CATÓLICA LISBON
SCHOOL OF BUSINESS & ECONOMICS

UNIVERSIDADE CATÓLICA PORTUGUESA

TECHNOLOGY IN HEALTHCARE

Business Process Reengineering and RFID

at Hospital Beatriz Ângelo

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Dissertation submitted in partial fulfilment of requirements for the degree of MSc in Business Administration, at the Universidade Católica Portuguesa

June 2012

ABSTRACT

TITLE: Business Process Reengineering and RFID at Hospital Beatriz Ângelo

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The purpose of this dissertation is to analyse if Radio Frequency Identification (RFID) can be used to improve the patient's food chain at Hospital Beatriz Ângelo.

Under the theory of Business Process Reengineering, the patient's food chain and related activities are monitored and documented. As a result, the main problems and wasteful activities are identified, being some examples of it, lack of internal auditing to the number of meals served, and the time consumed when printing and checking diet lists and adding extra information to diet labels by hand.

For every problem and wasteful activity identified, a solution is proposed and both technical and social designs are described. Gains derived from it are also evaluated.

From these solutions it is possible to conclude that RFID can effectively be implemented as an internal auditing tool, to control the number of meals served to hospitalized patients, avoiding over-billing and eliminating the non-accurate and time consuming activity of manual billing. This is ultimately translated into cost savings by the hospital.

Also, other technology is considered as a solution, a Zebra printer. This material is expected to eliminate the wasteful activities mentioned above, allowing staff to focus on more productive tasks.

This dissertation concludes that RFID technology can effectively be applied at Hospital Beatriz Ângelo to improve a primary process, the patient´s food chain.

RESUMO

TÍTULO: Business Process Reengineering and RFID at Hospital Beatriz Ângelo

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A presente dissertação tem como objectivo analisar se a tecnologia de Identificação por Ondas de Rádio (RFID) pode ser utilizada de forma a melhorar um processo interno no Hospital Beatriz Ângelo, o processo de preparação e distribuição de alimentação aos doentes internados.

De acordo com a teoria de Reengenharia de Processos, o processo em estudo e as actividades ao mesmo associadas são monitorizadas e documentadas. Desta observação, resulta a identificação de alguns problemas e actividades eliminàveis com recurso à tecnologia, sendo alguns exemplos, a não existência de auditoria interna ao número de refeições servidas aos doentes hospitalizados, o tempo consumido na impressão das listas de dietas e a adição, à mão, de informação às etiquetas de dieta dos doentes.

Para cada problema e actividade considerada eliminável, soluções são apresentadas, sendo o desenho técnico e social descritos para cada uma delas. Os ganhos derivados da implementação destas soluções são também considerados.

A partir destas soluções é possível concluir que a tecnologia RFID pode efectivamente ser implementada como uma ferramenta de auditoria interna ao número de refeições servidas diariamente aos doentes. A implementação de um sistema RFID nesta unidade de saúde evita a facturação por excesso, eliminando ainda a auditoria manual às refeições que é efectuada no presente. Esta solução traduz-se em redução de gastos por parte do hospital.

Adicionalmente, outra tecnologia é apresentada como solução para os problemas identificados, uma impressora de etiquetas. A referida impressora vem eliminar as actividades relacionadas com impressão de listas e etiquetas de dietas, acima referenciadas, permitindo que os colaboradores antes afectos a estas tarefas se foquem em actividades mais produtivas.

Deste modo, a presente dissertação conclui que se verifica a oportunidade de implementar a tecnologia RFID no Hospital Beatriz Ângelo, para melhoria do processo primário de preparação e distribuição de alimentação aos doentes internados.

ACKNOWLEDGES

When deciding which subject to develop as a dissertation, heath care was the obvious choice. Not only this area is related to my personal interests but also, would allow me to explore another topic that has risen some curiosity, RFID technology.

In addition to my personal interest, healthcare is a very unique and demanding sector which functioning deeply affects national economy. Also, improvements in this sector, both public and private, seem very appealing to general public.

Firstly, I would like to thank Espírito Santo Saúde and Itau for welcoming me during this dissertation period, especially, Dr. Pedro Lima, Dra. Marisa Raposo and Eng. Sandra Antunes. I would also like to thank to Eng. Carlos Alfaiate and Dr. Nuno Alfaiate, from Datelka, for the technical support provided during RFID testing and budgeting.

I would like to thank to my advisor, Professor Doutor Paulo Cardoso do Amaral, for the help provided, and for guiding me through this process with his precious orientations.

Finally, I also have to thank my family, friends and colleagues for always being very supportive and comprehensive during this period. My especial thanks to André de Oliveira, a beloved friend that although far, was always present.

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1. INTRODUCTION

In order to succeed and maintain a sustainable competitive advantage, companies need to take full benefit of both radical and incremental change (Hung 2006). Both these levels of change can and should be viewed as part of the continuous improvement efforts in any organisation (Hung 2006).

In response to this organisational demand, Hammer (1990) and Davenport and Short (1990) introduced a revolutionary concept, Business Process Reengineering (BPR). It emerged as a tool empowering managers and helping big corporations to succeed (Davenport 1993; Hammer & Champy 1993; Davenport & Stoddard 1994), in a market increasing in both competition and economic pressure (Davenport 1993).

After its boom, BPR concept was itself reengineered, and changed into a broader perspective named Business Process Management (BPM) (Melão & Pidd 2000).

Like BPR, BPM is also dedicated to business processes but, instead of pursuing radical change, is focused on a continuous approach to optimization (Zairi 1997). Additionally, BPM is seen as a tool to leverage and add value to the process under change (Zairi 1997).

Even though these two approaches seek for different goals and objectives, it is general agreement that technology, especially Information Technology (IT), can be a powerful enabler of both BPR (O'Neill P. & Sohal A.S. 1999; Davenport 1993; Hammer & Champy 1993; Davenport & Short 1990), and BPM (Hung 2006; Benner & Tushman 2003).

Radio Frequency Identification (RFID) was developed in the first half of the twentieth century, being originally used to identify friendly aircrafts during the Second World War (Bunduchi et al. 2011; RFID Journal a). Although more than fifty years old, it was not only until the eighties that RFID started to be available for business applications (Bunduchi et al. 2011).

Since 2000, this RFID technology has emerged as a promising technology in supply chain (Wu et al. 2006; Dutta et al. 2007; Lee & Özer 2007), giving unprecedented and unmatched visibility to it (Dutta et al. 2007; Delen et al. 2007; Lee & Özer 2007). Today, it is considered one of the hottest tools in this field of business (Lee & Özer 2007; RFID Journal a). The enthusiasm is so fervent, that RFID was presented by the Economist (2003) as "The Best Thing Since the Bar Code".

As any other emergent technology, RFID worldwide adoption carries some challenges, especially related to costs (Wu et al. 2006; Heese 2007) and some technological limitations (Wu et al. 2006; Delen et al. 2007). Although significant, these challenges are not insuperable, needing just some more time, research and development efforts to collect and study the data regarding pilot projects and the problems these are facing as well solutions being implemented (Wu et al. 2006).

Healthcare, especially hospital industry, is a unique and multifaceted industry including both public and private owned facilities, sometimes offering similar services and competing for the same workers and patients (Goldstein et al. 2002).

Healthcare poses a significant segment of the service sector (Li et al. 2002), growing both in complexity (Bates & Gawande 2003), and competition (Goldstein et al. 2002). According to World Health Organisation (WHO), in 2010, healthcare cost in Portugal rise up over 21 thousand million euros, corresponding to 11,3% of the Gross Domestic Product (GDP).

It is an area that deals with a large volume of human and material capital, having great needs in terms of facilities and equipment (Li et al. 2002). Consequently, hospital managers and executives need to be aware of this industry's unique demands and needs, understanding the nature of the decisions regarding workforce, facilities and equipment that are necessary to achieve both financial, quality and safety goals (Li et al. 2002).

By definition, this industry is also very patient-oriented, requiring a constant and continuous interaction with customers and patients (Li et al. 2002). Being aware of this very specific characteristic, several studies and documents focus on research regarding new approaches to diagnosis, treatment and patients' safety (Bates & Gawande 2003).

Hospitals, like any other organisation, need to develop strategies and decisions to evolve and to keep responding to both environmental changes and competitive challenges (Goldstein et al. 2002). This type of organisations can make substantial cost savings while improving clinical practice by better managing their material and human resources (Harmon 1996 sited by Kumar & Ozdamar 2004).

Healthcare providers are beginning to understand that BPR projects may be the solution to achieve the desired competitive advantage (Kumar & Ozdamar 2004). In this field, BPR is usually implemented in customer-focused and/or cost-reduction initiates (Harmon cited by Kumar & Ozdamar 2004; Elkhuizen et al. 2006).

Other important topic in healthcare includes investments in new technologies (Goldstein et al. 2002), being RFID one of the most promising investments in this field (van der Togt et al. 2008).

In healthcare, RFID is receiving a lot of attention (van der Togt et al. 2008). Examples of its implementation in hospitals are increasing since the year 2000 (Shang-Wei Wang et al. 2006; Chao et al. 2007), being healthcare considered the next big industry to fully adopt this technology (Bunduchi et al. 2011; Shang-Wei Wang et al. 2006). The main goal of this adoption is, as in the majority of other RFID adopting industries, to save costs (Bunduchi et al. 2011) by improving the organisation's operations and efficiency (Chao et al. 2007; Bunduchi et al. 2011).

Following this line, this dissertation attempts to evaluate the potential of RFID technology in improving a process related with workflow and resource management. To assess this very same potential in a real environment, the study is applied to an organisation, the healthcare facility, Hospital Beatriz Ângelo.

In order to make such an assessment and analysis, this dissertation focuses on answering to the following research question:

Is there an opportunity for RFID technology to improve the patient's food chain at the Hospital Beatriz Ângelo?

To answer the research question above, the dissertation considers several major chapters.

On the first one, named "Literature Review", a review of the literature concerning RFID technology and its applications in healthcare, mainly hospitals, is performed. Also, theory related to BPR and BPM is explored.

Some relevant information regarding ESS and the hospital under study are presented in the "Company Presentation" chapter.

Then, the "Methodology" chapter presents the framework to apply when analysing and reengineering the selected process.

On the "Patient's Food Chain Redesign" chapter, the process to be reengineered is selected and analysed. At this step, several collaborators from Hospital Beatriz Ângelo, including the Logistics Director of Espírito Santo Saúde, are interviewed. The goal of these interviews is to understand what are the major problems of this specific process and how collaborators see the possible integration of the RFID system in their daily routines and tasks.

Additionally, a reengineering proposal, considering both technical and social dimensions, for this process using RFID technology is presented, and calculations regarding operational cost and potential improvements are also evaluated.

Finally, main conclusions, study limitations and future research suggestions are presented in the chapter, "Conclusions, Limitations and Future Research".

At the end of this dissertation, the research question regarding the potential opportunity for RFID technology in improving the patient's food chain at Hospital Beatriz Ângelo, is expected to be answered in a clear and sustainable way.

2. Literature Review

This chapter covers the theoretical bases of this dissertation, presenting some scientific knowledge discussed in the literature, in the last decades. It is composed by four main topics, which are essential to answer the research question defined in the previous chapter.

The first two topics focus on business processes, more specifically, Business Process Reengineering and Business Process Management. These topics are fundamental, since this dissertation explores the possibility of transforming and improving an internal process of Hospital Beatriz Ângelo, by using a redesign framework.

The third sector explores the technology that is used to reengineer and improve the chosen process. It focus on what a Radio Frequency Identification system is and how it works, presenting its possible applications and also some challenges that companies face when trying to implement this technology.

Finally, a topic is also dedicated to both healthcare and technology. This section establishes a connection between hospital's main problems and needs and how Radio Frequency Identification systems are being applied to solve them. It also presents the main challenges and problems that are currently slowing down this technology adoption by hospitals.

2.1 Business Process Reengineering

With its roots in Information Technology (IT) management (Davenport & Stoddard 1994; Attaran 2004), Reengineering, or Business Process Reengineering, (BPR) has become one of the most popular issues in the business field, in the 1990s (Davenport & Short 1990; Melão & Pidd 2000).

Introduced by Hammer (1990) and Davenport and Short (1990), BPR emerged as a tool empowering managers and helping big corporations to succeed (Davenport 1993; Hammer & Champy 1993; Davenport & Stoddard 1994), in a market increasing in both competition and economic pressure (Davenport 1993).

Soon was BPR recognized as a powerful approach to radically change and improve business processes (Davenport & Stoddard 1994); attracting both executives and academics, and also being explored in several books that become popular bestsellers (Grover & Malhotra 1997; Melão & Pidd 2000). Thanks to this success, BPR is commonly outlined as "the buzzword of the 1990s" (Grover & Malhotra 1997).

Central to the concept of BPR is the notion of business process (Melão & Pidd 2000).

Davenport (1993) sees a process as "a structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organisation, in contrast to a product focus's emphasis on what. A process is thus a specific

ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs: a structure for action".

Davenport and Shorty (1990) define business processes as "a set of logically-related tasks performed to achieve a defined business outcome".

Hammer and Champy's (1993) definition is usually considered as a subset of Davenport's. They define a process as a "set of activities that, taken together, produce a result of value to a customer".

Despite the several definitions of business process in the literature (Zairi 1997), different authors usually identify processes as:

- Cross functional (Davenport & Short 1990; Lee & Dale 1998);
- Horizontal in nature, opposed to the usual vertical hierarchy of companies (Davenport & Short 1990; Lee & Dale 1998);
- Having customers, internal or external, that are the recipients of process outcomes (Davenport & Short 1990; Benner & Tushman 2003).

2.1.1 WHAT IS BPR?

Davenport and Short (1990) describe BPR as "the analysis and design of workflows and processes within and between organisations".

Hammer and Champy (1993) define reengineering as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, and speed".

There is some confusion both in the interpretation and the scope of this change concept, with authors adopting different terms – business redesign, process reengineering, or even process innovation – interchangeably (Grover & Malhotra 1997; Trkman 2010). However, although there is no consensus regarding BPR definition, the majority of them have some elements in common, presenting it as the core of reengineering (Grover & Malhotra 1997):

- *Radical*
  BPR is not about making small changes or modifications; instead it is about reinventing and making radical changes (Grover & Malhotra 1997; Davenport 1993; Hammer & Champy 1993).

- *Dramatic*
  Reengineering aims significant performance improvements, and not just marginal ones (Grover & Malhotra 1997; Davenport 1993; Hammer & Champy 1993).

- *Processes*

  BPR focuses on business processes (Grover & Malhotra 1997; Davenport 1993; Hammer & Champy 1993), so companies must change from a task-based to a process-based thinking (Hammer & Champy 1993).

- *Information technology (IT)*

  IT is an important enabler and facilitator of BPR (O'Neill P. & Sohal A.S. 1999; Davenport 1993; Hammer & Champy 1993; Davenport & Stoddard 1994; Davenport & Short 1990).

Hammer and Champy (1993) identify three types of companies that embrace BPR, and also the driving forces behind this radical change. Davenport and Short (1990) and Grover et al. (1995) identify the objectives:

TYPES OF COMPANIES	DRIVING FORCES	OBJECTIVES
Companies facing big problems and needing an extreme performance improvement to survive (Hammer & Champy 1993) ; Companies that, although not yet facing problems, are expecting it in the near future. These companies are protecting and preparing themselves for adversity (Hammer & Champy 1993) ; Companies that are in peak condition, and whose managers are ambitious and aggressive, searching for opportunities to raise the competition level and lead over its competitors (Hammer & Champy 1993).	Customers – Segmentation and diversification of customers (Hammer & Champy 1993); Competition – Intensification of competition to meet customer's demand and needs (Hammer & Champy 1993) ; Change – Fast change becoming a pre-requisite in markets (Hammer & Champy 1993).	Cost reduction (Davenport & Short 1990; Grover et al. 1995); Time reduction (Grover et al. 1995; Davenport & Short 1990); Improvement of customer service (Grover et al. 1995); Increased productivity (Grover et al. 1995); Improvement of quality output (Davenport & Short 1990).

TABLE 1 - TYPES OF COMPANIES UNDERTAKING BPR, DRIVING FORCES OF BPR, OBJECTIVE OF BPR.

Regardless of the cause(s) and objective(s) leading to reengineering projects, the focus is always on the business process (Davenport 1993; Hammer & Champy 1993; Grover & Malhotra 1997). The processes under study may refer to activities that offer value to the customer; that move work across

organisational borders; or activities related to control and/or improvement of workflows (Grover & Malhotra 1997).

2.1.2 BPR TOOLS AND METHODOLOGIES

The majority of BPR definitions suggest that radical improvement of business processes is its main goal (O'Neill P. & Sohal A.S. 1999; Davenport 1993; Grover & Malhotra 1997; Hammer & Champy 1993).

However, few authors refer a single technique as the right approach, when developing a BPR program (Carr & Johansson 1995 cited by O'Neill P. & Sohal A.S. 1999). The result is a large number of methodologies being proposed that, although different, share some common elements as, for example, the notion that a BPR project is divided into several sequential and discrete phases (Carr & Johansson 1995 cited by O'Neill P. & Sohal A.S. 1999). Most of these BPR methodologies incorporate a mixture of tools, being this mixture dependent on the process and/or application under study (O'Neill P. & Sohal A.S. 1999).

Essential in any BPR methodology is the focus on the outcome, instead of the tasks (O'Neill P. & Sohal A.S. 1999). This focus not only helps to determine the scope of the changes, but also gives direction and measurability (O'Neill P. & Sohal A.S. 1999). Goss et al. (1993) goes even further, declaring that the key element is visioning the outcome (Goss et al. 1993 cited by O'Neill P. & Sohal A.S. 1999).

Earl and Khan (1994) argue that independently of the methodologies and tools applied in a project, BPR should be seen as a strategic and cross-functional activity that has to be integrated with other management aspects, in order to succeed. They also state that this notion of integration is particularly true since "it is not the methodologies themselves, but rather the way that they are used which is unique in BPR" (Earl and Khan 1994 cited by O'Neill P. & Sohal A.S. 1999).

2.1.3 BPR AND TECHNOLOGY

It is widely accepted that technology, especially IT, can be a powerful enabler of BPR (O'Neill P. & Sohal A.S. 1999; Davenport 1993; Hammer & Champy 1993; Davenport & Short 1990). For example, IT can transform sequential tasks into parallel tasks; enhance communication between different tasks and therefore, improving efficiency and performance (Grover & Malhotra 1997).

Nevertheless, companies should be aware that despite of great value to BPR, technology does not offer all the answers (O'Neill P. & Sohal A.S. 1999). Additionally, Hammer and Champy (1993) state that companies should be really careful when applying technology to BPR, since its misuse can block reengineering by reinforcing old and wrong behaviours. Therefore, reengineering should not be confounded with IT or Information Systems (IS) initiatives (Davenport & Stoddard 1994).

2.1.4 BPR SUCCESS AND UNSUCCESSFUL PROJECTS

Dramatic success stories related to BPR have been presented in press (Grover & Malhotra 1997), being Ford reduction of headcount in its accounts payable department by 75% one of the earliest and most popular cases (Davenport 1996; Grover & Malhotra 1997). However, such success requires careful planning, evaluation and management of BPR projects (Grover & Malhotra 1997).

According to Davenport and Stoddard (1994), the primary reason for process reengineering failures, , is the fact that some organisations see BPR and transformation as synonymous, embracing too many transformations at a time, often doing it, when the market, products and organisational structures are also changing.

Carr and Johansson (1995) (Carr & Johansson 1995 cited by O'Neill P. & Sohal A.S. 1999), Grover and Malhotra (1997), Davenport (1996) and Attaran (2004), instead, focus on the human factors that usually affect BPR projects. Carr and Johansson (1995) identify what they call Organisational Risk, which is related to negative corporate reactions against the change, while the rest of the authors mentioned, state that not adequate attention to the human dimension of BPR is a major factor contributing to BPR project's failures. Lack of commitment and leadership skills from top management team is also a common human factor contributing to unsuccessful BPR projects (Attaran 2004).

Additionally, Attaran (2004) also argues that the misunderstanding and misapplication of the BPR concept are also factors leading to BPR failures.

Regardless of what causes the negative outcome of BPR, Hammer and Champy (1993) suggest that the rate of unsuccessful projects reaches 70%.

2.2 BUSINESS PROCESS MANAGEMENT

Although its origins can be traced to the beginning of twentieth century, it was only after the boom of BPR that Business Process Management (BPM) has emerged as a distinct and clear field (Melão & Pidd 2000).

The initial wave of literature regarding business processes was primarily focused on BPR, as stated by Hammer and Champy 1993; Davenport 1993 and Davenport and Short 1990. Despite some successful cases, BPR failed to deliver the expected results, with failure rates reaching 70% (Hammer & Champy 1993). To some authors, like Davenport (1996) this was the end of BPR in the USA.

In view of these developments, the BPR concept was itself reengineered, and changed into a broader perspective (Melão & Pidd 2000). This new standpoint is still focused on business processes, since it seems to be a natural way of working inside organisations (Melão & Pidd 2000; Davenport 1996).

Like BPR, business processes improvement is still the fundamental element of analysis of BPM (Melão & Pidd 2000). Nevertheless, BPM "presents a more comprehensive array of improvement options", helping the organisations to "avoid the tendency to fall prey to the hype of new management fad" (DeToro and McCabe cited by Lee & Dale 1998).

2.2.1 What is BPM?

According to Zairi (1997), BPM "is a structured approach to analyse and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company's operations".

Other authors, namely Lee and Dale (1998), state that this approach "is intended to align the business processes with strategic objectives and customer's needs but requires a change in a company's emphasis from functional to process orientation".

Although popular in the business field, like BPR, BPM has no single definition; rather, there are several topics and terms that are commonly associated and gathered under this term, like (Reijers 2003):

- Analytical (Reijers 2003; Lee & Dale 1998);
- Model and structure (Zairi 1997; Lee & Dale 1998);
- Control of business processes (Reijers 2003);
- Continuous improvement of business processes (Lee & Dale 1998; Zairi 1997);
- Cross functional (Reijers 2003).

Benner and Tushman (2003) identify several organisational benefits derived from the implementation of process management initiatives, being less rework, less waste, elimination of non-value-added processes the most common ones.

Additionally, BPM should always be used to leverage and add value to processes under change (Zairi 1997). Also BPM should be faced as a continuous approach to optimization (Zairi 1997), creating a focus on the customer (Zairi 1997; Hung 2006), and delivering results that fit corporate objectives, organisational structure (Zairi 1997; Trkman 2010) and that sustain competitive advantage (Hung 2006).

2.2.2 BPM tools and methodologies

Recent years have been marked by an increasing interest in methodologies, tools and techniques to support process improvement, more specifically, BPM (Melão & Pidd 2000).

There are numerous methodological approaches regarding BPM in literature, being one of the most quoted and analysed, the Process Breakthrough Methodology framework, created by Harrington (1995) (Zairi 1997; Lee & Dale 1998). This framework consists on 5 major phases, each one subdivided into a total of 27 activities (Appendix I) (Zairi 1997; Lee & Dale 1998).

Harrington (1995) states that by using systematic methodological approaches, such as his model, business processes may be improved, leading to positive results (Harrington 1995 cited by Zairi 1997). This author, also states that "the start of any improvement process is top management leadership" (Harrington 1995 cited by Lee & Dale 1998).

However, several other authors, such as DeToro &McCabe (1997) and Elizinga et al. (1995) prefer a more employee, team oriented approach to BPM (Lee & Dale 1998).

2.2.3 BPM AND TECHNOLOGY

Like in BPR, technology is an important enabler of BPM and organisational adaptation (Hung 2006; Benner & Tushman 2003).

Process changes may require a continuous adaptation of the supporting IS (Mutschler et al. 2008). Despite this continuous improvement, both of technologies and/or processes, a real fit between technology and business processes must always be established and maintained (Bendoly & Cotteleer 2008).

2.2.4 BPM SUCCESS AND UNSUCCESSFUL PROJECTS

Trkman (2010) states that BPM projects can be initiated for several reasons and purposes, which make it difficult to define what a successful BPM initiative is. However, the author proposes a very general definition: "BPM is successful if it continuously meets predetermined goals, both within a single project scope and over a longer period of time".

Organisational resistance to change is an important cause of unsuccessful BPM initiatives, mainly due to lack of proper involvement of employees, which creates fear and anxiety (Corrigan 1996 cited by Lee & Dale 1998). Hung 2006, argues that to overcome this resistance, when implementing BPM programs, companies should provide more authority to employees, so that they could manage their own work, encouraging them to pursue common organisational goals.

On the other hand, top management leadership, support and commitment are often considered the most important factors to guarantee BPM successful projects (Hung 2006). It is also important to ensure the fit between the modifications being applied in processes and the characteristics and contingencies of the organisation (Trkman 2010), being the alignment between business processes and strategic

objectives a key factor (Hung 2006). Bearing this in mind, it is strongly recommended not to simply copy successful BPM approaches developed for other processes and/or organisations, since it will not bring necessarily the same benefits (Trkman 2010).

2.3 Radio Frequency Identification

According to Bunduchi et al. (2011), Radio Frequency Identification (RFID) was developed during the Second World War, being primarily used to identify friendly aircrafts. Although more than fifty years old, it was not until the eighties that RFID started to be applied in the business field. Since the beginning of this century, RFID has been experiencing a fast diffusion of its applications, emerging as one of the most promising innovations in supply chain management.

Mandates from major companies and organisations, such as Wal-Mart, Target and the United States Department of Defence, were the main responsible for the majority of the early RFID implementations (Delen et al. 2007; Dutta et al. 2007; Bunduchi et al. 2011).

The number of RFID applications is increasing continuously, reaching new industries and contexts, apart from supply chain, such as hospitality (Öztayşi et al. 2009), aircraft servicing (Dutta et al. 2007), and healthcare (Bunduchi et al. 2011; Dutta et al. 2007).

2.3.1 What is RFID and how it works

RFID is the generic term used to name a system that transmits identity's information wireless, through radio frequency waves (Delen et al. 2007; Öztayşi et al. 2009; RFID Journal 2005). It belongs to a family of auto-identification technologies, which includes bar codes (Delen et al. 2007; Öztayşi et al. 2009; RFID Journal 2005) and magnetic stripes (Öztayşi et al. 2009; Delen et al. 2007).

A RFID system consists of two components – tag and reader (Delen et al. 2007; Whitaker et al. 2007; Öztayşi et al. 2009).

RFID tags are usually attached to the person or object to be identified, including a microchip and an antenna (Delen et al. 2007; Whitaker et al. 2007; RFID Journal 2005). The microchip allows the RFID tag to store information, while the antenna is necessary to transmit object´s information to the reader (Whitaker et al. 2007). The amount and type of information that each tag stores is variable, being some common examples, the serial number (unique for each tag) (Whitaker et al. 2007; Dutta et al. 2007), the manufacturer number (RFID Journal 2005; Dutta et al. 2007), and product destination (RFID Journal 2005).

The reader, or interrogator, which may have one or more antennas (Delen et al. 2007; RFID Journal 2005), creates a magnetic field, allowing tags to transmit information to it (Dutta et al. 2007; RFID Journal 2005). Complementing the system, is usually a computer, essential to control the readers, and to capture and store the data (Delen et al. 2007).

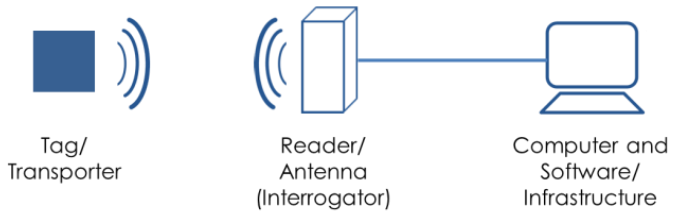

FIGURE 1 – RFID SYSTEM (ADAPTED FROM CIO).

According to working principles, tags can be classified into two different categories – passive and active (Delen et al. 2007; Lee & Özer 2007; RFID Journal b).

Passive tags do not have a power source; they are powered through the magnetic field created by the reader, sending information only when requested by the latter (Delen et al. 2007; Lee & Özer 2007; RFID Journal b). This type of tags can operate at Low Frequency (125-134 KHz), High Frequency (13.56 MHz) or Ultra-High Frequency (860 – 960 MHz) (RFID Journal b).

Active tags, on the other hand, have their own transmitter and power source, being able to initiate the information transmission process by themselves (Delen et al. 2007; Lee & Özer 2007; RFID Journal b).

This type of tags have a longer range than passive ones (20 to 100 meters vs. maximum of 10 meters) (Delen et al. 2007; Lee & Özer 2007; RFID Journal b), higher processing capabilities, more storage capacity and better accuracy (Delen et al. 2007). As a major setback, they demand more maintenance and are more expensive than passive tags (Delen et al. 2007; RFID Journal b). The frequency at which they operate is also different, typically at 455 MHz, 2.45 GHz, or 5.8 GHz (RFID Journal b).

2.3.2 APPLICATIONS AND BENEFITS OF RFID

Nowadays, RFID is present in several different industries, being used by companies to improve efficiency and effectiveness of existing processes (Delen et al. 2007) in order to improve competitive advantage (Chao et al. 2007).

Chao et al. (2007) defines four major applications for RFID:

- *Identification of objects and people;*

- *Process flow tracking;*
- *Authentication, authorization and security;*
- *Financial record keeping.*

Although several benefits have been associated with RFID implementation and applications, the key business benefits and the value derived from RFID do not lie in the technology itself (Delen et al. 2007; Dutta et al. 2007; Shang-Wei Wang et al. 2006); rather, the value comes from the organisation's ability to properly use the data , taking the advantage of having information and leveraging it to make better business decisions and changes (Delen et al. 2007; Dutta et al. 2007).

Dutta et al. (2007) states that RFID promises to improve the organisation's skill to strategically manage its daily operations, using real time data. However, once again, benefits do not derive exclusively from the technology, but also from economic and organisational factors.

According to Dutta et.al (2007) and Lee & Özer (2007) the benefits and value of RFID is associated with two major aspects:

- *Higher visibility*

  Since RFID may be used to track and identify both objects and people, and to process flow tracking, the entire supply chain is now visible to the eyes of the organisation (Dutta et al. 2007). Many industries report that this improved visibility is important, especially in inventory management (Dutta et al. 2007).

  RFID can be used to solve the problem of inventory uncertainty, by enabling a clear overview of inventory, both in terms of quality and location (Heese 2007; Lee & Özer 2007). This transparency helps to minimize inventory shrinkage (Dutta et al. 2007; Lee & Özer 2007) and promotes inventory level reduction (Lee & Özer 2007) .

  Shrinkage is often the result of both internal and external thefts, mistakes in the replenishment process, damages and fraud (Dutta et al. 2007; Lee & Özer 2007), leading to a negative gap between the actual and the recorded inventory (Lee & Özer 2007). RFID allows real-time inventory monitoring, reducing restocking mistakes and inventory stock outs (Dutta et al. 2007; Lee & Özer 2007). It also discourages thefts and frauds (Dutta et al. 2007; Lee & Özer 2007).

  Inventory reduction is also a positive consequence of real-time inventory management , since RFID implementation contributes to less dependency on inventory forecasting, and the associated consequences of forecast errors (Dutta et al. 2007; Lee & Özer 2007).

- *Cost savings*

  Several RFID tags can be read simultaneously without human intervention, resulting in labour cost savings (Dutta et al. 2007; Lee & Özer 2007). It also promotes fewer errors, especially, when counting inventory (Dutta et al. 2007).

2.3.3 Challenges to RFID adoption and implementation

In the last ten years, RFID technology has led to a lot of optimism (Wu et al. 2006). However, some challenges associated with this technology have arisen, acting as an obstacle to its adoption and implementation (Wu et al. 2006; Delen et al. 2007):

- *Technology challenges*

  When using a RFID system, a false negative, also called missing read, is a reality (Delen et al. 2007). In this situation, the reader fails to read the tags that are in its range (Delen et al. 2007). This can be due to several reasons, being the most common: a damaged tag (Delen et al. 2007), misorientation of interrogator antennas, and metals or liquids blocking or absorbing the reader signals (Wu et al. 2006; Delen et al. 2007).

  Multiple readings are also a problem associated with RFID technology, usually due to an improper layout of readers (Delen et al. 2007). It can also be considered as false positives, occurring when a tag is within the range of more than one reader, causing a doubled flow of information (Delen et al. 2007).

  Since several tags can be read simultaneously by just one reader (Delen et al. 2007; Dutta et al. 2007), the radio signals transmitted may interfere with each other, decreasing the chances of successful readings (Wu et al. 2006). Organisations should be aware of it, employing collision-resolution protocols to minimize the situation (Wu et al. 2006).

  The magnitude of data is also a challenge for the companies; since they need to guarantee the necessary hardware and software support to handle all the data collection, organisation, storage, maintenance and deployment (Delen et al. 2007).

- *Standard challenges*

  Lack of global RFID data and technology standards creates uncertainty for companies and organisations, slowing down RFID diffusion (Wu et al. 2006; Dutta et al. 2007). At the present, two identities, EPCGlobal and International Standards Organisation (ISO), are working to develop an international and global standard for RFID (Wu et al. 2006; Dutta et al. 2007). Developing international standards for this technology will ensure compatibility among tags and readers produced by different manufactures, reducing companies hesitation in adopting RFID and facilitating its acceptance and growth worldwide (Wu et al. 2006).

- *Patent challenges*

  Vendor's concerns regarding the payment of high royalties can pose a serious obstacle, slowing down RFID development (Wu et al. 2006).

- *Cost challenges*

  High manufacturing costs, especially those related to tags, is the major reason why RFID is not penetrating the market as fast as it would be expected, despite its wide applications and benefits (Bunduchi et al. 2011; Wu et al. 2006). Although tag costs are coming down (Dutta et al. 2007), companies still need to balance costs and future benefits, when deciding to adopt this technology or not (Heese 2007).

  Implementation of the infrastructure and customization costs associated to it are also relevant (Heese 2007; Wu et al. 2006). A RFID system generates a considerable amount of data, requiring a robust computing power to manage it and to guarantee optimal functioning of both tags and readers (Wu et al. 2006).

  Other authors, like Bunduchi et al. (2011), argue that other types of costs may be relevant, such as, initiation costs, capital costs, relational costs and ethical costs. Bunduchi et al. (2011) also state that these costs may vary and have different weights depending on the adoption stage of the organisation (early adopters vs. early majority).

- *ROI challenges*

  According to Wu et al. (2006), cost reduction and value creation are considered the two main benefits that influence both expected and actual returns. However, Return on investment (ROI) may be difficult to calculate due to limitations in the information available, regarding benefits of RFID adoption and implementation from pilot projects.

- *Bar code to RFID migration challenges*

  In the seventies bar codes became a very popular technology, being the principal form of auto identification in supply chain management (Delen et al. 2007). Although belonging to the same family, RFID and bar codes have significant differences; and the advantages of RFID over bar codes may strongly influence the transition between these two technologies (Delen et al. 2007).

RFID	BAR CODE
ADVANTAGES WHEN COMPARED TO BAR CODES	
▪ No line of sight requirements (Delen et al. 2007; Lee & Özer 2007; Dutta et al. 2007) ▪ More than one tag can be read simultaneously (Lee & Özer 2007; Delen et al. 2007) ▪ High durability – resistant to heat, dirt, solvents, and physical damages (Delen et al. 2007; Raviprakash et al. 2009) ▪ Individual power source (active tags) (Delen et al. 2007; Lee & Özer 2007) ▪ Ability to deliver, collect and store information (Delen et al. 2007) ▪ Possibility to write multiple times (Öztayşi et al. 2009; Delen et al. 2007) ▪ No need of human labour (Heese 2007; Lee & Özer 2007; Delen et al. 2007)	▪ Requires line of sight (Delen et al. 2007) ▪ One read at a time (Delen et al. 2007; Lee & Özer 2007) ▪ Low durability – easily damaged (Delen et al. 2007) ▪ No power source (Delen et al. 2007) ▪ Static label (Delen et al. 2007) ▪ Only one possibility to write (Delen et al. 2007) ▪ Need of human labour (Delen et al. 2007; Lee & Özer 2007)
DISADVANTAGES WHEN COMPARED TO BAR CODES	
▪ Expensive (more than bar codes) (Delen et al. 2007) ▪ Liquids and metals may cause reading problems (Delen et al. 2007; Wu et al. 2006)	▪ Cheap (when compared with RFID) (Delen et al. 2007) ▪ Optimal performance in liquids and metals (Delen et al. 2007)

TABLE 2 - RFID VS. BAR CODE.

Though RFID presents several advantages and benefits over bar codes, the strong implementation of the latter (Raviprakash et al. 2009; Wu et al. 2006) will cause a delay in the full replacement of bar codes by RFID technology, causing a coexistence of both systems for an indefinite period of time (Kumar et al. 2010; Wu et al. 2006).

- *Privacy and ethical challenges*

  Privacy challenges arise from improved tag capacity to store information and longer RFID reading ranges, being a major concern when using RFID for tracking people (Bunduchi et al. 2011). These issues can be broken down in concerns regarding tracking staff – the big brother effect – and concerns about information leakage, particularly in organisations that deal with sensitive private information, such as hospitals (Bunduchi et al. 2011).

  A wide range of solutions are being developed to respond to this worries, including disable tags (Bunduchi et al. 2011; Öztayşi et al. 2009), limit reading ranges and define access passwords (Bunduchi et al. 2011).

2.4 RFID IN HOSPITALS

Over the past years, healthcare has grown in complexity (Bates & Gawande 2003), and competition (Goldstein et al. 2002), putting hospitals under great pressure to reduce costs (Wicks et al. 2006; Li et al. 2002; Butler et al. 1996), while guaranteeing an exceptional quality service (Li et al. 2002; Butler et al. 1996). In this context, information and communication technology, especially RFID, is emerging as a tool to assist hospitals in meeting their current challenges and goals (Ting et al. 2009; Bunduchi et al. 2011).

Although the use of RFID in healthcare units is still in an early stage (Wu et al. 2006; Shang-Wei Wang et al. 2006), this industry is already considered the next big adopter of RFID technology (Shang-Wei Wang et al. 2006; Bunduchi et al. 2011). At present, many healthcare organisations and facilities are developing RFID systems and applying it to experimental projects to improve operational efficiency and gain competitive advantage (Bilge & Ozkarahan 2004 cited by Chao et al. 2007).

2.4.1 APPLICATIONS AND BENEFITS OF RFID IN THE HEALTHCARE INDUSTRY

RFID applications in healthcare have received a lot of attention in the past years because of its positive effects in several areas (van der Togt et al. 2008), from equipment management to staff and patients control (van der Togt et al. 2008; Wicks et al. 2006).

Najera et al. 2011, Bunduchi et al. 2011 and some other authors state that some of the major RFID applications in a hospital environment are:

- *Asset tracking*

  RFID tags can be placed in medical equipment tracking its movements and revealing its location (Najera et al. 2011; Kumar et al. 2010), which van be really valuable in a hospital, where critical assets are often shared, changing location indiscriminately and continuously (Lee et al. 2008).

  In this context, RFID is often used to locate high-value mobile equipment (Bunduchi et al. 2011), prevent the administration of counterfeit drugs (Chao et al. 2007; Raviprakash et al. 2009) and tracking blood products (Chao et al. 2007; Najera et al. 2011). The decreasing price of RFID tags is also permitting the incorporation of tags in a wider range of equipment, such as small surgical materials (Rogers et al. 2007).

  RFID for automated equipment tracking reduces time (Bunduchi et al. 2011; Lee et al. 2008; Oztekin et al. 2010) and costs associated with manual tracking (Bunduchi et al. 2011), allowing staff to focus on their daily activities and enabling a faster response to patient needs (Lee et al. 2008). Since objects are tracked, it also decreases the number of objects lost, consequently improving inventory management efficiency (Bunduchi et al. 2011; Kumar et al. 2010).

Given this, real-time tracking of medical equipment is an application that is expected to bring return (Najera et al. 2011), often assuming priority in the improvement of healthcare performance (Oztekin et al. 2010).

- *Medical equipment conditions monitoring and maintenance*

  RFID can be used to track and monitor medical equipment that requires regular maintenance (Lee et al. 2008; Bunduchi et al. 2011). This technology enables hospitals to monitor humidity and temperature, and to continuously check the condition of the equipment, without having to resort to human labour (Bunduchi et al. 2011).

  This assumes a particular importance in this industry, in which maintenance regimes are narrow and tight, in order to promote and guarantee patients' security (Bunduchi et al. 2011).

- *Patient identification and tracking*

  With RFID-wrist bands, hospitals can locate patients in real-time (Kumar et al. 2010; Shang-Wei Wang et al. 2006) allowing the monitoring of risk patients, such as dementia and trauma patients (Bunduchi et al. 2011). RFID allows to monitor patient workflow (Bunduchi et al. 2011), and to immediately identify patients accessing unauthorized areas in the hospital (Wicks et al. 2006; Crooker et al. 2009). It also enables reduction of identification errors, ensuring patients are at the right location receiving adequate treatment, and so reducing medical errors (Kumar et al. 2010; Raviprakash et al. 2009; Najera et al. 2011).

- *Staff identification and tracking*

  RFID technology can be used to track medical staff in a hospital (Shang-Wei Wang et al. 2006; Kumar et al. 2010; Carr et al. 2010). It can be used to monitor staff access to important data, such as data contained in electronic medical records (Chao et al. 2007), and to indicate when employees are entering restricted areas (Wicks et al. 2006). RFID system can be applied to in-depth analysis of staff workload, enabling improvement of personnel allocation (Najera et al. 2011).

- *Workflow and resource management*

  RFID systems are applied in both resource and workflow management applications (Bunduchi et al. 2011; Kohn and Henderson 2004 cited by Chao et al. 2007). It can optimise the use of resources, namely rooms and equipment (Bunduchi et al. 2011; Kohn and Henderson 2004 cited by Chao et al. 2007), while speeding up waiting lines and patients' care processes (Bunduchi et al. 2011; Kumar et al. 2010). Cost reduction (Bunduchi et al. 2011; Kohn and

Henderson 2004 cited by Chao et al. 2007), and improved quality of care (Kohn and Henderson 2004 cited by Chao et al. 2004) are also desired outcomes when applying RFID to these areas. Additionally, data gathered through RFID technology can also be used to identify and overcome inefficiencies of the current processes (Kumar et al. 2010).

To sum up, all these usages of RFID lead to countless benefits, such as:

- *Cost reduction* (Ting et al. 2009; Kumar et al. 2010)*;*
- *Lower levels of inventory* (Bunduchi et al. 2011)*;*
- *Reduced inventory costs* (Bunduchi et al. 2011)*;*
- *Compliance with regulatory requirements* (Bunduchi et al. 2011)*;*
- *Increased patient safety* (Bunduchi et al. 2011; Wicks et al. 2006; Najera et al. 2011)*;*
- *Improved patient satisfaction* (Kumar et al. 2010)*;*
- *Optimization of workflow* (Bunduchi et al. 2011; Kumar et al. 2010)*;*
- *Increased efficiency* (Bunduchi et al. 2011; Kumar et al. 2010)*;*
- *Improved quality of medical processes* (Ting et al. 2009; Kumar et al. 2010).

2.4.2 Challenges to RFID implementation in the healthcare sector

Some healthcare providers still feel hesitant to adopt RFID technology (Carr et al. 2010), due to considerations and concerns related to RFID implementation (Crooker et al. 2009; Carr et al. 2010).

Like any other organisation, these concerns include, long payback periods (Carr et al. 2010; Raviprakash et al. 2009), lack of standardization and technical issues (Carr et al. 2010).

Additionally, there are three other major concerns when implementing RFID systems in healthcare facilities, especially hospitals:

- *Patient and staff privacy*

  Tracking patients resorting to the use of RFID may pose some privacy concerns (Bunduchi et al. 2011; Carr et al. 2010; Crooker et al. 2009). Those concerns are primarily focused on potential risk to data security (Bunduchi et al. 2011), invasion of privacy (Bunduchi et al. 2011; Carr et al. 2010; Kumar et al. 2010) and inappropriate use of personal information (Crooker et al. 2009).

  Medical staff may also feel that the RFID system is invading their daily work routines, experiencing a sense of control and surveillance, misinterpreting the purpose of RFID usage (Bunduchi et al. 2011).

- *Electromagnetic interference*

  Some electronic equipment, including RFID, may interfere with medical devices (van der Togt et al. 2008; Santucci et al. 1998; van Lieshout et al. 2007). This electromagnetic interferences affect different devices, such as pacemakers and defibrillators (Santucci et al. 1998; van der Togt et al. 2008); and different types of interferences lead to different levels of damage and consequences (van der Togt et al. 2008; Santucci et al. 1998).

  Electromagnetic interference may also be experienced when using mobile phones (van der Togt et al. 2008; van Lieshout et al. 2007), being recently shown that even second and third generation mobile phones are capable of inducing significant interference (van Lieshout et al. 2007). However, median distance for RFID incidents may be more critical and severe when compared with short distance mobile phones interferences (van der Togt et al. 2008).

- *Cultural barriers*

  Many physicians and other medical staff usually feel reluctant to adopt new technologies into their daily medical routine and practice (Bates & Gawande 2003; Shang-Wei Wang et al. 2006), due to discomfort with computers and/or some concerns about relying on it to make medical and clinical decisions (Bates & Gawande 2003).

  Kumar et al. (2010) argue that medical staff and nurses need to be included in the discussions regarding initiatives that change the existing processes and workflow, including the adoption of RFID technology. Considering their participation and inputs is fundamental to avoid strong negative reactions to new decisions and practices.

Therefore, the adoption of RFID by healthcare facilities and units is dependent on the organisations' ability to overcome implementation barriers and inhibitions (Carr et al. 2010).

IN RESUME, for a company to keep competitive in a fast changing market, increasing both in competition and economic complexity, it may need to make some changes regarding internal processes. In this context, BPR and BPM emerge as powerful tools, allowing companies to increase both processes efficiency and efficacy. Often, BPR and BPM projects are strongly dependent on IT systems, being technology considered an important enabler of business process improvement activities.

One example of a technology that is increasing in popularity in business processes improvement is RFID. Companies are applying it to several areas, from inventory management to people and objects tracking, always keeping in mind an increased and sustainable competitive advantage.

Healthcare, especially hospitals, is considered the next big boom for RFID implementation. This technology seems promising with a wide range of applications, including optimization of workflow processes, and is expected to be a significant source of profits.

ON THE NEXT CHAPTER, the private healthcare group Espírito Santo Saúde and Hospital Beatriz Ângelo, the target of this reengineering project are presented.

3. COMPANY PRESENTATION

This chapter provides an overview of Espírito Santo Saúde Group and Hospital Beatriz Ângelo.

In the first section, the strategy, vision, mission and values that guide Espírito Santo Saúde intervention are presented. Also some numbers related to earnings and profits are considered.

The second section focuses on some global characteristics and numbers regarding Hospital Beatriz Ângelo, the medical facility targeted by the reengineering process under study in this dissertation.

All the information presented below, is available at Espírito Santo Saúde and Hospital Beatriz Ângelo websites, with a few mentioned exceptions.

3.1 ESPIRITO SANTO SAUDE

Espírito Santo Saúde SGPS, SA (ESS), was born on July 6, 2000. It is responsible for the definition and implementation of Espírito Santo Group's development strategy in two areas – healthcare services and senior residential.

STRATEGIC ORIENTATIONS

- Development of an integrated network of healthcare units, including hospitals, clinics and residential hospitals;
- Development of senior residential, providing services fully oriented to this age group;
- Establishment of partnerships with the public sector according to the Public-Private Partnership (PPP) program.

VISION

"Ser um operador de referência na prestação de cuidados de saúde, pela prática de uma medicina de excelência e inovação."

ESS vision is to be a reference in the healthcare sector, offering both excellence and innovation in medical care services.

Its commitment is clear, total and absolute: to guarantee the best diagnosis and medical treatment that talent, innovation and dedication can provide.

To achieve this vision, ESS provides a global offer of medical services responding to people's needs across their life cycle.

MISSION

"Diagnosticar e tratar de forma rápida e eficaz, no respeito absoluto pela individualidade do doente, e construir uma organização capaz de atrair, desenvolver e reter pessoas excepcionais."

ESS mission is to provide fast and effective diagnosis and treatment, always respecting the patient's individuality and integrity, and build up an organisation capable of attracting, develop and retain the best people.

To accomplish its mission, ESS is committed to:

- *Excellence*
  - Interests of the patients come first;
  - High ethical standards;
  - Focus on empathy with patients and families;
  - Long term relationships with clients, based on efficiency, integrity and confidencet.
- *Innovation*
  - Provide the best possible healthcare services;
  - Investment in the latest technologies.
- *Talent*
  - Work with the best professionals, promoting their continuous development through an internal culture based on high standards;
  - Manage an efficient healthcare facility, formed by a dynamic and competitive team, fully committed to the organisation.

VALUES

ESS stands on eight fundamental values that establish the pillars of its organisational culture:

- *Focus on results*
  - ESS is determined to achieve ambitious results, fulfilling its mission statement.

- *Intellectual rigor* — ESS assumes a critical and rational position regarding every issue and decision, always searching for the best idea and solution.
- *Continuous learning* — Learning with experience to improve future performance.
- *Personal responsibility* — ESS employees are committed to the organisation's goal and co-responsible for achieving the best possible results.
- *Respect and humility* — Respect others' opinions, ideas and contributions. ESS assumes its limitations, valuing different perspectives.
- *Positive attitude* — Ambitious in its goals, always open to new ideas and proud of the results achieved.
- *Integrity* — Honesty and loyalty in every task and action, having in mind the needs and expectations of both shareholders and clients.
- *Team spirit* — ESS believes that team effort is the best path to achieve results and enhance the impact of ESS actions on the community.

Since the year 2000, ESS opened a wide network of heath care facilities, including hospitals, clinics and senior housing, owning 18 different units:

HEALTHCARE FACILITIES

- Clipóvoa – Hospital Privado
- Clipóvoa – Clínica de Cerveira
- Clipóvoa – Clínica de Amarante
- Clipóvoa – Clínica do Porto
- Hospital da Arrábida
- Cliria – Hospital Privado
- Cliria – Centro Médico de Águeda
- Cliria – Clínica de Oiã
- Hospital do Mar
- Hospital da Luz
- Hospital da Luz – Centro Clínico da Amadora
- Irio – Instituto de Radioterapia
- Clínica Parque dos Poetas
- Hospital de Santiago
- Hospital da Misericórdia de Évora

SENIOR RESIDENTIAL

- Casas da Cidade – Residências Senior
- Clube de Repouso Casa dos Leões

PUBLIC-PRIVATE PARTNERSHIPS

- Hospital Beatriz Ângelo

TABLE 3 – ESS HEALTHCARE FACILITIES.

Annually, ESS carries out more than 1 million appointments, 35 thousand surgeries and births, and near half a million exams, which is translated into more than 1 million clients.

According to Relatório Annual & Contas Consolidadas Espírito Santo Saúde Group S.A. (2009), ESS financial performance is increasing and getting stronger every year, achieving an operational result of 215,7 million euros in 2009 (17,5% more than in 2008). In this previous year, 2011, this private healthcare group reported a 5 million profit (Económico 2012).

3.2 HOSPITAL BEATRIZ ANGELO

Integrated in the *Serviço Nacional de Saúde* (Nacional Healthcare System), the Hospital Beatriz Ângelo (Hba) opened its doors on 19th January 2012.

This hospital constitutes a reference in the Lisboa and Vale do Tejo region. It is a completely new facility, built to address the needs of 278 thousand people distributed through four different municipalities (Loures, Mafra, Odivelas and Sobral de Monte Agraço).

Hba is a public hospital belonging to the Public-Private Partnerships Program (PPP). Its project was developed by a private consortium – Consis Loures – led by ESS Group. This consortium also involved Mota-Engil, Opway, Banco Espírito Santo and Dalkia.

ESS Group is the major shareholder of Sociedade Gestora do Hospital de Loures S.A. The Hba clinical management was assigned to ESS for 450 million euros, over a period of 10 years.

Hba facilities include:

- 424 beds;
- 44 rooms for medical appointments;
- 8 surgery rooms;
- 5 birth rooms;
- 3 caesarean rooms;
- Day hospital;
- General, paediatrics and genecology-obstetrics emergency.

Hba is expected to have an annual activity of:

- 24.000 hospitalizations;
- 245.000 appointments;
- 11.400 surgeries, half of them in ambulatory care system;
- 2.200 births;
- 24.000 day hospital sessions;
- 126.000 emergencies.

IN RESUME, ESS group is growing and setting the pace for the national healthcare industry. Its commitment to quality and innovation is clear; and so is its goal of pursuing a service characterized by excellence and accuracy.

Hba, the most recent acquisition of ESS, is a real challenge to the group. This new public-private partnership, serving around 278 thousand people, is expected to be a role model for public healthcare facilities, requiring a demanding and effective management approach.

ON THE NEXT CHAPTER, the methodology used to answer to the research question is presented and the associated steps are explained and explored.

4. METHODOLOGY

In this fourth chapter, the methodology applied to answer the research question is presented, schematized and explored.

The first section justifies the choice of the methodology and the framework applied.

The second and last section of this chapter provides a diagram of the suggested framework for process reengineering. Also, a brief description of each step of the framework is presented, while other aspects, main questions and key activities are summarized in table 8 (Appendix II).

4.1 CHOOSING THE METHODOLOGY

As it was referred in the chapter 2, section 2.2.2, there is no single technique, methodology or framework that can be defined as the one and only approach when developing a BPR intervention (Carr & Johansson 1995 cited by O'Neill P. & Sohal A.S. 1999).

As a result, the BPR literature proposes a large number of methodologies that, although different, share at least one element, the notion that reengineering projects are divided into several sequential and discrete phases/steps (Carr & Johansson 1995 cited by O'Neill P. & Sohal A.S. 1999).

Most of these BPR methodologies incorporate a mixture of tools, being this mixture dependent on and adapted to the process under study (O'Neill P. & Sohal A.S. 1999).

Therefore, the methodology, and more specifically, the framework and tools chosen in this dissertation arise as a combination of two different frameworks available in BPR literature, Grover and Malhotra (1997) and Rohleder and Silver (1997).

The frameworks and activities are combined, shaped and adapted to the dissertation goal, available resources and available period of time.

4.2 PROCESS REDESIGN FRAMEWORK

The framework is divided into 8 different steps. As it is explained above, the this framework is adapted from two other frameworks presented on the literature, being steps 1, 3 and 4 based on Rohleder and Silver (1997); steps 6 and 7 are based on Grover and Malhotra (1997). Steps 2, 5 and 8 are approached in both the articles mentioned.

All steps are sequential, meaning that no step can be put in practice until the previous one is fully complete.

The framework sequence is illustrated hereby and the steps are briefly described. Key questions and activities for each step are mentioned in detail in appendix II.

FIGURE 2 – BPR FRAMEWORK.

ESTABLISHING APPROPRIATE ORGANISATIONAL SUPPORT (STEP 1)

The main goal of this first step is to get the consensus and support of the top management team, namely the ESS Logistics Director.

The Director of Logistics is interviewed in order to understand what ESS vision regarding the RFID role in healthcare industry is, and how RFID can specifically address ESS business goals. Additionally, present and future RFID projects at ESS facilities are also covered in this interview.

PROCESS THINK – SELECTING THE PROCESS (STEP 2)

During the interview, the process to reengineer is selected by the Logistics Director, according to ESS goals and needs.

To guarantee that the reengineered project is aligned with ESS expectations, some considerations have to be made in this selection, namely, the ESS motivations and objectives when reengineering this specific process.

Defining and understanding the process (step 3)

This step is focused on monitoring. Proper monitoring requires collecting appropriate data and measurements at key points of the process.

The primary focus is to identify current process flow and elements, to create a "vision" of what the process is.

The entire process is described and documented. For each step, the following elements must be identified: type of activity, activity description, time, human resources, and other relevant dimensions. A flow diagram representing of the process floe is also generated in this step.

Streamlining – Removal of obvious waste and problems identification (step 4)

This step aims to identify activities that substantially contribute to the total cost incurred or to the total cycle time, especially if they correspond to non-value-adding activities. It is also important to identify problems that may lead to outcomes that do not correspond to the final customer's (internal or external) wishes and expectations.

The Logistics Director is questioned about the main problems already identified and associated to the process under study.

Other people involved in the process under study may also be interviewed. These extra interviews, plus a proper monitoring and detailed documentation of the process in step 3 - Defining and understanding the process – may prove to be fundamental to identify other problems that top management team may not be aware of.

For each problem, a cause-and-effect analysis should be performed, allowing the identification of its main cause(s).

Creation - Process innovation (step 5)

The aim of this step is to set alternatives and to eliminate and/or improve the problems and wasteful activities (non-value-adding activities) identified in step 4.

Another goal of this process is to define additional changes that although not identified in the previous step, are helpful to improve the process performance, reduce the time cycle or reduce costs.

The purpose is to create the "ideal" process, without the traps and biases related to the way through which the current process operates. In this step, creative thinking is fundamental. So is creative examination of the customer's future needs, to avoid eliminating activities that will be further needed.

Therefore, for all the activities and problems identified a solution/alternative must be set.

RFID applications in the reengineered process are also pointed in this step.

Technical design (step 6)

This step refers to documentation of technical design.

It includes a technical description of hardware, software, procedures, systems, and controls employed in the redesigned process, carried out in the previous step. Materials and implementation costs are also analysed and presented.

Social design (step 7)

The technical design cannot be accomplished without considering social dimensions of the reengineered project.

In this last step, process change is analysed from the staff's perspective. Which human resources are needed to guarantee the functioning of the redesigned process, and how social elements will affect technical elements is considered. Also, staff that may be resistant to change, and the reasons behind that resistance are analysed.

Finally, incentives and change management techniques are also considered and defined.

Gains evaluation and Action plan (step 8)

The final proposal illustrating reengineered process, including both material and human resources, is presented. The reengineered workflow diagram is set side by side with the initial process, to clarify and enhance the modifications.

Qualitative and quantitative gains derived from suggested changes, both for Hba and Itau, are considered.

The action plan identifies the actions required and who is responsible for them. It also lists possible barriers to the implementation of the reengineered process, setting the preventing steps to remove/ neutralize them.

Since the introduction of changes may lead to unexpected problems, a control system to monitor the transition period is defined.

Finally, some permanent control and performance evaluation activities are set, in order to continuously monitor the performance and the effectiveness of the reengineered process.

IN SUMMARY, the methodology and framework applied are adapted and tailored both to the process under study and the resources available.

The methodology is divided into 8 sequential steps that, together, contribute to reengineer the process by applying RFID technology, improving it in a way that best fits the company's goals and motivations.

ON THE NEXT CHAPTER, the methodology and framework here described are applied to the process under study.

5. Patients Food Chain Redesign

In this chapter, the process to be reengineered is outlined and explained in detail, and also are the modifications to apply in the redesign context.

The analysis provided below is based on the framework discussed on the fourth chapter (Methodology), following all the sequential steps described on it.

5.1 Establishing appropriate organisational support (step 1)

Both Dr. Pedro Lima (ESS Logistics Director) and Eng. Carlos Alfaiate (Datelka[1] Administrator) are present at this first meeting.

Dr. Pedro Lima talks about how ESS sees the implementation of RFID in its facilities and which ESS needs RFID is expected to satisfy (appendix III).

Eng. Carlos Alfaiate explains how RFID can be used at a medical facility, providing examples of previous tests realized by Datelka. Eng. Carlos Alfaiate also helps Dr. Pedro Lima to define an objective and feasible plan for RFID implementation at Hba facilities.

At this meeting, is defined that both Hba staff, mainly Logistics Director, Hospitality Director (Dra. Marisa Raposo) and Datelka, will be involved in this process redesign, providing all the support needed, such as guidance during process observations, RFID testing and budgeting.

5.2 Process think — Selecting the process (step 2)

By matching Hba needs with the information provided by Eng. Carlos Alfaiate regarding RFID possible applications and current limitations, some processes in which this technology would be useful are considered.

Dr. Pedro Lima selects the process to be reengineered, the patient's food chain. The Logistics Director listed the complexity of the chain, and the need for internal auditing as the major reasons behind this choice. Also, the fact that this is a primary process, fundamental to guarantee patient's welfare and good recovery pose a significant weigh in this choice. Other aspects are considered in this selection, namely the possibility to quickly test and implement the RFID solution, and short-term cost savings that may arise when applying this technology to this specific process (appendix III).

[1] Datelka provides Engineer and Systems solutions. It is the official RFID supplier for Hba.

5.3 DEFINING AND UNDERSTANDING THE PROCESS (STEP 3)

This process goal is to provide to Hba patients all the meals they need, during their hospitalization period. It is a primary and value adding process at Hba facilities and its correct functioning, both in terms of output quality and delivery time, is fundamental to guarantee patient's safety and satisfaction. Gaps in this primary process may negatively affect the hospitalized patients, leading to longer and harder recovery periods, which is ultimately translated into higher costs for this medical facility.

Through this process, Hba is expecting to serve around 525 thousand meals per year, 1970 per day, corresponding to an annual investment of 1 million euros.

The patient's food chain is a process that lasts approximately from 6:30 am to 1:15 am, seven days a week. This process involves workers both from Hba, called *Auxiliares de Dietética e Nutrição*, and from Itau. The latter is the outsourced company responsible for preparing and supplying the meals. Itau has 30 workers allocated to this process, and Hba has 10. In both cases, workers are organised by shifts.

The meals provided by Itau are classified as breakfast, lunch, afternoon snack, dinner and supper. The preparation of these meals can be divided into a sequential number of steps and activities, each one employing specific material and human resources.

Although these meals are sequential in time, starting at breakfast and finishing with supper, its preparation process is not tight. At any time, during the day, is common to find both Itau and Hba workers engaged in several tasks and activities assigned to different meals.

The preparation of patients' mealtimes follows a very demanding schedule; any delay in just one activity will affect the entire process. This process has also to obey to strict dietetic orientations, provided by Hba dieticians. The goal of this is to guarantee that meals served are adequate to patient's dietetic needs and restrictions.

To simplify the understanding of the process, the same is presented divided into 6 different circuits. Each circuit represents a meal, and is identified using a single and unique colour. The sequence and colour of each process is presented below:

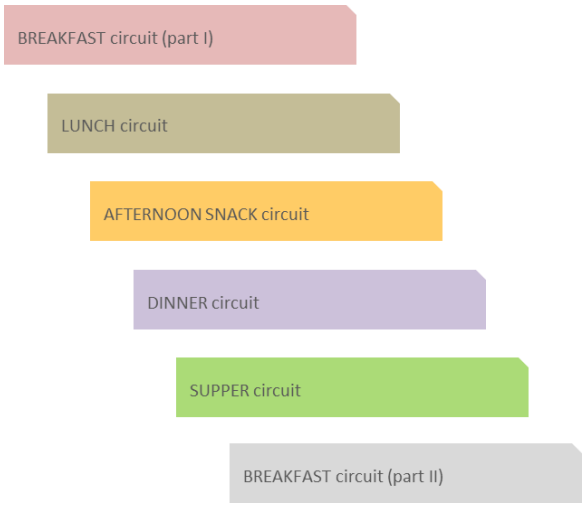

FIGURE 3 - CIRCUITS WORKFLOW AND IDENTIFICATION COLOURS.

For each circuit, the steps are presented in a sequential approach, always providing information regarding "Step name", "Type of activities", "Start", "End", "Duration", "Number of workers" and "Local". Also, a brief description of the associated activities is performed (appendix IV).

The process, as a whole, involves 37 different steps, distributed along 18 hours and 45 minutes. The cumulative time of all activities corresponds to 62 hours. It is important to notice that this is not a stable process, meaning that every day is unique and, although the activities and steps to perform are repeated at a daily basis, its starting, ending time and duration may vary depending on several aspects. The process flow diagram, including all the tasks from the different circuits can be found in appendix V.

The main activities performed in intermediary meals (breakfast, afternoon snack, supper) and main meals (lunch, dinner) are similar, both in sequence, resources and time. The tables below summarize the main steps that occur in each circuit, providing information about activities and room (detailed information, appendixes IV and V).

STEP	GENERAL DESCRIPTION
CHECKING AND PRINTING	ACTIVITY: Itau workers check all the diet lists to see if there is any alteration and print the diet labels, to place on the trays. These lists and diet labels contain information such as, bed number, patient's name, type of diet to serve and some additional observations regarding food allergies, intolerances, etc. These lists and labels are fundamental, since they guide the meals preparation step. ROOM: *Escritório*
MEALS PREPARATION	ACTIVITY: Itau and Hba workers put the diet labels and food on the trays. Then trays are distributed by the 13 available distribution cars. ROOM: *Confecção de dietas*

Checking	ACTIVITY: Itau or Hba workers compare the new diet list, released in the meanwhile, with the one used as a guide to prepare the intermediary meals. If some mismatch is observed, diet labels and the food already placed on the tray are corrected. ROOM: *Confecção de dietas*
meals distribution	ACTIVITY: As soon as distribution cars are ready, Hba *Auxiliares de Dietética e Nutrição* start distributing them through the different hospitalization areas. At the arrival to the C*opa,* the employee writes the arrival time on the control sheet and another *Auxiliar* from the hospital, signs it. This activity works as a control point, to guarantee that *Auxiliares de Dietética e Nutrição* are complying with the delivery schedules. ROOM: From *Confecção de dietas* to *Copas*
Cleaning	ACTIVITY: The room is cleaned and prepared to receive the activities assigned for the next meal. This step is performed by Itau workers. ROOM: *Confecção de dietas*
Cars picking	ACTIVITY: Distribution cars are brought downstairs by Hba *Auxiliares de Dietética e Nutrição* ROOM: From *Copas* to *Lavagem de carros*
Cleaning	ACTIVITY: Workers from Itau clean and wash all the crockery, trays and distribution cars. Washing up trays and crockery is divided into 3 sequential tasks: Pre-wash (40-45ºC); Wash (55-60ºC) and Drying (80-85ºC). Cars are also cleaned up, using a wet fabric. ROOM: *Lavagem de carros* and *Lavagem de loiça*

Table 4 – Summary of main steps and activities performed at intermediary meals.

STEP	GENERAL DESCRIPTION
Cooking	ACTIVITY: One worker, from Itau, cooks all the food needed for lunch and dinner. ROOM: *Cozinha*
Dessert preparation	ACTIVITY: Itau workers prepare desserts and fruit to be served at lunch and dinner. ROOM: *Pastelaria*
Dessert plating	ACTIVITY: Itau workers put desserts and fruit into appropriate crockery. ROOM: *Confecção de dietas*
Checking and printing	ACTIVITY: Itau workers check all the diet lists to see if there is any alteration and print the diet labels, to place on the trays. These lists and diet labels contain information such as, bed number, patient's name, type of diet to serve and some additional observations regarding food allergies, intolerances, etc. These lists and labels are fundamental, since they guide the plating step. ROOM: *Escritório*

Plating preparation	ACTIVITY: All the crockery, trays and distribution cars needed for the next step are placed at *Empratamento* room. Hba *Auxiliares de Dietética e Nutrição* are responsible for this activity. ROOM: *Empratamento*
Plating	ACTIVITY: Lunch and dinner are served and placed into meals trays. Those trays are organized and dispersed by the 13 available distribution cars. Workers both from Itau and Hba are involved at Plating step. ROOM: *Empratamento*
Meals distribution	ACTIVITY: As soon as distribution cars are ready, Hba *Auxiliares de Dietética e Nutrição* start distributing them through the different hospitalization areas. At the arrival to the C*opa,* the employee writes the arrival time on the control sheet and another *Auxiliar* from the hospital, signs it. This activity works as a control point, to guarantee that *Auxiliares de Dietética e Nutrição* are complying with the delivery schedules. Then meals are reheated, at 130ºC during 10 minutes. ROOM: From *Empratamento* to *Copas*
Cleaning	ACTIVITY: The *Empratamento* room is cleaned and get ready to receive the activities assigned for the next meal. This step is performed by Itau workers. ROOM: *Empratamento*
Cars picking	ACTIVITY: Distribution cars are brought downstairs by Hba *Auxiliares de Dietética e Nutrição*. ROOM: From *Copas* to *Lavagem de carros*
Cleaning	ACTIVITY: Workers from Itau clean and wash all the crockery, trays and distribution cars. Washing up trays and crockery is divided into 3 sequential tasks: Pre-wash (40-45ºC); Wash (55-60ºC) and Drying (80-85ºC). Cars are also cleaned up, using a wet fabric. ROOM: *Lavagem de carros* and *Lavagem de loiça*

Table 5 - Summary of main steps and activities performed at main meals.

5.4 Streamlining — Removal of obvious waste and problems identification (step 4)

The wasteful activities and problems described below are a result of the analysis performed based on process monitoring and documentation (appendixes IV and V), Dr. Pedro Lima interview (appendix III) and also Hba Dieticians and Itau Engineer interviews (appendixes VI and VII).

PROBLEM #1 – Lack of internal auditing of number of meals served

This is a serious problem, since Hba is relying almost 100% in its meals supplier, when it comes to billing. Without internal auditing to the number of meals served to inpatients, Hba has no way to confirm that the number of meals being paid corresponds to those being effectively served. If we consider that Hba is expecting to serve around 525 thousand meals per year, corresponding to approximately 1 million euros, even a slight deviation may cost a lot of money to this medical facility.

The Hospitality Department is already trying to solve this situation by asking its dieticians to, twice a week, compare the number of meals Itau says to distribute, with the diet lists elaborated that same day. Although better that the total absent of internal control, this system do not cover all the meals served during the weak, and also, is based on estimates that may not reflect reality. Additionally, is very time consuming, about 3 hours a week; dieticians could use this time to employ their talent into other activities directly related with their field of action.

CAUSE(S): Absence of a tool for internal auditing, this way requiring dieticians to dedicate to a non-accurate and time consuming task.

PROBLEM #2 – Not filling the control sheet at arrival to Copas

When *Auxiliaries de Alimentação* arrive to *Copas* with distribution cars, they have to register the arrival time, sign the attendance sheet, and then ask another Hba employee to confirm the cars arrival time to hospitalization units, signing this very same sheet (steps 1c, 2g, 3d, 4g). This activity is fundamental to internal control, being the attendance sheet the only tool applied by Hba to monitor possible late deliveries.

However, after checking these attendance sheets, is easy to verify that the majority is not properly filled, usually missing the signature of the second Hba employee involved in this control. Some of these sheets have less than 50% of the delivery controls signed by the two workers.

CAUSE(S): Meals distribution is a key activity in this process; if Itau workers do not follow the distribution schedule, patients will not receive their meals at the defined time. This situation may lead to patients' dissatisfaction, and negative dietetic implications, especially for patients with very demanding diet plans. Aware of this situation, *Auxiliares de Dietética e Nutrição*, often do not spend enough time trying to find an Hba collaborator available to sign the attendance sheet, restricting the control sheets to their signature, and so, not validating the arrival time to *Copas.*

PROBLEM #3 – Errors during meals preparation and plating

Diet labels placed on food trays have information regarding the type of diet that should be sent to each patient. The type of diets served to patients, and its characteristics are defined in a document, *Caderno de Encargos*, and should be strictly followed by workers during intermediary meals preparation (steps 1b, 3b, 5a) and plating (steps 2f, 4f). Otherwise, it may negatively affect patients' health and recovery. However, during meals preparation and plating some errors may occur, due to difficulties reading the labels.

CAUSE(S): Diet labels are small and contain a lot of information, written in a small sized letter, so it is easy to make mistakes, especially because these activities involve several people working in small spaces and under time pressure to accomplish time targets.

WASTFUL ACTIVITY #1 – Manual billing

Besides being a wasteful activity, this manual billing is also a clear duplication of effort.

Every week, Itau's Engineer has to check the diet lists used as a guide to prepare and plate every meal, from breakfast to supper, and calculate the number of meals served per day. This process takes her about 3 to 4 hours, and it is done at home in order to save some time at work. Alongside, as it is explained in problem #1 and appendix VI, Hba dieticians are also performing this counting, consuming a similar amount of time. This duplication of effort has costs for both companies, since the employees involved in this activity could be using their time and talent in other activities that themselves recognize to be more aligned with their obligations.

CAUSE(S): Lack of automatic billing system.

WASTFUL ACTIVITY #2 – Preparing and checking diet lists

Every day, using Sorion software, 3 diet lists (6:30 am, 2:30 pm and 6:30 pm) are elaborated by Hba dieticians and sent, in a PDF format, to Itau. The data contained in these lists is transferred by Itau engineer to an excel sheet, and is re-checked before the beginning of the preparation of each meal (steps 1a, 2d, 3a, 3c, 4d, 6a) This activity is time consuming, since the information has to be inserted patient by patient. The cumulative time of these activities corresponds to almost 6 hours. This activity consumes both time and human resources that may be valuable to perform other activities.

CAUSE(S): Itau workers do not have access to Sorion, receiving diet lists in a PDF format. Since diet labels used to guide both intermediary and main meals preparation and plating cannot be printed directly from this PDF file, it is fundamental to transfer all the information received in a PDF format to an excel file.

WASTFUL ACTIVITY #3 – Adding extra information to diet labels

After printing and checking the diet lists, Itau workers need to print the diet labels and add, by hand, all the extra comments and observations mentioned in the diet lists. This activity has to be performed 7 times a day (steps 1a, 2d, 3a, 3c, 4d, 6a) , which corresponds to a cumulative time of almost 6 hours. This activity consumes both time and human resources that may be valuable to perform other activities.

CAUSE(S): Diet labels are printed from an excel sheet elaborated by Itau, according to the diet lists sent by Hba dieticians. Itau workers need to add information to the labels by hand, namely extra comments and observations, because the current system does not allow printing this type of information directly on the label.

5.5 CREATION — PROCESS INNOVATION (STEP 5)

The solutions provided below are meant to neutralize, eliminate and/or transform the problems and wasteful activities mentioned on the previous step.

SOLUTION #1

RFID system can be used to solve problems #1, #2 and wasteful activity #1. By implementing a RFID control network at *Empratamento:*

1. Hba can automatically control the number of meals served daily, and so, perform automatic billing. In a fast and accurate way, this technology eliminates the Hba dependency on Itau when it comes to patients' food billing, also avoiding over-billing;
2. Hba dieticians are free to use their time to perform activities and tasks more related to their field of action, saving them, about 3 hours a week;
3. Itau Engineer is free to use her leisure time, saving her about 3 hours a week;
4. Hba is able to automatically control if distribution cars are leaving the kitchen according to pre-defined scheduling, and so identifying potential late meals deliveries;
5. Hba is able to identify both the distribution car and the employee carrying meals that are target of complaints by the patients (ex: late meals, cold meals, meals presenting quality problems, etc), being useful, for example, to detect distribution cars with technical problems.

SOLUTION #2

Reading mistakes and associated consequences explained at problem #3, can be prevented/reduced by using a simple colour scheme. For every type of diet, or at least, for the

ones that constitute the majority of the diets served to patients, a colour is attributed (appendix VIII). This pre-defined colour scheme will help employees to identify the type of diet to serve to each patient, in a faster and more precise way.

SOLUTION #3

Wasteful activities #2 and #3 can be easily solved by printing both diet lists and diet labels directly from Sorion software. This small change is going to simplify and improve the food chain by:

1. Eliminating the need for preparing and checking the diet lists (steps 1a, 2d, 3a, 3c, 4d, 6a). If diet lists are printed directly from its source, Sorion, the need to transfer information from the PDF file to the excel sheet no longer exists. Besides, lists can be printed immediately before the beginning of intermediary and main meals preparation and plating, which means that Itau workers, when starting to perform this task will have the latest list, always actualized. This solution will save around 6 hours to the food chain;
2. Eliminating the need to add extra comments to diet labels, by hand. Diet labels are printed directly from Sorion software, with all information including extra comments on it (appendix VIII). This way, steps 1a, 2d, 3a, 3c, 4d, 6a are removed saving 6 hours to the reengineered process.

5.6 TECHNICAL DESIGN (STEP 6)

SOLUTION #1

As it is explained in the previous step, the implementation of a RFID system allows automatic and real-time auditing and billing regarding the number of meals served to hospitalized patients. Also, this technology enables to match meals to the car and Hba worker distributing them, storing the time that meals leave the kitchen to be distributed to patients.

The RFID system to be installed is composed by two main elements, tags and readers, being the communication between these elements supported by the existent Hba wireless system.

TAGS

RFID tags are placed on three different types of resources, according to specific needs and goals:

RESOURCE	TAG/READER LOCATION	OBJECTIVE
Tray	Left border of the tray (to enhance tag-reader communication) (appendix IX)	Automatic internal auditing and billing
Distribution car	Under the car (to avoid metal doors) (appendix IX)	Identify the car and match it with the trays and meals transported Register the distribution hour
HBA *Auxiliar de Dietética e Nutrição*	Identification card (ID)	Identify the worker transporting the car and meals

TABLE 6 – TAGS LOCATION AND ITS OBJECTIVES.

Both for distribution cars and ID cards, any regular RFID tag can be used. However, tags to be placed on trays need to be liquid and dust tight, supporting temperatures around 100 degrees. Datelka recommends any RFID EPC Class1 Gen2 (ISO/EIC 18000-6) resistant to high temperatures and possessing a 67 protection level (PL67). Each tag is expected to cost about 1 euro, plus taxes.

Theoretically, these RFID tags can work for decades. However, physically they should not be able to resist more than 3 years, due to the harsh conditions they are subject to in this food chain, mainly during daily washes.

Before being put in circulation, by using proper software, all tags should be named: ID cards – Hba worker's name; distribution cars – Unit's name/wing of building name (e.g. 4.a) and trays – tray's number (e.g. tray 1). After this procedure, tags are glued to these resources, one tag per unit of material. Both trays and cars demand a specific position/orientation to guarantee a good tag-reader communication (table 6, tag/reader location column).

READERS

The control point (readers) is located at *Empratamento* room, right before the exit door. This control point is constituted by two readers, costing approximately 4000 euros plus taxes. Once again, several models and brands are available in the market, and like tags, readers have to be aligned with the ISO/EIC 18000-6 norm. Its life time is expected to be larger than the 10 years clinical management contract assigned to ESS.

RFID SYSTEM WORKFLOW

When all tags placed on trays, cars and ID cards are already registered in the support software, the RFID system is ready to work.

Once distribution cars are prepared, they should be queued in the *Empratamento* area, right before the waiting zone. This area works as an intermediary position between the end of the plating/meals preparation step and the control step.

When Hba *Auxiliares de Dietética e Nutrição* are ready to start distributing the meals, the control step begins. Before leaving the kitchen, the employee has to stop the distribution car on the RFID control point, open the car doors and show its ID car, closing the doors right away. During this brief period of time, the reader communicates with all the tags placed in front of it – trays, car and ID card – storing its identification and time. The car is then ready to leave the area.

The number of trays counted is crossed with the price of each meal resulting on automatic billing of those very same meals. The automatic auditing to the number of meals served is performed every meal, except for supper, since it is assumed that the number of patients receiving supper is equal to the number of having dinner. The circuit just described can be visualised on the figure below.

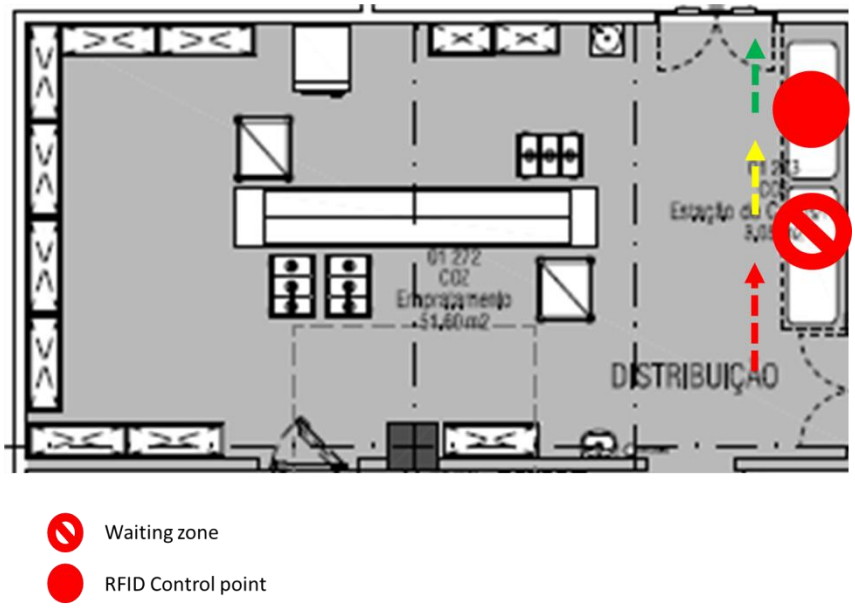

FIGURE 4 – RFID SYSTEM WORKFLOW.

For RFID readings to be effective, some technical considerations have to be strictly followed:

a. The left side of the tray, the one carrying the RFID tag, should always be placed on the cold side of the car (cold side vs. hot side), otherwise high temperatures will affect reading and rapidly erode the material;
b. Only one distribution car and one employee should be placed in front of the reader at a time, to guarantee a match between tags placed on ID card, trays and cars;
c. Car doors have always to be open, to guarantee that the reader properly counts the number of trays being served. This is due to the metal doors, that block the sign sent by the readers;
d. Trays always have to be transported inside distribution cars, and never piled up on its top, otherwise false negatives may occur.

The RFID system design to be implemented in this process will require an initial investment of 190.322 euros plus taxes; including both tags and readers, but also distribution cars that are needed to support the system and guarantee its reliability (appendix X). Set up and software costs are not considered in this budget, since they depend on several factors, such as the complexity of the software needed to support the system, for example.

For the 10 years-period clinical management contract, Hba is expected to spend around 6.359 euros in the maintenance of the RFID system, this value includes the maintenance of both tags and readers (appendix X).

SOLUTION #2 and SOLUTION #3

These two solutions can be put into practice by using the same hardware, a Zebra printer. There are several models available on the market, but the majority presents the characteristics needed do solve the problems mentioned: print tags and colourful printing. In order to print both diet list and diet labels directly from its source, Sorion software, the Zebra printer has to be placed at the Hba dieticians' office.

At the moment, Hba already owns the LP/TLP-2844 model, and the Information Systems Department (ISD) is studying the possibility of acquiring another unit for this purpose.

The acquisition of this specific model will cost the hospital around 237[2] euros plus taxes.

[2] Listopsis price.

5.7 SOCIAL DESIGN (STEP 7)

Although expected to generate significant benefits for Hba, and also for Itau, the selected changes do not affect the daily routine of the majority of the workers involved in this food chain. Also, the majority of employees both from Itau and Hba engaged in this process are aware of at least, one or two of the problems and wasteful activities described, recognizing and demonstrating some willing to change.

Given this, one of the major barriers to process redesign, resistance to change, is not likely to be felt, at least, at a significant level. However, employees' collaboration and acceptance is still fundamental to guarantee the optimal functioning of the solutions proposed.

Analysing solution by solution:

SOLUTION #1

For this solution to be effective, human intervention is fundamental. As it is explained in the previous step (Technical design), in order to RFID readers communicate with tags placed on food trays and read the information contained on it, Hba *Auxiliares de Dietética e Nutrição* have to open the distribution car doors. If they fail this activity, RFID readers will only be able to read staff and car identification, failing to read tray's tags, and so not considering those trays for automatic billing.

However, since automatic auditing and billing serves the interest of both parties, Itau and Hba, this activity is expected to be controlled by workers from the two entities, and so decreasing/preventing human errors, such as the one described above.

To prevent such forgetfulness, a large sign containing information regarding how to correctly read the car, employee and tray tags should be displayed on the wall. Notice that this extra information is only a complement of a proper training of Hba *Auxiliares de Dietética e Nutrição* on how to perform this control point.

Tags lifetime can also be negatively affected by human intervention. This may occur when employees place the tray inside the distribution car, on the wrong position – tags have always to be placed on the cold side of the car – unnecessarily subjecting the tags to high temperatures.

To avoid such situation, which ultimately may result in extra replacing costs for the hospital and some negative readings, all trays should have a visual sign attached to its left side, so that workers can easily identify where RFID is placed and how to correctly insert the tray in the distribution cars.

SOLUTION #2

Using colours to differentiate the type of diets served to Hba patients is not expected to lead to employees resistance. The main reason behind this assumption is that the new colour scheme will help those employees how may feel some difficulties when reading the diet labels but, those o prefer the old method can still do it. So, employees involved in those steps covered by this modification can decide whether to read the diet prescription or to use the colour scheme as a guide.

To guarantee employees have the necessary time to adapt to the new colour scheme, it is fundamental to provide at least on training session. On it, besides presenting the solution, the reasons behind this decision and the benefits both for Itau, Hba, employees and patients should be listed. Additionally, large sized posters illustrating the correspondence between diet prescription and colours should be displayed on the areas where trays and food are prepared and organized, namely *Confecção de dietas* and *Empratamento* rooms.

SOLUTION #3

Since only Hba personnel have access to Sorion, the activity of printing the diet lists and diet labels is transferred from Itau workers to Hba dieticians. After printing this, Hba dieticians also need to deliver these materials to Itau staff. The only exception is at breakfast, since at 7:00 am, when Itau workers start to prepare this meal, no dieticians are present at the hospital yet. Holidays and weekends are also exceptions once dieticians only work at week days.

To overcome this possible resistance of Hba dieticians to perform this new task, it is fundamental that top management team involves Hba dieticians when discussing the implementation of the new Zebra printer, explaining them the benefits of implementing this solution, especially for patients.

5.8 GAINS EVALUATION AND ACTION PLAN (STEP 8)

The introduction of the three solutions proposed affect the patient's food chain in four dimensions: reduce cycle time, reduce number of activities performed, eliminate wasteful activities and prevent some output errors. These changes can be seen both in intermediary and main meals circuits, as shown in the pictures below.

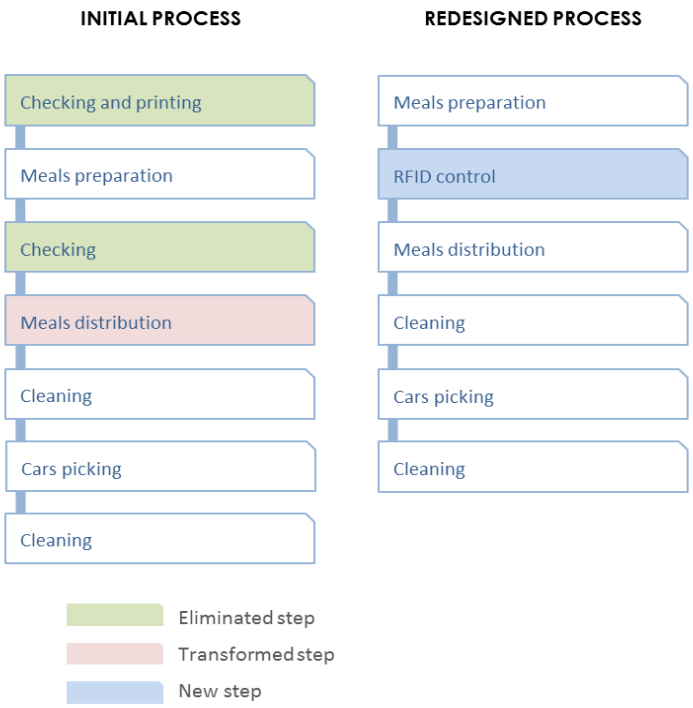

FIGURE 5 – SUMMARY OF MAIN STEPS AND ACTIVITIES PERFORMED AT INTERMEDIARY MEALS – INITIAL VS. REDESIGNED PROCESS.

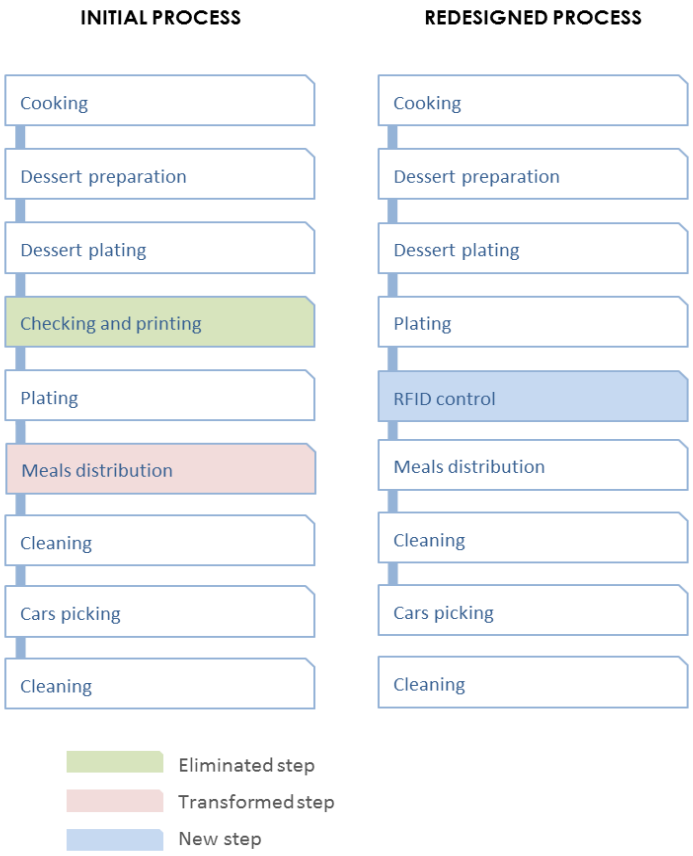

FIGURE 6 - SUMMARY OF MAIN STEPS AND ACTIVITIES PERFORMED AT MAIN MEALS – INITIAL VS. REDESIGNED PROCESS.

The changes above illustrated have a profound impact in the process, as a whole. The redesigned food chain is now composed by 38 steps (vs. 37), distributed along 56 hours and 42 minutes (vs. 62 hours and 6 minutes) (appendix XI vs. appendix V). This represents a time reduction of 5 hours and 24 minutes. However, improvements and savings on this chain are far larger than time reduction.

SOLUTION #1

The implementation of the described RFID system does not affect the patient's food chain process in terms of time or number of steps to perform. Its gains are more related with elimination of duplicated activities – manual auditing performed both by Itau and Hba – and the empowerment of Hba in terms of controlling what is effectively served to its patients, avoiding over-billing situations. With this system the Itau engineer will no longer have to spend her leisure time checking the number of meals served during the week. In parallel, Hba dieticians will save the 3 hours per week dedicated to the auditing task, saving approximately 624[3] euros per month, 7.493[3] euros per year.

The initial investment in this technology, especially when considering the distribution cars that have to be acquired to guarantee the perfect tag-reader communication (appendix X), may consist of a barrier to its implementation. However, the technical design presented for this solution already takes into account the minimum investment possible to make this technology a reality in this food chain, being the location of the control point (*Empratamento* vs. *Copas*) the reason behind the different levels of investment presented (appendix X). It is also important to notice that, although distribution cars represent the majority of the initial investment (€5.091 for RFID system and €185.231 for the cars), the hospital will always need to acquire them independently of deciding or not to implement the RFID technology, since they are currently experiencing shortage in terms of number of cars. This situation may act as a softener of this economical barrier.

The implementation of this RFID networks, acts essentially as an auditing system, preventing over-billing of meals. For this "prevention" system to be valuable and to cover the initial and maintenance investment by Hba in this technology, a total number of 180.571 meals in excess should be detected in 10 years. This corresponds to 18.057 per year, 1.505 per month and 50 per day (in a universe of 1.970 meals served daily).

An evaluation of the accuracy and effectiveness of the new system should be performed during the first month of functioning. This evaluation can be done by simply operating both control systems, the manual and automatic auditing, in parallel, and comparing the results. If some

[3] According to Dieticians' payment per hour.

mismatch is verified, the error source, human or technical, should be found and repaired. Every year, this control should be performed, to guarantee that the RFID system is functioning as expected.

Finally, Hba is a brand new facility, still trying to find the best approach to fit their goals as an organisation and, at the same time, to arrange the best possible medical care to its patients. This situation is reflected on the way internal processes are being conducted, and on how employees perform their daily tasks, and the patient's food chain is not an exception. Given this, the implementation of an RFID system, although valuable, may be seen as a source of control, leading to negative feelings by employees. Thus, the correct field implementation of social design activities (step 7), especially training and explanation of benefits is fundamental to guarantee employees acceptance and a smooth transition between initial and redesigned process.

SOLUTION #2 and #3

As shown in the pictures above, activities related to both intermediary and main meals suffer some changes. The introduction of the Zebra printer will eliminate two steps, both related with diet lists and labels printing and checking. Also, meals distribution step, namely the need to fill the control sheet at arrival to *Copas* is eliminated. This activity is, in the redesigned process, substituted by the new RFID control point that, as explained before, not only allows real-time and automatic billing of meals served to patients, but also stores information related with the distribution time, car and employee.

The changes above illustrated and described have a profound impact in the process, as a whole. The redesigned food chain is now composed by 38 steps (vs. 37), distributed along 56 hours and 42 minutes (vs. 62 hours and 6 minutes). This represents a gain, in terms of time, corresponding to 5 hours and 24 minutes, being this gain due to the implementation on the Zebra printer. In terms of gains, this solution will essentially free the Itau engineer from unnecessary office work, allowing her to apply her talent and focus on other activities that till date are being neglected due to lack of time. In quantitative terms, this solution is expected to save her 151 to 167 hours of work per month, corresponding to 1.429[4] to 1.580[4] euros. In one year, this saving may rise up to 18.959[4] euros.

IN RESUME, the patient's food chain is a long and complex primary process, involving several workers both from Itau and Hba. Due to its complexity, several problems and wasteful activities have been identified, as well as the respective solutions. RFID technology emerges as one of those solutions

[4] Assumption: Itau's Engineer wage per hour is equal to Hba Dieticians.

helping Hba to take control of the auditing of this process, in terms of number of meals served to patients, avoiding over-billing. The implementation of this technology in this specific process demands a very unique technical design which, should always be together with a careful and tailored social design. Implementation costs may function as the main barrier to the acceptance of this technological system, however, its benefits both in terms of time and costs savings are real.

THE NEXT CHAPTER the main conclusions regarding the opportunity for RFID to improve this process are discussed. Also, limitations of this study and hints for future research are considered.

6. Conclusions, Limitations and Future Research

The goal of this dissertation is to answer the following research question - **Is there an opportunity for RFID technology to improve the patient's food chain at the Hospital Beatriz Ângelo?**

In order to answer this question, and under the theory of Business Process Redesign (BPR), a methodology based on two popular BPR frameworks, Grover and Malhotra (1997) and Rohleder and Silver (1997), is applied to the process under study. This eight steps methodology is tailored to both time and resources available, and is explained at "Methodology" chapter.

According to the framework, the whole patient's food chain is analysed and documented in the chapter "Patient's Food Chain Redesign", section 5.3 "Defining and understanding the process – step 3". In this chapter, section "Streamlining – Removal of obvious waste and problems identification – step 4", by using the data collected during field observations and interviews with different Itau and Hba personnel, some major problems, namely lack of internal auditing to the number of meals served to hospitalized patients, and some wasteful activities, such as printing and checking diet lists and adding extra information to diet labels by hand, are identified.

Regarding the first problem stated, and according to section 5.5 "Creation – Process innovation – step 5", by using a RFID control point at *Empratamento* room and tags attached to food trays, RFID technology can be implemented as a tool to perform internal auditing of meals served to hospitalized patients, preventing over-billing. In parallel, as it is explained in the same section, the implementation of this RFID system eliminates the current manual billing, performed in duplicated both by Itau and Hba workers. This solution matches with the ones referred in the Literature Review chapter, where Financial record keeping is one of the possible applications of RFID technology already in practice. As said in the section 5.8 "Gains evaluation and action plan – step 8", automatic billing saves around 66 hours per month of work to Hba dieticians, corresponding to 624 euros per month and 7.493 annually.

About the wasteful activities mentioned above, and still in the section 5.8 "Gains evaluation and action plan – step 8", it is possible to conclude that a simple and widespread technology such as a printer, when implemented at the right place and time, can save 5 hours and 24 minutes to the process, daily. This saves between 151 to 167 hours of work to Itau's engineer allowing her to redirect her time and effort to more productive activities, more related to her filed of intervention. This will also save Itau between 1.429 and 1.580 euros per month, and a maximum of 18.959 euros per year.

Given the previous conclusions, the answer to the research question is positive, meaning that there is an opportunity for RFID technology to improve the patient's food chain at the Hospital Beatriz Ângelo.

6.1 LIMITATIONS

RFID limitations, more specifically technological challenges such as liquid and metal interferences, pose a significant constraint to the solution presented. These challenges limit the number of applications of RFID system in this process preventing Hba to fully exploit this technology as a solution to other internal problems related with this process, namely crockery thefts. Additionally, an effective solution for this situation requires mature workers, capable to perform this crockery control activity in a flawless manner, which is not possible under current conditions, especially since kitchen team is new and is still adapting to Hba work conditions.

The last RFID limitation is related with the practical viability of the suggested system. Although its technical design is effective in theory, since its auditing function depends on human hand, it is fundamental to have workers support so the system works as expected. Given this, there may be a gap between theory and reality, and some adjustments may be needed to guarantee the perfect functioning of this technology.

Also previous agreements with Datelka affect the final solution, especially in terms of equipment and budget, since no other options can be considered when choosing the supplier.

Regarding return on investment calculations related with the implementation of the Zebra printer, it is assumed that Itau's engineer wage per hour is equal to Hba dieticians. This assumption is due to the fact that Itau alleged monetary information is confidential. Given this, savings due to this technology are just a guidance value, and may not reflect reality.

6.2 FUTURE RESEARCH

This dissertation is focused in only one process, the patient's food chain. Although clearly valuable in the auditing activity, it would be interesting, with more time to explore the process and the limits of the technology itself, to evaluate the possibility of solving the crockery theft problem with this RFID system.

Also, other internal processes could be analysed under the BPR perspective. Similar to what is already done in some medical facilities, previously reported in the Literature Review chapter, it would be interesting to analyse the potential of RFID technology on other areas and processes of Hba, from inventory management, to staff, patients and material tracking; and so creating and integrated internal RFID network that could give life and visibility to every object, person and process.

IN SUMMARY, the answer to the research question is positive, meaning that RFID technology can be used to improve the patient's food chain at Hospital Beatriz Ângelo. This technology, and other such as the Zebra printer, under the wing of process redesign, when correctly applied and aligned with the

hospital needs, can easily help this public institution to better achieve its goals and commitments, by saving time and allowing staff to focus on what is essential. This is ultimately translated into a more efficient process and financial savings. Taking into account the evolution this technology has experienced in recent years, it is expected that in the near future, RFID can arise as a tool to solve some major issues of medical care facilities, including Hba.

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8. APPENDIX I

PROCESS BREAKTHROUGH METHODOLOGY (HARRINGTON 1995)

PHASE	KEY ACTIVITIES
ORGANISING QUALITY	. Defining critical business processes . Selecting process owners . Defining preliminary boundaries . Forming and training process improvement teams . Boxing in the process . Establishing measurements . Developing project and change management plans
UNDERSTANDING THE PROCESS	. Flowcharting the process . Preparing the simulation model . Conduct a process walk-through . Performing process cost and cycle-time analysis . Implementing quick fixes . Aligning the process and the procedures
STREAMING THE PROCESS	. Process redesign (focus improvement) . New process design . Benchmarking the process . Improvement, cost, and risk analysis . Preferred process selection . Preliminary implementation plan
IMPLEMENTATION, MEASUREMENTS AND CONTROL	. Finalized implementation plan . New process implementation . In-process measurements . Feedback systems . Poor-quality cost
CONTINUOUS IMPROVEMENT	. Major breakthrough in performance . Process improvement must continue . Natural work teams or department . Improvement teams take over

TABLE 7 - THE KEY ACTIVITIES OF THE PROCESS BREAKTHROUGH METHODOLOGY (HARRINGTON 1995 CITED BY ZAIRI 1997).

9. APPENDIX II

REENGINEERING METHODOLOGY

STEP	QUESTIONS ADRESSED	KEY ACTIVITIES
1. ESTABLISHING APPROPRIATE SUPPORT	. How ESS sees the potential of RFID in healthcare industry? . Is RFID already present in ESS facilities? . How ESS sees future RFID applications in its units? . How can RFID address ESS business goals?	. Interview with Logistics Director . Identifying corporate expectations regarding RFID
2. PROCESS THINK – SELECTING THE PROCESS	. What process(es) get highest priority for reengineering? . Why reengineering that process? . What are ESS major goals when reengineering the selected process?	. Interview with Logistics Director . Identify major processes requiring reengineering . Selecting the process to reengineering . Setting reengineering goals
3. DEFINING AND UNDERSTANDING THE PROCESS	. What are the objectives of the process? . Which are the steps and activities? . Which is the cycle time? . What are the current material and human resources? . How do resources and information work through process?	. Process monitoring . Process documentation . Process flow diagram
4. STREAMLINING –REMOVAL OF OBVIOUS WASTE AND PROBLEMS IDENTIFICATION	. Is there any complicated or unclear step? . Is there any unnecessary transportation/movement of products, workers or customers? . Is there any inspections? . Is there any waiting of products, workers or customers? . Is there any duplication of effort? . Is there unnecessary record keeping and data collection or processing? . Is there any defective output?	By using documentation generated in step 3: . Workflow analysis . Steps and linkages analysis . Workers activities analysis
5. CREATION - PROCESS INNOVATION	. How to eliminate/neutralize/transform the wasteful activities and problems? . How can IT be used to transform the process? . Ideally, how should the process work?	By using documentation generated in step 3: . Workflow analysis . Steps and linkages analysis . Workers activities analysis . Define and Integrate changes

6. TECHNICAL DESIGN	. What technical resources will be needed? . How will technical elements interact with each other? . How can resources be acquired? . What is the cost of materials and implementation?	. Workflow analysis . Examine steps linkages . Consolidate interfaces . Process modelling . Documentation of technical design
7. SOCIAL DESIGN	. What human resources will be needed for the reengineered process? . How will social elements interact with technical elements? . Who is likely to resist to change and why?	. Workflow analysis . Identify jobs and skills . Design incentives . Manage change
8. GAINS EVALUATION AND ACTION PLAN	. What is the different between the initial process and the reengineered? . What are the qualitative and quantitative gains? . What are the barriers to its implementation? . How to ensure smooth transition? . How to control and evaluate the performance and the effectiveness of the new process?	. Final workflow diagram . Qualitative and quantitative evaluation of redesign . Identify barriers . Set control and performance evaluation system

TABLE 8 – METHODOLOGY.

10. APPENDIX III

INTERVIEW WITH DR. PEDRO LIMA

ESS DIRECTOR OF LOGISTICS

12th April 2012

DO YOU BELIEVE RFID HAS POTENTIAL TO GENERATE PROFITS IN HEALTHCARE INDUSTRY, ESPECIALLY HOSPITALS?

[Pedro Lima (ESSAUDE)] Yes, there is potential both in hospitals and suppliers.

WHERE DO YOU THINK RFID CAN BE APPLIED IN HOSPITALS?

[Pedro Lima (ESSAUDE)] Monitoring equipment usage rate; monitoring pharmaceuticals/devices.

IS ESS ALREADY EXPLORING/USING THIS TECHNOLOGY? IF YES, IN WHICH PROCESSES/AREAS/FUNCTIONS/FINALITIES?

[Pedro Lima (ESSAUDE)] Yes. Outpatient pharmaceuticals delivery.

HAVE YOU SEEN POSITIVE OUTCOME OF USING RFID, UNTIL KNOW?

[Pedro Lima (ESSAUDE)] No, we are yet in an implementation stage.

IS ESS CONSIDERING TO IMPLEMENT RFID TO OTHER PROCESSES/OPERATIONS? WHERE? WHICH PROCESSES?

[Pedro Lima (ESSAUDE)] Yes. Monitoring equipment usage rate; monitoring pharmaceuticals/devices.

ARE YOU AWARE OF ANY NEGATIVE ASPECT OF IMPLEMENTING RFID? OR ANY DIMENSION/ASPECT OF THIS TECHNOLOGY THAT MAY FUNCTION AS A BARRIER TO ITS IMPLEMENTATION IN ESS?

[Pedro Lima (ESSAUDE)] The barrier in RFID adoption has always been cost/efficiency analysis. The negative aspects of implementing RFID aren't specific of this technology, and may include data security, or privacy issues.

WHAT PROCESS(ES) AT HBA GET HIGHEST PRIORITY FOR REENGINEERING?

[Pedro Lima (ESSAUDE)] Inside the Hospitality Management, one of the main concerns is the flow of production/management of the patients' meals.

WHY REENGINEERING THAT SPECIFIC PROCESS?

We are not 100% pleased with the results of the current process, and believe that it can improve with some adjustments to the way things are done in production. We also lack internal auditing os number of meals served.

WHAT ARE ESS/HBA MAJOR GOALS/OBJECTIVES WHEN REENGINEERING THE SELECTED PROCESS?

[Pedro Lima (ESSAUDE)] Increase client satisfaction, and improve the efficiency of our activity.

11. APPENDIX IV

PROCESS DESCRIPTION

PATIENT'S FOOD CHAIN

23th April 2012

BREAKFAST CIRCUIT (PART I)

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
1.a	Printing and Checking	06:30 am	7:00 am	30 min	1 Itau	*Escritório*

ACTIVITIES DESCRIPTION: 1 worker from the food company, Itau, prints the breakfast list (2 copies) made available at 6:30 am

After printing the lists, the employee matches it with labels already printed and placed on the food trays, the day before. Since these labels were printed according to the breakfast list released at 6:30 pm, the goal of this task to identify diet changes and patient's admissions or releases, which may have occurred during this 12 hours period. If some mismatch is identified, labels are corrected. Additionally, by hand, the employee adds some comments and extra information about patients' allergies, especial requests, among other comments.

Both lists and labels indicate the type of diet to serve to each patient hospitalized at Hba.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
1.b	Breakfast preparation	7:00 am	8:30 am	90 min	3 Itau + 3 Hba	*Confecção dietas*

ACTIVITIES DESCRIPTION: Using the breakfast list already printed, 3 workers from Itau prepare all the food for breakfast.

3 workers from Hba – *Auxiliares de Dietética e Nutrição* – distribute the food through the trays, according to the labels already placed on it.

Trays are then placed inside the distribution cars and, when the latter are full, its doors are closed.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
1.c	Breakfast distribution	8:36 am	8:55 am	19 min	3 Hba	From *Confecção de dietas* to C*opas*

ACTIVITIES DESCRIPTION: When all the cars are prepared and checked, the breakfast distribution starts. 3 *Auxiliares de Dietética e Nutrição* leave the kitchen with the breakfast cars distributing them through the different areas of hospitalization.

At the arrival to the C*opa,* the employee writes the arrival time at the control sheet and another *Auxiliar* from the hospital, signs it. This activity works as a control point, to guarantee that *Auxiliares de Dietética e Nutrição* are complying with the delivery schedules.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
1.d	Cleaning	9:00 am	9:30 am	30 min	3 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: 2 workers from Itau clean and prepare the room for the afternoon snack circuit.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
1.e	Cars picking	10:30 am	11:23 am	53 min	3 Hba	From *Copas* to *Lavagem de carros*

ACTIVITIES DESCRIPTION: The same Hba *Auxiliares* that went up with breakfast cars, are now taking them down, to the *Lavagem de carros* room. These cars contain crockery from both breakfast and supper, from previous night.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
1.f	Cleaning	10:55 am	1:51 pm	176 min	2 Itau	*Lavagem de carros and Lavagem de loiça*

ACTIVITIES DESCRIPTION: Itau workers prepare distribution cars, trays and crockery for the afternoon snack.

Washing up trays and crockery is divided into 3 sequential tasks: Pre-wash (40-45ºC); Wash (55-60ºC) and Drying (80-85ºC).

Cars are also cleaned up, using a wet fabric.

LUNCH CIRCUIT

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.a	Cooking	6:45 am	9:30 am	165 min	1 Itau	*Cozinha*

ACTIVITIES DESCRIPTION: 1 cook cooks all the food that needs to be sent to hospitalized patients.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.b	Dessert preparation	8:00 am	10:30 am	150 min	1 Itau	*Pastelaria*

ACTIVITIES DESCRIPTION: 1 worker from Itau prepares all the desserts and fruit that will be served at lunch.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.c	Dessert plating	9:35 am	12:40 pm	185 min	2 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: Desserts are placed in appropriate crockery.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.d	Checking and printing	9:40 am	11:00 am	80 min	2 Itau	*Escritório*

ACTIVITIES DESCRIPTION: 2 Itau workers, compare the 6:30 pm diet list with the 6:30 am one. They check if diets prescribed on both lists match, printing both the lists and diet labels. Once again, by hand, these employees add some extra observations to the labels, important to guide the next step, plating.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.e	Plating preparation	9:50 am	12:45 pm	175 min	4 Hba	*Empratamento*

ACTIVITIES DESCRIPTION: All the crockery needed to the next step, plating, is transferred from the *Lavagem de loiça* room to this space. This task is performed by 4 employees from Hba. They also bring the trays and the distribution cars, putting everything at the right place, to guarantee that the next phase starts on time and runs without any mishap.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.f	Plating	11:09 am	12:45 pm	96 min	4 Itau + 1 Hba	*Empratamento*

ACTIVITIES DESCRIPTION: This step follows as an assembly line. The first worker places the tray, the label, the dessert and the cutlery on the conveyor belt. The second worker puts the soup on the tray and the third the main course. At the end of the assembly, 1 *Auxiliar de Dietética e Alimentação* checks the diet label and places the tray inside the distribution car.

When the car is full, its doors are closed, and it is placed near the exit door.

The fifth element intervening in this step is also from Itau; it can be the Food Engineer or the Dietician. Her function is to control the quality of the process, to check if the meals served are according to the diet prescribed on the label and lunch list, and to guide the workers whenever is needed.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.g	Lunch distribution	11:35 am	12:55 pm	80 min	2 Hba	From *Empratamento* to *Copas*

ACTIVITIES DESCRIPTION: At 11:35 am the lunch distribution starts. 2 *Auxiliares de Dietética e Nutrição* leave the kitchen with the distribution cars driving them to *Copas*, at hospitalization floors.

At the arrival to the *Copa,* the employee writes the arrival time at the control sheet and another *Auxiliar* from the hospital, signs it. This activity works as a control point, to guarantee that *Auxiliares de Dietética e Nutrição* are complying with the delivery schedules. Meals are then reheated, at 130ºC during 10 minutes.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.h	Cleaning	2:00 pm	2:30 pm	30 min	1 Itau	*Empratamento*

ACTIVITIES DESCRIPTION: 1 Itau worker cleans the room preparing it for the dinner circuit.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.i	Cars picking	2:38 pm	4:00pm	82 min	2 Hba	From *Copas* to *Lavagem de carros*

ACTIVITIES DESCRIPTION: The same Hba *Auxiliares* that went up with lunch cars, are now taking them down, to the *Lavagem de carros* room.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
2.j	Cleaning	2:45 pm	6:15 pm	210 min	2 Itau	*Lavagem de carros* and *Lavagem de loiça*

ACTIVITIES DESCRIPTION: Itau workers prepare distribution cars, trays and crockery for dinner.

Washing up trays and crockery is divided into 3 sequential tasks: Pre-wash (40-45ºC); Wash (55-60ºC) and Drying (80-85ºC).

Cars are also cleaned up, using a wet fabric.

AFTERNOON SNACK CIRCUIT

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
3.a	Printing and checking	12:10 pm	12:55 pm	45 min	1 Itau	*Escritório*

ACTIVITIES DESCRIPTION: 1 worker from the food company, Itau, prints the diets list (2 copies) elaborated at 6:30 am, and the labels to place on the trays. Both lists and labels indicate the type of diet to serve to each patient admitted at Hba. Also, by hand, these employees add some extra observations to the labels.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
3.b	Afternoon snack preparation	1:06 pm	4:00 pm	174 min	3 Itau + 3 Hba	*Confecção dietas*

ACTIVITIES DESCRIPTION: Itau workers are responsible for placing the trays inside distribution cars and to distribute the diet labels.

Guided by the afternoon snack list already printed, these very same workers prepare all the food for the afternoon snack.

3 workers from Hba, *Auxiliares de Dietética e Nutrição*, distribute the food through the trays, according to the labels already placed on it.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
3.c	Checking	2:50 pm	3:55 pm	65 min	3 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: Before closing distribution cars, Hba employees match the diet labels with the afternoon snack list updated at 14:30 pm, to identify diet changes and patient's admissions or releases. If some mismatch is identified, labels and food are corrected. Cars are only allowed to go up after this rigorous control.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
3.d	Afternoon snack distribution	3:35 pm	4:05 pm	30 min	3 Hba	From *Confecção de dietas* to *Copas*

ACTIVITIES DESCRIPTION: All cars are prepared and checked, and the afternoon snack distribution starts. *Auxiliares de Dietética e Nutrição* leave the kitchen with the afternoon snack cars distributing them through the different hospitalization areas.

At the arrival to C*opa,* the employee writes the arrival time at the control sheet and another *Auxiliar* from the hospital, signs the sheet. This activity works as a control point, to guarantee that *Auxiliares de Dietética e Nutrição* are complying with the delivery schedules.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
3.e	Cleaning	4:10 pm	4:53 pm	43 min	2 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: 2 workers from Itau clean and prepare the room for the supper circuit.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
3.f	Cars picking	5.30 pm	6.25 pm	55 min	2 Itau	From *Copas* to *Lavagem de carros*

ACTIVITIES DESCRIPTION: The same Hba *Auxiliares* that went up with afternoon snack cars, are now taking them down, to the *Lavagem de carros* room.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
3.g	Cleaning	6.30 pm	9.20 pm	170 min	2 Itau	*Lavagem de carros and Lavagem de loiça*

ACTIVITIES DESCRIPTION: 2 Itau workers prepare distribution cars, trays and crockery for the supper.

Washing up trays and crockery is divided into 3 sequential tasks: Pre-wash (40-45ºC); Wash (55-60ºC) and Drying (80-85ºC).

Cars are also cleaned up, using a wet fabric.

DINNER CIRCUIT

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.a	Dessert preparation	12:30 pm	3:10 pm	160 min	1 Itau	*Pastelaria*

ACTIVITIES DESCRIPTION: 1 person form Itau prepares all the desserts, including fruit.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.b	Cooking	2:00 pm	4:30 pm	150 min	1 Itau	*Cozinha*

ACTIVITIES DESCRIPTION: 1 cook cooks all the food that needs to be sent to hospitalized patients, at dinner.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.c	Dessert plating	3:10 pm	7:00 pm	200 min	2 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: Desserts are placed in appropriate crockery.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.d	Checking and printing	4:00 pm	5:00 pm	60 min	2 Itau	*Escritório*

ACTIVITIES DESCRIPTION: 2 Itau workers print the diet labels based on the 2:30 pm diet list. By hand, these employees add some extra observations to the labels, important to guide the next step, plating.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.e	Plating preparation	4:00 pm	7:00 pm	180 min	4 Hba	*Empratamento*

ACTIVITIES DESCRIPTION: All the crockery needed to the next step, plating, is transferred from the *Lavagem de loiça* room to this space. This task is performed by 4 employees from Hba. They also bring the trays and the distribution cars, putting everything at the right place, to guarantee that the next phase starts on time and runs without any mishap.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.f	Plating	5:00 pm	7:10 pm	130 min	4 Itau + 1 Hba	*Empratamento*

ACTIVITIES DESCRIPTION: This step follows as an assembly line. The first worker places the tray, the label, the dessert and the cutlery on the conveyor belt. The second worker puts the soup on the tray and the third the main course. At the end of the assembly, 1 *Auxiliar de Dietética e Alimentação* checks the diet label and places the tray inside the distribution car.

When the car is full, its doors are closed, and it is placed near the exit door.

The fifth element intervening in this step is also from Itau; it can be the Food Engineer or the Dietician. Her function is to control the quality of the process, to check if the meals served are according to the diet prescribed on the label and dinner list, and to guide the workers whenever it is needed.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.g	Dinner Distribution	6:30 pm	8:35 pm	90 min	2 Hba	From *Empratamento* to *Copas*

ACTIVITIES DESCRIPTION: At 6:05 am the dinner distribution starts. 2 *Auxiliares de Dietética e Nutrição* leave the kitchen with the distribution cars driving them to *Copas*, at hospitalization floors.

At the arrival to the *Copa,* the employee writes the arrival time at the control sheet and another *Auxiliar* from the hospital, signs it. This activity works as a control point, to guarantee that *Auxiliares de Dietética e Nutrição* are complying with the delivery schedules. Meals are then reheated, at 130ºC during 10 minutes.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.h	Cleaning	8:35 pm	9:05 pm	30 min	1 Itau	*Empratamento*

ACTIVITIES DESCRIPTION: 1 Itau worker cleans the room preparing it for the lunch circuit, next day.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.i	Cars picking	10:00 pm	10:40 pm	40 min	2 Hba	From *Copas* to *Lavagem de carros*

ACTIVITIES DESCRIPTION: Hba *Auxiliares* are now taking them down, to the *Lavagem de carros* room.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
4.j	Cleaning	10:05 pm	1:15 am	190 min	2 Itau	*Lavagem de carros* and *Lavagem de loiça*

ACTIVITIES DESCRIPTION: Itau workers prepare distribution cars, trays and crockery for lunch, next day.

Washing up trays and crockery is divided into 3 sequential tasks: Pre-wash (40-45ºC), Wash (55-60ºC, and Drying (80-85ºC).

Cars are also cleaned up, using a wet fabric.

SUPPER CIRCUIT.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
5.a	Supper preparation	5:30 pm	6:15 pm	35 min	1 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: Using the breakfast list already printed, 1 worker from Itau prepares all the food needed for the supper. These meals follow on the top of distribution cars.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
5.b	Supper distribution	---	---	---	---	---

ACTIVITIES DESCRIPTION: Supper meals are distributed at the same time, and using the exactly same car as dinner distribution (see step 4.g).

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
5.d	Cleaning	6:15 pm	6:30 pm	15 min	1 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: 1 worker from Itau cleans and prepares the room for the breakfast circuit, nest morning.

BREAKFAST CIRCUIT (PART II)

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
6.a	Printing and checking	6:10 pm	7:00 pm	50 min	1 Itau	*Escritório*

ACTIVITIES DESCRIPTION: 1 worker from Itau, prints the breakfast list made available at 6:30 pm, and also prints the diet labels.

By hand, the employee adds some comments and extra information about patients' allergies, especial requests, among other comments.

STEP	NAME	STARTS	ENDS	DURATION	WORKERS	LOCAL
6.b	Trays preparation	7:00 pm	9:30 pm	150 min	2 Itau	*Confecção dietas*

ACTIVITIES DESCRIPTION: The same worker prepares the breakfast trays for the next day. Its function is to put a diet label and the necessary crockery at each tray, and then placed them in the distribution cars.

12. APPENDIX V

INITIAL PROCESS FLOW DIAGRAM

STEP	NAME	DURATION	WORKERS	LOCAL
BREAKFAST I circuit				
1.a	Printing and Checking	30 min.	1 Itau	*Escritório*
1.b	Breakfast preparation	90 min.	3 Itau + 3 Hba	From *Confecão de dietas* to *Copas*
1.c	Breakfast distribution	19 min.	3 Hba	*Escritório*
1.d	Cleaning	30 min	3 Itau	*Confecção de dietas*
1.e	Cars picking	53 min.	3 Hba	From *Copas* to *Lavagem de carros*
1.f	Cleaning	176 min.	2 Itau	*Lavagem de carros* and *Lavagem de loiça*
LUNCH circuit				
2.a	Cooking	165 min.	1 Itau	*Cozinha*
2.b	Dessert preparation	150 min.	1 Itau	Pastelaria
2.c	Dessert plating	185 min.	2 Itau	*Confecção de Dietas*
2.d	Checking and Printing	80 min.	2 Itau	*Escritório*
2.e	Plating preparation	175 min.	4 Hba	Empratamento
2.f	Plating	96 min.	4 Itau + 1 Hba	Empratamento
2.g	Lunch distribution	80 min.	2 Hba	From *Empratamento* to *Copas*
2.h	Cleaning	30 min.	1 Itau	Empratamento
2.i	Cars picking	82 min.	2 Hba	From *Copas* to *Lavagem de carros*
2.j	Cleaning	210 min.	4 Itau + 1 Hba	*Lavagem de carros* and *Lavagem de loiça*
AFTERNOON SNACK circuit				
3.a	Printing and checking	45 min.	1 Itau	*Escritório*
3.b	Afternoon snack preparation	174 min.	3 Itau + 3 Hba	*Confecção de dietas*
3.c	Checking	65 min.	3 Itau	*Confecção de dietas*
3.d	Afternoon snack distribution	30 min	3 Itau + 3 Hba	From *Confecção de dietas* to *Copas*
3.e	Cleaning	43 min.	2 Itau	*Confecção dietas*
3.f	Cars picking	55 min.	2 Hba	From *Empratamento* to *Copas*
3.g	Cleaning	170 min.	2 Itau	*Lavagem de carros* and *Lavagem de loiça*

DINNER circuit				
4.a	Dessert preparation	160 min.	1 Itau	*Pastelaria*
4.b	Cooking	150 min.	1 Itau	*Cozinha*
4.c	Dessert plating	200 min.	2 Itau	*Confecção de Dietas*
4.d	Checking and printing	60 min.	2 Itau	*Escritório*
4.e	Plating preparation	190 min.	4 Hba	Empratamento
4.f	Plating	130 min.	4 Itau + 1 Hba	Empratamento
4.g	Dinner distribution	90 min.	2 Hba	From *Empratamento* to *Copas*
4.h	Cleaning	30 min.	1 Itau	Empratamento
4.i	Cars picking	40 min.	2 Hba	From *Copas* to *Lavagem de carros*
4.j	Cleaning	190 min.	2 Itau	*Lavagem de carros* and *Lavagem de loiça*
SUPPER circuit				
5.a	Supper preparation	35 min.	1 Itau	*Confecção de dietas*
5.b	Supper distribution	---	---	---
5.c	Cleaning	15 min	1 Itau	*Confecção dietas*
BREAKFAST II circuit				
6.a	Printing and checking	50 min.	1 Itau	*Escritório*
6.b	Trays preparation	150 min.	2 Itau	*Confecção de dietas*

FIGURE 7 – INITIAL PROCESS WORKFLOW DIAGRAM.

IN SUMMARY:

CIRCUIT	# STEPS	CUMULATIVE TIME
Breakfast I	6	398 min. / 6 hours and 36 min.
Lunch	10	1253 min. / 20 hours and 54 min.
Afternoon snack	7	582 min. / 9 hours and 42 min.
Dinner	10	1240 min. / 20 hours and 36 min.
Supper	3	50 min.
Breakfast II	2	200 min / 3 hours and 19 min.
Total	37	62 hours and 6 min.

13. APPENDIX VI

INTERVIEW WITH DIETICIANS SÓNIA VELHO AND ANDREIA SOUSA FERREIRA

HBA DIETICIANS

24th April 2012

Note: This interview was performed after the first look to the process. Some of the questions are chosen according to some problems already identified at this stage.

HOW IS HBA AUDITING THE FOOD DISTRIBUTION PROCESS?

[Dietician (Hba)] Itau is the only responsible for checking the number of meals distributed to our patients. This control is done both during lunch and dinner plating, using as a guide, the diet lists elaborated daily by Hba dieticians.

Twice a week, one of the Hba dieticians compares the number of meals Itau says to distribute, with the diet lists regarding that very same day, to check if they match. This process takes us approximately 1h30 to complete, summing a total of 3 hours per week just checking lists.

DO YOU BELIEVE THAT THE AUDITING PROCESS IN PRACTICE FITS YOUR CURRENT NEEDS?

[Dietician (Hba)] Definitely not. In our perspective, checking the lists is time consuming and is not that effective. We are only four dieticians for 424 beds, and we could spend that time in more productive activities, related with our job specifications. Also, when we do this control, we are working with estimates, so we know that this control is not 100% accurate.

DO YOU HAVE ANY ALTERNATIVES TO SOLVE THIS AUDITING "PROBLEM"?

[Dietician (Hba)] We believe that having the food company as the only auditor is not the best situation. To prepare and distribute meals in a hospital involves a significant investment, especially in a hospital of this dimension, so is our best interest to have both external and internal auditing.

We know that some hospitals have human resources allocated just of this auditing task; it would be an option for Hba. Not only would save us, dieticians, those 3 hours we spend every week checking the meals served, but also, it would guarantee that Hba is actually paying what is served to our patients, not less and not more (it would be fair do Itau too). This is the only alternative that we have in mind right now, but we are definitely open to everything that can bring automation and precision to this task.

BESIDES AUDITING, HAVE YOU IDENTIFIED SOME OTHER PROBLEMS REGARDING THIS PROCESS? DO YOU HAVE ANY IDEAS FOR POTENTIAL SOLUTIONS?

[Dietician (Hba)] Besides auditing, we have in hands another major problem. We know that some staff is inadvertently keeping kitchen materials to themselves; spoons, plastic boxes, etc, so mainly crockery. This may sound as a minor problem, but we are talking about hundreds of missing spoons in just three months of activity and this is just an example; replace all these missing items will cost us money that could be used in other areas. And, worst, we have no clue how to solve or at least to minimize this situation.

ANY OTHER CONSIDERATION?

[Dietician (Hba)] There is a very important aspect to keep in mind, this is a brand new and considerable big medical facility, that deals with thousands of people every day. The demand for this hospital, in terms of number of patients seeking for our medical services, is high above the initial forecast, meaning that everyone is in a rush to guarantee an appropriate answer to this unexpected demand.

And the kitchen is not an exception. Both Itau and staff from Hba that is somehow involved with food activities, are still in a learning phase, meaning that we are still trying to find ways to improve this process.

ARE YOU AWARE OF RFID TECHNOLOGY AND ITS APPLICATIONS?

[Dietician (Hba)] No, I have never heard about that technology.

DO YOU BELIEVE RFID CAN BE USED TO SOLVE SOME OF THE PROBLEMS YOU STATED, OR EVEN TO IMPROVE THE WORKFLOW OF THIS PROCESS? (After explaining what is RFID, how it works and its applications in hospitals).

[Dietician (Hba)] Definitely yes. We welcome every decision that may automate and improve this process. The food chain in a hospital is a very complex process, involving a lot of human and material resources. It is really easy to make a mistake and, unfortunately, even small mistakes may have a negative impact in our patients. Adding, Hba investment in this service area is significant, so any "tool" that may improve efficiency is a valuable asset.

Given what you explained to us, I believe that RFD would be worthwhile both in auditing the number of meals served every day, and also to continuously check inventory levels of several kitchen materials, especially those that I mentioned as preferred theft targets. Probably it would also be interest to study if it is possible to use it to find out the hospital units where kitchen materials are been stolen, so we can investigate and ascertain responsibilities.

14. APPENDIX VII

INTERVIEW WITH ENG. SANDRA ANTUNES

ITAU FOOD ENGINEER

24th April 2012

Note: This interview was performed after the first look to the process. Some of the questions are chosen according to some problems already identified at this stage.

HOW IS ITAU AUDITING THE FOOD DISTRIBUTION PROCESS?

[Engineer (Itau)] I am the person responsible for this activity. Every week, I check the lists we used to plate every meal, from breakfast to supper, and calculate the number of meals served per day. I repeat this process, for every day that week, which takes me about 3 to 4 hours. After this, I still have to match these numbers with the estimates from Hba dieticians.

DO YOU BELIEVE THAT THE AUDITING PROCESS IN PRACTICE FITS YOUR CURRENT NEEDS?

[Engineer (Itau)] Definitely not. The auditing method is time consuming, and may not be that accurate, since it is not easy to keep focused during 3 to 4 hours, reading an endless list of meals. It is easy to make a mistake. Besides, I do it at home, otherwise I would have to leave behind important tasks at my job, to count this lists.

DO YOU HAVE ANY ALTERNATIVES TO SOLVE THIS AUDITING "PROBLEM"?

[Engineer (Itau)] I used to work at another hospital where meals' billing and auditing was automatic. I would love to have that system here, or at least something that could free me from this activity. Also, I believe that automatic auditing may be more accurate than the current system.

BESIDES AUDITING, HAVE YOU IDENTIFIED SOME OTHER PROBLEMS REGARDING THIS PROCESS? DO YOU HAVE ANY IDEAS FOR POTENTIAL SOLUTIONS?

[Engineer (Itau)] I would say, just one, and it is similar with the auditing problem. This situation is related with the method we use to print our diet labels and to decide which food to send to Hba patient during meals preparation and plating periods.

I will try to explain it, in a concise way. Hba dieticians use a software, called Sorion, to elaborate the diet lists. These lists are divided by hospitalization unit, and contain information regarding: bed

number, patient name, type of diet, and extra observations. We receive the lists in a PDF format, 3 times a day, at 6:30 am, 2:30 pm and 6:30 pm. After receiving those lists, we transfer the information to an excel sheet, and we have to do it one by one. At the moment, we are talking about 300 beds, so we have to insert information from about 300 patients. It is and activity that takes time and patience. Finally we have to print the diet labels, and add, by hand, extra comment, such as food allergies and intolerances, etc. We have to do it by hand, because it is not possible to print this type of information directly on the label.

Once again, this continuous diet lists and labels actualization is time consuming. I could use this time, and we are talking about 3 hours a day, just for this tasks, in a more productive way. I could use it to audit quality, hygiene and security, which is an area that we are constantly failing in terms of achieving the goals and norms defined.

ANY OTHER CONSIDERATION?

[Engineer (Itau)] Not that I remember.

ARE YOU AWARE OF RFID TECHNOLOGY AND ITS APPLICATIONS?

[Engineer (Itau)] No.

DO YOU BELIEVE RFID CAN BE USED TO SOLVE SOME OF THE PROBLEMS YOU STATED, OR EVEN TO IMPROVE THE WORKFLOW OF THIS PROCESS? (After explaining what is RFID, how it works and its applications in hospitals).

[Engineer (Itau)] Can it solve our auditing problem? If yes, it would be great. I really need that time to perform other important tasks.

15. APPENDIX VIII

CURRENT DIET LABELS VS. REDESIGNED DIET LABELS

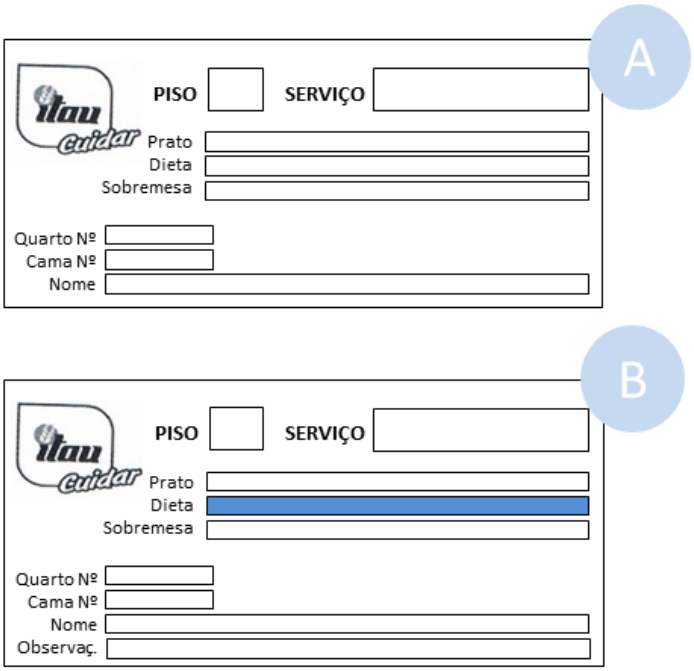

FIGURE 8 – CURRENT DIET LABEL (A) AND REDESIGNED DIET LABEL (B).

Note: The second diet label has already incorporated the colour scheme and the observations.

16. APPENDIX IX

TAGS LOCATION – TRAYS AND DISTRIBUTION CARS

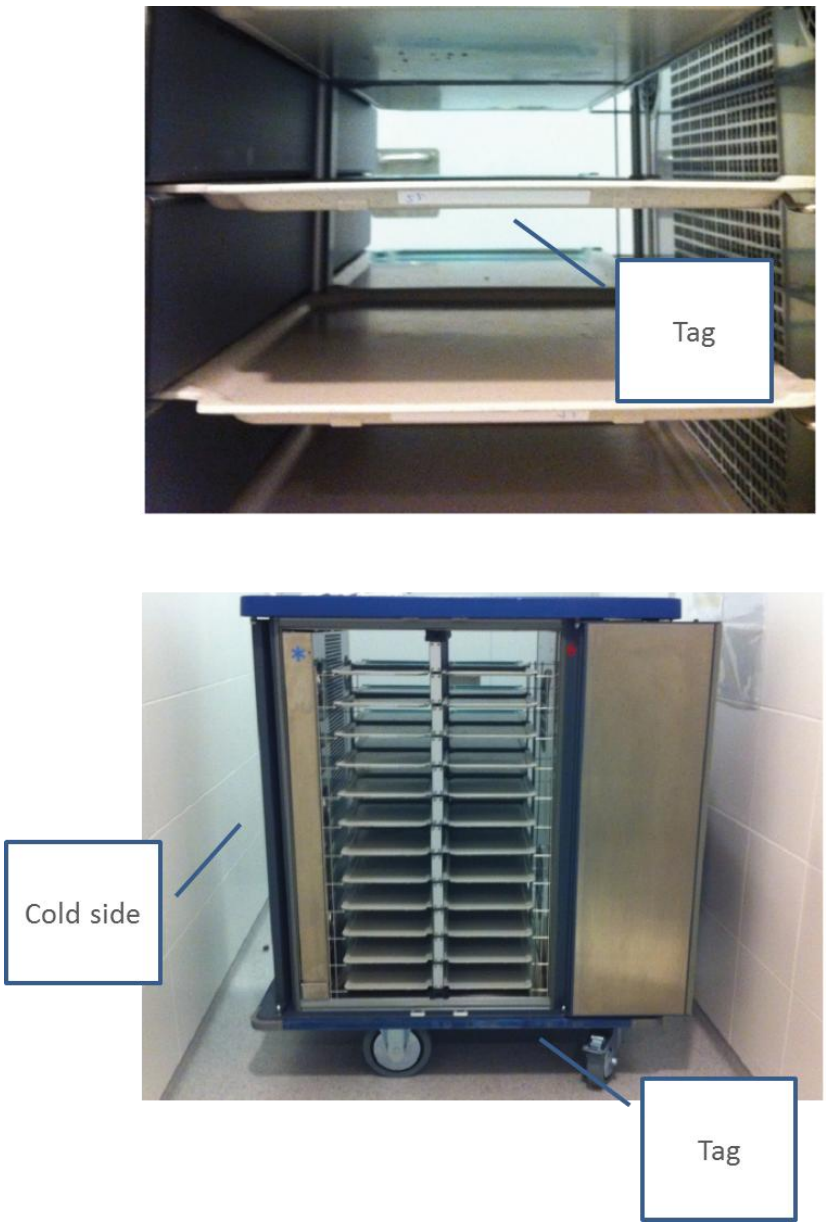

FIGURE 9 – TAGS LOCATION: TRAYS (ABOVE), CARS (BELOW).

17. APPENDIX X

PROCESS REDESIGN INVESTMENT

OPTION 1 - Control point: Empratamento

INITIAL INVESTMENT (Only RFID system) Excluding taxes

		TAGS			READERS						
MATERIAL	UNITS	# TAGS	COST/UNIT	TOTAL COST	# READERS	COST/UNIT	TOTAL COST		MATERIAL	UNITS	Cost/UNIT	TOTAL
ID cards	10	10	1,00 €	10,00 €	-	-	-		Cook chill cars	13	12.575,00 €	163.475,00 €
Trays	1028	1028	1,00 €	1.028,00 €	-	-	-		Other cars	14	1.554,00 €	21.756,00 €
Cook-chill cars	26	26	1,00 €	26,00 €	-	-	-		TOTAL		185.231,00 €	
Other cars	27	27	1,00 €	27,00 €	-	-	-					
Control points	1	-	-	-	1	4.000,00 €	4.000,00 €					
TOTAL	-	1091	-	1.091,00 €	1	-	4.000,00 €					
TOTAL INVESTMENT			5.091,00 €					190.322,00 €				

MAINTENANCE (only RFID system) Excluding taxes

MATERIAL	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Tags	109,10 €	109,10 €	1.200,10 €	109,10 €	109,10 €	1.197,90 €	109,10 €	109,10 €	1.197,90 €	109,10 €
Readers	200,00 €	200,00 €	200,00 €	200,00 €	200,00 €	200,00 €	200,00 €	200,00 €	200,00 €	200,00 €
TOTAL	309,10 €	309,10 €	1.400,10 €	309,10 €	309,10 €	1.397,90 €	309,10 €	309,10 €	1.397,90 €	309,10 €
TOTAL INVESTMENT				6.359,60 €						

Note: The number of cars Hba need to acquire is based on table 9. Without this new cars the RFID system Is not viable for the number of beds considered.

Assumptions for maintenance costs (based on Datelka report):

- 10% of tags “die” every year;
- The average life time of a tag is 3 years;
- Annual maintenance costs correspond to 5% of hardware initial investment;
- The average lifetime of a reader is larger than 10 years.

OPTION 2 - Control point: Copas

INITIAL INVESTMENT (year 0) Excluding taxes

MATERIAL	UNITS	TAGS # TAGS	COST/UNIT	TOTAL COST	READERS # READERS	COST/UNIT	TOTAL COST
ID cards	10	10	1,00 €	10,00 €	-	-	-
Trays	1028	1028	1,00 €	1.028,00 €	-	-	-
Cook-chill cars	26	26	1,00 €	26,00 €	-	-	-
Other cars	27	27	1,00 €	27,00 €	-	-	-
Control points	10	-	-	-	10	4.000,00 €	40.000,00 €
TOTAL	**-**	**1091**	**-**	**1.091,00 €**	**10**	**-**	**40.000,00 €**
TOTAL INVESTMENT			**41.091,00 €**				**226.322,00 €**

MATERIAL	UNITS	Cost/UNIT	TOTAL
Cook chill cars	13	12.575,00 €	163.475,00 €
Other cars	14	1.554,00 €	21.756,00 €
TOTAL		**185.231,00 €**	

MAINTENANCE (only RFID system) Excluding taxes

MATERIAL	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Tags	109,10 €	109,10 €	1.200,10 €	109,10 €	109,10 €	1.197,90 €	109,10 €	109,10 €	1.197,90 €	109,10 €
Readers	2.000,00 €	2.000,00 €	2.000,00 €	2.000,00 €	2.000,00 €	2.000,00 €	2.000,00 €	2.000,00 €	2.000,00 €	2.000,00 €
TOTAL	**2.109,10 €**	**2.109,10 €**	**3.200,10 €**	**2.109,10 €**	**2.109,10 €**	**3.197,90 €**	**2.109,10 €**	**2.109,10 €**	**3.197,90 €**	**2.109,10 €**
TOTAL INVESTMENT				**24.359,60 €**						

Note 1: The number of cars Hba need to acquire is based on table 9. Without this new cars the RFID system Is not viable for the number of beds considered.

Note 2: The number of control points is equal to the number of *Copas*, and is based on data from table 9.

Assumptions for maintenance costs (based on Datelka report):

- 10% of tags “die” every year;
- The average life time of a tag is 3 years;
- Annual maintenance costs correspond to 5% of hardware initial investment;
- The average lifetime of a reader is larger than 10 years.

FLOOR	UNIT	# BEDS	# CARS NEEDED (Cook-chill)	# OTHER CARS NEEDED	# COPAS
0	Pedopsiquiatria	7	1	1	1
0	Psiquiatria	24	1	2	1
1	UC Intensivos	10	1	1	1
1	UC Intermédio	12			
1	U.T Obstetrícia/Ginecologia	21	1	1	1
2.1	U.T Médico-cirúrgicas	30	2	2	1
2.2	U.T Médico-cirúrgicas	30	2	2	
2.3	U.T Médico-cirúrgicas	30	2	2	1
2.4	Pediatria	10	1	1	
3.1	U.T Médico-cirúrgicas	30	2	2	1
3.2	U.T Médico-cirúrgicas	30	2	2	
3.3	U.T Médico-cirúrgicas	30	2	2	1
3.4	U.T Médico-cirúrgicas	30	2	2	
4.1	U.T Médico-cirúrgicas	30	2	2	1
4.2	U.T Médico-cirúrgicas	30	2	2	
4.3	U.T Médico-cirúrgicas	30	2	2	1
4.4	U.T Infectocontagiosas	10	1	1	
TOTAL		394*	26*[1]	27*[1]	10*
Current # of cars			13	13	
Number of cars to acquire			13	14	

TABLE 9 – NUMBER OF CARS NEEDED ACCORDING TO HBA UNITS, BEDS AND *COPAS*.

* This value is according to Hba building documents.

*[1] This value is based on distribution cars capacity, 24 and 22 respectively.

18. APPENDIX XI

REDESIGNED PROCESS

STEP	NAME	DURATION	WORKERS	LOCAL
BREAKFAST I circuit				
1.a	Printing	5 min.	1 Itau	*Escritório*
1.b	Breakfast preparation	90 min.	3 Itau + 3 Hba	From *Confecão de dietas* to *Copas*
1.c	RFID control	1 min.	1 Hba	*Empratamento*
1.d	Breakfast distribution	19 min.	3 Hba	*Escritório*
1.e	Cleaning	30 min	3 Itau	*Confecção de dietas*
1.f	Cars picking	53 min.	3 Hba	From *Copas* to *Lavagem de carros*
1.g	Cleaning	176 min.	2 Itau	*Lavagem de carros* and *Lavagem de loiça*
LUNCH circuit				
2.a	Cooking	165 min.	1 Itau	*Cozinha*
2.b	Dessert preparation	150 min.	1 Itau	*Pastelaria*
2.c	Dessert plating	185 min.	2 Itau	*Confecção de Dietas*
2.d	Plating preparation	175 min.	4 Hba	*Empratamento*
2.e	Plating	96 min.	4 Hba + 1 Hba	*Empratamento*
2.f	RFID control	1 min.	1 Hba	*Empratamento*
2.g	Lunch distribution	80 min.	2 Hba	*From Empratamento to Copas*
2.h	Cleaning	30 min.	1 Itau	*Empratamento*
2.i	Cars picking	82 min.	2 Hba	*From Copas to Lavagem de carros*
2.j	Cleaning	210 min.	4 Itau + 1 Hba	*Lavagem de carros and Lavagem de loiça*
AFTERNOON SNACK circuit				
3.a	Afternoon snack preparation	174 min.	3 Itau + 3 Hba	*Confecção de dietas*
3.b	RFID control	1 min.	1 Hba	*Empratamento*
3.c	Afternoon snack distribution	30 min	3 Itau + 3 Hba	From *Confecção de dietas* to *Copas*
3.d	Cleaning	43 min.	2 Itau	*Confecção dietas*
3.e	Cars picking	55 min.	2 Hba	From *Empratamento* to *Copas*
3.f	Cleaning	170 min.	2 Itau	*Lavagem de carros* and *Lavagem de loiça*

DINNER circuit				
4.a	Dessert preparation	160 min.	1 Itau	*Pastelaria*
4.b	Cooking	150 min.	1 Itau	*Cozinha*
4.c	Dessert plating	200 min.	2 Itau	*Confecção de Dietas*
4.e	Plating preparation	190 min.	4 Hba	Empratamento
4.f	Plating	130 min.	4 Itau + 1 Hba	Empratamento
4.g	RFID control	1 min.	1 Hba	*Empratamento*
4.h	Dinner distribution	90 min.	2 Hba	From *Empratamento* to *Copas*
4.i	Cleaning	30 min.	1 Itau	Empratamento
4.j	Cars picking	40 min.	2 Hba	From *Copas* to *Lavagem de carros*
4.k	Cleaning	190 min.	2 Itau	*Lavagem de carros* and *Lavagem de loiça*
SUPPER circuit				
5.a	Supper preparation	35 min.	1 Itau	*Confecção de dietas*
5.b	Supper distribution	---	---	---
5.c	Cleaning	15 min	1 Itau	*Confecção dietas*
BREAKFAST II circuit				
6.a	Trays preparation	150 min.	2 Itau	*Confecção de dietas*

FIGURE 10 - REDESIGNED PROCESS WORKFLOW DIAGRAM.

Note: New steps are emphasised with the blue colour and the transformed with pink.

IN SUMMARY:

CIRCUIT	# STEPS	CUMULATIVE TIME	TIME DIFFERENCE
Breakfast I	7	374 min. / 6 hours and 12 min.	24 min.
Lunch	10	1174 min. / 19 hours and 36 min.	79 min.
Afternoon snack	6	473 min. / 7 hours and 54 min.	109 min.
Dinner	10	1181 min. / 19 hours and 42 min.	59 min.
Supper	3	50 min.	0 min.
Breakfast II	1	150 min / 2 hours and 30 min.	50 min.
Total	37	56 hours and 42 min.	5 hours and 24 min.