the success of this implementation and, more than just adopting a single style, adopt attitudes related to these attributes.

This research has some limitations due to the limited number of studies and conclusions about the most indicated leadership style to the LSS implementation. Therefore, this is

still a working field and suggestion for future researches may include make efforts to identification of a new leadership style. Moreover, despite this research focus being the LSS implementation, it is not divided in the different implementation phases. In the same way, although inferring about leader's attributes, it is not divided in senior and middle managers. Thus, these are also opportunities for new researches.

References

- Aij, K. H., M. Visse and G. A. M. Widdershoven (2015), "Lean leadership: an ethnographic study", *Leadership in Health Services*, Vol. 28, No. 2, pp. 119-134.
- Alsmadi, M., A. Almani and R. Jerisat (2012), "A comparative analysis of lean practices and performance in the UK manufacturing and service sector firms", *Total Quality Management*, Vol. 23, No. 4, pp. 381-396.
- Andersson, R., P. Hilletoft, P. Manfredsson and O.-P. Hilmola (2014), "Lean Six Sigma strategy in telecom manufacturing", *Industrial Management & Data Systems*, Vol. 114, No. 6, pp. 904-921.
- Antony, J. (2006), "Six sigma for service processes", *Business Process Management Journal*, Vol. 12, No. 2, pp. 234-248.
- Assarlind, M., I. Gremyr and K. Bäckman (2013), "Multi-faceted views on a Lean Six Sigma application", *International Journal of Quality & Reliability Management*, Vol. 29, No. 1, pp. 21-30.
- Assen, M. (2016), "Exploring the impact of higher management's leadership styles on Lean management", *Total Quality Management & Business Excellence*, pp. 1-30.
- Avolio, B. J. and, B.M. Bass (2004), "Multifactor Leadership Questionnaire: Third Edition Manual and Sampler Set", Menlo Park, CA: Mind Garden Inc.
- Backar, F.A.A., K. Subari and M. A. M. Daril (2015), "Critical success factors of lean six sigma deployment: a current review", *International Journal of Lean Six Sigma*, Vol. 6, No. 4, pp. 339-348.
- Bass, B. M. (1990), "From Transactional to Transformational Leadership: Learning to Share the Vision", *Organizational Dynamics*, Vol. 18, No. 3, pp. 19-31.
- Bendell, T. (2006), "A review and comparison of Six Sigma and the Lean organisations", *The TQM Magazine*, Vol. 18, No. 3, pp. 255-262.
- Bhuiyan, N. and A. Baghel (2005), "An overview of continuous improvement: from the past to the present", *Management Decision*, Vol. 43, No. 5, pp. 761-71.
- Büyüközkan, G., G. Kayakutlu and İ. S. Karakadılar (2015), "Assessment of lean manufacturing effect on business performance using Bayesian Belief Networks", *Expert Systems with Applications*, Vol. 42, No. 19, pp. 6539-6551.
- Camacho-Miñano, M. D. M., J. Moyano-Fuentes and M. Sacristán-Díaz (2013), "What can we learn from the evolution of research on lean management assessment?", *International Journal of Production Research*, Vol. 51, No. 4, pp. 1098-1116.

- Chakravorty, S. S. (2009), "Six Sigma programs: An implementation model", *International Journal of Production Economics*, Vol. 119, No. 1, pp. 1-16.
- Dahlgaard, J. J. and S. M. Dahlgaard-Park (2006), "Lean production, six sigma quality, TQM and company culture", *The TQM Magazine*, Vol. 18, No. 2, pp. 263-281.
- Dombrowski, U., and T. Mielke (2013), "Lean leadership—fundamental principles and their application", *Procedia CIRP*, Vol. 7, pp. 569-574.
- Dun, D. H. and C. P.M. Wilderom (2016), "Lean-team effectiveness through leader values and members' informing", *International Journal of Operations & Production Management*, Vol. 36, No. 11, pp. 1530-1550.
- Gelei, A., D. Losonci and Z. Matyusz (2015), "Lean production and leadership attributes – the case of Hungarian production managers", *Journal of Manufacturing Technology Management*, Vol. 26, No. 4, pp. 477-500.
- Hartog, D. N., J. J. Muijen, and P. L. Koopman (1997), "Transactional versus transformational leadership: An analysis of the MLQ", *Journal of occupational and organizational psychology*, Vol. 70, No. 1, pp. 19-34.
- House, R., M. Javidan and P. Dorfman (2001), "Project GLOBE: An Introduction", *Applied Psychology: An International Review*, Vol. 50, No. 4, pp. 489-505.
- Jeyaraman, K. and L. K. Teo (2010), "A conceptual framework for critical success factors of lean Six Sigma", *International Journal of Lean Six Sigma*, Vol. 1, No. 3, pp. 191-215.
- Jung, D. I., C. Chow and A. Wu (2003), "The role of transformational leadership in enhancing organizational innovation: Hypotheses and some preliminary findings", *The Leadership Quarterly*, Vol. 14, No. 4, pp. 525-544.
- Kahai, S. S., J. J. Sosik and B. J. Avolio (2004), "Effects of participative and directive leadership in electronic groups", *Group & Organization Management*, Vol. 29, No. 1, pp. 67-105.
- Konczak, L. J., D. J. Stelly, and M. L. Trusty (2000), "Defining and measuring empowering leader behaviors: Development of an upward feedback instrument", *Educational and Psychological Measurement*, Vol. 6, No. 2, pp. 301-313.
- Lande, M., R.L. Shrivastava and D. Seth (2016), "Critical success factors for Lean Six Sigma in SMEs (small and medium enterprises)", *The TQM Journal*, Vol. 28, No. 4, pp. 613-635.

- Laohavichien, T., L. D. Fredendall and R. S. Cantrell (2009), "The effects of transformational and transactional leadership on quality improvement", *The Quality Management Journal*, Vol. 16, No. 2, pp. 7-24.
- Laureani, A. and J. Antony (2012), "Critical success factors for the effective implementation of Lean Sigma", *International Journal of Lean Six Sigma*, Vol. 3, No. 4, pp. 274-283.
- Laureani, A. and J. Antony (2016), "Leadership - a critical success factor for the effective implementation of Lean Six Sigma", *Total Quality Management & Business Excellence*, pp. 1-22.
- Laureani, A. and J. Antony (2017), "Leadership characteristics for Lean Six Sigma" *Total Quality Management & Business Excellence*, Vol. 28, No. 3-4, pp. 405-426.
- Li, M., W. Liu, Y. Han, Y. and Zhang, P. (2016), "Linking empowering leadership and change-oriented organizational citizenship behavior: The role of thriving at work and autonomy orientation", *Journal of Organizational Change Management*, Vol. 29, No. 5, pp. 732-750.
- Liu, W., D. P. Lepak, R. Takeuchi and H. P. Sims (2003), "Matching leadership styles with employment modes: Strategic human resource management perspective", *Human resource management review*, Vol. 13, No. 1, pp. 127-152.
- Lorinkova, N. M., M. J. Pearsall and H. P. Sims (2013), "Examining the differential longitudinal performance of directive versus empowering leadership in teams", *Academy of Management Journal*, Vol. 56, No. 2, pp. 573-596.
- Manville, G., R. Greatbanks, R. Krishnasamy, and D.W. Parker (2012), "Critical success factors for Lean Six Sigma programmes: a view from middle management", *International Journal of Quality & Reliability Management*, Vol. 29, No. 1, pp. 7-20.
- Näslund, D. (2013), "Lean and six sigma – critical success factors revisited", *International Journal of Quality and Service Sciences*, Vol. 5, No. 1, pp. 86-100.
- Ohno, T. (1988), "Toyota production system: beyond large-scale production", Portland: Productivity Press.
- Olhager, J. and D. I. Prajogo (2012), "The impact of manufacturing and supply chain improvement initiatives: A survey comparing make-to-order and make-to-stock firms", *Omega*, Vol. 40, No. 2, pp. 159-165.
- Opoku, A., V. Ahmed and H. Cruickshank (2015), "Leadership style of sustainability professionals in the UK construction industry", *Built Environment Project and Asset Management*, Vol. 5, No. 2, pp. 184-201.

- Pamfilie, R., A. J. Petcu and M. Draghici (2012), "The importance of leadership in driving a strategic Lean Six Sigma management", *Procedia-Social and Behavioral Sciences*, Vol. 58, pp. 187-196.
- Park, S. H. (2003), "Six Sigma for Quality and Productivity Promotion", Tokyo: Asian Productivity Organization.
- Pearce, C. L. and H. P. Sims (2002), "Vertical versus shared leadership as predictors of the effectiveness of change management teams: An examination of aversive, directive, transactional, transformational, and empowering leader behaviors", *Group dynamics: Theory, research, and practice*, Vol. 6, No. 2, pp. 172-197.
- Pearce, C. L., H. P. Sims, J. F. Cox, G. Ball, E. Schnell, K. A. Smith and L. Trevino (2003), "Transactors, transformers and beyond: A multi-method development of a theoretical typology of leadership", *Journal of Management development*, Vol. 22, No. 4, pp. 273-307.
- Pongpearchan, P. (2016), "Effect of transformational leadership on strategic human resource management and firm success of Toyota's dealer in Thailand", *Journal of Business and Retail Management Research*, Vol. 10, No. 2, pp. 53-63.
- Prasad, B. and P. Junni (2016), "CEO transformational and transactional leadership and organizational innovation: The moderating role of environmental dynamism", *Management Decision*, Vol. 54, No. 7, pp. 1542-1568
- Rafferty, A. E., and M. A. Griffin (2004), "Dimensions of transformational leadership: Conceptual and empirical extensions", *The Leadership Quarterly*, Vol. 15, No. 3, pp. 329-354.
- Rossum, L., K. H. Aij, F. E. Simons, N. van der Eng and W. D. ten Have (2016), "Lean healthcare from a change management perspective", *Journal of Health Organization and Management*, Vol. 30, No. 3, pp. 475-493.
- Rother, M. and J. Shook (2003), "Learning to See: Value Stream Mapping to Add Value and Eliminate Muda", Cambridge, MA: Lean Enterprise Institute.
- Salah, S., A. Rahim and J. A. Carretero (2010), "The integration of Six Sigma and lean management", *International Journal of Lean Six Sigma*, Vol. 1, No. 3, pp. 249-274.
- Sarti, D. (2014), "Leadership styles to engage employees: evidence from human service organizations in Italy", *Journal of Workplace Learning*, Vol. 26, No. 3-4, pp. 202-216.
- Sarver, M. B. and H. Miller (2014), "Police chief leadership: styles and effectiveness", *Policing: An International Journal of Police Strategies & Management*, Vol. 37, No. 1, pp. 126-143.

- Shah, R. and P. T. Ward (2007), "Defining and developing measures of lean production", *Journal of operations management*, Vol. 25, No. 4, pp. 785-805.
- Snee, R. D. (2010), "Lean Six Sigma – getting better all the time", *International Journal of Lean Six Sigma*, Vol. 1, No. 1, pp. 9-29.
- Snee, R. D. and R Hoerl (2003), "Leading Six Sigma: a step-by-step guide based on experience with GE and other Six Sigma companies", New Jersey: Financial Times Prentice Hall.
- Sunder V. M. (2015), "Corporate perspectives: commonalities and differences between Six Sigma and Lean", *International Journal of Lean Six Sigma*, Vol. 6, No. 3, pp. 281-288.
- Sureerattanan, C., K. Napompech and V. Panjakhajornsak (2014), "Model of leadership and the effect of lean manufacturing practices on firm performance in Thailand's auto parts industry", *Research Journal of Business Management*, Vol. 8, No. 2, pp. 104-117.
- Suresh, S., J. Antony, M. Kumar and A. Douglas (2012), "Six Sigma and leadership: some observations and agenda for future research", *The TQM Journal*, Vol. 24, No. 3, pp. 231-247.
- Thomas, A. and R. Barton (2011), "Using the Quick Scan Audit Methodology (QSAM) as a precursor towards successful Lean Six Sigma implementation", *International Journal of Lean Six Sigma*, Vol. 2, No. 1, pp. 41-54.
- Thürer, M., I. Tomašević, and M. Stevenson (2017), "On the meaning of 'Waste': review and definition", *Production Planning & Control*, Vol. 28, No. 3, pp. 244-255.
- Tjahjono, B., P. Ball, V.I. Vitanov, C. Scorzafave, J. Nogueira, J. Calleja, M. Minguet, L. Narasimha, A. Rivas, A. Srivastava, S. Srivastava and A. Yadav (2010), "Six Sigma: a literature review", *International Journal of Lean Six Sigma*, Vol. 1, No. 3, pp. 216-233.
- Yadav, G. and T. N. Desai (2016), "Lean Six Sigma: a categorized review of the literature", *International Journal of Lean Six Sigma*, Vol. 7, No. 1, pp. 2-24.
- Yahaya, R., and F. Ebrahim (2016), "Leadership styles and organizational commitment: literature review", *Journal of Management Development*, Vol. 35, No. 2, pp. 190-216.
- Yang, M. G. M., P. Hong and S. B. Modi (2011), "Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms", *International Journal of Production Economics*, Vol. 129, No. 2, pp. 251-261.

Zhang, X. and K. M. Bartol (2010), "Linking empowering leadership and employee creativity: The influence of psychological empowerment, intrinsic motivation, and creative process engagement", *Academy of management journal*, Vol. 53, No. 1, pp. 107-128.

Annex 1 - Questionnaire

The leadership style and the Lean Six Sigma implementation

This questionnaire is carried out within the scope of the Master's degree in Management dissertation of the Faculty of Economics of the University of Porto, and aims to study the relationship between the leadership style and the successful implementation of Lean Six Sigma.

All data collected will be treated with TOTAL ANONYMATE and confidentiality, in aggregate form and will only be used for the purposes of this academic study.

Thank you for your availability and collaboration.

I. General information about the company

1. Your job role in the company: _____
2. Company activity sector: _____
3. CAE: _____
4. Sales volume (in euros) in 2017: _____
5. Company number of employees (2017): _____

II. Assess the leadership style

This part of the questionnaire consists of 38 items and corresponds to an adaptation of three questionnaires: the Avolio and Bass (2004) Multifactor Leadership Questionnaire (form 5X-Short), the Leader Empowering Behavior Questionnaire of Konczak *et al.*'s (2000), and the questionnaire developed Pearce and Sims (2002).

There is no "right" leadership style. Anyone can lead to success or failure. Please respond as accurately as possible, taking into consideration that there are no right or wrong answers, and no more or less adequate answers.

The items below allow you to gauge your leadership style. Please choose from 1 to 5, which is the frequency that best describes your behavior as a leader.

(1)not at all (2)once in a while (3)sometimes (4)fairly often (5)frequently, if not always

		1	2	3	4	5
1.	I ensure that continuous learning and skill development are priorities in my department					
2.	I spend time teaching and coaching					
3.	I help others to develop their strengths					
4.	I give instructions to others on how to carry out their work					
5.	I encourage others to use systematic problem-solving methods					
6.	I get others to look at problems from many different angles					

7.	I try to help others arrive at their own solutions when problems arise, rather than telling them what they would do					
8.	I encourage others to develop their own solutions and make their own decisions about problems they encounter in their work					
9.	I suggest new ways of looking at how to complete assignments					
10.	I re-examine critical assumptions to question whether they are appropriate					
11.	I encourage others to try out new ideas even if there is a chance they may not succeed					
12.	I am willing to risk mistakes on others part if, over the long term, they will learn and develop as a result of the experience					
13.	I seek differing perspectives when solving problems					
14.	I consider an individual as having different needs, abilities, and aspirations from others, and not just as a member of a group					
15.	I focus on corrective action rather than placing blame when others make a mistake					
16.	I focus attention on irregularities, mistakes, exceptions, deviations from standards and complaints					
17.	I keep track of all mistakes					
18.	I direct my attention toward failures to meet standards					
19.	I display a sense of power and confidence					
20.	I give others the authority they need to make decisions and changes that improve work processes and procedures					
21.	I delegate authority to others that is equal to the level of responsibility that they are assigned					
22.	I provide others with assistance in exchange for their efforts					
23.	I discuss in specific terms who is responsible for achieving performance targets, and those are held accountable for results					
24.	I make clear what one can expect to receive when performance goals are achieved					
25.	I express confidence that goals will be achieved					
26.	I express satisfaction when others meet expectations					
27.	I establish others' performance goals					
28.	I hold people in the department accountable for customer satisfaction					
29.	I provide others with the information they need to meet customers' needs					
30.	I share information that others need to ensure high quality results					
31.	I specify the importance of having a strong sense of purpose					
32.	I consider the moral and ethical consequences of decisions					
33.	I emphasize the importance of having a collective sense of mission					
34.	I talk enthusiastically about what needs to be accomplished					
35.	I talk optimistically about the future, articulating a compelling vision					
36.	I talk about my most important values and beliefs					
37.	I instill pride in other for being associated with me					
38.	I act in ways that build others' respect for me					

III. Assess lean manufacturing implementation

The 43 items presented below (adapted from the topics developed by Shah and Ward, 2007) provide a description of some practices related to lean in the manufacturing system/service provision of a company.

Please indicate the extent of use of each of the following practices in the company.

(1)never (2)rarely (3)sometimes (4)fairly often (5)frequently, if not always

		1	2	3	4	5
1.	We are in close contact with our suppliers					
2.	Our suppliers visit our plants					
3.	We visit our suppliers' plants					
4.	We give our suppliers feedback on quality and delivery performance					
5.	We strive to establish long-term relationship with our suppliers					
6.	Suppliers are directly involved in the new product/service development process					
7.	Our key suppliers deliver to plant on JIT (just-in-time) basis					
8.	We have a formal supplier certification program					
9.	We have corporate level communication on important issues, with key suppliers					
10.	We take active steps to reduce the number of suppliers in each category of products/consumables					
11.	Our key suppliers manage our inventory (concerning the component they provide)					
12.	We evaluate suppliers on a basis of total cost and not per unit price					
13.	We are in close contact with our customers					
14.	Our customers visit our plants					
15.	Our customers give us feedback on quality and delivery performance					
16.	Our customers are actively and directly involved in current and future product/service offerings					
17.	Our customers share current and future demand information with marketing department					
18.	We conduct customer satisfaction surveys					
19.	Production decisions are made only after the arrival of an order or need for an intermediate product (ie, production is "pulled"*** by the shipment of finished goods)					
20.	We use Kanban***, squares, or containers of signals for production control					
21.	Products/services are classified with similar processing /service provision requirements					
22.	Products are classified with similar production/ service provision routing requirements					
23.	Equipment is grouped to produce a continuous flow of families of products (or to provide a continuous service)					
24.	Families of products/services determine our factory layout					
25.	Pace of production/service provision is directly linked with the rate of customer demand					
26.	Our employees practice the preparation/set-up of the equipment to reduce the time required to start up (set-up)					
27.	We are working to lower set-up times of production / preparation of equipment in our company					
28.	We use statistical techniques to reduce production process/service provision variance					
29.	Charts showing defect rates are used as tools on production/service provision area					
30.	We use fishbone type diagrams to identify causes of quality problems					
31.	We conduct production/service provision process capability studies before product/service launch in the market					
32.	Production/service provision employees are key to problem solving teams					
33.	Production/service provision employees drive suggestion programs					
34.	Production/service provision employees lead product/process improvement efforts					
35.	Production/service provision employees undergo cross functional training					

36.	We dedicate a portion of everyday to planned equipment maintenance related activities					
37.	We provide maintenance to all our equipment					
38.	We maintain excellent records of all equipment maintenance related activities					
39.	We post equipment maintenance records on shop-floor for active sharing with employees					

* *Just in time* means “at the defined time (neither advanced nor late) and the defined quantity”

**Pull production is based on demand

** Kaban is a Japanese word that means “visual signal”

**Please, consider now a different scale to answer the following questions:
(1)none (2)very little (3)some (4)substantial (5)very much/all**

		1	2	3	4	5
40.	Our suppliers are contractually committed to annual costs reduction					
41.	Our key suppliers are located in close proximity to our plants					
42.	The machines in our plant have low setup times					
43.	Our equipment/ processes in the production area are currently being controlled using a statistical process quality control tool					

IV. Awareness about lean manufacturing

1. How long has the company been using Lean tools?_____ (years)

Please, answer the following questions with “Yes” or “No”. In case you answer “Yes”, please choose from 1 to 5 what was the impact of Lean in each factor.

(1)very low (2)low (3)moderate (4)high (5)very high

2. Lean implementation has improved production/service provision processes (e.g. production time, less waste)?

☐ Yes ☐ No

☐1 ☐2 ☐3 ☐4 ☐5

3. Lean implementation in the organization has increased its financial profitability (e.g. profit)?

☐ Yes ☐ No

☐1 ☐2 ☐3 ☐4 ☐5

4. Lean implementation in the organization has increased its market share?

☐ Yes ☐ No

☐1 ☐2 ☐3 ☐4 ☐5

5. Has Lean been successful in reaching goals/expectations of your organization?

☐ Yes ☐ No

☐1 ☐2 ☐3 ☐4 ☐5

V. Awareness about leadership style

1. Please identify the leadership style that best describe your behavior. Order them from 1 (the most similar to your style) to 4 (the less similar).

☐ Recognize accomplishments and promise rewards for good performance and effort (Transactional)

☐ Expand the interests of the employees and incentive the employees to look for the good of the group instead of looking to the personal good (Transformational)

☐ Recognition of the potential of the employees, giving them power rather than directing them (Empowering)

☐ Engages in providing direction and assigning goals to the followers (Directive)

Thank you for your collaboration.

If you want to get access to the final results of this study, please indicate your e-mail address here:

Annex 2 – Questionnaire translation

O estilo de liderança e a implementação do Lean Six Sigma

O presente questionário é realizado no âmbito da dissertação de Mestrado em Gestão da Faculdade de Economia da Universidade do Porto, e pretende estudar a relação entre o estilo de liderança e o sucesso de implementação do Lean Six Sigma.

Todos os dados recolhidos serão tratados com TOTAL ANONIMATO e confidencialidade, de forma agregada e apenas serão usados para efeitos deste estudo académico.

Obrigada pela disponibilidade e colaboração.

I. Informação geral

1. O seu cargo na empresa: _____
2. Sector de atividade da empresa: _____
3. CAE: _____
4. Volume de vendas (em euros) em 2017: _____
5. Número de trabalhadores na empresa (2017): _____

II. Aferir o estilo de liderança

Esta parte do questionário é constituída por 38 items e corresponde a uma adaptação de três questionários: o *Multifactor Leadership Questionnaire* (form 5X-Short), de Avolio e Bass (2004); o *Leader Empowering Behavior Questionnaire* de Konczak *et al.*'s (2000); e o questionário desenvolvido por Pearce e Sims (2002).

Não há um estilo de liderança "certo". Qualquer um pode conduzir ao sucesso ou ao insucesso. Responda, por favor, o mais rigorosamente possível tendo em consideração que não há respostas certas ou erradas, respostas mais ou menos adequadas.

Os itens abaixo permitem aferir o seu estilo de liderança. Por favor escolha de 1 a 5, qual é a frequência que melhor descreve o seu comportamento enquanto líder.

(1)nunca (2)raramente (3)às vezes (4)bastante frequente (5)muito frequentemente, se não sempre

		1	2	3	4	5
1.	Asseguro que a aprendizagem contínua e o desenvolvimento de competências são prioridades no meu departamento					
2.	Invisto o meu tempo formando e ajudando os outros a resolver problemas					
3.	Ajudo os outros a desenvolverem os seus pontos fortes					
4.	Dou instruções específicas e claras aos outros sobre como realizar o seu trabalho					
5.	Encorajo os outros a usar métodos sistemáticos de resolução de problemas					

6.	Faço com que os outros vejam os problemas de várias e diferentes perspectivas					
7.	Tento ajudar os outros a chegar às soluções quando surgem problemas, em vez de lhes dizer o que deveriam fazer					
8.	Encorajo os outros a desenvolverem as suas próprias soluções e tomar as suas decisões para os problemas que encontram no seu trabalho					
9.	Sugiro novas formas de realizar e completar as atividades					
10.	Reflito sobre críticas que me são feitas e verifico se são ou não adequadas					
11.	Encorajo os outros a experimentar novas ideias, mesmo se houver probabilidade de não terem sucesso					
12.	Estou disposto a assumir erros dos meus colaboradores se, a longo prazo, eles aprenderem e se desenvolverem como resultado da experiência					
13.	Procuro perspectivas diferentes ao solucionar os problemas					
14.	Considero cada indivíduo como tendo necessidades, capacidades e aspirações diferentes das dos outros, e não apenas como mais um membro do grupo					
15.	Concentro-me na ação corretiva em vez de colocar a ênfase na culpa, quando os outros cometem um erro					
16.	Foco a atenção em lidar com irregularidades, erros, exceções, desvios das regras e queixas					
17.	Mantenho-me a par de todos os erros					
18.	Dirijo a minha atenção para as falhas a fim de atingir os objetivos esperados					
19.	Exibo um sentido de poder e de confiança					
20.	Concedo a autoridade de que os outros precisam para tomar decisões que melhorem os processos e procedimentos de trabalho					
21.	Delego autoridade aos outros que é igual ao nível de responsabilidade que lhes é atribuído					
22.	Dou apoio aos outros em troca dos seus esforços					
23.	Discuto quem é o responsável por atingir metas específicas de desempenho, e estes são responsabilizada pelos resultados					
24.	Torno claro o que cada um pode esperar quando os objetivos de desempenho são atingidos					
25.	Expresso confiança de que os objetivos serão alcançados					
26.	Exprimo satisfação quando os outros correspondem às expectativas					
27.	Estabeleço as metas de desempenho dos que estão sob a minha alçada					
28.	Responsabilizo as pessoas do departamento pela satisfação do cliente					
29.	Forneço aos outros as informações de que precisam para atender às necessidades dos clientes					
30.	Partilho informações que os outros precisam para garantir resultados de alta qualidade					
31.	Realço a importância de se ter um forte sentido de missão					
32.	Pondero as consequências éticas e morais das minhas decisões					
33.	Enfatizo a importância de se ter um sentido de missão coletivo					
34.	Falo com entusiasmo acerca daquilo que é preciso realizar					
35.	Falo com otimismo acerca do futuro, apresentando uma visão motivadora					
36.	Converso sobre os meus valores e crenças mais importantes					
37.	Faço os outros sentirem-se bem por estarem associados a mim					
38.	Ajo de forma a ganhar o respeito dos outros					

III. Aferir a implementação do lean

Os 43 itens apresentados abaixo (adaptados dos tópicos desenvolvidos por Shah e Ward, 2007) fornecem uma descrição de algumas práticas relacionadas com o lean no sistema de produção/prestação do serviço da empresa.

Indique, por favor, a dimensão de uso de cada uma das seguintes práticas na empresa.

(1)nunca (2)raramente (3)às vezes (4)bastante frequente (5)muito frequente, se não sempre

		1	2	3	4	5
1.	Estamos em contacto estreito com os nossos fornecedores					
2.	Os nossos fornecedores visitam as nossas fábricas					
3.	Visitamos as fábricas dos nossos fornecedores					
4.	Damos aos nossos fornecedores feedback sobre a qualidade e desempenho da entrega					
5.	Esforçamo-nos para estabelecer um relacionamento de longo prazo com os nossos fornecedores					
6.	Os fornecedores estão diretamente envolvidos no processo de desenvolvimento de novos produtos/serviços					
7.	Os nossos principais fornecedores entregam para a fábrica numa base de <i>just in time</i> *					
8.	Temos um programa formal de certificação de fornecedores					
9.	Temos comunicação a nível corporativo sobre questões importantes, com fornecedores-chave					
10.	Tomamos medidas ativas para reduzir o número de fornecedores em cada categoria de produto/consumíveis					
11.	Os nossos principais fornecedores gerem o nosso inventário (relativo ao componente que fornecem)					
12.	Avaliamos os fornecedores com base no custo total e não no preço unitário					
13.	Estamos em contacto estreito com os nossos clientes					
14.	Os nossos clientes visitam as nossas fábricas					
15.	Os nossos clientes providenciam feedback sobre qualidade e desempenho de entrega					
16.	Os nossos clientes estão direta e ativamente envolvidos nas ofertas atuais e futuras de produtos/serviços					
17.	Os nossos clientes partilham informações com o departamento de marketing sobre as procuras atuais e futuras					
18.	Realizamos questionários de satisfação do cliente					
19.	As decisões de produção são tomadas apenas após a chegada de uma encomenda ou necessidade de produto intermédio (i.é, a produção é "puxada"*** pela expedição de produtos acabados)					
20.	Usamos Kanban***, quadrados, ou outros sinais para controlo da produção					
21.	Os produtos/serviços são classificados/organizados tendo em conta as semelhanças de processo/prestação de serviço					
22.	Os produtos são classificados/organizados tendo em conta as semelhanças de rota de produção/ prestação de serviço					
23.	O equipamento é agrupado para produzir um fluxo contínuo de famílias de produtos (ou para prestar um serviço contínuo)					
24.	As famílias de produtos/serviços determinam o layout da fábrica					
25.	O ritmo de produção/prestação de serviço está diretamente ligado à taxa de procura dos clientes					
26.	Os nossos trabalhadores treinam a preparação/ set-up do equipamento para reduzir o tempo necessário para o arranque (set-up)					
27.	Trabalhamos para reduzir os tempos de arranque da produção/preparação dos equipamentos na nossa empresa					
28.	Utilizamos técnicas estatísticas para reduzir a variabilidade do processo produtivo/de prestação do serviço					

29.	Gráficos que mostram as taxas de defeitos são usados como ferramentas na área de produção/prestação de serviço					
30.	Usamos diagramas do tipo espinha de peixe para identificar as causas dos problemas de qualidade					
31.	Realizamos estudos acerca da capacidade dos processos produtivos/de prestação do serviço antes do lançamento do produto/serviço no mercado					
32.	Os trabalhadores da produção/prestação do serviço são fundamentais para as equipas de resolução de problemas					
33.	Os trabalhadores da produção/prestação do serviço são responsáveis pela elaboração de programas de sugestões de melhoria					
34.	Os trabalhadores da produção/prestação do serviço lideram os esforços de melhoria dos produtos/processos					
35.	Os trabalhadores da produção/prestação do serviço são submetidos a treinos multifuncionais					
36.	Dedicamos uma parte de cada dia para atividades de manutenção de equipamento planeadas					
37.	Realizamos a manutenção dos nossos equipamentos					
38.	Temos registos excelentes de todas as atividades relacionadas com a manutenção de equipamentos					
39.	Afixamos os registos de manutenção de equipamentos na área de produção para partilha ativa com os empregados					

* *Just in time* significa “na altura definida (nem adiantado, nem atrasado) e na quantidade definida”

** Produção puxada (*pull*) é baseada na procura

*** *Kaban* é uma palavra japonesa que significa “sinal visual”

Por favor, considere agora uma escala diferente para responder às próximas perguntas:

(1)nenhum (2)muito poucos (3)alguns (4)muitos (5)quase todos, se não todos

		1	2	3	4	5
40.	Os nossos fornecedores estão contratualmente comprometidos a reduções anuais de custos					
41.	Os nossos principais fornecedores estão localizados nas proximidades da nossa fábrica					
42.	As máquinas na nossa fabrica apresentam baixos tempos de preparação (set-up)					
43.	Os nossos equipamentos/ processos na área de produção estão atualmente a ser controlados utilizando uma ferramenta do tipo controlo estatístico da qualidade de processo					

IV. Perceção acerca do lean

1. Há quanto tempo a empresa tem utilizado ferramentas Lean? _____(anos)

Por favor, responda às seguintes perguntas com "Sim" ou "Não". No caso de responder "Sim", por favor, escolha de 1 a 5 qual foi o impacto do Lean em cada um dos fatores.

(1)muito baixo (2)baixo (3)moderado (4)alto (5)muito alto

2. A implementação do Lean melhorou os processos de produção/prestação de serviço (ex: tempo de produção, menor desperdício, maior motivação)?

☐ Sim ☐ Não

☐1 ☐2 ☐3 ☐4 ☐5

3. A implementação do Lean na empresa fez aumentar a sua rentabilidade financeira (medida, p. ex. pelo lucro)?

☐ Sim ☐ Não

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

4. A implementação do Lean na empresa aumentou a sua quota de mercado?

☐ Sim ☐ Não

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

5. O Lean tem ajudado no atingimento dos objetivos/expectativas da empresa?

☐ Sim ☐ Não

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

V. Perceção acerca do estilo de liderança

1. Por favor, identifique o estilo de liderança que melhor o descreve enquanto líder. Ordene de 1 (o mais semelhante com seu estilo) a 4 (o menos semelhante).

☐ Reconhece as conquistas e promete recompensas pelo esforço e performance (Transacional)

☐ Expande os interesses dos empregados e incentive-os a colocar o interesse do grupo antes do próprio interesse (Transformacional)

☐ Exerce a sua liderança com base no reconhecimento do potencial dos seus trabalhadores, dando-lhes poder mais do que dirigindo-os (Emponderador)

☐ Fornece a direção e os objetivos aos trabalhadores (Diretivo)

Obrigado pela sua colaboração.

Caso pretenda ter acesso aos resultados finais deste estudo, indique por favor o seu e-mail aqui:

Annex 3 – Email example

Boa tarde, Dr. X.

O meu nome é Rosário Moreira e sou docente da Faculdade de Economia da Universidade do Porto. Pretendia aferir se estaria disponível para responder a um questionário on-line (cerca de 5-10 min.) sobre a implementação/controlo/acompanhamento dos processos de melhoria ou a implementação do Lean/Kaizen. Se não for a pessoa indicada para tal, dada a temática em causa, agradecia reconhecidamente que me informasse o e-mail do responsável a contactar.

Tal pedido prende-se com um trabalho que se encontra em curso no âmbito de uma dissertação do Master in Management da Faculdade de Economia da Universidade do Porto, sobre a relação entre o estilo de liderança e o sucesso de implementação do Lean Six Sigma. Todos os dados recolhidos serão tratados com total anonimato e confidencialidade, de forma agregada e apenas serão usados para efeitos deste estudo académico.

Fico a aguardar o seu contacto. Obrigada pela disponibilidade e atenção,

Rosário Moreira

Annex 4 – SPSS Outouts (H1.1, H2.1, H3.1 and H4.1)

Test Statistics^a

	Trans
Mann-Whitney U	57,500
Wilcoxon W	85,500
Z	-,336
Asymp. Sig. (2-tailed)	,737
Exact Sig. [2*(1-tailed Sig.)]	,745 ^b
Exact Sig. (2-tailed)	,759
Exact Sig. (1-tailed)	,377
Point Probability	,011

a. Grouping Variable: Groups

b. Not corrected for ties.

Test Statistics^a

	Transf
Mann-Whitney U	44,500
Wilcoxon W	72,500
Z	-1,128
Asymp. Sig. (2-tailed)	,260
Exact Sig. [2*(1-tailed Sig.)]	,270 ^b
Exact Sig. (2-tailed)	,273
Exact Sig. (1-tailed)	,136
Point Probability	,006

a. Grouping Variable: Groups

b. Not corrected for ties.

Test Statistics^a

	Direct
Mann-Whitney U	55,000
Wilcoxon W	226,000
Z	-,503
Asymp. Sig. (2-tailed)	,615
Exact Sig. [2*(1-tailed Sig.)]	,657 ^b
Exact Sig. (2-tailed)	,663
Exact Sig. (1-tailed)	,333
Point Probability	,037

a. Grouping Variable: Groups

b. Not corrected for ties.

Test Statistics^a

	Empow
Mann-Whitney U	20,500
Wilcoxon W	48,500
Z	-2,590
Asymp. Sig. (2-tailed)	,010
Exact Sig. [2*(1-tailed Sig.)]	,008 ^b
Exact Sig. (2-tailed)	,008
Exact Sig. (1-tailed)	,004
Point Probability	,000

a. Grouping Variable: Groups

b. Not corrected for ties.

Annex 5 – SPSS Outputs (H1.2, H2.2, H3.2 and H4.2)

Test Statistics^a

	transact
Mann-Whitney U	59,500
Wilcoxon W	164,500
Z	-,967
Asymp. Sig. (2-tailed)	,334
Exact Sig. [2*(1-tailed Sig.)]	,344 ^b
Exact Sig. (2-tailed)	,347
Exact Sig. (1-tailed)	,173
Point Probability	,005

a. Grouping Variable: GroupRentF

b. Not corrected for ties.

Test Statistics^a

	transact
Mann-Whitney U	53,500
Wilcoxon W	81,500
Z	-,580
Asymp. Sig. (2-tailed)	,562
Exact Sig. [2*(1-tailed Sig.)]	,574 ^b
Exact Sig. (2-tailed)	,586
Exact Sig. (1-tailed)	,290
Point Probability	,010

a. Grouping Variable: GroupMktShare

b. Not corrected for ties.

Test Statistics^a

	transact
Mann-Whitney U	24,000
Wilcoxon W	277,000
Z	-,759
Asymp. Sig. (2-tailed)	,448
Exact Sig. [2*(1-tailed Sig.)]	,497 ^b
Exact Sig. (2-tailed)	,503
Exact Sig. (1-tailed)	,264
Point Probability	,062

a. Grouping Variable: GroupGoals

b. Not corrected for ties.

Test Statistics^a

	transf
Mann-Whitney U	75,000
Wilcoxon W	141,000
Z	-,110
Asymp. Sig. (2-tailed)	,912
Exact Sig. [2*(1-tailed Sig.)]	,936 ^b
Exact Sig. (2-tailed)	,925
Exact Sig. (1-tailed)	,462
Point Probability	,011

a. Grouping Variable: GroupRentF

b. Not corrected for ties.

Test Statistics^a

	transf
Mann-Whitney U	32,000
Wilcoxon W	38,000
Z	-,084
Asymp. Sig. (2-tailed)	,933
Exact Sig. [2*(1-tailed Sig.)]	,969 ^b
Exact Sig. (2-tailed)	,951
Exact Sig. (1-tailed)	,471
Point Probability	,007

a. Grouping Variable: GroupGoals

Test Statistics^a

	transf
Mann-Whitney U	61,500
Wilcoxon W	89,500
Z	-,091
Asymp. Sig. (2-tailed)	,927
Exact Sig. [2*(1-tailed Sig.)]	,929 ^b
Exact Sig. (2-tailed)	,942
Exact Sig. (1-tailed)	,470
Point Probability	,012

a. Grouping Variable: GroupMktShare

b. Not corrected for ties.

Test Statistics^a

	direct
Mann-Whitney U	57,500
Wilcoxon W	162,500
Z	-1,109
Asymp. Sig. (2-tailed)	,268
Exact Sig. [2*(1-tailed Sig.)]	,291 ^b
Exact Sig. (2-tailed)	,289
Exact Sig. (1-tailed)	,136
Point Probability	,009

a. Grouping Variable: GroupRentF

b. Not corrected for ties.

Test Statistics^a

	direct
Mann-Whitney U	28,500
Wilcoxon W	56,500
Z	-2,169
Asymp. Sig. (2-tailed)	,030
Exact Sig. [2*(1-tailed Sig.)]	,034 ^b
Exact Sig. (2-tailed)	,031
Exact Sig. (1-tailed)	,019
Point Probability	,010

a. Grouping Variable: GroupMktShare

b. Not corrected for ties.

Test Statistics^a

	empow
Mann-Whitney U	75,000
Wilcoxon W	180,000
Z	-,110
Asymp. Sig. (2-tailed)	,912
Exact Sig. [2*(1-tailed Sig.)]	,936 ^b
Exact Sig. (2-tailed)	,925
Exact Sig. (1-tailed)	,463
Point Probability	,011

a. Grouping Variable: GroupRentF

b. Not corrected for ties.

Test Statistics^a

	direct
Mann-Whitney U	15,000
Wilcoxon W	268,000
Z	-1,563
Asymp. Sig. (2-tailed)	,118
Exact Sig. [2*(1-tailed Sig.)]	,151 ^b
Exact Sig. (2-tailed)	,140
Exact Sig. (1-tailed)	,085
Point Probability	,035

a. Grouping Variable: GroupGoals

b. Not corrected for ties.

Test Statistics^a

	empow
Mann-Whitney U	54,500
Wilcoxon W	225,500
Z	-,518
Asymp. Sig. (2-tailed)	,604
Exact Sig. [2*(1-tailed Sig.)]	,615 ^b
Exact Sig. (2-tailed)	,625
Exact Sig. (1-tailed)	,312
Point Probability	,013

a. Grouping Variable: GroupMktShare

b. Not corrected for ties.

Test Statistics^a

	empow
Mann-Whitney U	20,500
Wilcoxon W	26,500
Z	-1,053
Asymp. Sig. (2-tailed)	,293
Exact Sig. [2*(1-tailed Sig.)]	,311 ^b
Exact Sig. (2-tailed)	,321
Exact Sig. (1-tailed)	,164
Point Probability	,011

a. Grouping Variable: GroupGoals

b. Not corrected for ties.

Annex 6 – SPSS Outputs (Correlations)

- Correlations between leadership styles

		transact	transf	direct	empow
transact	Correlation Coefficient	1,000	,544**	,474*	,655**
	Sig. (2-tailed)	.	,005	,017	,000
	N	25	25	25	25
transf	Correlation Coefficient	,544**	1,000	,469*	,687**
	Sig. (2-tailed)	,005	.	,018	,000
	N	25	25	25	25
direct	Correlation Coefficient	,474*	,469*	1,000	,347
	Sig. (2-tailed)	,017	,018	.	,089
	N	25	25	25	25
empow	Correlation Coefficient	,655**	,687**	,347	1,000
	Sig. (2-tailed)	,000	,000	,089	.
	N	25	25	25	25

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

- Correlations between leadership styles and LSS implementation success

			Lean
Spearman's rho	transact	Correlation Coefficient	,088
		Sig. (2-tailed)	,674
		N	25
	transf	Correlation Coefficient	,347
		Sig. (2-tailed)	,089
		N	25
	direct	Correlation Coefficient	,154
		Sig. (2-tailed)	,463
		N	25
	empow	Correlation Coefficient	,530**
		Sig. (2-tailed)	,006
		N	25
	Lean	Correlation Coefficient	1,000
		Sig. (2-tailed)	.
		N	25

- Correlations between leadership styles dimensions and LSS implementation success

			Lean
Spearman's rho	D1Transact	Correlation Coefficient	,142
		Sig. (2-tailed)	,498
		N	25
	D2Transact	Correlation Coefficient	,131
		Sig. (2-tailed)	,534
		N	25
	D1Transf	Correlation Coefficient	,186
		Sig. (2-tailed)	,374
		N	25
	D2Transf	Correlation Coefficient	,204
		Sig. (2-tailed)	,327
		N	25
	D3Transf	Correlation Coefficient	,199
		Sig. (2-tailed)	,341
		N	25
	D4Transf	Correlation Coefficient	,337
		Sig. (2-tailed)	,099
		N	25
	D5Transf	Correlation Coefficient	,401*
		Sig. (2-tailed)	,047
		N	25
	D1Direct	Correlation Coefficient	,358
		Sig. (2-tailed)	,079
		N	25
	D2Direct	Correlation Coefficient	,060
		Sig. (2-tailed)	,776
		N	25
	D1Empow	Correlation Coefficient	,318
		Sig. (2-tailed)	,121
		N	25
	D2Empow	Correlation Coefficient	,259
		Sig. (2-tailed)	,211
		N	25
	D3Empow	Correlation Coefficient	,335
		Sig. (2-tailed)	,101
		N	25

	D4Empow	Correlation Coefficient	,447*
		Sig. (2-tailed)	,025
		N	25
	D5Empow	Correlation Coefficient	,592**
		Sig. (2-tailed)	,002
		N	25
	D6Empow	Correlation Coefficient	,171
		Sig. (2-tailed)	,414
		N	25
	Lean	Correlation Coefficient	1,000
		Sig. (2-tailed)	.
		N	25