ISCTE Business School
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APPLICATION OF LEAN THINKING APPROACH TO AN INTERNAL SERVICE SYSTEM OF A UTILITIES COMPANY

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Abstract

An ineffective and inefficient provision of internal services has impacts on the performance and sustainability of organisations. The current research aims at verifying if effectiveness and efficiency gains result from the application of a systematic lean approach to the internal services of a utilities company. Lean thinking is the conceptual framework considered for such purpose.

The methodology serving such intents is based on a case study developed at the markets division of a utilities company with business on the power and gas markets. The information that sustains this research was collected through direct observation and informal interviewing of the staff of the markets division, as well as of its internal customers. The lean thinking systematic approach encompasses the application of lean tools. In this regard, *process activity mapping* is employed, as well as other lean tools, like problem solving, *kaizen blitz* events, *kanban*, or work standardisation.

Three processes concurring to the provision of internal services are studied: market risk hedging, database parameterisation for financial derivatives register, and CO2 emission allowances stock calculation. The assessment of such processes within a lean thinking tools framework and their customer value and waste identification are followed by the implementation of improved versions of such processes. Results indicate that effectiveness gains are achievable and carry real impacts in terms of value for the internal customer, an aspect sparsely developed on previous research. In terms of efficiency impacts, lead time is reduced 74%, 97% and 89% for each process, respectively, whilst personnel participation is reduced 7%, 20% and 57%.

Keywords: Lean Thinking, Internal Services, Utilities, Processes.

JEL Classification System: M11 – Production Management; L94 – Electric Utilities.

Resumo

Uma inefectiva e ineficiente prestação de serviços internos gera impacto na performance e sustentabilidade das organizações. A presente investigação visa verificar se a aplicação sistemática da perspectiva *lean thinking* aos serviços internos de uma empresa do sector das *utilities* resulta em ganhos de efectividade e eficiência.

A metodologia que serve o propósito da presente investigação é sustentada por um caso de estudo levado a cabo na unidade de mercados de uma empresa do sector energético. Toda a informação obtida foi recolhida a partir de observação directa, ou de entrevistas informais dos colaboradores da unidade de mercados, bem como dos clientes internos da mesma. A perspectiva *lean thinking* considerou a aplicação de ferramentas *lean*, nomeadamente *process activity mapping*, *problem solving*, eventos *kaizen blitz*, kanban, e estandardização de actividades.

Três processos que concorrem para a prestação de serviços internos são estudados: cobertura de risco de mercado, parametrização de base de dados para registo de derivados financeiros, e cálculo do stock de licenças de emissão de CO2. A avaliação de tais processos numa perspectiva de aplicação de ferramentas *lean thinking*, bem como a identificação do desperdício e do valor dos serviços na perspectiva dos clientes internos, é seguida da implementação de versões melhoradas dos mesmos processos. Os resultados da investigação indicam que impactos positivos de efectividade são possíveis, originando ganhos de valor para o cliente interno, aspecto parcamente abordado em investigações anteriores. Em termos de eficiência, o *lead time* dos processos foi reduzido em 74%, 97% e 89% para cada um dos mesmos, enquanto que a participação dos colaboradores for reduzida em 7%, 20% e 57%.

Palavras-chave: *Lean Thinking*, Serviços Internos, Utilities, Processos.

Sistema de Classificação JEL: M11 – Production Management; L94 – Electric Utilities.

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This research could not have been perpetrated without thorough support. With regards to such, I must underline the full coverage my family has given me. They are my standpoint and my accomplishments, whichever they may be, are only possible because of them.

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1. Introduction

Any organisation, aside from its core activity, develops a set of supporting activities, which are commonly accepted as the structure that sustains the organisation itself (Gremler *et al.*, 1994; Johnston, 2008; Lovelock, 1996; Parente *et al.*, 2002; Zeithaml *et al.*, 2006). Whether a manufacturing company, a service providing firm, or a public institution as a university or a court house; organisations must have some internal service units, perpetrating actions that enable the development of the organisation's core activity. Marketing units, research and development, financial analysis, information technology, human resources, sales department are mere examples of internal service units that sustain the core business of an organisation and whose performance matters in terms of goals' achievement (Maleyeff, 2006).

The impact of such internal service units on an organisation's overall performance is not easily measurable (Maleyeff, 2006). Nevertheless its efficiency may be improved, seldom with impact on:

- the levels of external customer satisfaction (Johnston, 2008; Gremler *et al.*, 1994; Zeithaml *et al.*, 2006);
- the staff attitudes, its retention and compliance (Johnston, 2008; Lings and Greenley, 2005);
- the organisation's financial performance (Heskett, 1987; Heskett *et al.*, 2003).

Several authors have researched within the internal services spectrum (Johnston, 2008). Franco and Bourne (2003) have researched on the improvement of internal services coordination, aiming at strategy fit through internal services optimisation; Oke *et al.* (2007) have focused on product or service innovation through cross-functional approaches, taking internal service provision as a starting point; Heskett (1987) has considered the necessity of developing internal competences (internal services' improvement), while considering the significance of fitting internal operations and marketing.

1.1 Problem stating

Lean thinking approach has a track record of effectiveness starting from its origins on the automotive industry, up to several other manufacturing areas (Womack and Jones, 2003), but also to supply chain management (Lamming, 1996; Efficient Consumer Response, 2005), healthcare systems (Seddon, 2003; Womack and Jones, 2005) or call-centre operations

(Allway and Corbett, 2002). Such effectiveness was translated into measurable efficiency improvements on operations, with real gains for the organisations applying them (Womack and Jones, 2003).

Some researchers as Juroff (2003), Holmes (2007), Demers (2002), Vinas (2004), Chaneski (2005) or Smart *et al*. (2003) have applied lean tools to internal service areas as an extension of a shop-floor lean transformation. Rich and Piercy (2009) consider that such attempts have been successful in creating efficiency gains.

Despite such research advances, literature has been sparse in terms of conveying the application of a lean thinking approach to utilities' companies, particularly in key areas of the energy business. In this sense, the present work will focus on contributing to bring to light the potential of the application of lean tools to a specific internal service area of an energy player.

In view of the purpose of lean thinking approach being to create value and reduce waste, i.e., to generate greater value for the customer and increased efficiency of processes (Womack and Jones, 2003), the current work aims at *analysing if the application of* lean *tools to the business processes of an internal service system of a specific utilities company induces effectiveness and efficiency gains for the company.*

Aside from the main purpose just mentioned, the present research holds the following partial goals:

- To identify criteria to select the most appropriate internal services to be analysed;
- To choose three business processes from the internal service system on the energy markets division;
- To identify the customer that each of the chosen processes services, and to define value for such customer;
- To map the chosen processes and subsequently analyse them;
- To measure the processes initial effectiveness situations, regarding value creation for the internal customer; and efficiency, in terms of lead times and personnel participation;
- To identify the types of waste observable on the processes according to the mapping results;
- To identify the appropriate lean thinking tools to analyse the selected internal services;
- To analyse the selected internal processes using the identified lean thinking tools;

- To develop improved versions of the analysed processes according to the analysis performed;
- To implement the improved versions of the analysed processes;
- To measure the improvements, in terms of effectiveness and efficiency, after the application of the lean thinking tools.

1.2 Research question

Bearing in mind the problem stated and the general objective of the present thesis, the following investigation question is defined:

RQ: How can lean thinking tools affect the effectiveness and the efficiency of a set of independent processes of an internal service system?

1.3 Case study approach justification

A case study is an empirical inquiry that enables the research of contemporary phenomenon observable in real-life events. The phenomenon and the events themselves are not fundamentally apart from each other (Yin, 1989). Case study methodology hence becomes a suitable research method for the collection of information on organisational or management processes.

The case study methodology, fitting exploratory research (Eisenhardt, 1989), consists of an advantage when compared to more qualitative methods, whenever the situations characterised are not about homogeneity of behaviours and involve creativity and innovation (Delgado and Ferreira, 2010). With regards to the current study, the option for a case study was also a consequence of the fact that the potential of the application of lean thinking tools to internal service systems is still at a very early stage of investigation (Eisenhardt, 1989).

Yin (1989) considers case studies should tend to fulfil three identifiable characteristics as criteria: (i) research question of the type “how” or “why”; (ii) little or none control over the behavioural events under research; and (iii) the focus of the study should be on contemporary events.

If the above mentioned criteria are to be held into account, a research whose aim is to comprehend, through observation, how lean tools can influence the effectiveness and efficiency of a set of processes of a specific internal service system of a contemporary utilities business may only be qualified as case study material.

1.4 Scope of research

According to the purpose previously defined, the research will be developed on the energy markets division of a utilities company with business on the power and gas markets. The core activity of the energy markets division is to provide the service of market operational activities, such as managing market risk or forecasting market variables. The nature of such service provision is clearly internal, making use of the information and specialized knowledge gathered in such unit.

In this sense and with regards to scope limitation, it should be stressed that this research is confined to the three processes chosen, identified and analysed on chapter 4 within a lean thinking tools application paradigm. In fact, the choice of processes, the application of such tools, the observation of results and following evaluation of effectiveness and efficiency gains are the scope up to which this research ranges.

1.5 Thesis outline

The outline of the present thesis will entail the five following chapters:

- **Introduction** – the theme is presented and brief considerations are advanced on the purposes of this study, its research question, as well as on its scope and limitations;
- **Literature review** – as the fundamental theoretical guideline for this study, lean thinking approach is drilled down;
- **Methodology** – the research methodology is disclosed, the usage of a case study is justified and methods and procedures are dissected;
- **Case study description** – the pilot implementation of lean thinking in the energy markets division is contextualized and the three business process transformations are thoroughly disclosed, the application of lean thinking tools is described and the results of such transformations are advanced;
- **Conclusions** – the results of the investigation are analysed, its limitations considered and the research purposes evaluated, hinting possible future developments and investigations.

2. Literature review

On this chapter, a literature review on the lean thinking approach will be performed. Such analysis will comprehend a walkthrough on some of the key concepts of the above mentioned approach, envisaging the focus of the present thesis.

In this sense, the following chapter will commence with an overview on the birth and evolution of lean thinking throughout time, not disregarding more recent and holistic contributions to the concept of lean thinking. Following, the five fundamental principles of lean thinking will be analysed (Womack and Jones, 2003). Furthermore, lean thinking application with regards to service providing organisations will be visited according to the contributions of various authors. Finally, finishing this chapter, the seven types of waste considered in lean thinking approach will be disclosed, as well as a possible reinterpretation of the latter in a services provision context.

2.1 Lean Thinking evolution

Even though one may travel back as far as the 15th century in order to convey the birth of process rationalization in manufacturing, as to understand the context in which lean thinking was brought up, one should start by considering the contribution of Henry Ford to the production process (Womack, 2002).

In fact, Ford's contributions shaped up what could be considered the manufacturing process paradigm in Europe and in the United States of America by the time of the Second World War. Such paradigm comprehended mass production, in large batches, usually of a single product, aiming at cheap unitary costs. By this time, in Japan, a different approach started being developed in the automotive industry, mainly due to demand shortages. It became fundamental for the Japanese automakers to produce in shorter quantities and with wider variety (Ohno, 1988). The Toyota Production System was then taking its first steps, looking for efficiency through continuous waste reduction.

Toyota was in fact quite probably one of the first companies to understand that demand could not absorb whole of the supply (Ohno, 1988). Not every produced product was sold. Accordingly, it became fundamental to not only meet customer's expectations, but also to reduce and eliminate waste.

While mass production was dealing with excessive, undesired and imperfect production, Toyota was resizing its manufacturing machines for smaller volumes, making the product

flow all along the production process, and thus matching the necessities of more demanding customers, which were now considering higher variety and quality, low costs and rapid adaptation (Womack, 2002). The base ideas of lean thinking emerged here: production was to become efficient through waste reduction and process flow, but also effective as it was to address comprehensively and flexibly any shift in market's demand.

The table 2.1 summarizes the four subsequent phases of lean thinking evolution as considered by Hines *et al.* (2004). Lean evolution contributions' framing will be concluded with more recent perspectives, which envisage a more holistic approach to lean thinking, through behaviour and organisational culture considerations.

Phases	1980-1990 Awareness	1990-mid 1990 Quality	Mid 1990-2000 Quality, cost and delivery	2000+ Value System
Literature Theme	Dissemination of shop-floor practices	Best practice movement, benchmarking leading to emulation	Value stream thinking, lean enterprise, collaboration in the supply chain	Capability at system level
Focus	JIT techniques, cost	Cost, training and promotion, TQM, process reengineering	Cost, process-based to support flow	Value and cost, tactical to strategy, integrated to supply chain
Key business process	Manufacturing, shop-floor only	Manufacturing and materials management	Order fulfilment	Integrated processes, such order fulfilment and new product development
Industry Sector	Automotive – vehicle assembly	Automotive – vehicle assembly	Manufacturing in general – often focused on repetitive manufacturing	High and low volume manufacturing, extension into service sectors
Main Authors	Shingo (1981, 1988) Monden (1983) Ohno (1988) Mather (1988)	Womack *et al.* (1990) Hammer (1990) Stalk and Hout (1990) Harrison (1992) Andersen Consulting (1993, 1994)	Lamming (1993) MacBeth and Ferguson (1994) Womack and Jones (1994, 1996) Rother and Shook (1998)	Bateman (2000) Hines and Taylor (2000) Howeg and Phil (2001) Abbas *et al.* (2001) Hines *et al.* (2002)

Table 2-1 - Lean Evolution
Source: Hines *et al.*, 2004

As mentioned previously, lean thinking was developed in Toyota mainly by Taiichi Ohno throughout the 1950s and onwards (Hines *et al.*, 2004), but it was only in the 1970s that the first manuals with contributions towards concepts that were to shape up lean thinking's approach were written in Japanese, as they were kept as an industrial secret by Toyota.

Another decade had to pass till such contributions were to be edited in English (Shingo, 1981, 1988; Monden, 1983; Ohno, 1988; Hines *et al.*, 2004). This was the first phase of the lean evolution and it was a discovery phase, based on the automotive sector and just-in-time production methods, as well as cost reduction.

The edition of the book *The Machine that Changed the World* by the authors Womack and Jones, back in 1990, was a keystone on lean thinking's evolution. The phrase *lean production* was there coined by such authors for the first time, setting the stage for the second phase of the evolution (Hines *et al.*, 2004). The book, even though having the automotive sector as a starting point, considers production and technology problems as common management problems applicable to (almost) any industry (Womack *et al.*, 1990; Hines *et al.*, 2004).

Lean thinking's progression from its second to its third stage was materialized through a literature focus movement from quality (early 1990s), to quality, cost and delivery (late 1990s), as well as for an expansion of the lean thinking scope beyond the factory boundaries, considering the whole supply chain (Hines *et al.*, 2004). Henceforth a thorough materialization of the lean principles occurred, principles that will be drilled down further on the sub-chapter 2.2.

The fourth stage of lean's evolution, for Hines *et al.* (2004), was characterized by the focus on customer value, as well as on the application of lean thinking to organisations other than high volume manufacturing, including service organisations. The lean thinking approach to services will be considered on sub-chapter 2.3.

2.1.1 Lean thinking evolution: culture, strategy, leadership and behaviours

Lean thinking as a management approach tends to seek the intent of leading waste reduction to match value enhancement (Hines *et al.*, 2008). Literature focus, as well as many practitioners' action (Bowen and Youngdahl, 1998; Chaneski, 2005; Esimai, 2004; Hines, 2006, Hines and Martins, 2005; Jones and Clarke, 2002; Abernathy *et al.*, 2000), has been done concerning the replication of lean tools and techniques, in order to attain such intent. Most of these techniques and tools were inspired by the Toyota Production System lean tools (*kanban*, *gemba* walks, *value stream mapping*, 5S, etc.) (Hines *et al.*, 2008).

Nonetheless, and taking it from Hines *et al.* (2004) perspective on lean thinking's evolution, it is fair to acknowledge a more recent tendency for authors to engage in a more holistic perspective on lean thinking, framing it up within a broad transformation process that organisations pursue. Accordingly, many such authors refer to lean thinking as a change

process envisaging continuous improvement, which requires cultural and behavioural transformation (Abdi *et al.*, 2006; Hines *et al.*, 2008; Mann, 2009; McCuiston, 2010), and occurs within the scope of a movement towards strategic alignment (Hines *et al.*, 2002; Hines *et al.*, 2008). Such broad process should be triggered and developed from top-down. Hence, inspiring leadership is seen as a key success factor for the implementation of a truly effective lean thinking approach (Hines *et al.*, 2002; Piercy and Rich, 2009; McCuiston, 2010; Mann, 2009; Grove *et al.*, 2010).

In fact, Mann (2009) goes as far as stating that, even though it is common to convey lean thinking as a bundle of tools aiming at waste reduction and process standardization, 80 percent of a lean transformation process is borne by the change of procedures and mindsets of leaders. Their effort is the trigger that establishes conditions for organisations to develop the remainder 20 percent of the effort, which is about implementing lean tools and techniques. Furthermore, on a research in a health visiting service unit in the UK, Grove *et al.* (2010) identified as main barriers to a lean transformation, amongst others, the misunderstanding of lean (excessive focus on tools) and the poor communication and leadership.

One of the most important literature contributions to the above mentioned holistic approach is certainly the one wrapped up by Hines *et al.* (2008). On their edition of the lean implementation guideline – *Staying Lean* –, the authors expose graphically (see figure 2.1) lean transformation as an iceberg with a small *visible* part composed of tools, technology and techniques, aiming at process management, whilst below, as the infrastructure sustaining it, one may find the broader and *invisible* part of the iceberg: strategy and alignment, leadership, and behaviour and engagement.

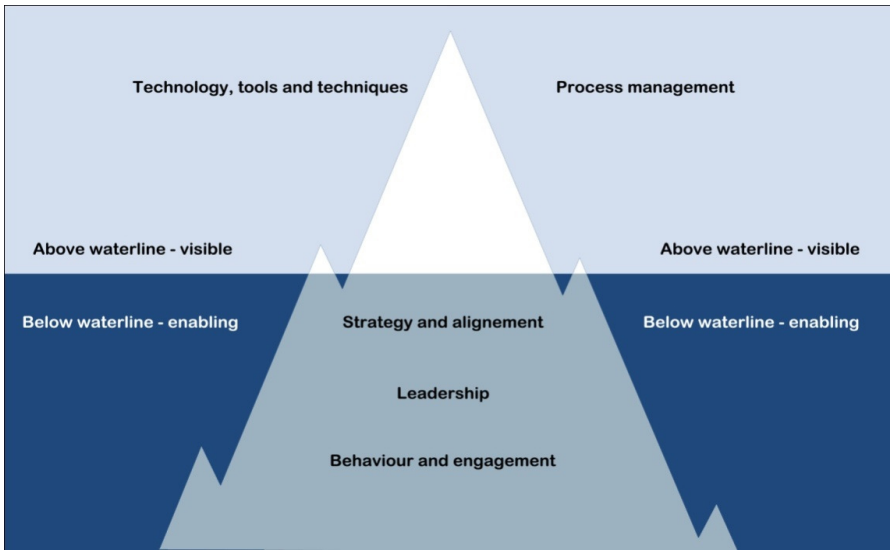

Figure 2-1 - Lean transformation iceberg
Source: Hines *et al.*, 2008

2.2 Lean's fundamental principles

For Womack and Jones (2003), lean thinking is the antidote for waste, enabling the specification of value and creating the best sequential layout for activities, eliminating interruptions and achieving greater efficiency. Such authors describe lean approach as "[…] a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers with exactly what they want […]" (Womack and Jones, 2003:15). Indeed, after having coined the term lean manufacturing, Womack and Jones (1996) again contributed heavily for the conceptualization of lean practices when listed the five key principles guiding lean thinking's approach:

(1) product or service **value** specification according to the customer's perspective;

(2) **value stream** identification for each good or service;

(3) assurance of smooth **flow** for the activities that create value;

(4) allowing the client to **pull** the value from the system;

(5) striving for **perfection**, by reviewing the principles and banishing waste.

2.2.1 Value

According to Womack and Jones (2003), any process aiming at the production of a good or the provision of a service should not start without a complete comprehension of what the consumer (whether an individual or an organisation) desires from it. In other words, the *value* is defined by the customer and the product or service is the materialization of such value, for him perceived and specified, according to his expectations, at a certain moment and for a certain price. The value of a product or service is hence the perception each customer has of it.

Lean thinking's goal of eliminating waste does not hence start at an operational level, rather is born from the perception of *value* for the customer. Without understanding the customer concept of value, how can waste be identified? (Hines *et al.*, 2008). A lean transformation, starting from such initial point, will focus on unnecessary activities, enabling the creation of new goods or services, or at least their updating (Hines *et al*., 2004).

Nonetheless, it is not always easy to start a lean transformation process from the customer's *value* point. For Womack and Jones (2003), producers often resist to any change, preferring to keep their "way of doing things around". The focus should however be on *value* for customers, not for individual firms, functions or departments. (Hines *et al.*, 2002). On another hand, the customer's views are not always easy to obtain, also because customers are often

not specific enough, whenever inquired on their expectations for *value* (Womack and Jones, 2003).

Another reason concurring for difficultness of assessing customer's *value* has to do with the fact that many products or services are depending on a supply chain to which different organisations or companies contribute. In this sense, the final value of a product or service will depend on the adding up of the several partial values of each company all along the supply chain. It is hence fundamental that companies communicate along *value streams*, potentiating the *value* for the customers (Womack et Jones, 2003).

Womack and Jones (2003) define the identification of a targeted cost for each product as essential for *value* specification. Such identification should consider the available resources and the proposed effects, i.e., the *value* creation for the customer.

2.2.2 Value Stream

Once defined the value of a product or service according to customer's perceptions and from it inferred a targeted cost, it is necessary to assess each step of the *value stream*. In Hines *et al.* (2002:3) words, the value stream is composed of "[…] all the steps necessary to design, order and produce […]" a good or service.

For an effective lean transformation it is fundamental to thus map all the steps or activities necessary to attain the pursued good or service. Such procedure is often described as *value stream mapping* and it lists not only all the activities developed in the process of developing a product or service, but also the resources spent in each of the activities, either in terms of people and time spent. Through such mapping process, one is able to identify which activities actually add value to the customer and which do not, therefore being subject to a removal attempt, as they may be considered waste (Womack and Jones, 2003).

Accordingly, Womack and Jones (2003) consider three types of activities:

- **value adding activities**: add value to the good or service, according to the customer's perspective;
- **support activities**: do not directly add value to the customer, but are necessary for the process as it is, even though they may be target of a removal if improvement occurs as they are waste;
- **waste or non value adding activities**: do not add value in the customer's perspective, but also are unnecessary for the process as it is and therefore should be promptly removed.

Hines *et al.* (2002) identifies another type of activity, the future value adding activity, referring to those activities whose development will produce value added somewhere in the future, despite currently not adding value from the customer's point of view. The development of a new good or service clearly suits this description.

2.2.3 Flow

Once the value streams are designed, the focus should fall upon the necessity of making activities that create value for the good or service to flow without stoppages, interruptions, bottlenecks or breaks (Abdi *et al.*, 2006).

The way organisations are structured often disrupts flow. Departments and functions seldom protect themselves as a whole, instead of perceiving the organisation or the value stream as a sole piece. As Abdi *et al.* (2006) underline, the excessive focus on own activities in accordance with lack of communication culminates in waste. Flow achievement is therefore elemental, as an enabler of a leaner value stream. Nevertheless, it requires from organisations a profound interruption with the past. Flow accomplishment will require new ways of doing things, limiting or altering the traditional scopes of jobs, careers and functions.

In fact, Womack and Jones (2003) consider three aspects that should be undergone to successfully develop flow. Firstly, the good or service must be seen as whole, not as a combination of partial processes. Secondly, the above mentioned jobs, careers and functions should be redesigned in favour of a structure where impediments to flow are eliminated. Finally, a thorough reassessment of the tools and activities used all along the value stream should be performed, in order to abolish interruptions, redundancies and unnecessary activities, or in other word, waste.

2.2.4 Pull

In order to describe this fourth principle, Abdi *et al.* (2006:5) compare lean organisations, in which "[…] operations are designed to respond to ever-changing requirements of end-user customers […]", to those of batch and queue paradigm, where operations are planned for responding to the company's own wishes. Hence the *pull* principle relies on the assumption that no good or service should be produced without a respective customer demand for such. Accordingly, new procedures are commonly required within a lean transformation process, shaping organisations into quick response operators to market requests (Womack and Jones, 2003).

2.2.5 Perfection

The last principle of lean thinking is perhaps the most difficult one to implement. It is inferred from the implementation of the first four principles, but not any kind of implementation. The fifth principle of lean thinking comprises a systematic implementation of the previous principles, as they should be constantly renewed and redone, aiming at continuous improvement, or in another word, *perfection*. Womack and Jones (2003) consider that organisations will always find better and more efficient ways of perpetrating their processes, always bearing in mind the vector waste-value.

Traditionally, a lean transformation starts off with radical change events, the *kaizen blitzs* events (Hines *et al.*, 2008), as people embrace such transformation with great zest. Nevertheless, often such energetic process starts to falter and results fail to endure. For such reason, it is fundamental to perceive lean thinking as a systematic approach, a long lasting one. *Perfection* is to be pursued, but never to be found, since improvements are always possible.

One may even consider a parallel here, between the cultural and behavioural dimension of lean thinking, mentioned previously, as a fundamental aspect to achieve *perfection*. If an organisation does not adopt lean thinking's principles as part of its DNA, in the long run lean potential will go astray and *perfection* forgotten.

2.3 Lean thinking and services

Service providing organisations face, as any other business, several challenges. Allway and Corbett (2002) list some of such challenges which service companies necessarily cope with: rising customer expectations; revenue pressures; competitive pressures; increasing expenses; and regulatory pressures.

Should such organisations seek for solutions on operations? And if so, should they regard lean thinking as a viable approach when aiming for performance improvement? The answer to such questions may not be straightforward, especially if the origin of lean thinking is borne in mind. In fact, lean thinking derived from the automotive industry as mentioned previously and it thus started out as being strongly manufacturing oriented.

Bowen and Youngdahl (1998) suggest however that throughout times researchers have advocated two approaches with regards to principles' transfer between services and manufacturing. If in the 1970s the views of authors such as Levitt (1972; 1976) defending a

manufacturing approach to services was perceived as appropriate, later in the 1990s arguments against such view were launched, defending instead the opposite, i.e., the usage of service principles in industry. Bowen and Youngdahl (1998) defend the transfer of industrial practices to services, not framed within a mass production paradigm as Levitt (1976) assumed, but rather within a more suitable approach – lean thinking.

Allway and Corbett (2002) sustain a similar argument when consider that organisations, whether industrial or not, are responsible for developing operations and processes in order to attain delivery of value to the customer. Accordingly, a transformation process seeking efficiency of operations, waste reduction, leaner processes, and greater customer satisfaction may only be a valuable transformation trigger for any such organisation. The authors advocate further. They consider that service organisations adopting lean thinking will quickly observe benefits on their key processes, improve their operations, and respond more efficiently to customers.

Three main obstacles to be transposed are considered when implementing lean transformation: first, overcoming the perception that lean does not suit service provision; secondly, establishing a metric-driven environment, which may be harder to achieve than in a manufacturing environment; and thirdly, creating a culture that is prone to change (Allway and Corbett, 2002).

2.3.1 Lean thinking application to services and usage of mapping techniques

If some researchers corroborated the idea that lean thinking conceptually is suitable for service organisations, many others not only corroborated such idea, as also went farther and applied lean principles beyond the four walls of manufacturing facilities. Piercy and Rich (2009) contributed with a wrap up on the major developments and achievements with regards to application of lean thinking to services.

The authors stress the application of lean thinking to lean supply strategy. Hines (1996) suggested creating closer relationships with key suppliers. Within such framework, it was the retail sector who obtained further successful evidence with regards to application of lean principles. Efficient consumer response movement has been quite structured (Lamming, 1996; Efficient Consumer Response, 2005) and with gains in terms of holding stocks costs, write-off costs and increased pull system potential (Jones and Clarke, 2002; Fernie and McKinnon, 2003; Abernathy *et al*.., 2000). More importantly within the scope of the present thesis, it is to

observe that *value stream mapping* was successfully used in the transfer of lean principles from manufacturing environments to supply chain management (Bicheno, 2004).

According to Piercy and Rich (2009), the healthcare systems were another area where efforts were undergone towards the application of lean thinking. The movement of patients through treatment process was considerably investigated, in an attempt for an optimization similar to the one of a lean approach to a manufacturing assembly line. This permitted the usage of mapping techniques and waste reduction (Seddon, 2003; Womack and Jones, 2005). Fundamentally, it may be observed how process mapping allowed for waste and inefficiency reductions, whenever flow was envisaged (Swank, 2003; Jones and Mitchell, 2007; Towill and Christopher, 2005; Esimai, 2004; Massey and Williams, 2005).

Some other researchers have found evidence of manufacturing companies exporting lean concepts from shop-floor to the administrative areas with successful results (Piercy and Rich, 2009; Juroff, 2003; Holmes, 2007; Demers, 2002). Furthermore, Vinas (2004) and Chaneski (2005), respectively, highlight sales-order processing time and order and accounting system as areas where gains were obtained through application of *value stream mapping*.

Within different service areas, Tishcler (2006) researched and applied lean principles and *value stream mapping* to the admission process in the researcher's own university, as Hines and Lethbridge (2008) also performed a lean transformation on their university. Further, Hines and Martins (2005) tested the application of lean principles on the legal sector, again making use of *value stream mapping*.

On another hand, Maleyeff (2006) drove a meta-analysis of 60 internal service systems, finding evidence of regular structural characteristics on such type of service provision, as well as having confirmed the potential of lean thinking approach. In fact, the author contributed with several findings on such type of service which have great parallel with the type of service the pilot-projects to be studied on the present thesis, and thus his contributions will be summoned further below.

The findings of the various authors above mentioned lead us to two ideas: one, that lean thinking is a valuable approach for service organisations, when aiming for efficiency; and two, *value stream mapping* is fundamental when surfacing such approach as it holds great potential for understanding a process and its inefficiencies.

Whilst manufacturing industries deal mostly with the flow of materials or goods, services organisations are required to focus on the flow of information. In this sense, process mapping becomes essential as an enabler for comprehending information flow.

2.3.2 Application of lean tools to services

The application of mapping techniques to services as part of lean transformation is thus transversal to most researches perpetrated. Notwithstanding, some authors applied other lean tools to services with mentionable results.

Vinas (2004) researched on the application of problem solving techniques, aside from mapping, to the sales-order and quotation processes of Kato's Enginnering. The results of such research indicate efficiency gains to the processes, though impacts on the effectiveness improvement from the customer's value perspective are not considered. Similarly, Buzby *et al.* (2002) use cycle and takt time to trace efficiency gains on quote processing, again neglecting whether such improvements correspond to more value to the customer of such processes. Accordingly, Sprigg and Jackson (2006) used work standardisation as to successfully increase efficiency on "leaner" call centres, though noting downside effects on personnel motivation.

On another hand, Searcy (2009) documented the improvement of AMG's rental operations through a broader lean transformation process, using mapping techniques, *kaizen* events and personnel contributions to solve problems. The author demonstrated improvements of effectiveness and efficiency for the company and its customers.

Bearing in mind the abovementioned contributions, it is fair to point out that some authors have researched and documented on the potential of lean tools as efficiency enablers, though not all researchers evaluated whether such tools convey effectiveness gains, i.e., value additions for the customer, as lean thinking's philosophy encompasses (Womack and Jones, 1996).

2.3.3 The seven types of waste within a service context

As mentioned previously, waste identification is fundamental within a lean thinking transformation process. Hines *et al.* (2002) define waste simply as something that does not add value to the customer. Accordingly, a standard listing of types of waste is considerably clear for researchers and practitioners, although designed within the manufacturing paradigm, and since value is conceived as deriving from a tangible good (Maleyeff, 2006).

Consequently, the seven types of waste as put by Ohno (1988) are: defects; excessive inventory; unnecessary motion; transportation; processing inefficiency; waiting; and overproduction.

Some authors have adapted such listing of wastes to a service context. Hines and Martins (2005) advanced an interpretation of wastes within a legal sector lean application, whilst Maleyeff (2006) reinterpreted the seven types of waste within an internal service provision context. As the focus of the present thesis beholds an internal service context, the latter contribution will be following disclosed:

- *delays*, arising from queuing time on a succession of activities;
- *reviews* perpetrated in order to inspect previously performed activities and obtain superior approval, within a logic of mistakes or omissions mitigation;
- *mistakes* that may originate the necessity of redoing the task, if found internally, or even reputation damage, if found by the customer;
- *duplication* of activities within the same system;
- *movement* such as unnecessary physical movement of information, personnel or equipment;
- *processing inefficiencies,* resulting from the ineffective usage of a resource (lack of efficient standardization);
- *resource inefficiencies,* consequential of wasteful management of personnel, equipment, materials or capital.

2.4 Literature review: synthesis

This chapter aimed at exposing the principal academic and practical contributions achieved up to the moment within the lean thinking investigation area, always envisaging the scope of the present thesis and the theoretical support required to fulfil its purpose. Such research has worked as a guideline for the completion of this work, thus being worth mentioning for a better comprehension of the latter.

Firstly, the context in which lean thinking appeared, as well as its evolution, was considered. The more intricate and more recent comprehension of lean thinking as a behavioural and cultural transformation process was mentioned, again envisaging the scope of this research.

Following, the fundamental principles of the lean methodology, which tend to consist of a good explanation of it, were disclosed. The *value stream mapping* necessity, in order to attain

effective flow, was at this point stressed, once more bearing in mind the importance of such tools and concepts for the present thesis.

Finally, the application to the services area of a methodology born inside the walls of factories was addressed, framing it up within theoretical and practical contributions. Again the importance of mapping techniques was stressed through the evidence attained by some researchers. Subsequently, reference was made to an interpretation of the classical listing of seven types of waste within a context of internal services provision, yet again in accordance with the context in which the present work intends to be developed.

3. Methodology

On this chapter, the methodological type of research taken forth on the current thesis is justified and contextualized. All steps to be performed on the present study are disclosed and drilled down. Further, the main purpose of this study is brought up, so that an advance on some partial objectives of research is undertaken.

From the research question, and considering some common structural characteristics of internal service systems (Maleyeff, 2006), propositions are developed. The criteria that led to the choice of the processes studied are disclosed, in order to justify such options when the processes are presented. Finally, the principles behind the usage of some specific lean thinking tools are highlighted and such tools are contextualised.

3.1 Case study approach

The methodology developed consists on the usage of a case study approach, as, in accordance with the research question previously disclosed, this study intends to study a set of contemporary events in a real-life utilities business internal service system. Further, throughout the research, little or no control over the events is materialised (Yin, 1989). Finally, the form of the research question tends to suit a situation of research through case study (Yin, 1989).

The option for a case study methodology, according to Yin (1989), also fits the fact that the observation is performed in an internal services system of a specific utilities company, limiting scientific generalisation.

Yin (1989) elaborates on the concept of “analytic generalisation”. For the author, such concept describes the usage – as a template – of previously developed theory, working as a comparison point for the empirical data obtained in the case study. In accordance with such concept, hereafter, a study on internal services improvement will be developed, sustained upon the usage of a previously recognised theoretical background, namely the usage of the lean thinking approach.

3.1.1 Case study characterization

The present study is developed under an exploratory approach, since it has the purpose of choosing and applying lean thinking tools to some likewise chosen and typified processes of an internal service system. Throughout this process, lean thinking principles are considered

and the results of the lean tools application are compared with the prior situation to their application.

3.1.2 Case study design

According to Yin's (1989) designation, the present study may be typified as:

- Multiple case, since it considers the application of lean tools to processes of three different internal services;
- Embedded, given the observation and analysis of three processes, hence involving more than one unit of analysis.

3.1.3 Data collection

The data considered will be obtained through three main types of processes: direct observation of the business processes; document analysis; informal interviews with unit managers, general implementation manager for lean thinking throughout the group, and all the participants of each process to be analysed, performed from the 1st of September 2011 till the 30th of March 2012.

3.2 Theory framing and research orientation

As mentioned previously on chapter 2, lean thinking's evolution is leading the concept into a more holistic perspective, one that encompasses continuous improvement, cultural change and behavioural transformation (Abdi *et al*., 2006; Hines *et al*., 2008; Mann, 2009; McCuiston, 2010).

Lean thinking has evolved as an industrial concept and its evolutionary matrix has always been primarily about manufacturing, though it has been spread to other activities and services (Womack and Jones, 2003).

The answer to the research question this study pursues intends to act as a bridge linking the two former statements, within a context of an internal service provision. Accordingly, a lean thinking transformation process may be suitable for internal services and it shall require a holistic approach. Nonetheless, it may seem wise to advance to more thorough research on the application of the *visible part of the lean iceberg* (namely lean tools) (Hines *et al.*, 2008), before a lean thinking holistic transformation is considered for internal service systems.

It is thus the purpose of this study to observe if the application of lean thinking tools brings effectiveness and efficiency to a set of processes in an internal service system of a utilities

company. Aside from such main purpose mentioned on chapter 1, and disclosed below once more, the present study has other worth mentioning partial objectives.

Main researching purpose: analyse if the application of lean tools to internal service system business processes of a specific utilities company induces effectiveness and efficiency gains for the company.

Partial goals:

- To identify criteria to select the most appropriate internal services to be analysed;
- To choose three business processes from the internal service system on the energy markets division;
- To identify the customer that each of the chosen processes services, and to define value for such customer;
- To map the chosen processes and subsequently analyse them;
- To measure the processes initial effectiveness situations, regarding value creation for the internal customer; and efficiency, in terms of lead times and personnel participation;
- To identify the types of waste observable on the processes according to the mapping results;
- To identify the appropriate lean thinking tools to analyse the selected internal services;
- To analyse the selected internal processes using the identified lean thinking tools;
- To develop improved versions of the analysed processes according to the analysis performed;
- To implement the improved versions of the analysed processes;
- To measure the improvements, in terms of effectiveness and efficiency, after the application of the lean thinking tools.

To better understand the nature of the energy markets division, the meta-analysis study of approximately 60 internal service systems performed by Maleyeff (2006) is hereafter mentioned. In such study, evidence of a number of common structural characteristics in internal service systems was found. Such characteristics should allow a greater comprehension of the nature of the energy markets division as an internal service system:

- *Importance of information* – transformation of information is the fundamental operation undergone;
- *Significant task variability* – the tasks and processes duration vary considerably;
- *Process* flow *across departments and functions* – a typical process tends to entail the contribution of several departments and different people throughout the unit;
- *Many handoffs of information* – as information is fundamental, many handoffs containing it tend to be created;
- *Numerous management or technical reviews* – informational outputs are reviewed abundantly, often due to superior approval necessity or accuracy testing;
- *No explicit motivation for urgency* – as the internal service's nature is one of support to business, pressure for tight deadline respect is often not considered, redounding in reduced motivation for urgency.

From the characteristics of the internal service system described above, some propositions may be designed as research guidelines. Therefore, the following propositions intend to yield possible waste reduction opportunities to be highlighted through the research process.

P1: The lack of convenient information flow creates waste down the service value stream of the analysed processes.

If the main intake of the energy markets division is information, from a lean thinking perspective, it may be said that its flow is fundamental so that waste is avoid or reduced. Bearing in mind the former idea, the research will observe if information flow disruptions create waste and impact value creation.

P2: Lean thinking tools promote information flow in the analysed processes.

Flow is one of the fundamental principles of lean thinking, as mentioned on chapter 2. The present research will focus on information flow improvement for the selected processes, through the application of lean thinking tools.

P3: Task variability disrupts flow and increases waste for the studied processes.

It is possible that waste tends to be magnified and flow disrupted given the considerable task variability characteristic of internal service systems.

P4: For the researched processes, task standardisation increase is achievable and works as flow enabler.

The increase of task standardisation, addressed within a lean thinking tools application process, as a means to reduce waste, should create greater information flow.

P5: Process flow through departments and functions causes delays in the investigated processes.

If the participation of several departments and functions causes delays (a typical type of waste for lean thinking), then the present research should consider it, as to comprehend which of such participations does create value.

P6: Reduction of cross-department and cross-function activities transforms the analysed processes into leaner processes.

If waste is removed, by eliminating cross-function activities that do not create value, process flow should increase.

P7: Numerous management or technical reviews delay the scrutinised processes and increase waste.

This study should observe whether processes' flow finds bottlenecks due to necessity of hierarchical approvals or not.

P8: Non-value creation management and technical reviews should be removed as to increase value in the internal services processes analysed in the present research.

A leaner flow might be accomplished, whenever hierarchical approvals that are not value accretive are removed.

3.3 Methodology implementation steps

In order to develop this study some iterative actions will be undertaken. Firstly, the set of business processes to be analysed will be carefully chosen. Secondly, bearing in mind such type of processes, a mapping technique will be applied to them, and from its analysis some other lean thinking tools or actions will be performed, according to waste identification.

Upon the outcome of the initial process mapping, effectiveness and efficiency will be assessed. Likewise, the result obtained after the tools are applied will be compared with the initial moment, once again in terms of effectiveness and efficiency of the processes.

It is hence critical to stress that any effectiveness measurements will be performed with regards to the internal service customer's perspective of value. For such, the information and feedback to be obtained through the interviews with the personnel responsible for each process, as well as with the internal service customer's counterparts, are elemental for comprehending what is the value perception of such customers.

On another hand, the efficiency measurements will relate mostly with the effort spent by the energy markets division in order to service the internal customers of the processes to be studied, specifically in terms of processes' lead times and personnel resources allocated. Once more, such data will be acquired through the interviews with the participants of each process, as well as through direct observation.

3.3.1 Choice of processes

The set of three business processes analysed will be chosen considering several criteria, as listed below. Data on the procedures for choosing the processes is mentioned on the annexes that convey the informal interviews.

Criteria 1 – Core Processes

The processes observed should have significant and observable impact on the quality of the service provision, in the sense that they should influence the internal service provided by the energy markets division, they should be "core processes" (Hines *et al.*, 2008).

Criteria 2 – Engage of information flows

The processes considered should involve information flows, as information is the key input of many internal service systems (Maleyeff, 2006) and particularly of the case under research.

Criterion 3 – Involvement and/or impact of different functions or departments

As the unit is divided in several sub-areas, and since most business processes involve informational inputs from different areas, it was given importance to processes whose scope crosses functions and sub-areas, as these may be subject to greater waste (Maleyeff, 2006).

Criterion 4 – Existence of waste

As lean thinking is said to be the "antidote for waste" (Womack and Jones, 2003), the purpose was to choose processes in which waste was considered present by the customers and participants of such processes.

3.3.2 Choice of lean thinking tools

Value stream mapping will be the lean tool toolkit applied to each of the processes, since it is commonly used by practitioners in order to provide guidance on the listing of all activities that concur to the process, thus underlining waste locations (Hines and Rich, 1997). Furthermore, as mentioned on sub-chapter 2.3.1, process mapping, and particularly *value*

stream mapping, were abundantly applied to services by researchers as a means to comprehend information flow.

Upon the analysis of the output of the application of *value stream mapping*, some other lean tools may be applied, such as problem solving, *kaizen blitz* events, work standardization or *kanban* (Bicheno, 2004; Hines et al., 2008).

Problem solving as lean tool in which the process participants critically identify a problem and contribute to their solution has been applied to services by Vinas (2004) and Searcy (2009). Searcy (2009) used also *kaizen blitz* events, another lean thinking tool, as a more structured method for obtaining contributions from the process participants aiming at transforming and improving a specific process.

On another hand, *kanbans*, as originally used in the Toyota Production System, are signalling systems that trigger action by saying "activity A is done, activity B may now start", which ultimately is a way of increasing communication and information flows (Hines et al., 2008). Bearing such in mind, *kanban* techniques will be considered whenever communication enhancements should be considered necessary.

Finally, work standardisation, as applied by Sprigg and Jackson (2006) to services, may also be considered hereafter as a method for defining the scope of the activities within a process, aiming at their effectiveness and efficiency improvement (Hines et al., 2008).

Taking from the research of authors as Hines and Rich (1997), or Hines *et al.* (2002), when opting for the *value stream mapping* toolkit, it is important to understand which type of waste is being considered. Some types of waste are better detailed and comprehended by some of the *value stream mapping* tools than others.

Accordingly, Hines *et al.* (2002) consider five types of mapping tools: *process activity mapping, production variety funnel, quality filter mapping, demand amplification mapping* and *process costing*. For each of the seven lean thinking types of waste, the authors hint on which of the mentioned mapping tools holds potential or not for detailing such type of waste. As presented on the matrix illustrated by table 3.1, "Yes"; "Maybe"; and "No" indicate if a certain mapping technique entails potential for explaining a specific type of waste (Hines *et al.*, 2002).

The authors consider the standard lean thinking seven types of waste usually applied for manufacturing, contrarily to this research, which mentions the lean thinking seven types of

waste within a services perspective, as put by Maleyeff (2006): *delays, reviews, mistakes, duplication, movement, process inefficiencies, and resource inefficiencies*.

	Process activity mapping	Production variety funnel	Quality filter mapping	Demand amplification mapping	Process costing
Overproduction	Maybe	No	Maybe	Maybe	Yes
Waiting	Yes	Maybe	No	Maybe	Yes
Excessive transportation	Yes	No	No	No	No
Inappropriate processing	Yes	Maybe	Maybe	No	Yes
Unnecessary inventory	Maybe	Maybe	No	Yes	Yes
Unnecessary motion	Yes	No	No	No	Yes
Defects	Maybe	No	Yes	No	Yes

Table 3-1 - *Value Stream Mapping* toolkit
Source: Hines *et al.*, 2002:35

Taking from the types of waste mentioned on table 3.1, a comparison may be advanced between the standard types of lean thinking waste and the services types of lean thinking waste. As listed on table 3.2, *delays* may compare with *waiting*; *reviews* may compare with *inappropriate processing; mistakes* may compare with *defects; duplication* with *overproduction; movement* with *unnecessary motion* and *excessive transportation;* and both *process and resources inefficiencies* may compare with *inappropriate processing*.

Services lean type of waste	Standard lean type of waste
Delays	Waiting
Reviews	Inappropriate processing
Mistakes	Defects
Duplication	Overproduction
Movement	Unnecessary motion / excessive transportation
Process inefficiencies	Inappropriate processing
Resources inefficiencies	Inappropriate processing

Table 3-2 - Standard and services type of waste comparison
Source: Own creation

Table 3.3 adapts Hines *et al.* (2002) matrix, considering the services types of waste within a lean thinking perspective.

The outcome of table 3.3 yields that *process activity mapping* tool ensures that all types of waste are identifiable through its application (they are at least "maybe" identifiable through

such tool). Hines *et al*. (2002), consider this tool fundamental since, by mapping all activities of a certain process, lead times and productivity increasing opportunities are highlighted. Furthermore, it allows the mapping of information flows (Hines *et al.*, 2002).

	Process activity mapping	Production variety funnel	Quality filter mapping	Demand amplification mapping	Process costing
Delays	Yes	Maybe	No	Maybe	Yes
Mistakes	Maybe	No	Yes	No	Yes
Duplication	Maybe	No	Maybe	Maybe	Yes
Movement	Yes	No	No	No	Yes
Reviews, process and resources inefficiencies	Yes	Maybe	Maybe	No	Yes

Table 3-3 - *Value stream mapping* toolkit adapted
Source: Hines *et al.*, 2002, adapted

Process activity mapping will be applied to processes, once these will be chosen, provided that the types of waste initially identified on such processes by their customers and participants are suitable for such *value stream mapping* tool.

Process activity mapping will be applied to processes, once these will be chosen, provided that the types of waste initially identified on such processes by their customers and participants are suitable for such *value stream mapping* tool.

On another hand, process costing is also considered suitable for comprehending most of the types of waste. Yet, it is not always easy to consider the costs of internal services as they relate mostly to hours of labour. The reduction of a particular waste in terms of labour hours may or may not imply that such labour hours would be used specifically for another value accretive activity (the freed labour hours may be spent without any productive purpose). Such scenarios are certainly difficult to prove within the scope of this research. Yet, the measure of lead times (through *process activity mapping*) should yield some key information on reduction of wasteful hours of labour.

4. Case Study

The present chapter aims at, taking from the research question and the propositions enounced on chapter 3, evaluate three processes of an internal service provision unit at a utilities company. This chapter should thus condense the researched and obtained data, within the perspective of the scope of this thesis.

Accordingly, it will commence with a brief description of the energy markets division activity and its fundamental functions and departments.

Following, the application of the criteria elected on sub-chapter 3.2.1 for the choice of processes will be borne in consideration, so that the choice of the processes to be studied is performed. Upon such step, the processes will be presented, observed and analysed.

Each process will be described and it will have its value identified in accordance with its internal customer perspective. Following, *process activity mapping* will be applied and its output scrutinized. The types of waste identified will be highlighted and an effectiveness and efficiency assessment will be perpetrated.

The subsequent lean tools choice and application will then be unveiled, considering the implementation of improved versions of the processes. The output of such procedure will be framed by a new *process activity mapping* assessment. The results of the lean tools application and the transformed process value stream will be hence considered. Eventual gains in terms of effectiveness and efficiency, in accordance with the customer's perspective, will be measured by comparison with the initial effectiveness and efficiency levels.

4.1 Energy markets division portrayal

As a utilities company operating in a liberalised power market, the organisation in which the present study will be performed entails on its functional architecture an in-house business unit specialized in using energy markets knowledge.

Such unit's activity should leverage the company's performance, having for such the collaboration of 62 professionals. The information on markets gathered up in the energy markets division is thus a valuable asset, working as an enabler for the perpetration of a specific set of fundamental operations to the organisation's business.

The energy markets business division is thus responsible for selling, as a wholesaler, the power generated by the company's Iberian power plants, as well as controlling such plants in real-time, according to the market requirements. Consequently, it is due to the level of

knowledge on the market functioning held by the energy markets division that it provides such internal service to the power production business.

The energy markets division is also responsible for purchasing energy for the retail customers of the company. In fact, the energy markets division offers the commercialisation business unit a forward price of energy, upon which the commercialisation unit negotiates with its final customers. Afterwards, on the spot market, the energy markets division purchases the negotiated energy volumes and sells it to the commercial business unit. Like this, the commercialisation unit hedges off its price risk, knowing beforehand which is going to be the price of the energy its customers consume. The risk is thus taken by the energy business unit, whose market knowledge enables a more efficient risk management.

The energy markets division is therefore a provider of internal services both for the power generation business (sells its production as a forwarding agent) and for the commercialisation business (as an energy purchaser and risk taker at the same time).

Further, all the risk management and risk hedging strategy for the group, as well as trading activities, are decided and performed at the energy markets division. The coal and other commodities purchasing processes for the power plants are also managed at this division.

The energy markets division is hence responsible for providing a fundamental set of internal services for the business's current operation. Its main input is markets information and the activities disclosed above are operated upon the usage of such information, as figure 4.1 illustrates.

Figure 4-1 - Internal service provision at the energy markets division
Source: Own Creation

For better comprehension of the operational activities developed within the energy markets division, it is important to understand that it is divided in four main departments: Front Office, Middle Office, Back Office and Commodities Procurement. Each department is led by

a manager, who reports to the division's general manager. Figure 4.2 displays the energy markets division operational structure.

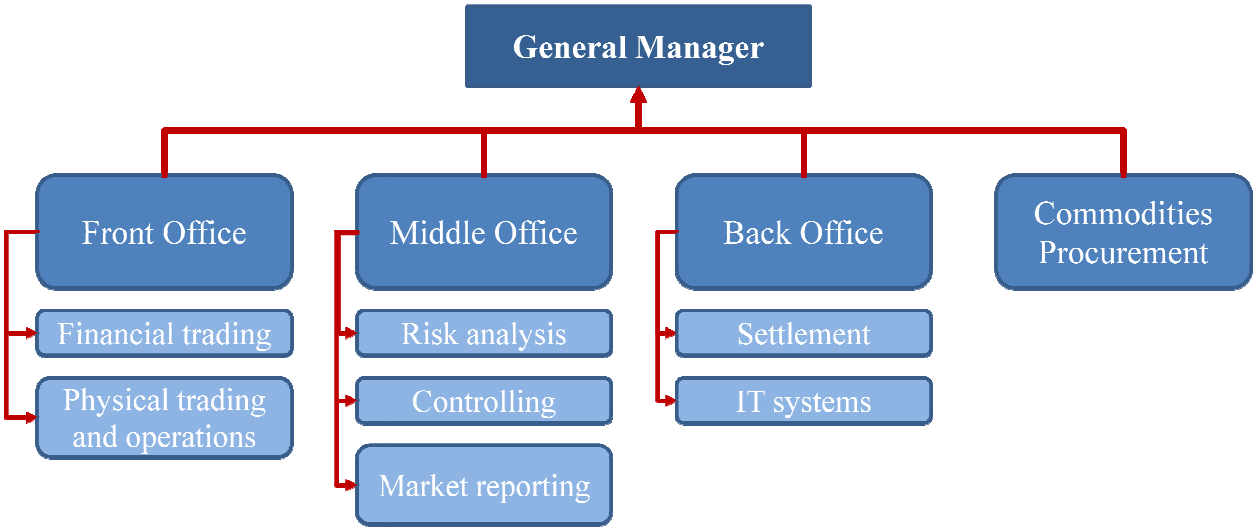

Figure 4-2 - Energy markets division operational structure
Source: Own Creation

Front Office is structured in two sub-areas:

- Financial trading unit, where all the financial derivatives trading is developed;
- Physical trading and operations unit, responsible for physical energy trading and power plant coordination.

Middle Office considers three main sub-areas:

- Risk analysis unit, which studies and creates risk management models;
- Controlling unit, responsible for business and financial analysis;
- Market reporting unit, whose tasks involve provision of market data inputs.

Back Office is divided in two functional areas:

- Settlement unit, responsible for contracts and derivatives settlement, as well as for accountancy reporting;
- IT systems unit, whose function encompasses providing IT and systems assistance all throughout the unit.

Finally, Commodities Procurement department is responsible for purchasing coal and fuel for the power plants.

4.2 Choice of processes

The observation of the energy markets division's activity, alongside with feedback obtained from the general manager and the middle-office manager during the informal interviews (see annexes), as well as of the consideration of the criteria mentioned on sub-chapter 3.2.1 redounded on the option for three processes. Such observation took into account the feedback obtained from the informal interviews with the general management and the middle office manager of the energy markets division. Such feedback pointed out some key areas to the division's operation as bearing potential ineffectiveness and inefficiency processes. In this sense, the observation highlighted this particular set of processes.

The enunciation of such set of processes is performed below, together with a justification with regards to the purpose of matching the criteria previously mentioned by each of the processes.

(i) **Financial hedging process on market risk for the gas market group's operator**

Criterion 1 – Core process:

The process of receiving a market risk hedging request, managing it and presenting an output to the group's gas operator is a core process to the internal service of market risk management.

Criterion 2 – Engage of information flows:

This process considers energy markets data and financial derivatives as the primary intake of such service, thus corresponding to the information flow engagement criterion.

Criterion 3 – Involvement and/or impact of different functions and departments:

The hedging process for the group's gas operator crosses different functions and departments (risk analysis unit, financial trading unit, settlement unit, etc.).

Criterion 4 – Existence of waste:

Through the informal interviewing process, references to *delays, mistakes* and *process and resources inefficiencies* on the here considered process were recurrently mentioned, indicating possible waste.

(ii) Identification of (new) financial derivative types and subsequent risk database parameterisation

Criterion 1 – Core process:

Financial derivatives contracting are elemental for the provision of market risk management provision. In this sense, the identification and database parameterisation of new derivatives becomes a core process in order to deploy the provision of risk management as an internal service.

Criterion 2 – Engage of information flows:

Financial derivatives imply information flows as primary intake to be transformed and managed, in order to develop a market risk management service.

Criterion 3 – Involvement and/or impact of different functions and departments:

The database parameterisation implies contributions of several functions or departments (reporting unit, controlling unit, financial trading unit, settlement unit and IT systems unit).

Criterion 4 – Existence of waste:

Through the informal interviewing process, references to *delays* and *process and resources inefficiencies* and *movement* on the here considered process were recurrently mentioned, indicating possible waste.

(iii) Calculation and updating of CO2 emission allowances stock

Criterion 1 – Core process:

The purchase of CO2 emission allowances (as of other energy commodities) for the group's generation plants is one of the internal services provided by the energy markets division. With regards to such, the procedure for maintaining the emission allowances stock up-to-date is a core process for such internal service provision. It allows for understanding of future allowances liabilities and it allows for risk mitigation.

Criterion 2 – Engage of information flows:

Calculating the CO2 emissions allowances stock implies information as the primary intake to be transformed and managed. It involves data regarding plants effective emissions, free allocated allowances by regulation, and allowances trading.

Criterion 3 – Involvement and/or impact of different functions and departments:

This process involves several departments' contributions (financial trading unit, controlling unit, settlement unit and risk analysis unit).

Criterion 4 – Existence of waste:

Through the informal interviewing process, references to *delays*, *process and resources inefficiencies, duplication, mistakes* and *movement* on the here considered process were recurrently mentioned, indicating possible waste.

4.3 Types of waste and mapping tool

The types of waste initially identified were then *delays; mistakes; duplication; movement; process and resources inefficiencies*. Considering the table 3.3 on sub-chapter 3.3.2, such type of lean thinking waste is potentially identifiable through *process activity mapping*. Thus, such tool will be applied to each of the processes, before any waste removal attempt is perpetrated, in order to assess the processes as they are at their current state. Also, after lean tools approach is applied to the processes, *process activity mapping* will once more be applied, as a ground basis for situations' comparison.

As *process activity mapping* will be performed for all three analysed processes, the following explanation on the structure of the maps to be disclosed on the current research is common to all analysed processes.

The maps are compound by nine columns. The first column refers to the numbering of the activity. The second column contains the description of the activity. The third column discloses the type of activity (ToA), which might range, as mentioned on sub-chapter 2.2.2, from value adding activities signalled with "V"; to support activities signalled with "S"; to waste signalled with "W". The fourth column considers in which sub-area such activity is performed. Column five refers to the time duration of each activity, while columns six and seven consider the minimum and maximum time duration for the activity. The eighth column displays the number of people involved (NPI) in each activity. Finally, column nine is added as a space for any additional commenting.

It should be stressed at this point that the time duration of each activity is the actual useful time of each activity. Some of the activities involve great technical work and, unless waiting or plain wasteful periods were visible, the complete duration of an activity was considered useful time.

4.4 Process 1: Financial hedging process on market risk for the gas market group's operator

4.4.1 Process description, internal customer identification and value perception

The financial markets offer a wide variety of energy market related products. The contracting of such products enables the possibility of hedging market risk for the energy business, creating value for the internal customer(s) and ultimately for the company. Yet, the means through which such markets and derivative products operate as to control risk does not relate to the subject under study here. The focus will therefore be placed on the process of contracting such derivatives and not on comprehending and describing the implications of financial derivatives for risk hedging purposes.

Accordingly, the energy markets division holds a good level of knowledge on risk management through financial derivatives. In fact, as mentioned previously, the provision of market risk management for the power business is one of the main internal services provided by the company.

Upon request, financial derivatives' contracting is also developed for the group's gas retailer. With such requests, the gas retailer wishes to control the market risk arising from price fluctuations on commodities as natural gas and oil, which may impact negatively its business.

The process through which the energy markets division services its internal customer – the group's gas retailer – starts with a non-binding request for a tailor-made derivative in accordance with the gas retailer's business contingencies.

The energy markets division, having the knowledge on the markets, the qualified personnel as traders, market researchers and treasury back-office, as well as the trading know-how, offers a quote to the gas retailer. In case of acceptance, such offer originates a contract. Following such contract, treasury and accountancy consequences arise for the group, both for the energy markets division, as well as for the gas operator. Such impacts are dealt and resolved by the energy markets division.

Bearing in mind the above, it is quite clear that the customer of the internal service is the group's gas retailer. The service provided is thus the contracting of tailor-made financial derivatives. Accordingly, the value for the customer is related with an effective provision of financial derivatives' contracting services.

Considering the information obtained through informal interviews with the risk control responsible at the group's gas operator, the service is effective whenever a tailor made

derivative contract is offered by the energy markets division in accordance with the requirements explained henceforth:

- Response within an appropriate time frame (three working hours as maximum) for the solution proposal, as external client negotiations are fast paced and demanding;
- Clear comprehension of the purpose of the derivative and consequent well organised service provision, as not to force the group's gas player to allocate several personnel resources to deal with information provision to the energy markets division;
- Timely and accurate preparation of contracts, in order for the gas operator to be able to deal with a financial audit, may such occur;
- Correct and timely treasury and accountancy reporting of the financial impacts of the derivatives from the gas operator's perspective.

Consequently, the above mentioned requirements' observation impacts directly the value perception of the gas retailer.

4.4.2 Initial *process activity mapping*

The process activity map, as visible on table 4.1, was obtained through the observation of a derivatives request launched by the group's gas operator on the 25th of October 2011.

As mentioned previously, the process starts with the group's gas operator requesting a quote for a derivatives contract (activity #1). Upon the email receiving, one person from the risk analysis unit starts evaluating the technical requirements and designs a solution. One other person at the risk analysis team re-checks the design and derivatives quotes are requested from the financial trading unit (activity #2).

According to the informal interviews with the risk analysis unit personnel, at this step, some delays were often occurring, since the trading unit was not always prioritising this activity enough, leading to waiting periods (activity #3). Such periods could last up to 1 hour and 30 minutes, whilst for the observed situation it lasted for 30 minutes.

The traders should address the market and obtain quotes (activity #4), passing them to the risk analysis unit (activity #5). Upon reception of the market quotes, two persons from the risk analysis unit evaluate the operation and submit it by email for approval of the middle office manager (activity #6 and #7). A period of waiting for management's availability occurs, varying up to one hour (activity #8).

#	Description	ToA	Function or sub-area	Duration (hh:mm)	Min (hh:mm)	Max (hh:mm)	NPI	Comments
1	Request received by email	S	Client (Gas Operator)	0:00	-	-	1	
2	Requirements analysis and solution design	V	Risk analysis unit	0:30	-	-	2	
3	Quote solicition to trader	S	Risk analysis unit	0:10	-	-	1	
4	Waiting for trading personnel's availability	W	Financial trading unit	0:30	0:00	1:00	-	
5	Attainment of quotes from the market	S	Financial trading unit	0:50	-	-	1	
6	Operation evaluation	S	Risk analysis unit	0:30	-	-	2	
7	Submittal to hierarchical approval	W	Risk analysis unit	0:05	-	-	1	
8	Waiting for management's approval	W	Middle-office management	0:15	0:00	1:00	-	
9	Management approval	W	Middle-office management	0:25	-	-	1	
10	Solution presented to gas operator	V	Risk analysis unit	0:05	-	-	1	
11	Gas operator acceptance	S	Client (Gas Operator)	0:25	-	-	1	If declines, the process ends
12	Inverse financial market operation design	S	Risk analysis unit	0:30	-	-	2	
13	Inverse operation submittal to management	W	Risk analysis unit	0:05	-	-	1	
14	Waiting for management's approval	W	Middle-office management	0:15	0:00	1:00	-	
15	Management approval and submittal of operation from traders	W	Middle-office management	0:30	-	-	1	
16	Derivatives contracting	S	Financial trading unit	3:55	2:00	5:00	1	
17	Deal insertion on database	S	Financial trading unit	1:00	-	-	1	
18	Waiting	W	Controlling unit	5:00	0:00	8:00	-	Database is refreshed once a day
19	Query on database and search for new deals	S	Controlling unit	0:30	-	-	1	
20	Request data on new deals from risk analysis unit	W	Controlling unit	1:00	0:30	1:30	1	
21	Check if new deals are according to requirements	S	Controlling unit	1:00	0:30	1:30	1	
22	Reports' parameterisation as to include new financial contracts	S	Market reporting unit	1:30	-	-	2	
23	Profit/Loss calculation	S	Controlling unit	2:00	-	-	1	
24	Waiting	W	Settlement unit	80:00	8:00	240:00	-	10 days passed till the new contract was detected
25	Contract preparation	V	Settlement unit	1:30	1:00	2:00	2	
26	Contract signing and submittal by mail	V	Settlement unit and management	0:15	-	-	2	
27	Contract settlement, treasury and accountancy reporting	V	Settlement unit	8:30	-	-	2	Periodically, each month
28	Management approval	W	Front-office management	0:30	-	-	1	
			TOTAL	13 days, 7 hours and 45 minutes	3 days, 6 hours and 20 minutes	34 days, 7 hours and 20 minutes	30	

Subtitle: W - Waste activity; S - Support activity; V - Value-adding activity; NPI - Number of people involved.

Table 4-1 – Process1: Gas operator's derivatives contracting – initial *process activity mapping*
Source: Own creation

If the manager disapproves the solution, a revision is performed (it was not the case on the observed situation). This revision would take the process back to activity #2. In case of

approval, the solution is presented by email (sent by the risk analysis unit) to the gas operator (activities #9 and #10).

The gas operator may choose to decline the energy markets division offer (activity #11), thus leading the internal service not to be completed. Such case might happen if the financial derivatives solution found by the energy markets division does not meet the gas operator's expectations. The energy markets division is nevertheless not accountable for the financial markets' conditions, as price volatility may go against the gas operator's purpose.

If the gas operator accepts the offer, the process continues. The risk analysis team (two persons) immediately designs an inverse operation (activity #12) to be contracted in the market by the traders, thus ensuring risk mitigation.

Considering market volatility, such inverse derivatives operation has a sense of urgency, as prices might evolve in the wrong direction, generating losses for the energy markets division. Yet, the design of the inverse operation is submitted for management approval (activity #13), again with a period of waiting lasting up to 1 hour (activity #14) and subsequently the request for the respective derivatives' contracting is forwarded (by email) to the financial trading unit (activity #15).

The financial trading unit contracts the derivatives with market counterparts (activity #16), activity that may last from 2 to 5 hours, having lasted for 3 hours and 55 minutes on the observed situation. Subsequently the financial trading unit introduces the contracts information on the database (activity #17).

A query on the database is run daily. Hence, activity #18 corresponds to waiting for such query, which lasted for 5 hours in the observed situation. Such waiting period may range from no waiting up to 8 hours.

Upon the update of database query, the controlling unit checks the results of such query (activity #19). If evidence is found on the new derivatives, the controlling unit enquires the risk analysis team on such data (activity # 20). Thence the controlling unit confirms if the new deals obtained on the database query are according the contracted requirements (activity #21). Both the duration of activity #20 and #21 may range from 30 minutes to 1 hour and 30 minutes.

Following, the market reporting unit parameterises reports with the convenient market information on the new derivative contracts (activity #22).

Finally, the profit or loss assessment of the whole operation is computed by the controlling unit (activity #23).

The term sheets of the derivatives contract (the actual document) is created by the settlement unit. This creation is performed when a search on new derivatives is performed on the database. Until then, a variable period of waiting is considered, amounting up to 10 working days for the observed situation (activity #24). Such waiting period may range from 1 to 30 days. The contract term sheet is then prepared (activity #25) in a period between 1 and 2 hours.

Once the contract term sheet is concluded, it requires a management signature and final approval before the subsequent submittal by mail to the gas operator (activity #26).

Finally, to conclude the service provision, a monthly activity is required. The settlement unit perpetrates all activities of contract settlement, treasury implications, and accountancy reporting upon management approval (activities #27 and #28).

It should be stressed that the time measurements observed for each activity are indicative. Such periods actually occurred during the observation process, though they may vary each time the process is taken forth. Whenever a duration range is mentioned for a certain activity, it should also be considered indicative and it is information obtained during the informal interviews with the participants.

4.4.3 Waste identification and initial effectiveness and efficiency assessment

As mentioned on sub-chapter 4.2, through the initial interviews with the process participants and internal service customers, with regards to process 1, reference was made to waste related to *delays*, *mistakes,* and *process and resources inefficiencies*.

The reference to *delays* was expressed by the gas operator risk management responsible, i.e., the internal service customer, as well as by the middle office management. Such allusion was made as a reference to occasional waiting for the initial offer made by the energy markets division to the gas operator, leading the gas operator to sometimes outsource such service.

Not always the offer was presented within the previously mentioned three hours requirement. In fact, the time taken until the proposal was presented to the customer was of 3 hours and 20 minutes for the observed proposal (up to activity #10), although this timeframe may vary from 2 hours and 35 minutes to 4 hours and 35 minutes. The immediate conclusion is that the process' current state may harm the customer's effectiveness.

Moreover, the middle office management complained about some misinformation between risk analysis and trading units, as communication was not always sound, leading to *mistakes*

on the inverse derivatives contracting. The potential losses, may such occur, are significant for the energy markets division.

Some of the participants of the process, namely the risk analysis unit, the controlling unit and the settlement unit, mentioned they were often kept unaware of all the required data, leading to *process and resource inefficiencies*.

On another hand, the controlling team mentioned some issues related with the unawareness of new derivatives contracting, until the moment when they would show up on their queries. This, supposedly, required the team to inquire colleagues about contracts' data. Such data would thus reach some of the participants in an unstructured and unclear manner, leading to waste. This was outlined as *resource inefficiencies*.

As for effectiveness measurement purposes, the criteria considered was the one disclosed on sub-chapter 4.4.1, and it embeds high subjectivity. According to the data collected through the interviewing process with the gas operator's personnel, the value expectations were not entirely fulfilled, as the response by the energy markets division was not fully according to requirements, specifically with regards to the less than three hours solution proposal requirement. Furthermore, it lacked on effectiveness due to long waiting periods for term contracts signature (activity #26) and submittal (12 working days, 6 hours and 45 minutes, with a working day corresponding to 8 hours).

With regards to efficiency, the complete lead time of the process amounted up to **13 working days, plus 7 hours and 45 minutes**, of which 11 days, 7 hours and 35 minutes were spent on wasteful activities, while 10 hours and 50 minutes were spent on actual value accretive activities. This lead time may nevertheless vary between 3 days, 6 hours, 20 minutes up to 34 days, 7 hours and 20 minutes.

The number of interventions of personnel amounted for 30 contributions.

Considering the process activity map shown on sub-chapter 4.4.2, and taking from the assessment performed concerning the type of activity, it may be concluded that waste exists. In fact, wasteful activities amount up to 79 per cent, as shown on figure 4.3.

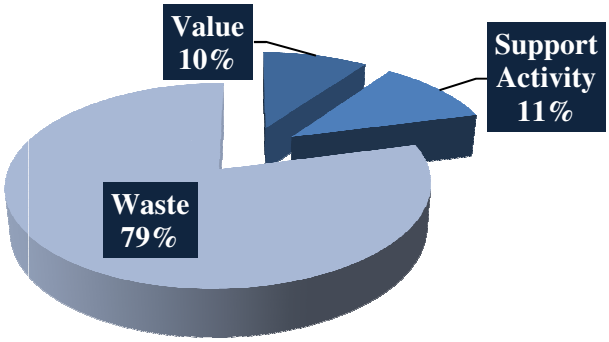

Figure 4-3 - Process 1: Time spent by type of activity
Source: Own creation

4.4.4 Subsequent lean tools application and waste elimination attempts

The initial move towards waste elimination was to deploy the problems listed by the process participants. In this sense, it became clear that the overall problem observed on the *process activity map* and perceived through the interviews was related with the lack of an organised structure for the process. Accordingly, flow constraints, as a consequence of such disorganised structure, were the main cause of waste. Specifically, the controlling and settlement units were frequently unaware of the necessity of participating on the process, as anticipated communication was inexistent.

It is important to mention at this point that the outputs of the initial *process activity mapping* were shown to the process participants, and discussed as a starting point for problem solving, having this happened for all three processes analysed.

The first lean tool used, aside from the previously applied *process activity mapping* tool, was therefore problem solving. If the process was considered too random, without a perceived structure, then a solution should be created, envisaging flow.

The problem solving initiative led to a proposed solution based on three lean tools or techniques:

- Work standardisation, as to structure activities and increase flow;
- Creation of a file with the fundamental data on each new contract, in order to work as sort of a *kanban,* a signalling system, triggering communication (Hines *et al.*, 2008);
- Waste elimination, namely redundant reviews.

In order to attain the standardisation and structuring of the process, each participant area should become aware of when and how to act. Each participant unit should be instructed on what to do and when. Such intent should be achieved through process mapping visualisation

and by management indication of accountability for each activity (which did not occur explicitly till the moment). This should be particularly important to stop any possible *delays* derived from non prioritisation by the trading unit (activity #4).

In parallel, the creation of a common file, accessible by all participants, emerges as fundamental. The several intervenient areas should be required to introduce essential data on the derivatives contracting in such file and subsequently forward it to the next person on the process activity line (warning such person it was time to participate). The filling in of such file should be considered a support activity, given the fact that it enables a quick access to all the necessary data on a specific contract in any moment in time. This may prove to be essential for providing quick replies to any inquires perpetrated by the gas operator. In fact, such system should work as sort of a *kanban*.

On another hand, waste elimination should be accomplished also through the removal of management reviews (activities #8, #15 and #28). Such change should be an effective delegation of decision power and it should be evaluated and authorised by management.

Management may nonetheless be aware of each new process, since whenever key data is forward from one area to another by email, the middle office manager should be copied on the email. Therefore, it should be possible to maintain an overview on each service provision to the gas operator, though flow disruption should no longer occur.

4.4.5 Reshaped *process activity mapping* and post lean tools application effectiveness and efficiency assessment

After the application of the lean thinking tools as well as of the proposals resulting from it and mentioned previously, another application of *process activity mapping* was perpetrated, after the observation of the process on the 5th of December 2011. The results of it are expressed by table 4.2.

The output of the reshaped process, in terms of the *process activity mapping*, is not very different from the initial one, except for two main differences: the wasteful reviews were discontinued and the filling in of the *kanban* file became part of the process for all intervenients, enabling better communication and allowing the removal of waiting periods.

The application of lean tools to the process triggered effectiveness gains for the service's customer. Not only was such confirmed by the *process activity mapping* tool, as also informal interviewing of the gas operator corroborated such conclusions, once the customer manifested satisfaction for a faster disposability of the term contracts.

#	Description	ToA	Function or sub-area	Duration (hh:mm)	Min (hh:mm)	Max (hh:mm)	NPI	Comments
1	Request received by email	S	Client (Gas Operator)	0:00	-	-	1	
2	Requirements analysis and solution design	V	Risk analysis unit	0:30	-	-	2	
3	*Kanban* file preparation and quote solicition to trader	S	Risk analysis unit	0:20	-	-	1	
4	Attainment of quotes from the market and kanban file preparation	S	Financial trading unit	1:00	-	-	1	
5	Operation evaluation	S	Risk analysis unit	0:30	-	-	2	
6	Solution presented to gas operator	V	Risk analysis unit	0:05	-	-	1	Middle-office management is copied on email
7	Gas operator acceptance	S	Client (Gas Operator)	0:25	-	-	1	If declines, the process ends
8	*Kanban* file preparation and inverse operation submittal both to trading and controlling units	S	Risk analysis unit	0:45	-	-	2	Middle-office management is copied on email
9	Derivatives contracting	S	Financial trading unit	3:55	2:00	5:00	1	
10	Deal insertion on database	S	Financial trading unit	1:00	-	-	1	
11	Waiting	W	Controlling unit	5:00	0:00	8:00	-	Database is refreshed once a day
12	Query on database and search for new deals	S	Controlling unit	0:30	-	-	1	
13	Check if new deals are according to requirements	S	Controlling unit	1:00	0:30	1:30	1	
14	Reports' parameterisation as to include new financial contracts	S	Market reporting unit	1:30	-	-	2	
15	Profit/Loss calculation	S	Controlling unit	2:00	-	-	1	Middle-office management is informed
16	Kanban file preparation and submittal to settlement unit	S	Controlling unit	0:10	-	-	1	
17	Contract preparation	V	Settlement unit	1:30	1:00	2:00	2	
18	Contract signing and submittal by mail	V	Settlement unit and management	0:15	-	-	2	
19	Contract settlement, treasury and accountancy reporting	V	Settlement unit	8:30	-	-	2	Periodically, each month
			TOTAL	3 days, 4 hours, 55 min.	2 days, 5 hours	4 days, 2 hours	25	

Subtitle: W - Waste activity; S - Support activity; V - Value-adding activity; NPI - Number of people involved.

Table 4-2 - Process 1: Gas operator's derivatives contracting – reshaped *process activity mapping*
Source: Own creation

Accordingly, not only the solution was presented to the customer (activity #6 of the reshaped mapping) in less time (2 hours and 25 minutes vs. the initial 3 hours and 20 minutes, corresponding to a 19% reduction), but also the contracts became available much sooner (2 working days, 4 hours and 25 minutes vs. the initial 12 working days, 6 hours and 45 minutes, corresponding to a 80% reduction), as visually visible on figure 4.4.

The minimum duration of the complete process should now be of 2 days and 5 hours, corresponding to a 31% reduction, whilst the maximum duration should now be of 4 days and 2 hours, corresponding to an 88% reduction.

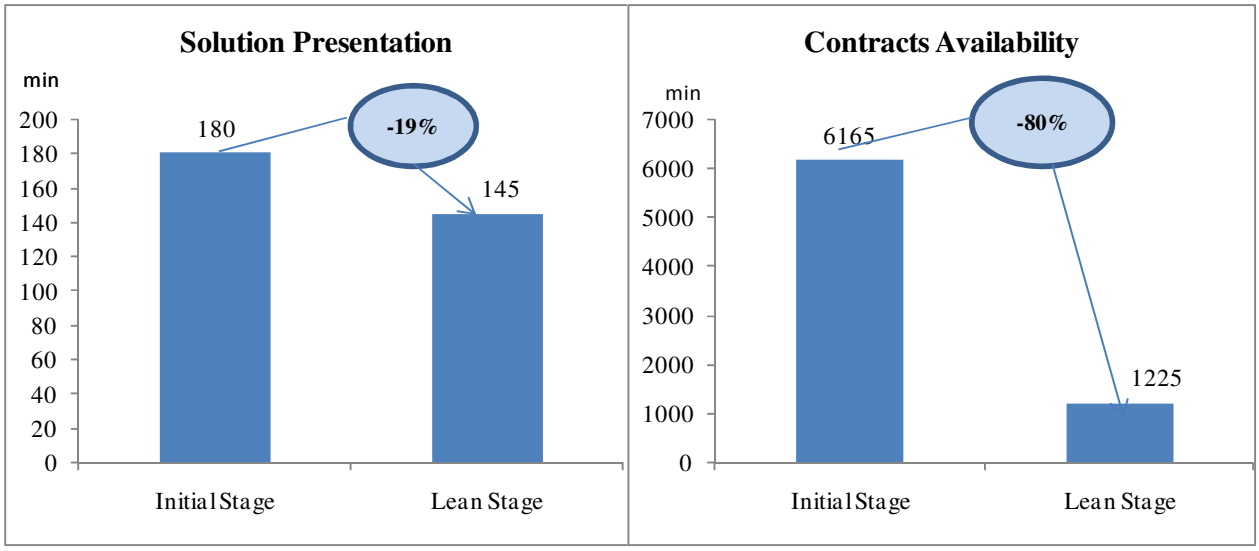

Figure 4-4 - Customer value perception: effectiveness after lean tools application
Source: Own creation

On another hand, the trading unit was held accountable for prioritising the quotes provision, diminishing the possibility of proposing a solution to the customer above the three hours period requirement.

Considering the improvements mentioned above, and bearing in mind that value for the customer was dependent on a quick initial solution presentation from the energy markets division and on a timely preparation of the contracts for auditing requirements, it becomes clear that the effectiveness levels increased. Further, the creation of a file, where all information on each contract is kept, addresses the purpose of responding quickly and accurately to any inquiry from gas operator to the energy markets division, thus increasing value once more.

In terms of efficiency, the application of the lean thinking tools had a clear positive impact on the process. As shown on figure 4.5, the visible waste was almost fully eliminated (only the necessity of waiting for database updating was not eliminated), whilst the time spent on value accretive activities is now more significant (38% vs. 10%).

The **total lead time** of the process **decreased 74%** for the observed situation (31% for the minimum lead time and 88% for the maximum lead time scenario). Furthermore, the participation of personnel also decreased 7%, corresponding to 2 hours and 50 minutes (the rest of the decreased lead time corresponds to elimination of waiting periods). Adding up to such figures, the number of interventions of personnel stumbled from 30 to 25 contributions, thus decreasing 17%.

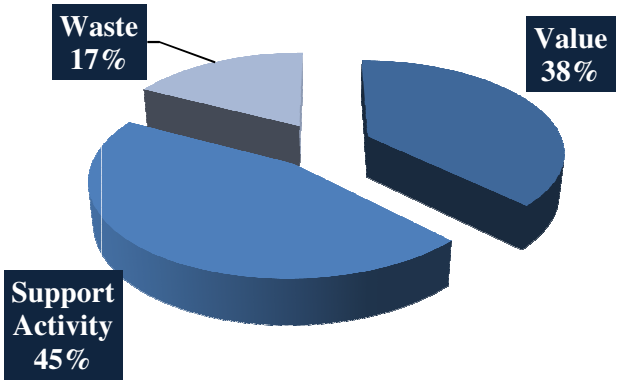

Figure 4-5 - Process 1: Time spent by type of activity, post lean tools application
Source: Own creation

4.4.6 Discussion

The effectiveness and efficiency comparison between the initial process and the reshaped process seems to be clear in terms of identified improvements. Bearing in mind that verifying if such improvements are possible through the application of lean tools is the object of the present study, some of the propositions advanced on the sub-chapter 3.2 are now visited.

Firstly, it should be stressed that the process relates fundamentally to information flows. The existence of wasteful activities and the fact that considerable waiting periods occurs indicates information flow suffers several disruptions. Such situation occurs due to waiting periods, but also due to lack of continuity in terms of information flow, as suggested on proposition 1. In fact, according to the initial interviews to the participants, not always the participants knew when they were required to act and perform their tasks. The *kanban* file improved the information flow.

In this sense, the application of lean thinking tools to this process increased information flow, namely due to the greater communication standards achieved through the *kanban* file, concurring to the possibility of concluding that proposition 2 is accurate.

Further, as far as the information obtained through the interviews with the process participants indicated, the tasks that should be developed for the execution of the process were not clearly structured. The participants could not indicate undoubtedly which tasks were expected and to whom should they forward information. At this level, some task variability may be observed impacting negatively the process flow, which may concur to the possibility of considering proposition 3 as valid.

On another hand, proposition 4 should also be considered in the present analysis, since the standardisation of the process activities (through work standardisation) enabled flow.

The fact that process flow crossed several departments and functions, clearly triggered waste, as communication between them was poor and unstructured. As examples, one may consider that the controlling unit had to ask the risk analysis unit for the data on the new contracts; or that the settlement unit was unaware of new contracts until they were noticed on the database. Accordingly, contributions are made to confirm proposition 5.

Going back to proposition 6, which considered less cross-functional activities, it may be observed that once communication was enhanced the necessity of cross department back inquiring on the characteristics of each contract was reduced, leading to greater flow and a leaner process. These observations also contribute to confirm propositions 1 and 2.

Finally, analysing the map, the management reviews do not pass unnoticed (activity #9, #15 and #28 of the initial map). Such reviews were considered unnecessary and thus wasteful, indicating the pertinence of proposition 7.

In this sense, proposition 8 was regarded since three management reviews were removed from the process, reducing lead time and hence increasing customer's value.

On a different level, the types of waste indicated on the preliminary interviews (*delays, mistakes, process and resources inefficiencies*) seem to be confirmed by the *process activity mapping*.

In fact, d*elays* are a consequence of wasteful periods, as mentioned previously. On another hand, *process and resource inefficiencies* result from the lack of convenient flow, process standardisation and lack of communication. *Reviews*, as a type of waste, should also be considered for this purpose.

4.5 Process 2 - Identification of (new) financial derivative types and subsequent risk database parameterisation for risk management purposes

4.5.1 Process description, internal customer identification and value perception

As described on sub-chapter 4.1, one of the most important internal services provided by the energy markets division is market risk management.

Accordingly, in the liberalised power and gas market players, either producers or retailers, have to deal with market risk. The energy markets division is responsible for managing such risk for the power market, through a holistic vision of the power business. At special request, it may also do it for the group's gas player, as mentioned on the description of Process 1.

Such risk management service starts with an analysis (and reporting) on the market exposure to different risk factors (price of power and other commodities as coal, oil or gas, currencies exchange rates, etc.). Following such analysis, and depending on the strategy defined by senior management, financial hedging is seldom performed, in order to mitigate risk factors.

When a decision for contracting such financial products is taken forth it has several consequences in terms of risk management. In fact, the derivatives impact the risk exposure. On another hand, such products create financial results and thus need to be correctly comprehended and managed for accounting and treasury purposes.

In this sense, the energy markets division created a database in which all the relevant and typified data on each new derivative contract is introduced. Such database was created by an IT supplier and it is currently managed by such contractor. It enables the departments responsible for treasury and accountancy (settlement unit), risk management reporting (risk analysis unit), and credit risk and business analysis reporting (controlling unit) to obtain the required data for their functions.

The database is parameterised with all the typified types of financial derivatives contracts, as for instance power, coal, dated brent, CO2 emissions allowances, natural gas, etc. However, whenever a new specific derivative contract is set up, for instance a contract whose price formula is indexed to the price of natural gas through specific parameters, it is necessary to introduce such typified specification on the database.

While such process occurs, all the analysis and activities performed by the above mentioned departments are suspended, impacting the provision of risk management as an internal service.

Bearing in mind the above, it should be highlighted that the customer of the risk management service provision is the overall company's business, since such internal service is provided to the power business (energy production and commercialisation), but also to the group's gas operator, as mentioned on process 1. In this sense, both the power business and the gas business are impacted by the internal service provision here under analysis, as visible on figure 4.6.

From the feedback obtained through informal interviewing process with the power and gas business counterparts for risk management, it was possible to comprehend that the value created by the provision of risk management services to the company's business depends heavily on a constant update (at least on weekly basis) of risk exposure. In fact, markets are volatile and assumptions change on a daily basis. Furthermore, if the risk management

reporting, credit risk reporting, business analysis and financial reporting are not able to perform their timely analysis with all required data (as the new derivatives contracts), the value created to the internal customer is severely diminished.

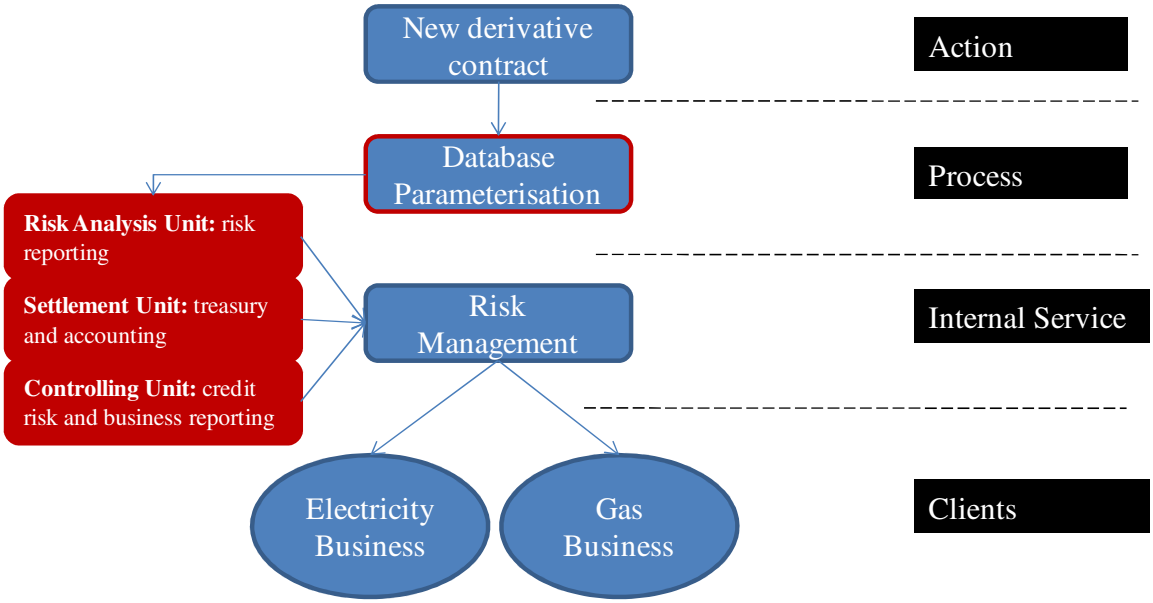

Figure 4-6 - Database parameterisation's impact on risk management internal service
Source: Own creation

In this sense, the process under study here is the actual parameterisation of the database as to include new types of derivatives as part of the risk management service provision perpetrated by the energy markets division to the group's power production operator and the power commercialisation operator (and circumstantially the gas operator). For such final customers, the more accurate and faster the risk management activities are performed, the greater is the value obtained.

4.5.2 Initial process mapping

The process activity map, as visible on table 4.3, was obtained through the observation of a database parameterisation request started on the 13th of November 2011.

The process starts with a management meeting after which a risk mitigation request is launched (by email) to the financial trading unit (activity #1). Such risk mitigation process involves the contracting of a commodity derivative.

The financial trading unit negotiates and contracts such derivative with market counterparts (activity #2) and, whenever the database is not prepared to register such type of derivative, a necessity for parameterisation is identified and the information on such is sent by email to the

middle office department (activities #3 and #4). Activity #2 may last for a period of one to five hours.

#	Description	ToA	Function or sub-area	Duration (hh:mm)	Min (hh:mm)	Max (hh:mm)	NPI	Comments
1	Risk mitigation request	V	Management	1:00	-	-	4	
2	Negotiation of a new type of derivative	V	Financial trading unit	3:00	1:00	5:00	1	
3	Identification of database parameterisation necessity	S	Financial trading unit	0:05	-	-	1	
4	Submittal of information to middle-office department	S	Financial trading unit	0:10	-	-	1	
5	Waiting for personnel availability	W	Market reporting unit	0:15	0:00	1:30	-	
6	Verification of settlement requirements and submittal to trading unit	S	Market reporting unit	0:30	-	-	2	
7	Waiting for personnel availability	W	Financial trading unit	1:00	0:00	4:00	-	
8	Parameterisation request to database IT supplier	W	Financial trading unit	1:00	-	-	1	
9	Waiting for parameterisation	W	IT supplier	36 days	30 days	50 days	0	
10	Waiting for personnel availability	W	Financial trading unit	1:00	0:00	4:00	-	
11	Reviewing of parameterisation	W	Financial trading unit	1:00	-	-	1	If failed, recheck by IT supplier
12	Waiting for personnel availability	W	Controlling unit	0:20	0:00	1:30	-	
13	Reviewing of parameterisation	W	Controlling unit	1:00	-	-	1	If failed, recheck by IT supplier
14	Waiting for productive environment passage	W	IT supplier	8:00	-	-	0	
15	Risk exposure update	V	Risk analysis unit	3:00	-	-	2	
			TOTAL	38 days, 5 hours, 20 minutes	32 days, 45 minutes	53 days, 7 hours, 45 minutes	10	

Subtitle: W - Waste activity; S - Support activity; V - Value-adding activity; NPI - Number of people involved.

Table 4-3 - Process 2: Identification of (new) financial derivative types and subsequent risk database parameterisation for risk management purposes – initial *process activity mapping*
Source: Own creation

After a period of waiting for personnel from the market reporting unit (activity #5), which may last up to one hour and half, the specific settlement characteristics of each derivative are identified and thence submitted to the financial trading unit (activity #6).

Since the trading personnel is sometimes occupied with trading activities, a waiting period of zero to four hours occurs until a formal request for database parameterisation by the IT provider is launched (activities #7 and 8). The parameterisation perpetrated by the IT provider is considered wasteful not because it did not create value, rather due to its time duration, which is not compatible with the customer's requirements and operation dynamics.

The IT supplier took, on the observed case, 36 days to deliver a parameterisation solution, though in the past, according to the feedback obtained through informal interviewing of the financial trading unit, this time may vary between 30 days and 50 days.

This solution is then tested by the financial trading unit and by the controlling unit, as to confirm if it is according to requirements. Aside from the waiting for the IT supplier response, once more waiting for both the trading and middle office personnel occurs. (activities #9, #10, #11, #12, and #13).

If the tests' results are positive, the IT supplier launches the solution in a productive environment, becoming operational (activity #14). Following, the risk exposure of the power business activity is updated (activity #15).

4.5.3 Waste identification and initial effectiveness and efficiency assessment

As mentioned on sub-chapter 4.2, through the initial interviews with the process participants and internal service customers, with regards to process 2, reference was made to waste related to *delays*, *process and resources inefficiencies*, and *movement*.

The reference to *delays* (as a result of waiting periods) was present during the interviewing of all participants of the process, as well as from upper management responsible for the strategy on the power market (the customer's representatives for the internal service provision), whose risk exposure assessments are fundamental for an accurate strategy for the business. The time elapsed since a risk mitigation request through derivatives was launched until such mitigation was reflected on the risk exposure report was considered too long by the energy markets division management, exceeding the possibility of updating risk exposure at least on a weekly basis, impacting the value perception for the internal service customer.

On another hand, the participants of the process, namely the controlling unit and the financial trading unit, mentioned there were *process inefficiencies* since the gathering of the data required for the parameterisation was described as random, encompassing the participation of several units. Plus, the database as a resource was being tremendously inefficient (*resource inefficiency*), once its usage was time consuming and inappropriate for the dynamics of the operation. With regards to this, once again it should be stressed that the necessity of outsourced parameterisation, due to its time consuming nature, was not compatible with the urge of the operation.

The controlling unit also reported that the process was going back and forth from one unit to another (activities #3 to 8# and 10# to 13#), when it could be managed by only one unit, indicating possible *movement*.

Through an inquiry to the settlement and controlling units, it was also revealed that during the lead time of the process all the settlement activities (financial and treasury reporting), as well

as business analysis, were performed manually, and not based on database information, which could lead to greater chances of *mistakes* occurrence. This potential for *mistakes* occurrence was disregarded by the participants, since it was not mentioned on the preliminary informal interviews.

In terms of effectiveness' assessment, the contracting of new derivatives and subsequent database parameterisation was considered ineffective as it was not responding to the creation of value for the customer. As mentioned previously, customer's value was dependent on a fast (at least once a weak) update of risk exposure assessment. Further, simultaneously, activities of credit risk analysis, business analysis, or financial and treasury reporting were also not performed timely or were performed manually for the period while database was not conveniently parameterised. Such situation induced ineffectiveness on the provision of the internal service of risk management by the energy markets division to the group's power (and gas) operators.

With regards to efficiency, the complete lead time of the process amounted up to **38 working days, plus 5 hours and 20 minutes**, of which 37 days and 5 hours and 35 minutes were spent on wasteful activities, while only 7 hours were spent on actual value accretive activities. This lead time may nevertheless vary between 32 days and 45 minutes up to 53 days, 7 hours and 45 minutes. The number of interventions of personnel amounted to 10 contributions.

It should also be considered for the purpose of efficiency measurements that the provision of the parameterisation service by the IT supplier cost the energy markets division 2.800 Euro for the observed case, whilst in the previous year such service had an overall cost, for all parameterisations taken forth, of 33.600 Euro.

Considering the *process activity map* shown on sub-chapter 4.5.2, and taking from the assessment performed concerning the type of activity, it may be concluded that waste exists. In fact, wasteful activities amount up to a percentage of 98%, as shown on figure 4.7.

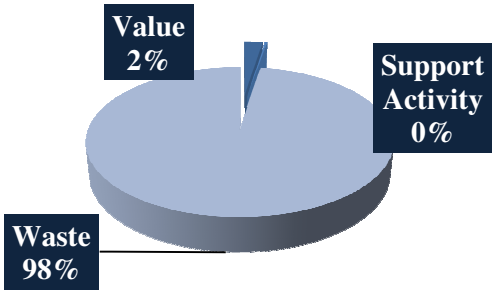

Figure 4-7 - Process 2: Time spent by type of activity
Source: Own creation

4.5.4 Subsequent lean tools application and waste elimination attempts

A quick observation of the value stream map immediately allows the identification of an immense waiting period corresponding to the outsourcing of the database parameterisation (activity #7). This parameterisation was necessary for the process and for the service provision. Nevertheless, the long lasting period the IT provider was taking for delivering the solution was incompatible with the operation requirements. It was thus considered a wasteful period, corresponding to 93% of the process' lead time.

Any attempt for wasteful elimination had to start at such point. Accordingly, the participants of the process were instigated to provide suggestions, as part of a lean thinking technique. For such, some *kaizen blitz* events (Hines *et al*., 2008) were organised.

Two meetings between the financial trading unit, the controlling unit and the market reporting unit were promoted in order to discuss how to improve the process. On the first of those events held on the 20th of November, it was suggested that the IT supplier should prepare the means for the parameterisation to be performed in-house, being no longer outsourced.

After some discussion with the IT provider, the team realised that the parameterisation could be done in-house and a task force was created on the second meeting held on the 30th of November, in order to learn how to do it. Such task-force comprehended one person from the controlling unit and one from the settlement unit.

On one hand, the disappearance of the IT provider contribution enabled flow (eliminating waiting periods) and also decreased costs, since no extra personnel was hired to perform the parameterisation and parameterisation hours were no longer charged.

Further, the process standardisation was reassessed since the reviewing activities were abandoned and the controlling unit became entirely and clearly responsible for the parameterisation.

4.5.5 Reshaped *process activity mapping* and post lean tools application effectiveness and efficiency assessment

After the application of the lean thinking tools mentioned previously, another application of *process activity mapping* was perpetrated, upon the observation of the process on the 20th of January 2012. The results of it are expressed by table 4.4.

The output of the reshaped process, in terms of the *process activity mapping*, is not very different from the initial one, except for two main differences: the parameterisation was now

fully performed in-house and all visible wasteful activities were removed from the process. The controlling unit became fully responsible for the parameterisation.

According to the energy markets division's management and the power and gas operator counterparts, the effectiveness of the service improved due to the application of lean tools. The risk exposure was simply not being updated within a reasonable timeframe whenever a new type of derivative was contracted, and the elimination of the outsourcing of the parameterisation allowed for a considerable improvement. The lead time till the updating of the risk exposure assessment was improved to only 8 hours and 45 minutes, which allowed for an internal service provision clearly within the requirement of constant update of risk exposure ("at least once week").

#	Description	ToA	Function or sub-area	Duration (hh:mm)	Min (hh:mm)	Max (hh:mm)	NPI	Comments
1	Risk mitigation request	V	Management	1:00	-	-	4	
2	Negotiation of a new type of derivative	V	Financial trading unit	3:00	1:00	5:00	1	
3	Identification of database parameterisation necessity	S	Financial trading unit	0:05	-	-	1	
4	Submittal of information to middle-office department	S	Financial trading unit	0:10	-	-	1	
5	Verification of settlement requirements and submittal to controlling unit	S	Market reporting unit	0:30	-	-	2	
6	Parametersation of database	S	Controlling unit	1:00	-	-	1	
7	Risk exposure update	V	Risk analysis unit	3:00	-	-	2	
			TOTAL	8 hours, 45 minutes	6 hours, 45 minutes	10 hours, 45 minutes	8	

Subtitle: W - Waste activity; S - Support activity; V - Value-adding activity; NPI - Number of people involved.

Table 4-4 - Process 2: Identification of (new) financial derivative types and subsequent risk database parameterisation for risk management purposes – reshaped *process activity mapping*
Source: Own creation

Further, simultaneously, the activities of credit risk analysis, business analysis, or financial and treasury reporting were now subject to a shorter period during which they would have to be performed manually or not performed at all.

In terms of efficiency, the reshaped process induced significant improvements at three levels. On the one hand, the total time of the process decreased by **97%** (from 38 working days, 5 hours and 20 minutes to 8 hours and 45 minutes), whilst in parallel the minimum and maximum lead times also decreased, 97% and 98% respectively.

All wasteful activities were removed, though the total time spent on value accretive activities was maintained on a total of 7 hours. Figure 4.8 illustrates such improvement, especially if compared with figure 4.7.

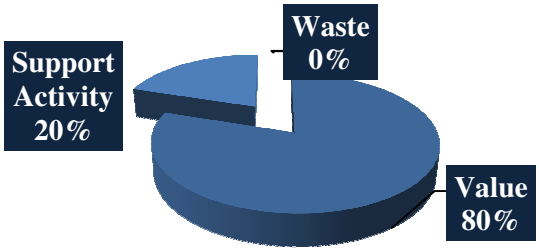

Figure 4-8 - Process 2: Time spent by type of activity, post lean tools application
Source: Own creation

Secondly, the total number of personnel participations was reduced from 10 to 8 (a reduction of 20%), once the activities related with the reviewing of the parameterisation were removed. Finally, the cost related with the outsourcing of the parameterisation by the IT supplier was eliminated.

4.5.6 Discussion

Given that the effectiveness and efficiency comparison between the initial process and the reshaped process seems to be straightforward in terms of proven improvements, the propositions that guide the present research will now be revisited.

The process once more relates to information flows (the specifications of each new derivative as to parameterise the database). As proposition 1 suggests, an inconvenient information flow leads to disruptions and waste (and waiting). In this particular case, the disruption occurs whenever information on the new parameters is sent to the IT provider, which showed to be ineffective.

In view of such, the application of lean thinking tools to the process improved the information flow continuity, as a result of the elimination of wasteful activities. Also, the attribution of the parameterisation task to the controlling unit and the elimination of the reviewing process enabled flow, contributing to confirm proposition 2.

The different units perpetrate different tasks throughout the process, indicating some level of task variability. In fact, both the controlling and settlement units' personnel during the interviewing process mentioned some randomness of tasks with regards to the computing of all required information. According to them, the characteristics of the new derivatives were often not clearly communicated (either by management or the trading unit). Some waste could be deriving from such randomness, namely the necessity for double reviewing of the parameterisation. According to this discussion, input is provided to the confirmation of proposition 3.

The improvement of the process standardisation was achieved through the attribution of responsibility in the parameterisation to one single unit. The process activities were thus standardised, which enabled flow and concurred to confirm proposition 4.

The significant process flow from one department to another increased delays in the initial situation (waiting periods were more significant). Moving from outsourcing to in-sourcing and assigning the responsibility of the parameterisation to a single unit allowed for the elimination of some cross-department flow, therefore making the process leaner, which contributed to the confirmation of propositions 5 and 6.

Finally, the reviewing activities relate to proposition 7 as they were considered wasteful and unnecessary. In accordance, the elimination of some wasteful reviews from the process impacted the flow of the process and increased value, which follows the stipulated by proposition 8.

4.6 Process 3 - Calculation and updating of CO2 emission allowances stock

4.6.1 Process description, internal customer identification and value perception

The energy markets division is responsible for purchasing and managing CO2 emission allowances, as to deal with the company's power plants liabilities. As mentioned previously, such internal service provision is related with the performing of commodities' procurement and, in parallel, management of the market risk arising from such commodities stock.

Within the European Union system, energy producers are forced to mitigate their CO2 emissions with the purchase of specific allowances. Such allowances are traded in a public market similarly to any other commodity. Given its market knowledge, it is the energy markets division who performs such service for the group's power production business.

In accordance with the informal inquiries performed to management, the power business, as a client of such internal service, has a value perception impacted by several factors: firstly, the less expensive the allowances are, the better; secondly, the stock held by the company should be within a certain volume interval that minimises the market and regulation risks; thirdly, the allowances trading should comply with treasury availability, i.e., the moments for purchasing or even selling allowances should not bear unsustainable impacts for treasury.

Considering the value perceived by the service's customer, the energy markets division operates at different levels: the financial trading unit purchases and sells the allowances; the risk analysis unit studies the compliance of stock levels against expected future liabilities, as to manage stock and risk levels; the settlement unit reports on the trading impacts for treasury

and accountancy; and, finally, the controlling unit reports on the business profit and losses arising from the allowances trading.

In this particular sense, the process of calculating and updating the allowance's stock is fundamental as to provide the internal service here under research. Such process must consider, at any moment, the initial stock, the purchases and sales of allowances, and the power plants past and future liabilities.

4.6.2 Initial process mapping

The process was observed and mapped on the period between the 21st and the 30th of November 2011, and is visible on table 4.5.

#	Description	ToA	Function or sub-area	Duration (hh:mm)	Min (hh:mm)	Max (hh:mm)	NPI	Comments
1	Necessity of stock update	V	Risk analysis/settlement unit	0:00	-	-	1	At least once a month
2	Request for an update from trading unit	W	Risk analysis/settlement unit	0:05	-	-	1	
3	Waiting for personnel availability	W	Financial trading unit	1:00	0:00	1:30	-	
4	Computing last stock update, present liabilities and list of all trades since last update, according to own registers	S	Financial trading unit	2:00	1:30	3:00	1	
5	Stock calculation	V	Financial trading unit	0:25	-	-	1	Performed manually on a spreadsheet
6	Submission by email of the result of the updated stock	S	Financial trading unit	0:05	-	-	1	
7	Compliance with database figures	W	Settlement unit	1:00	0:30	2:00	1	
8	Publication of updated stock	V	Settlement unit	0:05	-	-	1	
			TOTAL	4 hours, 40 minutes	2 hours, 40 minutes	7 hours, 10 minutes	7	

Subtitle: W - Waste activity; S - Support activity; V - Value-adding activity; NPI - Number of people involved.

Table 4-5 - Process 3: Calculation and updating of CO2 emission allowances stock – initial *process activity mapping*
Source: Own creation

Whenever management decides to assess the level of stock of CO2 emission allowances, whether for risk management or for evaluating trading opportunities, a request for a report containing data on such stocks is sent to the risk analysis unit. On another hand, the process may also be triggered by the settlement unit, whenever a necessity of reporting on accountancy and treasury impacts of CO2 emission allowances' trading occurs (activity #1).

Either the risk analysis unit or the settlement unit request a stock update from the financial trading unit, since such unit, besides trading the allowances, gathers information on stocks levels, liabilities and any change to regulation (activity #2).

In this sense, after a period of waiting for the financial trading unit personnel (which lasted for 1 hour for the observed process, but may range up to 1 hour and 30 minutes), one person computes the required data and calculates the stock (activities #3, #4, #5). The gathering of information, as to prepare the calculation (activity #4), may have a duration varying from 1 hour and 30 minutes up to 3 hours.

The information is then sent to the settlement unit by email (activity #6), which perpetrates a compliance of the figures sent by the financial trading unit with the figures inserted on database (activity #7). This activity may last between 30 minutes to 2 hours.

Finally, the updated stock figures are forwarded by email to all required stakeholders (risk analysis unit, the controlling unit and financial trading unit) (activity #8).

4.6.3 Waste identification and initial effectiveness and efficiency assessment

As mentioned on sub-chapter 4.2, through the initial interviews with the process participants and internal service customers, with regards to process 3, reference was made to waste related to *delays*, *process and resources inefficiencies, duplication, movement,* and *mistakes.*

The *duplication* of the process, as mentioned by the middle office management, is a consequence of the attainment of information from database being computed twice, both by the financial trading unit and the settlement unit. In fact, the financial trading unit collects information on trades from the database, an action later repeated by the settlement unit as part of its compliance activity.

Movement, as mentioned on the informal interviewing research procedures by the financial trading unit personnel, was also visible, since both the risk analysis unit and the settlement unit were inquiring or obtaining information from the financial trading unit, while all information on trades is accessible through a database query.

The *process* was considered *inefficient* by the risk analysis unit since often, when a stock update was requested, the financial trading unit responsible would not be immediately available for continuing the process, which could be an evidence of lack of available personnel and led to periods of *waiting*.

Some *resource inefficiency* was considered by the controlling unit, given that a poor usage of database's capabilities was pointed out.

Finally, comments were made by the controlling unit personnel pointing out data inconsistencies (the stock figures were not always accurate), which could be a result of the manual procedures and an indication of *mistakes*.

In terms of effectiveness for the customer, the value criteria to consider are the ones expressed on sub-chapter 4.6.1. The update of the stock levels allows management to take decisions that impact the value for the power business in terms of price (according to stock, the company buys or sells allowances when market price is more convenient); risk minimisation (the stock levels should be within the right interval); and treasury (the stock levels allow to take decisions that impact treasury).

Bearing in mind the above, in terms of effectiveness, the main claim mentioned by the power business personnel was that the stock figures was at times inaccurate, reducing the value of the service provision. In fact, if the stock levels were reported incorrectly, market decisions could be incorrect, leading to possible losses. Such inconsistency could be a result of the manual procedures performed as to compute the stock levels. In this sense, the existence of *mistakes* works as a value reducer, in accordance with the customer's perspective.

With regards to efficiency, the complete lead time of the process was of **4 hours and 40 minutes** (according to the feedback obtained through the informal interviewing, this period could range from 2 hours and 40 minutes up to 7 hours and 10 minutes). From such period, 2 hours and 5 minutes were spent on wasteful activities, while only 30 minutes were spent on actual value accretive activities. The number of interventions of personnel amounted up to 7 contributions.

Considering the process activity map shown on sub-chapter 4.6.2, and taking from the assessment performed concerning the type of activity, it may be concluded that waste exists. In fact, wasteful activities amount up to a percentage of 44%, as shown on figure 4.9.

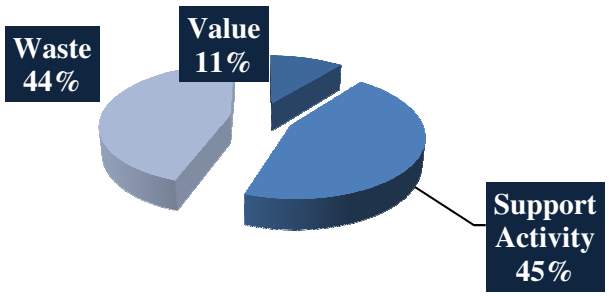

Figure 4-9 - Process 3: Time spent by type of activity
Source: Own creation

4.6.4 Subsequent lean tools application and waste elimination attempts

The duplication resulting from the database querying performed by the financial trading unit followed by the settlement unit's compliance was addressed as a waste elimination attempt.

For such, the participants of the process were instigated to provide suggestions (problem solving was thus used), as part of a lean thinking technique. For such, a *kaizen blitz* event (Hines *et al.*, 2008) was once more organised on the 12th of December 2011.

On such event, the financial trading unit, the controlling unit and the settlement unit discussed an alternative process that would not consider duplication. It was then suggested that the database should be the basic source of data on the stocks and it should thus compute such data.

Following, it was requested to the IT supplier a preparation and parameterisation of the database in order for it to be able to offer the stock figures. The trades were already part of the database, and therefore, if the data on the initial stocks and annual liabilities was introduced by the trading personnel at the beginning of each year, the database would have all the required information to offer the updated stock level at any given moment.

Such parameterisation occurred within a two months period and had a cost of 4.500 Euro. It allowed for the elimination of the visible waste on the initial process mapping, as well as possible mistakes arising from manual calculations, since any unit required to update the figures on the allowances stock had now only to perform a query on the database.

4.6.5 Reshaped *process activity mapping* and post lean tools application effectiveness and efficiency assessment

After the application of the lean thinking tools mentioned previously, another application of *process activity mapping* was perpetrated, after the observation of the process on the 15th of March 2012. The results of it are expressed by table 4.6.

#	Description	ToA	Function or sub-area	Duration (hh:mm)	Min (hh:mm)	Max (hh:mm)	NPI	Comments
1	Necessity of stock update	V	Any unit	0:00	-	-	1	
2	Query on database	V	Any unit	0:10	-	-	1	
3	Verification of numbers consistency	S	Any unit	0:20	0:20	2:00	1	May vary up to 2h if mistakes are found
			TOTAL	30 minutes	30 minues	2 hours, ten minutes	3	

Subtitle: W - Waste activity; S - Support activity; V - Value-adding activity; NPI - Number of people involved.

Table 4-6 - Process 3: Calculation and updating of CO2 emission allowances stock – reshaped *process activity mapping*
Source: Own creation

The process became much simpler. Any person requiring a stock update could query the database and obtain such figures. The database was maintained up to date by the trading

person responsible for CO2 emissions allowances and, if any information stakeholder had any doubt with the consistency of the figures, it would question the trading responsible.

In terms of effectiveness, the process scored significant improvements. On the one hand, its lead time diminished from 4 hours and 40 minutes to only 30 minutes (**an 89% reduction**), whilst in parallel the minimum and maximum lead times also decreased, 81% and 70% respectively. Such enhancements enabled a quick assessment of the market conditions by management, at any given moment, while in possession of updated stock figures.

On another hand, and more important in terms of value for the customer, the database calculation of stocks decreased the chances of mistake occurrence induced by the manual calculations. Accordingly, any information stakeholder (the risk analysis, the controlling unit, the settlement unit) would check the same database figures, auditing such numbers and more effectively finding inconsistencies or mistakes.

As mentioned, the process became also more efficient. Despite the initial cost of database parameterisation (4.500 Euro) and the necessity of an annual input of data on liabilities and initial stock performed by the trading responsible for CO2 allowances, the process reduced 89% of its lead time and the personnel contributions fell from 7 to 3 (a 57% reduction). The wasteful activities were removed, as illustrated on figure 4.10.

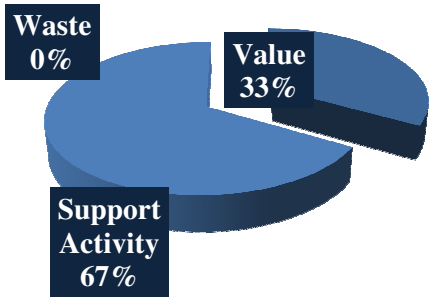

Figure 4-10 - Process 3: Time spent by type of activity, post lean tools application
Source: Own creation

4.6.6 Discussion

Given that the effectiveness and efficiency comparison between the initial process and the reshaped process seems to be clear in terms of visible improvements, the propositions that guide the present research will now be revisited.

The process was based on information on CO2 emissions allowances. In accordance to such, it was possible to observe how some information disruptions created waste, concurring to support proposition 1. This was visible for example on the necessity the settlement unit felt of

performing a compliance of data on the trades, which disrupted flow and was wasteful, as it was a duplication of the database querying.

The creation of a common depository for all data, which also computed such data, was a result of a lean techniques application and increased information flow, assisting the purpose of verifying proposition 2.

Task variability was visible whenever the process was stopped due to waiting for personnel's availability periods (inducing different task duration periods), or on the duration intervals of each activity, and worked as a waste inducer, contributing to confirm proposition 3.

Finally, propositions 5 and 6 advocate that cross-department flow causes delays and therefore the reduction of cross-department flow should promote waste reduction and value increase. In the discussed process such ideas were visible on the delays and waiting periods arising from cross unit inquires and activities. Their elimination promoted flow and increased value for customer.

5. Conclusions

The main purpose of this thesis was to analyse if the application of lean tools to three internal service system business processes of a specific utilities company induced effectiveness and efficiency gains.

For such, three processes were chosen according to pre-defined criteria and analysed within a *value stream mapping* assessment. The customer such processes serve was identified, as well as the perspective of value for such customer. In accordance, an initial effectiveness and efficiency assessment was performed, followed by an application of lean thinking tools, aiming at waste reduction. The results were implemented and the new process was analysed, once more in terms of effectiveness and efficiency, and the propositions that guided the present research were evaluated upon the output and findings of each process.

In the following chapter, the aforementioned propositions are given a final assessment and the research question is revisited in the light of the research results. Following, the validation of the results and their limitations are considered. As final considerations, some opportunities on future research possibilities are underlined.

5.1 Research question, goals and propositions analysis

The propositions that guided the present research were designed considering previous research on lean thinking application to internal service provisions. With regards to such, the purpose was to evaluate whether such propositions were valid for the specific internal service studied on the present research.

Departing from such theoretical framework, the present research conveyed the pertinence of proposition 1 in the sense that the lack of convenient information flow created waste down the value stream of the analysed processes. In fact, all three analysed processes were grounded on the base of information flows, since information was the key material to be transformed. For the first process, the transformation of information of market price quotes for hedging purposes was fundamental; for the second process, database parameterisation with trading contracts characteristics was developed; and for the third process, updates on the allowances' stock were considered.

The reshape of such information flows, developed through the application of lean thinking tools and techniques as *process activity mapping*, problem solving, *kanban* or *kaizen blitz* events, sustained improvements on information flow, confirming proposition 2. *Process*

activity mapping was used on all processes. On the first process, problem solving and *kanban* were used, whilst on the second and third processes, problem solving and *kaizen blitz* events were developed.

On another hand, research confirmed for all three processes that internal service provision not only has activities whose scope and duration varies, but also encompasses processes crossing different departments and functions. Such characteristics induced greater flow disruptions with negative impacts on effectiveness and efficiency of the services, which allowed the confirmation of propositions 3 and 5.

Lean tools have provided solutions for tackling such flow disruptions inducers, namely through process standardisation and reduction of the department/function crossing, consenting the confirmation of propositions 4 and 6.

Finally, for processes 1 and 2, the existence of several technical and hierarchical reviews proved to be waste inducing. In the light of such, proposition 7 could be confirmed under the scope of this research.

Once more, the visualisation of the output of *process activity mapping* flagged such wasteful activities, which subsequently, through problem solving and process standardisation application, were eliminated. In this sense, also proposition 8 was confirmed, given that such elimination increased the effectiveness of the processes, particularly when lead time was important for value creation, as it was the case for process 1.

Overall, it should be concluded that propositions 1, 2, 3, 5 and 6 were confirmed by all three processes analysed, while propositions 4, 7 and 8 were confirmed by processes 1 and 2.

Revisiting the partial goals of this research, it can be mentioned that:

- Criteria aiming at the selection of the most appropriate internal services were identified on sub-chapter 3.3.1;
- According to such criteria, three processes were chosen;
- For each of the processes, the customer was identified, as well as its value perception;
- The processes were mapped, in accordance with *process activity mapping*, and analysed;
- The processes were then assessed in terms of effectiveness for the internal customer, and efficiency for in terms of lead times and personnel participation;
- The types of waste visible through the process mapping were underlined;

- One or more lean thinking tools (problem solving, *kanban*, *kaizen blitz* events, work standardisation) were identified and used for analysing the processes;
- According to such analyses, improved versions of the processes were developed and implemented;
- After the application of the aforementioned lean thinking tools and the subsequent implementation of the improved versions of the processes, the improvements in terms of effectiveness and efficiency were observed and measured.

Taking it from the last partial objective abovementioned and considering the main purpose of this research, it may be said that the alterations induced in the processes were hence not only suggested as part a lean thinking tools' analysis, rather they were implemented and observed.

The research question which the present work tried to address was:

RQ: How can lean thinking tools affect the effectiveness and the efficiency of a set of independent processes of an internal service system?

All three processes analysed proved to be positively impacted in terms of efficiency and effectiveness after lean thinking tools were applied. The usage of *process activity mapping*, as a *value stream mapping* technique, proved to be thoroughly insightful as a guiding tool for the subsequent lean tools application. Problem solving, *kaizen blitz* events, *kanban*, work standardisation, and management reviewing removals were implemented as a part of a systematic lean approach. Their results were consistent for with the scope of the primary purpose of this research, i.e., they have impacted positively the effectiveness and efficiency of the processes.

In this particular regard, and within the limitations of this study, two ideas may seem plausible.

On one hand, effectiveness gains tend to have a subjective nature, as they are related to the customer's perspective. In this sense, seems to be fundamental, as to improve such effectiveness, to comprehend and formally depict the customer's value perspective, which comes in accordance with the first lean thinking principle of understanding value. Overall, in order to enhance value, the value of perception must be understood. For the scope of this research, lean thinking tools proved to be valuable not only for comprehending value, but also to enhance it.

On another hand, efficiency gains tend to be more of a quantitative enhancement, as they consider lead times, personnel participation, waste reduction. Nonetheless, findings from

process 1 showed that they carry impacts on the effectiveness level, particularly if the lead time is important for the customer.

The application of lean tools showed another positive impact in the analysed processes. It engaged the process participants in a proactive approach, aiming for improvements and casting efforts in the attempt of understanding the perspective of value for the customer. This relates to the cultural and behavioural impact of lean thinking as an organisation transformation approach (Abdi *et al.*, 2006; Hines *et al.*, 2008; Mann, 2009; McCuiston, 2010).

In response to the research question it can therefore be stated that the lean thinking tools applied in a systematic approach indeed impacted positively the effectiveness and efficiency of the processes studied at an internal service system of the energy markets division of the utilities company under analysis.

5.2 Results validation

As stated on sub-chapter 3.1, the present research was developed upon a concept of "analytic generalisation" (Yin, 1989). In fact, a previously proved theoretical background considering the application of lean tools to services was regarded throughout the research.

Such theoretical background, as described on sub-chapter 2.2.3, considered lean tools as mapping tools and problem solving (Vinas, 2004), work standardisation (Sprigg and Jackson, 2006), or mapping techniques, kaizen events and personnel contributions to problem solving (Searcy, 2006), as having mostly impacts in terms of efficiency gains. In fact, except for Searcy (2006), the impact of lean tools application in terms of effectiveness and customer value enhancement was mostly neglected, showing a gap in literature.

From the point of view of efficiency, the findings from the present research are in line with the results from previous research.

Notwithstanding, the present research allowed the verification of the impact of lean thinking tools in terms of effectiveness and value enhancement for the customer. This situation was observable particularly due to the identification and conveying of the customer's value perception, an aspect not so much targeted on previous research.

Finally, the present research also proposed on sub-chapter 3.3.2 a comparison between the standard types of lean thinking waste and the services types of lean thinking waste. Following this comparison, an adaptation of Hines *et al*. (2002) matrix on types of waste and *value*

stream mapping tools was developed with the purpose of identifying the most suitable type of *value stream mapping* tool for each lean thinking services type of waste.

5.3 Research limits

The aforementioned findings are kept within the walls of the main limitation of this research. They are considerable only within the perimeter of the case study. In this sense, the findings of the present thesis are only relatable to the three business processes observed in the context of a specific utilities company. As Yin (1989) considers, case studies findings may be generalised to theoretical propositions only.

Nonetheless, the findings of this research may be insightful data for the specific utilities company where the present study was perpetrated. Furthermore, such findings, though not to be generalised, may still offer insights to practitioners or researchers wishing to consider more data regarding the importance of improvement of internal service provision through the usage of lean thinking tools.

It should be stressed once more that this research aimed at studying and applying lean thinking tools only to three specific processes of the energy markets division. Would this research have aimed for a wider scope, namely the application of the wider lean thinking program being applied to the energy markets division, and a different methodology would have been prosecuted.

It was never envisaged by this research to accomplish a continuous improvement culture with the mere application of lean tools, though the application of lean tools sets a practical example on the potential of such approach.

5.4 Future research alternatives

Literature on lean thinking tools application to internal services is scarce. The present research contributed to the intent of exploring the potential of the application of lean thinking to such specific type of services. Bearing in mind the aforementioned, it should be considered the natural evolution of this research to study a holistic and broader application of lean thinking to an internal service system, particularly an internal service system depending on information flows.

On another hand, a re-design of the lean thinking principles adapted for the internal services could be considered. With regards to such, it must be stressed once more that internal services tend to have very specific characteristics, which differentiate them from goods or other types

of services. In order to comprehend and to set a framework for applying lean thinking to internal services, it could be relevant to re-design the principles that guide the lean thinking approach.

Some questions leading to possible future research focuses arise throughout this research: Should the perspective of value to be considered encompass only the internal customer of such service? Or should it encompass the company as a whole, since sometimes there are concurrent interests? Isn't the value stream of internal services dealing almost entirely with information flows? How to perfect such flows? Should flexibility fight variability? Should there be information models? Don't most internal services already work according to pull systems?

Lean thinking has long expanded its potential outside the manufacturing areas. Such potential may be conveyed by its principles, even though they were initially set within a manufacturing mindset. Nonetheless, would such principles be re-adapted to internal services purposes, they would possibly transmit not only a stronger framework for practitioners, but also an enhanced potential for such areas.

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Annexes

Informal interviewing procedures

Phase 1: assessment of the energy markets division's activity and choice of processes

The informal interviewing process started on the 1st of September 2011 with a conversation with the general manager of the energy markets division regarding the scope of this research. The initial purpose was to obtain some inputs from the general manager with regards to key areas or processes, for the division's operation, that he would consider having potential for improvement. The feedback obtained was at this point too general, though the general manager pointed out the units' managers as having a more operational and thorough knowledge on the processes.

Following, on the 2nd of September 2011, an informal interview with the general manager for lean thinking implementation for the company was perpetrated. The focus was at this point to comprehend up to which extent lean thinking approach was implemented on the energy markets division. His feedback was conclusive: the energy markets division had had little progression with regards to a lean thinking approach implementation. A person from the energy markets division had had training on lean thinking and, following such training, a focus group had been formed with some of the division's staff, in order to develop an agenda for lean thinking application, which had not been finished by the start of this research. Moreover, none of the processes analysed during the present research was on the agenda of the company in a lean thinking application context. The processes were chosen and analysed only within the scope of this research and as a consequence of it.

The informal interviews with the unit managers occurred on the following days until the 9th of September 2011. The most substantial one, with regards to the scope of this research, was the one with the middle-office manager. As a responsible for the risk management for the power business and having straight contact with the gas operator risk control manager, the middle-office manager held a clear perspective on the focus of the internal services perpetrated by the energy markets division. This enabled the comprehension of the nature of the services provided. Following such feedback, the manager mentioned some processes that were elemental for the division's operation and that according to him could suffer improvements.

This highlighted the possibility of effectiveness improvements, since the middle-office manager had a perspective on the value of the internal services, once his role encompassed frequent meetings with the customers of the internal services of risk management, both for the power and gas businesses. From this interviewing step, a set of services of risk management internal services was highlighted.

The next step was to interview informally the participants of the processes that could feed the internal services. In this sense, informal interviews with at least two or more persons from the following units were perpetrated, individually: financial trading unit, controlling unit, settlement unit and risk analysis unit. These interviews lasted from the 12th till the 23rd of September 2011.

The focus, at this point, was to understand how these persons and their activities were contributing to the provision of the internal services highlighted by the middle-office manager. From this point, it was possible to point out a set of processes, their scope, their purpose, and their value. It was hence possible to assess them considering the criteria mentioned on the sub-chapter 3.3.1 of the present thesis. Three processes were chosen.

Phase 2: processes and services value assessment

The following procedure encompassed two stages. Firstly, the representatives of the customer of the internal services such processes concurred for were addressed as part of an informal interviewing process, and, secondly, all process participants were inquired on the processes activities, as well as on their general opinion of the process (value, waste, inefficiencies).

In this sense, the gas business risk control manager was interviewed informally on the 27th of September 2011, in order to comprehend the inherent value perception for processes 1 and 2, as well as to obtain feedback on an informal assessment of the processes in terms of effectiveness. Also for feedback on customer's value perception for the second process and third process, the risk manager for the power business was inquired on the 10th of October 2011.

The second stage of this phase was developed as part of the processes observation procedures. Accordingly, the process participants were listed and each of them indicated their role on the process value stream. They were inquired about their view on the value created with the

processes for their customer's. The process participant's opinions on inefficiencies of the processes were also regarded.

Phase 3: processes value assessment after lean thinking tools application

The risk managers for the power and gas business were informally interviewed once more after the changes on the processes were implemented. The risk manager for the power business was interviewed on the 16th of April 2012, whilst the risk manager for the gas business was interviewed on the 18th of April 2012. The topic of these conversations was to obtain feedback on the value perception changes that may have occurred, as a consequence of the renewed processes.

The middle-office manager and general manager for the energy markets division were also interviewed informally on the 20th of April 2012, in order to regard their considerations on the effectiveness and efficiency changes induced by the implementation of the reshaped processes.