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Dissertation

A Knowledge Management Architecture for Information Technology Services Delivery

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"We all need people who will give us feedback. That's how we improve."
(Bill Gates)

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List of Acronyms

KM	Knowledge Management
ITSM	IT Service Management
KMA	Knowledge Management Application
URLs	Uniform Resource Locators
W3C	World Wide Web Consortium
RDF	Resource Description Framework
SPARQL	SPARQL Protocol and RDF Query Language
OWL	Web Ontology Language
SKOS	Simple Knowledge Organization System
IC	Intellectual Capital
OM	Organizational Memories
KB	Knowledge Base
ERP	Enterprise Resource Planning
ITIL	Information Technology Infrastructure Library
CCTA	Central Computer and Telecommunications Agency
SKMS	Service Knowledge Management System
BI	Business Intelligence
OLAP	Online Analytical Processing
SLA	Service Level Agreement
KPIs	Key Performance Indicators
SLA	Service Level Agreement
BPMN	Business Process Model and Notation
UML	Unified Modeling Language

Abstract

Knowledge Management is a scientific area related to the organizational value of knowledge and is understood as a multidisciplinary field of research. Notions and practices are emerging and incorporated in organizations in different areas, as is the case of IT Service Management. Today's business environment is increasingly unstable, characterized by uncertainties and changes, where technology changes rapidly, competitors multiply, and products and services quickly become obsolete. In this context, management is increasingly focused not only on people management, but on the knowledge they have and how to capture it. An Information System aligned with Knowledge Management and Intellectual Capital aims to represent and manage explicitly the different dimensions associated with an organizational competence. If organizations integrate Knowledge Competencies, Knowledge Engineering, Information Systems and Organizational Memories, these will improve the organization's knowledge and subsequently improve the quality of the service provided to users and customers. This research will use Design Science Research methodology to create an artifact to be applied in a case study from an organization aligned with ITIL best practices. This organization is supported by an Intranet and an ERP for laptop repair process. The outcome of this dissertation aims to demonstrate if Knowledge Management improves the IT services delivery.

Keywords: Knowledge Management; Knowledge Engineering; Organizational Memories; Intranet Management; IT Service Management; Service Delivery

1. Introduction

This chapter provides an introduction to the research work accomplished within this Master's thesis, outlining Knowledge Management Architecture for Information Technology Services Delivery. The motivation for this research and the explanation of the necessity of the utilization and the presentation of knowledge generated by daily operations to improve the IT Service delivery, is presented. Problem definition of capturing tacit knowledge that derives from the services to transform it in tacit knowledge, to be reused as explicit knowledge is described. The Identification of the objectives aligned with the company management are expressed in goals to be achieved with this research. The methodologic process of Design Science Research Methodology is described and align with this research within a proposed solution to the problem exposed. Finally is described the document structure.

1.1 Context

Knowledge Management (KM) is a scientific area related to the organizational value of knowledge and it is interpreted as a multidisciplinary research field where many theoretical and practical notions are incorporated. This theme evolved considerably in the past three decades and research has developed new theories and approaches [1], [2] to understand organizational knowledge and its applications.

This dissertation focuses on KM in organizations, namely the advantages that it brings to the delivery of IT services. This topic is relevant, because the business scenario is currently experiencing a phase where competition is dominated by knowledge, expertise and innovation practices, the more knowledge the organization has the more competitive advantage it presents in any operations area. Knowledge has generated changes in the social space itself, over the years and consequently in organizations. Intense competition among markets requires organizations to be able to effectively develop and manage their human and structural resources, which translates into an improvement in their financial capital.

Therefore the ability of organizations to exploit their intangible assets has become more decisive than the ability to invest and manage their physical assets [1]. The market is increasingly unstable, characterized by uncertainties and changes, where technology changes rapidly, competitors multiply, and products and services quickly become obsolete. In this

context, management is increasingly focused not only on people management, but on the knowledge they have and how to capture it.

Tacit knowledge can be captured from the operation practitioners and made explicit so that can be saved for later re-use. This knowledge is recognized as an important strategic resource for any organization that wants to achieve a competitive advantage, and therefore successful organizations are characterized by their ability to create, share, incorporate and integrate knowledge in a consistent way, to manage it effectively [2]. Thus knowledge represents a valuable resource for organizations and the economy in general, because it promotes new ideas and new knowledge from the existing one, being virtually unlimited.

1.2 Motivation

The motivation for this research involves the necessity of the utilization and the presentation of knowledge generated by daily operations to improve the IT Service Management (ITSM) and service delivery. Organizations, most of the times, didn't capture this knowledge or did not manage it in the best way, thus having larger expenses with technological and human resources.

Due to the evolution of the nature of IT companies and the products and services they offer, it is necessary for organizations and their collaborators to continually develop skills to remain competitive. The development of abilities has become an ongoing process in large parts of the technology industry.

Organizational competence and intellectual capital is understood as the set of professional experiences, valences and heuristics of human resources both from the perspective of the individual, as well as from the perspective of the group and the organization [3]. In an organization, a competency is described by different semantic levels of representation according to different areas of application in the organization under analysis [4].

An information system for KM and competences aims to represent and manage explicitly the different dimensions associated with an organizational competence. In today’s reality, if organizations integrate knowledge competencies, knowledge engineering, information systems and organizational memories, improve the organization's knowledge and subsequently improve the quality of the service provided to the users and customers [5].

Consequently, this provides different levels of granularity associated with the ITSM knowledge domain. The ITSM function should be seen as a service organization that provides

IT services with the goal of building and delivering IT services, defined as a set of practices aligned with the requirements of the organization [6].

With this purpose, ITIL framework provides the best practices and general guidelines to the implementation of these processes. Since the significant data that is generated in the course of everyday IT operations creates valuable information when analysed, contextualized, and presented in a dashboard or report to provide knowledge, this knowledge could be used to support decisions makers [7], improving the service delivered to users.

1.3 Problem Definition

During the operation, new problems arise daily, related to the equipment hardware and software. In the course of the IT service delivery there are several different roles who deal with the same issues and find the solutions to these same problems, but unfortunately do not share this knowledge with the rest of the team. This issue derives in more costs to the organization and decreases the productivity of the collaborators and eventually reduces the quality of the service delivered to the customer. However, for IT teams, it is not always easy to explicitly register the solution to the problem, since once the cause of the anomaly is identified, several solutions can be found. It is in this context and in view of this need that the present research explores knowledge management associated with the delivery of IT services.

This thesis will focus on the capture of knowledge in the daily operation, how it can be captured, processed and delivered to users through the correct channels. The management of knowledge assets and their relationship with the management of IT services and human resources management allows a better strategic alignment of the organization [8]. This research wants to identify if KM improves the IT services delivery.

1.4 Objetives

This research objectives are, contributing to the understanding of how KM improves a company's internal procedures and external services delivered to customers. Identifying what are the advantages of implementation the KM model and how this will improve the IT service delivery throughout the organization. This research aims to contribute to the evolution of KM in the IT domain, in order to support ITSM and other professionals trying to improve the efficiency of the IT service delivery. This research will use a case study from an organization

supported by an intranet and an ERP for laptop repair, aligned with ITIL best practices. The following specific objectives are defined by the researcher and company management:

Table 1 - Research Improvement Objective

Objectives	2017 SLA Results	Research Improvement Objective
Total Average Time in days (TAT)	3,3	3
Repeated Repairs	2,6%	2%
Repair Turnaround Time (total days)	4 Days	under 4 Days
Parts used per Repair	1,2	1
Number of repairs made by technicians (per day)	10	12
Customer satisfaction index (0-5)	4	4,5

Table 1 represents the company's SLA with the last year's average of the service delivered to customers, detailing the objectives that should be met. These SLA were adjusted during the course of the research, as requested by the administration. This research's main goal is to understand if these objectives can be met with the implementation of the KM model through a prototype. Total Average Time (TAT) is the indicator that measures total days in repair without interruptions, this research aiming to improve 0,3 or more days. The repeated repairs represent 2,6% of the total number of repairs, this research aiming to decrease 0,6 % or more of this indicator. The Repair Turnaround Time represents the number of days that an equipment is under the repair process, this research aiming to decrease this to under 4. In indicator Parts use Per Repair, this research has the objective of decreasing it by 0,2%. The Number of Repairs made by technicians represents the productivity of the daily operation, the aim being an increase of 2 repairs per day. The last indicator, but certainly not the least important, is the Customer Satisfaction Index, a strategic indicator for the company, measured by an e-mail inquiry delivered to all customers when the repair process is finished. The established objective is an improvement of 0,5. These improvement margins would represent the impact of the KM prototype on the company's daily operations and on the service delivered to customers.

1.5 Design Science Research Methodology

Information systems are implemented in organizations with the aim of improving the organization. The capabilities of the information system, the particularities of the organization, its workflows, its people with their functions and their development and implementation together with methodologies, express how this goal is achieved [9].

Design Science paradigm has its principles in engineering and the sciences of the artificial. To solve information system problems, it is crucial to create new components that provide new ideas and practices, through which the analysis, design, implementation, management and use of information systems can be efficiently performed [10].

Like proposed by the author [11] the Design Research Methodology provides an understanding of how to conduct, evaluate, and present design science research to IS researchers and practicing business managers. This author proposed seven guidelines that will be aligned with this research, these are: (1) Design as an Artifact, (2) Problem relevance, (3) Design evaluation, (4) Research contributions, (5) Research Rigor, (6) Design as a search Process, (7) Communication of research. This research will follow the methodology and will focus in the main next steps, represented in table 2:

Table 2 - Methodology used to the research

Steps	Objectives
1. Design as an Artifact	. Create a Meta-Model of KM based on ITIL SKMS to support IT Service delivery. . Define a process model . Create prototype UML model. . Create a low functional prototype.
2. Design evaluation	. SLA´s analysis . Users Survey
3. Research contributions	. This Model could be used in future for other IT company and others, since the model should be replicable for different areas. . Prove that the introduction of the concept of knowledge management is important for organizations
4. Communication of research	. An article was submitted and approved in the conference CISTI'2018 - 13ª Conferência Ibérica de Sistemas e Tecnologias de Informação. . A second article will be submitted to a journal paper

This research's first objective is creating an Artifact, developing a Meta-Model of KM to support the IT service and delivering based on ITIL SKMS. Then this model will be instantiated to a specific case study, which will be a company that actually wants improve service delivery. This problem is relevant and considered strategic for the company, a solution based on technology will be provided through a model, to be used under the company's ERP.

To support the design evaluation, SLA´s from 6 months will be evaluated, 3 months before prototype implementation and 3 months after. A survey will be made to all prototype users, Technicians, administrative, and managers to understand if the developed artifact will improve the daily service operation and service delivered to customers. This artifact, aims to contribute to this specific company and others with similar scenarios and different domains, since the model could be replicated.

In essence, this will be contribution to this research area as a new model of IT KM. A rigorous alignment with Designed Research Method in construction and evaluation of the artifact will be followed by researcher. In order to communicate the results, an article was submitted and approved in the conference CISTI'2018 - 13ª Conferência Ibérica de Sistemas e Tecnologias de Informação, and a second article will be submitted to a journal paper.

1.6 Proposed Solution

The proposed solution aims to contribute for the evolution of Knowledge Management in IT domain to support IT managers and professionals, in order to improve the efficiency of the IT service delivery. This solution will be provided by a knowledge Meta-Model and a prototype, to capturing tacit knowledge for the organization system to improve the reutilizations of knowledge arising from the daily operation.

1.7 Thesis structure

The following document structure, initiates with chapter two, State of The Art, where topics related to Knowledge Management and its specification are identified and the subtopics described.

Chapter three Case study identifies the knowledge Meta-model, its process and design out of which the prototype's development and description derive from. Chapter four, Evaluation and Results, presents the evaluation and results of prototype implementation to understand if goals are achieved. Chapter Five Conclusions and Future Challenges, describes the research conclusions where limitations and future works are identified.

2. State of The Art

This chapter presents a literature review of the current state-of-the-art, which analyses information published around the topics of Knowledge Management, intellectual capital, intranet management, ITIL and Data Science covered by this Thesis. It provides a theoretical foundation for this research and identifies the work already developed by other researchers that are investigating in the same area.

2.1 Organizational Knowledge

Human knowledge can be seen as an outgrowth of a complex process that ranges from the issuing of information to the interpretation and apprehension of it by individuals within the framework of their innate aptitudes and the competencies they develop throughout life [12].

A pragmatic approach to define organizational knowledge is through the differentiation of what knowledge is and not is. One of the recurring distinctions in contemporary literature is distinguishing between knowledge, information and data. For [1] Data is a set of discrete, objective facts about events. In an organizational context, data is most usefully described as structured records of transactions. As represented in Figure 1, Information is aggregated data with importance and meaning which suggests that data by itself has a little relevance or purpose [13]. For example data can be defined as raw numbers, images, words, and sounds derived from observation or measurements.

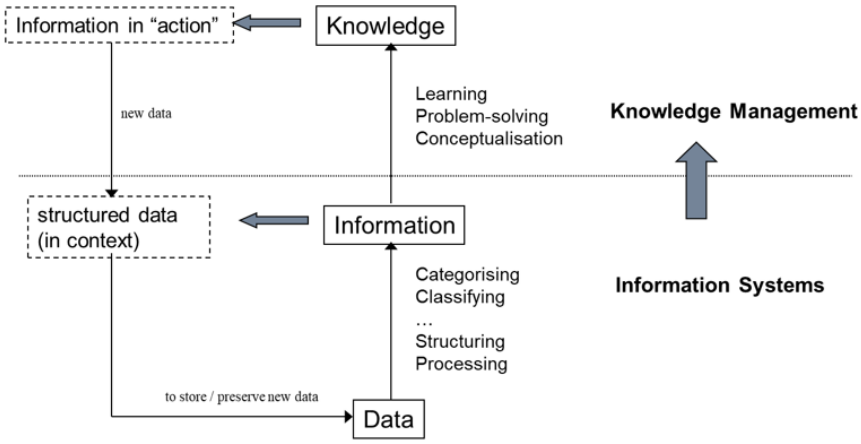

Figure 1 - Data, Information and Knowledge [14]

In comparison, the information represents the data grouped in patterns where some intellectual input was added, and organized with some propose. Knowledge can be understood as the analysis application, and execution of the use of information, that is, knowledge comes

from the addition of an intellectual layer interpreted with structured meaning, linked to other systems of knowledge already existing [15].

The author [1] describes knowledge as a fluid of framed experiences, values, contextual information, and expert insights that provides a framework for evaluating an incorporating new experiences and information. This knowledge often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms. This derives into a complex mixture of elements difficult to manage inside of the organization's context.

For [13] knowledge is dynamic, since it is created in social interactions between individuals and organizations. Knowledge has a specific context because it depends on a certain time and space. Without it being placed in a context, it is just information, not knowledge. For example, "Z30-C-138 "is just a non-context alphanumeric data set, meaning nothing. However, if we put it into a context, it becomes knowledge: " Z30-C-138 is this laptop's model, meaning it comes from manufacturer x, with ideal features to improve professional work".

Wisdom is on top of the knowledge structure and is related to the data or information, although the first concept is related with these two. The difference between these concepts is only often a matter of degree. The main difference is that wisdom exists within people and is an integral part, of human complexity and unpredictability. Wisdom involves the values and purposes of each individual [16].

2.2 Knowledge Management

KM is described as the process of creating, sharing, using and managing the knowledge and information of an organisation [2]. It refers to a multidisciplinary approach to achieving organizational objectives by making the best use of knowledge aligned to the new challenges of globalization.

This management is the process responsible for sharing perceptions, ideas, skills and information, and for ensuring that these are available to the correct people in the right place and at the right time. KM process enables informed decisions, and improves efficiency by reducing the need to rediscover knowledge.

Within KM there are taxonomies that specify some types of knowledge. The recurrent distinction is between tacit knowledge and explicit knowledge [17], but there are other types of knowledge as described in table 3. Tacit knowledge derives from an individual's own experience that determines self-thinking, that is, generates knowledge that is difficult to articulate. Most of the knowledge is initially tacit in its origin and developed based on

experiences over a long period of time, through a process of trial and error. For [18] some insights are embedded in business processes, activities, and relationships with stakeholders that have been built up over time by incrementing and implementing continuous improvements.

Table 3 - Types of Knowledge adapted by [7], [19].

Types of Knowledge	**Definition**
Tacit	Knowledge that individuals or groups possess, but that is not accessible to them consistently. This knowledge is acquired in the effort to understand something, by processes that are not directly controlled by the learner. For example, best means of dealing with specific suppliers.
Explicit	Knowledge that has been made explicit and, therefore, has been brought to a conscious level. Thus, not only does the person or the group recognize that they have certain knowledge, but can also convince others that it is so. For example, knowing the list of major suppliers in the region.
Implicit	Knowledge that individuals or groups have, that influences their action and reasoning, and that is shared by the culture and collective experience, but which has not yet been made explicit in order to bring it to the individual or collective consciousness. For example, insights gained from a completed work project.
Social	Knowledge shared by the group, in a conscious and nonconscious way. Defines with the group, how attach meaning to joint action. For example, norms for inter- group communication.
Declarative	Knowledge about something that applies the use of "That". It is all the knowledge that is based on facts and the information that the individual already knows. It is in this way that all knowledge is initiated, or any of the abilities of the individual is apprehended. For example, "that drug is appropriate for the therapy".
Procedural	Know-how which applies the use of "How". Technical knowledge on how to perform a certain task. It is the type of knowledge that allows the individual to know how to perform certain activities. This knowledge is acquired through the interpretation of the knowledge the knowledge that already exists. For example, "how to administer a specific drug".
Conditional	Knowledge for the understanding of the strategy "when" and "why". It is the knowledge that allows understanding the strategy, referring to declarative and procedural knowledge. This knowledge helps the individual to select and apply the two types of antecedent connection in

	order to reach their objectives. For example, understanding when and why to administer a drug.
Relational	Knowledge that sustains a particular relationship. It is knowledge that enables the individual to understand how a component and its properties interact with another component, for example, how a drug interacts with another drug.
Cognitive	Mental constructions about the external reality of the individual. Cognitive knowledge is a process of successive qualitative and quantitative changes in mental structures. The construction of knowledge occurs when actions that cause the disequilibrium in the scheme, take place. Consequently, processes of assimilation and accommodation are needed for construction of new mental structures.
Emotional	Automatic (human) responses to external stimuli. Emotional knowledge includes the ability to identify and name emotions through the recognitions of facial expressions, as well as, describe circumstances and causes that activate the emotions of the person and others.

Explicit knowledge appears in the form of words, phrases, documents, organized data, applications, and other explicit forms of information, that is transmittable in formal, systematic language [20]. These two types of knowledge referred to above, derive in the creation of organizational knowledge. The latter focus on the process of conjugation and distribution of the knowledge created by the individuals of the organization, as well as the implementation and connection to the knowledge system.

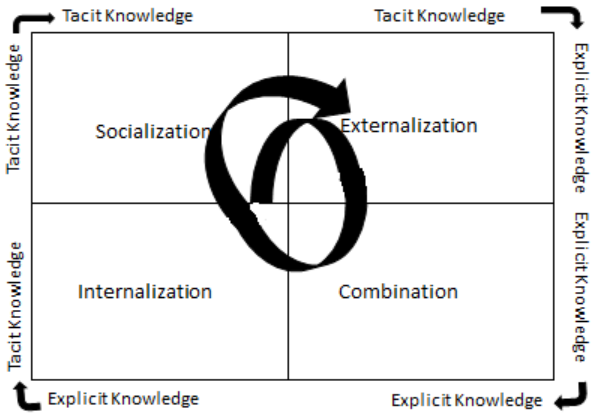

Figure 2 - Knowledge Spiral [18]

Nonaka's article [18] developed the theory of organizational knowledge creation to explain this process. The concept of "tacit knowledge" is a fundamental point in the theory of the

creation of organizational knowledge and encompasses all unconscious knowledge, intuition, and implicit rules. Tacit knowledge differs from explicit knowledge because it is captured, developed and represented by informational artefacts.

The concept of knowledge conversion explains how tacit and explicit knowledge interact throughout a continuous process, with the aim of generating knowledge with a high value for the organization that can be used and reused in the development of several projects that require the same type of information.

Figure 2 is the representation of the knowledge conversions proposed by [18] between four main areas: Socialization, Externalization, Internalization and Combination. This approach makes the assumption that knowledge is created through conversion between tacit and explicit knowledge with four different types of knowledge conversion, from tacit knowledge to tacit knowledge, from explicit knowledge to explicit knowledge, from tacit to explicit knowledge, and from explicit to tacit knowledge.

Although some academic research [1], [21], [17] has made significant progress in the development, testing and extension of organizational knowledge creation theory, on the other hand, some academic contributions have also raised questions about this theory and have proposed alternative approaches to understanding particular and tacit knowledge in organizations [22].

According to the author [20] Knowledge Management is the planning, organization, motivation and control of people, processes and systems in an organization, to ensure that their knowledge-related assets are improved and effectively implemented. These processes encompass the acquisition, creation, storage, sharing and use of this knowledge. The KM´s main function in the organization is to operate these processes, develop methods and systems to support and motivate employees to participate in this activity.

The objectives of KM are to develop and improve the knowledge assets of the organization to achieve better knowledge practices by all employees, promoting organizational behaviours in order to obtain better decisions and better organizational performance in general.

Although individuals can personally accomplish each of the KM processes, this management is largely an organizational activity that focuses on several aspects. Namely, what managers can do to enable KM goals to be achieved how these can motivate employees to participate in this activity and how they can create social processes. All of these will determine the success of KM.

These social processes include communities of practice where organized groups of employees share common interests and networks are established to enable those with less skills

to get in touch with people with more experience. These social processes are essential because the knowledge that initially exists for an individual is different from that which exists for another individual. Hence, for KM to be successful, knowledge must be transmitted through social groups, and networks supported by information systems.

Therefore, KM processes are more dependent on people and less technology-intensive than it would be desirable. Despite this, although a modern knowledge-driven company must support KM with the right information and communication technologies to raise its level of operation in the market [23].

2.3 Knowledge Management and Engineering

2.3.1 Ontology as a form of Knowledge Representation

An ontology is a form of knowledge representation and has a formal software specification to represent conceptualizations, thus, formally, an ontology has to be machine-readable. The concepts and constraints used in the ontology specification must be explicitly defined and the knowledge embedded in ontologies must have a consensual form of knowledge which is not only related to an individual, but also recognized by a group.

With this notion, [24] also describes that ontology may be extended, refined, modified, or even replaced, but the base form provides a foundation for methodical KM research, study, and practice. This concept also provides a basis for designing and investigating technological approaches to KM.

To [5] ontologies provide structuring and modelling in KM scope, for example in organizational memory, that integrates informal, semi-formal and formal knowledge in order to simplify its access, the sharing and re-usage of information by practitioners of the organizations provides solutions to their individual or collective tasks.

In this context, knowledge has to be modelled, properly structured and interlinked for supporting integration and personalized presentation to the customer.

2.3.2 Taxonomy for Knowledge Representation

A taxonomy is a type of ontology defined by controlled vocabulary in which each term is hierarchized from the widest to the narrowest with equivalent relations [25]. By its hierarchical nature, a taxonomy imposes a structure on the information. This concept defines that the broader and narrower terms are essential for an understanding of the hierarchy itself, facilitating its

navigation. For example the term "Vehicle" is broader than the term "car" or "motorcycle"; therefore, both terms are narrower than "Vehicle".

Thus the taxonomy can be used as an orientation to define strategies and implement KM systems in organizations [26]. For [27] the knowledge taxonomy can be defined in three perspectives, Taxonomy as a Classification Scheme, Taxonomy as a Semantic Model and Taxonomy as a Knowledge Map.

Classification scheme is a classification of schemes that are designed to set related things together, so that if the necessity to find one thing inside a category exists, it is easy to find other connected things in that same category [27]. Taxonomy is semantic in a way that it expresses the interactions between terms in itself. With this base the Knowledge map should allow for the immediate association and understanding of a knowledge domain for any user, thus being able to accurately predict where and how to access resources. The taxonomy should be broad, conjectural and easy to navigate.

Based on these three attributes, [28] classifying information becomes more significant as the quantity of items rises and people have more trouble remembering what they have and where to find it. Taxonomies [27] can be represented in various forms like Lists, Trees, Hierarchies, Matrices, System Maps etc. Table 4 is an example of a simplified taxonomy structure that represents conceptualization of a relationship between superordinates and subordinates expressed in a tree structure.

Table 4 - Relationship expressed in a tree structure adapted by [27].

Taxonomy	**Superordinate Term**	**Subordinate Term**	**Relationship Term**
Military rank	General	Coronel	Power/authority
Landscape	River	Douro	General : specific
Terrorism	ISIS	Abu Bakr al-Baghdadi	Group : member
Vehicles	Motorcycle	Brakes	Whole : Part
Disease control	Infection	Symptoms	Causality, sequence

Each of these attributes must be analysed for the most appropriate strategic definition of the organization and where it will be implemented. This management should have as main input the characteristics of the knowledge of the organization through its sector of activity.

Related with this topic the Ontologies provide a simplified and explicit discrimination of an abstraction that we wish to represent relative to a field of knowledge [29]. The ontologies are useful to taxonomies, because they clarify the components that define it, thus helping in the understanding and methodical modelling of this same abstraction.
In this research in the prototype development phase, simple taxonomies will be used to identify the product to which the generated knowledge will be associated.

2.4 Intellectual Capital

Intangible assets are increasingly needed to determine the success of an organization. The importance of knowledge is now an essential factor for growth and sustainable development in the global marketplace where organizations operate. To be competitive, organizations must be concerned and aware of the importance of the Intellectual Capital (IC).

The IC is defined by the collective knowledge of individuals in organizations which have significantly improved the competitiveness of the organization, adding value for their customers. This kind of knowledge can be used to create wealth and increase the production of assets and to obtain sustainable competitive advantages [30]. IC consists in the knowledge possessed, experience, organizational technology, customer relationships and professional skills [31].

For understanding what IC is, it is necessary to recognise that an organization has tangible and intangible capital. This tangible capital is what can be measured, for example the value of a product or the cost of fixed assets. Intangible capital is the result of the organization's informal activities such as interpersonal relationships, and the knowledge developed by the practitioners over the years of working, which tends to be ignored in the organization [4].

The IC includes the value of the organization knowledge's intangible assets, and ultimately intangible resources and capabilities. KM practices are a method to tracing and keeping tacit knowledge inside the business. The Author [3] identifies three types of core IC: Human Capital, Relational Capital and Structural Capital, with a fourth element that is the Social Capital. The Human capital is related to the knowledge, skills, and experience of the individuals required to provide solutions to customers.

The Structural Capital is related to the internal procedures, processes, and internal organizational structures that have evolved to enable the organization to function as it does, for example, standard methods or heuristics passed from person to person.

The Relational Capital is associated to the value of an organization’s relationships with its customers, suppliers, and others it engages with to accomplish its business, for example, its access to specific markets or resources [4] . The fourth element, Social Capital is described as the most important [22] as a Financial Value, because it is in this area that practitioners shared values and behaviours that establish the members of human networks and communities and makes cooperative work possible.

2.5 Organizational Memories

More and more managers are looking for the language of the organization's culture in order to make more precise decisions according to the planning. These managers seek to understand how employees share their knowledge, including their precepts, interpretations, and how they deal with and solve problems. The sharing of knowledge generated by the organization's employees are the precursors of the construction of Organizational Memories (OM), a powerful mechanism to manage the knowledge [32].

According to [33], organizational learning produces OM. This learning of experiences and accumulated knowledge, translates into a system that influences the members of the organization. When this instrument is used effectively [34], organizational memory supports businesses by avoiding mistakes and taking advantage of the lessons learned in the past to ensure continued use of best practices, and taking advantage of the collective shared wisdom for the present and future projects.

The OM as a conceptual model should reflect the ability to capture the information that should be archived, to hierarchize through taxonomies and categorize this information. The aim is to provide sharing mechanisms, in order to deliver the information to those who need it and to be used as an advantage to the organization. In his research [35] describes a structure of organizational memory, related to a set of components relative to the management of the organization. This model represents the key mechanisms that facilitate the process of knowledge sharing through an organizational memory.

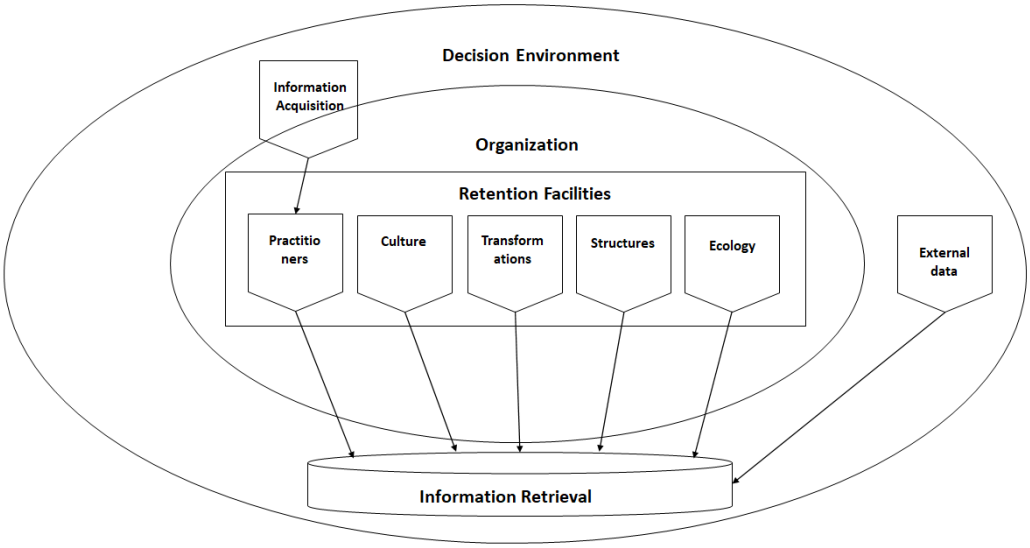

Figure 3 - Organizational Memory Structure [35].

Figure 3 represents an OM structure approach that puts into evidence three main features: information acquisition, information retention and information retrieval. Information acquisition, includes all the actions related to decisions and solved problems available to the organization's practitioners, which constitutes the basis of OM over time. Information retention represents the different elements inside the organization that can obtain information, such as: practitioners, culture, transformations, structures and ecology. Finally, informational retrieval includes the information that is derived from both outside (external data) and inside the organization, that is readily available for present or future analysis. This should occur in automatically or in a controlled mode.

2.6 Intranet Management

There are different definitions of intranet [36],[37], some more related to technological interpretation, such as an internal network of the organization itself with its associated infrastructure, others more related to the business support based upon internet technology. In this case the approach will be developed with intranet as a set and web-based applications and services that help support the organization's business.

A new vision of the intranet has emerged [36], with a focus centred on professionals and their needs, aligning directly with the business in order to sustain a workspace that supports daily operations. This type of thinking began to support in a more concrete way the communication of the collaborators and the management of the community. The more intranets

develop the more they support the organization's core process, supporting management and all legacy systems [37].

According to [38] the Intranets have completely changed their role from a more technological approach in 90s to a one-dimensional top-down channel for communication and dissemination of information that the author defines as virtual working space. Consequently, turning this into an integrated space where the organization's employees find what they need to work, learn and interact with each other.

Directly related to the concept of intranet, arises the extranet concept [39] if we consider the whole of a collaborative network. This type of platform allows strategic partners to connect over the extranet into an organization intranet, accessing specific content.

The extranet allows the development of a knowledge network, since it aggregates the information related to the business partners. This information generated with the interactions may translate into the organization as effective knowledge used to develop and promote the business [36]. An intranet supports KM in at least three different ways [40], providing compression of time and space among users, offering the flexibility to exchange information and supporting information transfers and organizational networking independent of direct contacts between users. In this way the organization's intranet should be used to capture the tacit knowledge of the specialists that interact with it. Thus, the Intranet should be used in order to aggregate the knowledge and create a network that allows integrating and storing the knowledge dispersed across all layers of the organization [38].

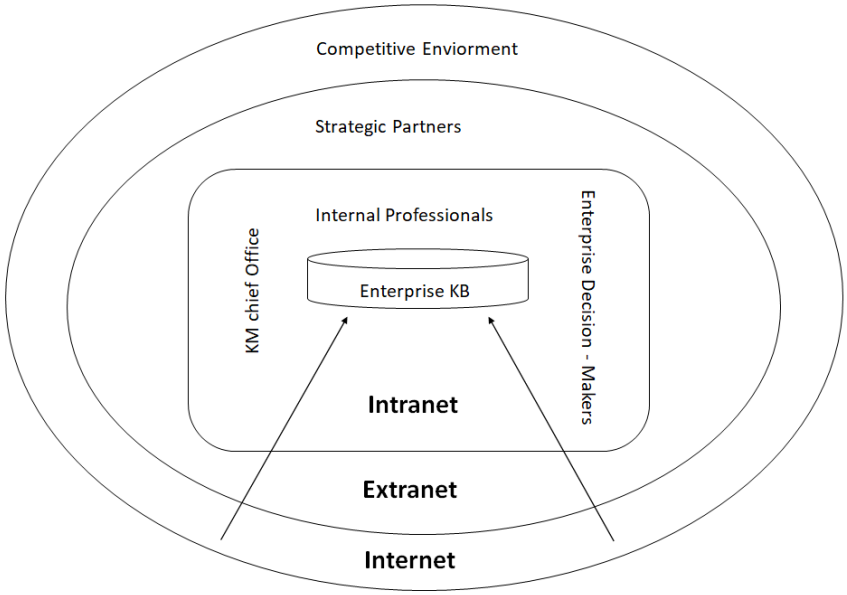

Figure 4 - The role of Intranet in the Knowledge Network [36]

Figure 4 represents the importance of the Intranet in the Knowledge Network. All of these layers represented, derive in the enterprise Knowledge Base (KB). The base of intranet is supported by the internet where a competitive environment exists for most of the economical players.

Internet is the vehicle for the next two layers. The Extranet layer is the middle layer that represent the strategic partners, who contribute with knowledge to the Intranet with different forms of collaboration. Partners can view information or update the platform with different forms of knowledge, tacit and explicit.

The internal layer represents the intranet itself where the internal professionals with interactions between systems and users are represented. The Knowledge Chief Office is the role or department which manages the information of the organization, represented in the Enterprise KB. Decision-Makers have the responsibility to make decisions based on the organization KB and other strategic variables. With the evolution of the intranet tools, with other tools like the ERP, it will become possible to integrate them in a unique platform. In the future the internal professionals will only use one central platform to work with, that will be the organization Portal [38].

2.7 ERP and Knowledge Management

The Enterprise Resource Planning (ERP) is a crucial information system for today's organizations[41]. With this system, organizations can manage their supply chain processes in an integrated way. This information system facilitates the integration of processes and data internal and external to the organization in order to sustain all business transactions [42].

ERP systems consist in several different modules, such as the supply chain, production, financial services, among others, integrated to promote a symbiosis of processes with the aim of facilitating decision making [43]. Despite their high cost of implementation and customization, many small and large organizations stand out for implementing them because they can better [41] manage their resources.

Knowledge Management is a mature process of information management [44]. The relationship between these two concepts is their common concern for knowledge. Both concepts aim at a shared knowledge across the organization with the objective of developing the business as a supply chain of added value.

Some authors [42],[45] investigated the possibility of compliance between KM and ERP and concluded that ERP as a tool satisfies the competitive advantages of organizations through

critical information that is produced, shared and managed by the organization's employees. It promotes cost reduction, control of resources and improves decision quality, based on these same variables. The KM in turn emphasizes how an organization can improve its competitive advantage more effectively, building on its main resource, the know-how.

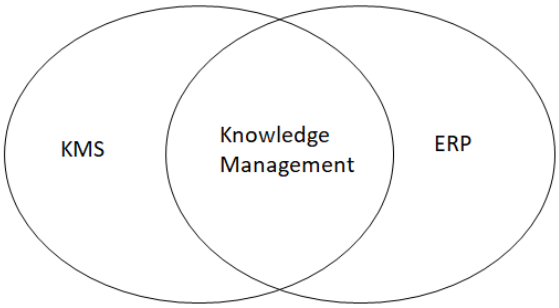

Figure 5 - Integration of ERP and KM adapted by [42] ,[45].

In the study of [42] is revealed a difference between these two concepts in their orientation. KM systems focus on innovation and flexibility, while ERP focuses on efficiency and flexibility, with flexibility in common. Thus, the author suggests that ERP and KM complement each other, it enables an improvement to the business process. As represented in the figure 5 KMS and ERP should be integrated to facilitate the management of knowledge trough the organization.

In the study of [45], the relationship between KM and ERP competencies was also explored. This study, also suggested a positive and significant relationship between both concepts. The author analyses factors such as the quality of systems, the quality of information, the impact of the individual and of the organization. These factors associated with KM competencies such as knowledge creation, retention and transfer, suggested strong evidence of improvement in the outbound cycle of KM with the integration of an ERP.

This evidence of integration of both concepts suggests a principle to improve management of IT services delivery as a complement to the existing tools in the intranet.

2.8 IT Service Management

According to [46] Service Delivery, covers the service that business requires of IT, to enable adequate support to the business users. This includes processes for service-level management, availability management, capacity management, financial management for IT services, and

continuity management.IT Service Management (ITSM) manages the IT function as a service function. This contrasts with technology-centric approaches to IT operations. There is no exact definition for the role of ITSM, but the concept is represented in several books, articles and white papers as referred in [47]. IT service providers can no longer focus only in technology and in the internal organization. In Today's reality the role of ITSM must consider the quality of the services and the relationship with customers. The IT function should be seen as a service organization that provides IT services to a company with the goal of building and delivering IT services, defined as a set of practices aligned with the requirements of the organization [6]. The first version of Information Technology Infrastructure Library (ITIL) was developed during the 1980s by a British public body entitled as the Central Computer and Telecommunications Agency (CCTA). This version of ITIL has grown from a collection of best practices observed in the industry. The second version of ITIL, released between 2000 and 2002, has become so popular that ITIL is now considered the standard for ITSM. The third version of ITIL, published in 2007 and later revised in 2011, explains in five volumes the various tasks that an IT service provider must perform [47].

ITIL describes [48] how an IT service moves throughout its lifecycle, how it should be planned and built, and how the IT service and related changes must be validated, tested, and implemented. It should also describe how events and requests for IT services should be handled. Also, verify how the basic configuration that supports the IT service must be controlled and how the operational problems must be solved.

The ITIL framework is a benchmark of best practices compiled from the study of different public and private sector organizations worldwide. The goal of the framework is to provide high quality services, essentially for ITSM. There are two main reasons for the change in ITIL implementation. The first reason is the increased focus on customer service and the second reason is the increased interest in IT governance in an effective and transparent manner [6]. ITIL has proven to provide many benefits [49], such as cost savings, adequate risk management and rationalization of IT services.

ITIL provides only general guidelines on the processes to be implemented. As such, many IT managers had questions about the best implementation practice, often heavily reliant on consultants and suppliers [50]. Another common challenge in implementing ITIL is the resilience it receives from staff due to mismanagement of change. To overcome or at least reduce the limitations and setbacks of implementation, there must be adequate change management aligned with organizational culture.

The framework as described in table 5, is organized in five phases with a several topics around the life cycle. It includes service strategy, service design, service transition and continuous service improvement that allows for the provision of a service that meets the needs of customers taking into account IT capabilities, business requirements and operationalization. Efficiency, customer satisfaction and trust are key factors [49] in running a service.

Table 5 - ITIL framework Phases and Topics adapted by [49].

ITIL Phase	**Main Topics**
Service Strategy	. Financial Management . Service Portfolio Management . Demand Management . Strategy Generation
Service Design	. Service Level management . Availability Management . Capacity management . Supplier Management . Service Catalogue Management
Service Transition	. Change Management . Knowledge Management . Release & Deployment Management . Service Testing & Validation . Configuration Management System
Service Operation	. Problem Management . Event Management . Incident Management
Continual Service Improvement	. Service Improvement . Service Measurement . Service Reporting

The ITIL framework main objectives are to reduce costs, reduce risks, increase quality and productivity, and improve decision-making capacity.

Service Knowledge Management System (SKMS), as described in ITIL Service Transition, defines the best practices in transition planning and support, change management, asset management and service management, release and deployment management, service validation and testing, change assessment, and knowledge management. Service Transition provides guidance on how to manage complexity related to changes in services and service management processes while avoiding unwanted consequences while enabling innovation.

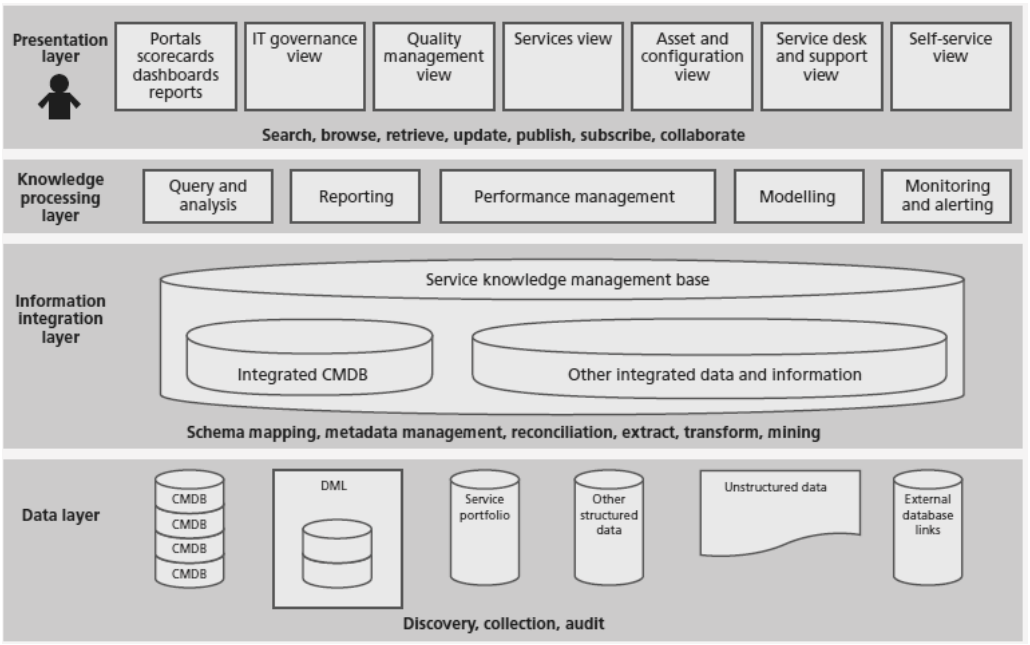

Figure 6 - Architectural layers of an SKMS [51]

Figure 6 represents the architectural layers of SKMS, composed by four layers. The Data layer is where the data is collected and stored from multiples sources. Information Integration layer is represented by the SKMS Database where information is mapped with schemes and where the information is transformed by mining models. Knowledge Processing Layer is where the knowledge is generated with query's analyses, models and reporting tools. Finally the Presentation Layer is where the knowledge is presented to the user by different tools with different views, depending on the role that the actor is operating. Those views should be enriched and supported by dashboards reports, to facilitate the analysis. This knowledge, arising from the analysis, may become wisdom when combining individual experiences applied in problems difficult to solve, with the goal of developing a single integrated solution to register in the knowledge base of the organization, so that it is not lost and can be reused in similar problems that may occur.

2.9 Data Science and Business Intelligence

The concept of data science was initially proposed by the scientific community of mathematicians and statisticians, where their main focus was on analysing the data [52]. Nowadays, this concept has evolved and has become more widespread in other scientific areas such as Data Mining, Machine Learning and Business Intelligence (BI) [53].

It has become a transversal discipline that builds and synthesizes a great number of disciplines and their body of knowledge.

The complexity of the data in these days is a very present reality in organizations. It is a reflection of current circumstances that includes features such as large-scale data with large dimensionality (often online), where real-time analysis is required (with a high availability), often required in data analyses that sometimes are considered critical. Data science is a type of scientific intelligence [52] with the goal of transforming data into knowledge through types of intelligence so that they become wisdom.

Organizations generate a large amount of data, in which much is not used in the decision-making process. Transforming this data into knowledge can increase profits, reduce costs and make management more effective [54].

For this reason it is increasingly necessary to integrate data science solutions such as BI into the decision-making process of organizations.

The BI concept is the result of a series of innovations over the years. Its antecedents are the early decision support systems. Each iteration [55], was more refined than the one before it. Today, software brings all of these components organized in a single system.

A data warehouse, that represents a central role in BI, is a repository specifically constructed to consolidate the organization's information into a valid and consistent format, allowing its users to selectively analyse data.

The BI concept integrates data warehousing activity, including predefined queries, ad hoc queries, and reporting, which typically allow the monitoring of the evolution of key business drivers throughout the organization's life cycle [7].

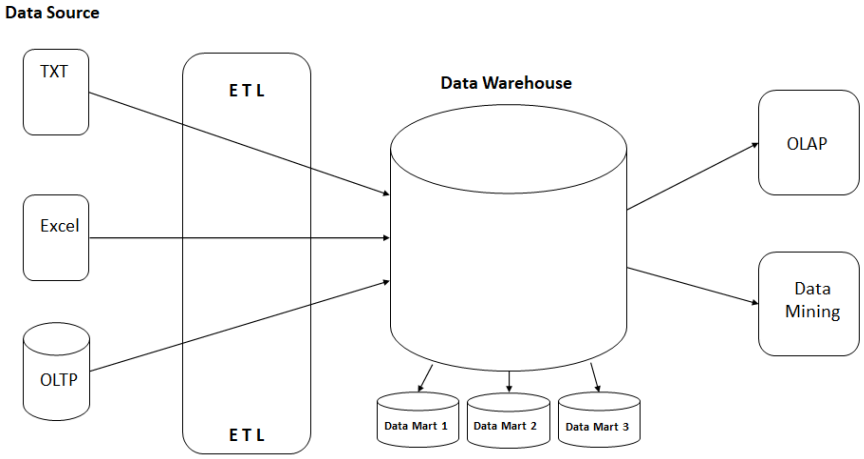

Figure 7 - Data Warehouse Architecture [7].

The Data Warehouse Architecture represented in figure 7 describes the process, the data is extracted from various repositories, different databases, excel sheets, etc. Then the data is transformed with the defined tune and converted into field and record standards. Finally the Meta-Data in the Data Warehouse is loaded to OLAP cubes or Data Mining tools to analyse data and extract intelligent knowledge to the organization's decision makers in the form of queries, reports or dashboards [56].

If BI relies on data that can be converted into information and then into knowledge [57], one of the main objectives of ITSM is the definition of Service Level Agreement (SLA) and key performance indicators (KPIs). This type of data should be analysed with BI tools [54], to extract information from the operation process, improve the effectiveness of the process, and manage future actions to align with customers demands.

3. Case study

This chapter describes how the research is conducted, starting with the Knowledge Meta-Model, that provides the basis to the BPMN process. UML software design is also described in order to support the prototype creation. This chapter also analyses the prototype functions integrated in the main system that is the ERP used by the company, were this case study is applied. This software artifact tries to prove the concept exposed in the proposed solution identified in chapter one and provides results to be analysed in the Evaluation and Results chapter.

3.1 Organization Overview

This case study is developed in a Portuguese company that provides IT services solutions. This company has 23 years of experience in the Portuguese market with national level coverage and competencies in the areas of computer equipment assistance services, micro-soldering, complementary solutions, equipment, accessories, as well as optional equipment and training.

This company invests in quality services, which are implemented through the continuous selection of products, process and methods, as well as the training of technical and commercial teams that are considered the company’s main capital. This company is a Computer Systems Authorized Technical Assistance for a well-known Japanese hardware brand, having in the team certified technicians with extensive experience.

3.2 Knowledge Meta-Model

This model represented in figure 8 was inspired and adapted from the ITIL SKMS [51] and represents four main layers, which are the Data, Information, Knowledge and Wisdom. Those layers are segmented in five sub-topics, each one having specific components that represent how the service should be delivered, with the goal of supporting decision makers.

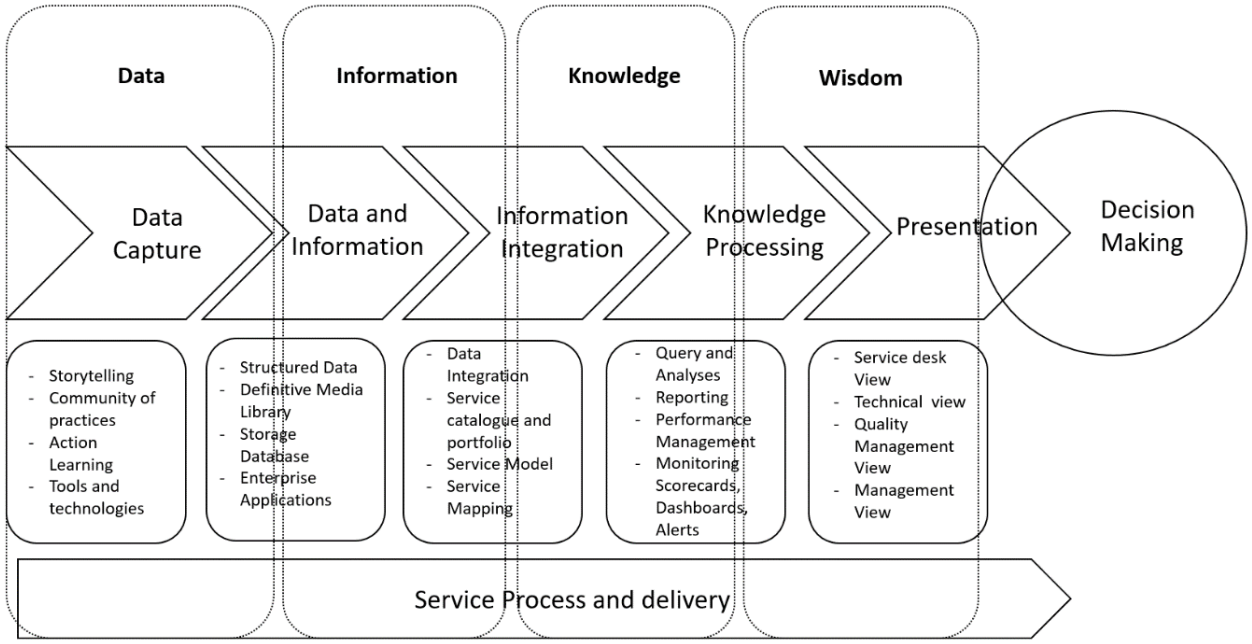

Figure 8 - Knowledge Meta-Model adapted by [51]

The five sub-topics will be described in detail in the next sections, in order to specify the utility of the model and the possibilities of instantiation for IT service delivery. This model has a focus in the IT area but could be replicated in other domain areas.

3.2.1 Data Capture

This topic is integrated in two different layers, Data and Information which provide the first input to this model by capturing the tacit knowledge from the field technicians that deals with the problems in a daily base. Capturing this data will provide the benefits described in the following topics by enriching the quantity and quality of data to be analysed as well as transforming it into knowledge and wisdom , in order to support decision makers.

Storytelling is a basic form of data capture by sharing stories of experiences occurred in the operation process that allows all practitioners to understand what is happening in previous and actual projects. This will allow the group to know the issues and how they are solved by the projects' practitioners.

This should be present in all areas of the company, creating a culture that will enrich the knowledge management process. Different ways could be used to capture stories. For example, internal templates structured to be a standard, will allow for better understanding further facilitating the specification of the data. The promotion of workshops with specific themes is another possibility to capture data through this component.

Community of Practices consists in the promotion of interaction between members which pursue a common practice between them. This will allow a collective and social practice across the organization departments, in order to promote the community interactions. This interaction could occur informally or explicitly by meeting or events organized by the same community. Once more this should be a part of the organization's culture.

The implementation of these practices and the establishment of communities like the IT Community of Practices or other related communities, should allow the capture of more specific data and knowledge from the individual. This will help practitioners aid each other with the sharing of their tacit knowledge. A person inside the organization like the service manager or department responsible, should be the leader of the community to ensure a well-functioning knowledge sharing mechanism.

Action Learning topic consists in a powerful organizational tool that will work through a group of a few participants from diverse backgrounds and areas who are assembled to solve difficult and urgent problems. While Action Learning group works to find innovative solutions to a specific problem, this group of practitioners also develops leadership and group competencies effectively. This symbiosis in knowledge capture, allows solving and simultaneously capturing knowledge for future projects.

This team of Action Learning should be composed by different practitioner's roles in the IT domain of the company, this procedure warranty different perspectives about the problem. With this approach, service should be delivered more quickly and with more consistence since different approaches are considerate to solve the problem. This new data arising the solved problems will be an important input when introduced in database.

Tools and technologies consists in a set of web 2.0 tools and technologies that should be used to capture data and disseminate knowledge through the organization. Forums and wikis are the selected tools for this specific domain. Those tools are available on the company's

intranet and are linked to the ERP support component. This allows exchanges of experiences among the practitioners that will improve the data capture and the service delivered to the customer by the structuring of this same data in the next steps.

The forum provides interactions between all practitioners from this area and a discussion overview for all company departments. A taxonomy of the topics should be well defined and categorized to promote rapid access to data to those who need it. Knowledge Managers have the role of organizing the structure of the forum, defined on the specific community of practice related to this topic. The forum moderation is also a role of the knowledge Manager with the Service Manager support.

Wiki is a tool to be used within the company intranet based on web pages whose contents can be edited by multiple practitioners, normally by the technicians. These content pages related with the repair process, should be developed through the collaboration and experiences, of those who can add, modify or delete information related to repair process. The wiki format is very useful for dissemination of knowledge and for teamwork. These wikis should include a history of changes making it possible to track back to an earlier stage, in order to correct any mistakes as well as to track who made which changes.

3.2.2 Data and Information

This topic is directly connected with the last, because is integrated in the same layer, Data and Information. At this phase data is explicit in files and documents and persisted in the databases used by company. The knowledge Manager is responsible for the transition and the assurance of the quality of data registered in the databases.

Data needs to be well organized based on the taxonomies previously defined, in order to be easily accessed. Service Portfolio is the database where all services are registered and described. Old, actives and under devolvement services are detailed to provide a clear view for all stakeholders.

The configuration management database (CMBD) is related with IT assets normally referenced as the Configuration Item (CI) derived from the company's operation and all of their interactions. A CI can be any IT component, including software, hardware, documentation and personnel, as well as any arrangement between them. These components provide the understanding off all assets like the ERP and other information systems presented in company, like systems that storage events occurred through the IT infrastructure.

3.2.3 Information Integration

This topic is incorporated in two different layers, Information and Knowledge. Integration is the keyword used in this topic, providing knowledge for the organization through data integration from different databases. Those databases are from the ERP and other applications used by the IT service. Service Portfolio and Catalogue are also presented in this layer. Catalogue is where all active services are listed and available to users, representing services that IT and technical department presently offers. With this type of register, users can interact with the help desk and technical department, requesting services that are well documented and defined.

This allows systems for user requests that provide the necessary tracking, normally with tickets in order to get requests taken care of more effectively and rapidly, ensuring the quality of the service. Service Portfolio provides the complete list of IT Services and products, which includes the retired and active services.

In this domain, service Model and Mapping are also integrated. The service Model not only describes how the service creates value for the company's portfolio, verifying the demand needed for each customer, but also introduces a dynamic structure for the service. Model could include activity patterns, workflows diagrams, process maps and others. Service Mapping is integrated in this topic by mapping all services with business services, applications and CI´s.

3.2.4 Knowledge Processing

This topic is integrated in two different layers, Information and Wisdom. In this stage data is processed in different forms, the first form being that of knowledge, in order to support decision makers in the organization. Queries and analyses are made from the integrated databases to identify important knowledge that derives from the all previous stages.

This knowledge also arises in a form of reporting, normally in a daily basis to ensure the services and repairs are under the SLA defined by the service provider. Some software benchmarks should be configured to monitor the operation performance, this will provide knowledge for the Service Manager to mitigate the risk of low performance in critical services throughout the organization.

Monitoring scorecards and analysing services performance dashboards are crucial to make important decisions. This will provide knowledge to decision makers as, at this stage, this provides support for the service manager to achieve the expected SLA results previously agreed

with the customer. To avoid difficulties in the analyses, given the large volume of data after the services are active, several alerts should be configured to, once more, support the risk mitigation as well as the application of corrective measures.

3.2.5 Presentation

This topic is represented in the Knowledge and Wisdom layer, being the last stage that provides the visualisations needed to support the decision makers in a more direct way. This could be considered the materialization, in the form of visualization, of the combination of all previous layers. All knowledge views like service desk, technical, quality and management should be available to the ones who need it. Security policies must be defined to assure that the right information is only available to the correct rules.

The platform of these visualizations could be the organization's intranet or the ERP or the combinations of these two, where linked knowledge could be provided to assure the quick delivery of knowledge. The form of how knowledge is presented is crucial, because it could determine the operation's performance. Service Desk and Technical Department should have different visualizations oriented to service and customer support. Quality Management should look towards the Service Desk and technical department for support, in order to ensure the quality of the service provided. Otherwise management should have a simple and clear view of the operation and a more complex and detailed one of the act of managing. This visualization shall provide a holistic view to help in the decisions that will support the service continuity.

This Knowledge Meta-Model will offer a guideline to manage knowledge under the service and help the teams to access the recorded knowledge and generate new, ensuring the premises of continuous improvement. The final result is a more knowledgeable and effective support to teams, so they can quickly process incidents' reports and find solutions to provide a superior customer service.

This Meta-Model will be used as a base for the design of service model, presented in the next topic. This Process will determine the service delivery workflow and the way that tacit knowledge should be captured. Design key points are identified, pointing where this same knowledge shall be captured, in order to feed the knowledge Manager so he can transform this knowledge into explicit knowledge and present this information in the prototype.

3.3 Service Model

This model describes the flow of the repair process, designed in BPMN, represented in figure 9 and in Annex A. This process was redesigned from a previous one, already implemented in the organization, with the objective of defining the knowledge capture points in the process flow, in order to acquire new knowledge under the technical department process.

This model has different actors and rules, which are the following: Call Centre Support, the entity responsible to provide phone support to customers and warranty service request; the manufacturer, who develops the products associated with the service, provide technical solutions and systems to support the repair service; the Assistance Service Provider (ASP), which is the service owner represented by three different roles, an Administrative Department who is responsible for all non-technical activities, a Technical Department who is responsible for all technical activities and the Knowledge Manager who is responsible for managing the data and information acquired from the technical department. The customer is the one who delivers the equipment for repair and finally the Prototype, which is the system that provides the knowledge to technicians in the repair process.

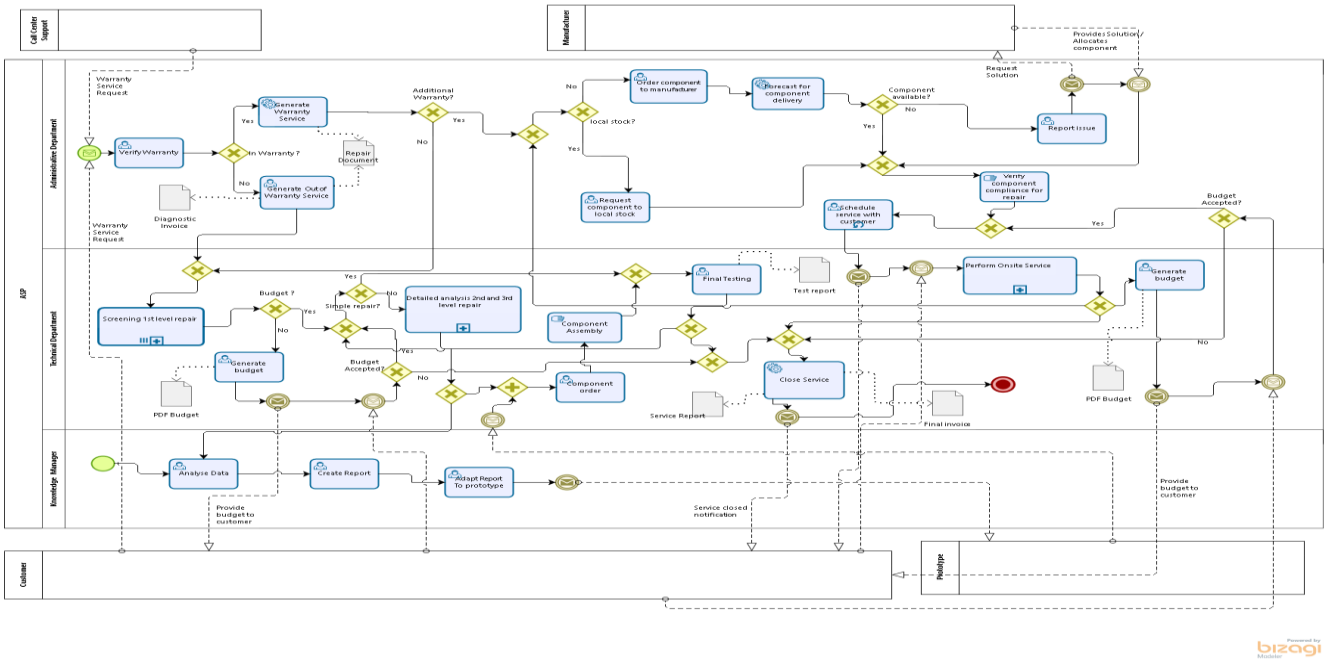

Figure 9 - Repair Process BPMN Model

Changes were made specifically in the organization's core activities with the sub-processes represented in the flow. Those core activities are the Screening 1st Level Repair and Detailed

analysis 2nd and 3rd level repair. This Screening 1st Level Repair sub-process represented in figure 10 is where the first analysis of the equipment starts. The malfunctions could be solved or not in this activity. The Flow starts with the identification of the problem reported by the customer. In this activity the technician should check in the Knowledge Base if there is a similar problem already identified.

If the problem is still not reported, the technician should report the problem immediately to the Knowledge Manager. In case the problem is already reported and identified in the Knowledge Base, the repair should proceed through the normal flow. In case the technician has a different solution than the one already registered, he should also report to the Service Manager. The next step will be the final Quality Test, this validation being considered as a fundamental point of the process by the organization. In case the final test is performed successfully the service is closed. In case the test fails, the technician must simultaneously validate the repair performed and re-test to identify the problem. If the malfunction continues to manifest itself, the service should be forwarded to the next level of repair. In case the malfunction is solved the service is closed.

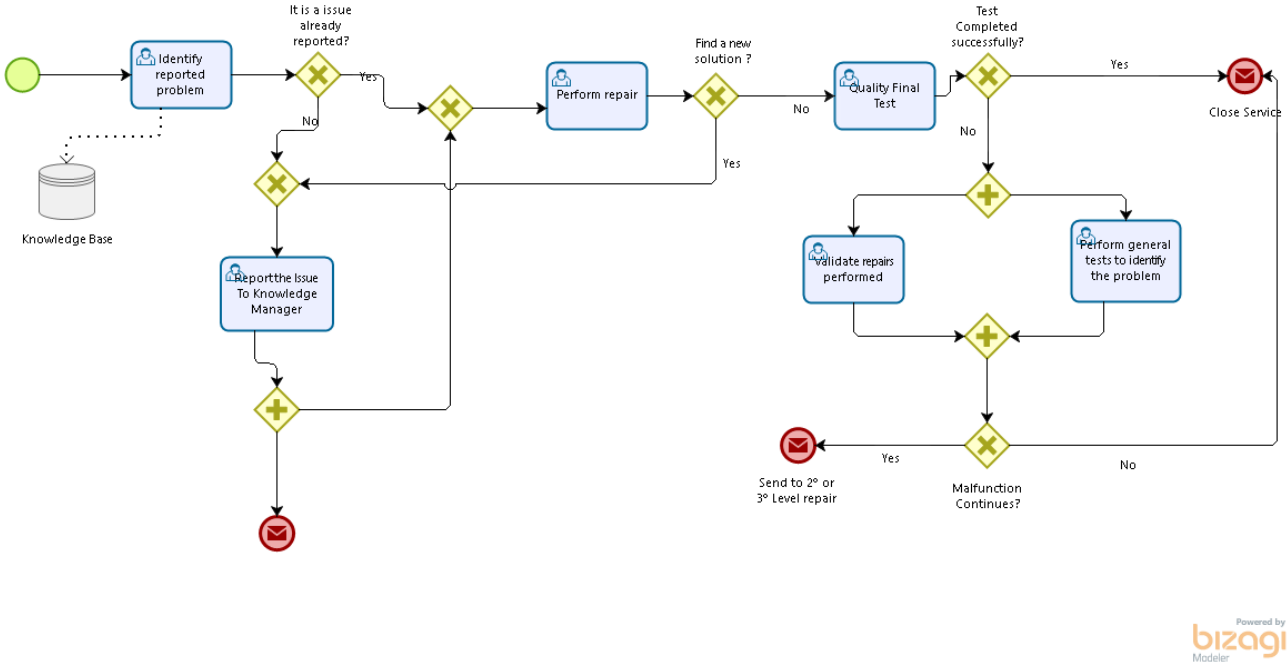

Figure 10 - Screening 1st Level Repair Sub-Process

The Detailed analysis 2nd and 3rd level repair is where the most complex malfunctions are solved by technicians. This sub-process represented in figure 11 starts with the identification of the

problem reported by customer. In this activity the technician should check in Knowledge Base if there is any similar issue identified. If the problem is not reported, the technician should perform a detailed analysis to understand the origin of the problem and provide a solution considering the SLA associated to service.

Then the Technician shall check if there were any similar problems reported in the last week, which should be verified in the ERP incidences monitor. In the case of registration, the process should be forwarded to the Knowledge Manager with a Technical report. In case there is no incident reported, this should be registered in the ERP for future consultation. The next step will be the final quality test, which will focus in the malfunction repaired and all other components identified by the manufacturer, as a quality assurance. In case the final test is performed successfully the service is terminated. In case it fails, the technician must simultaneously validate the repair performed and re-test the equipment to identify the problem. If the malfunction persists the service should return to perform repair activity, in case the problem is solved the service is closed.

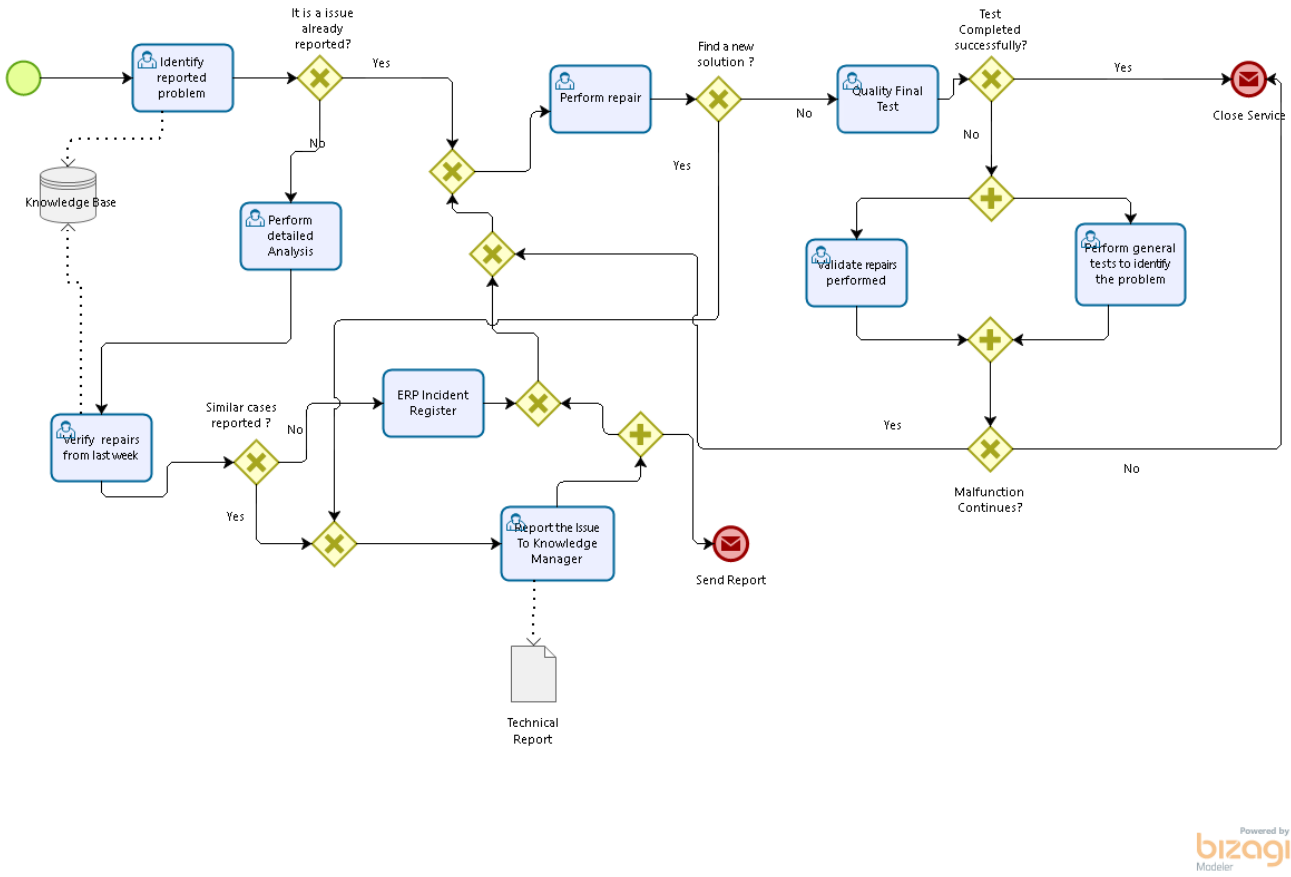

Figure 11 - Detailed analysis 2nd and 3rd level repair process

3.4 UML Software Design

3.4.1 Context Diagram

This diagram represents the high level scope of the software development, actors and their interactions with the system and finally, it describes what the ERP knowledge Model is, in order to facilitate the understanding of the system and its environment.

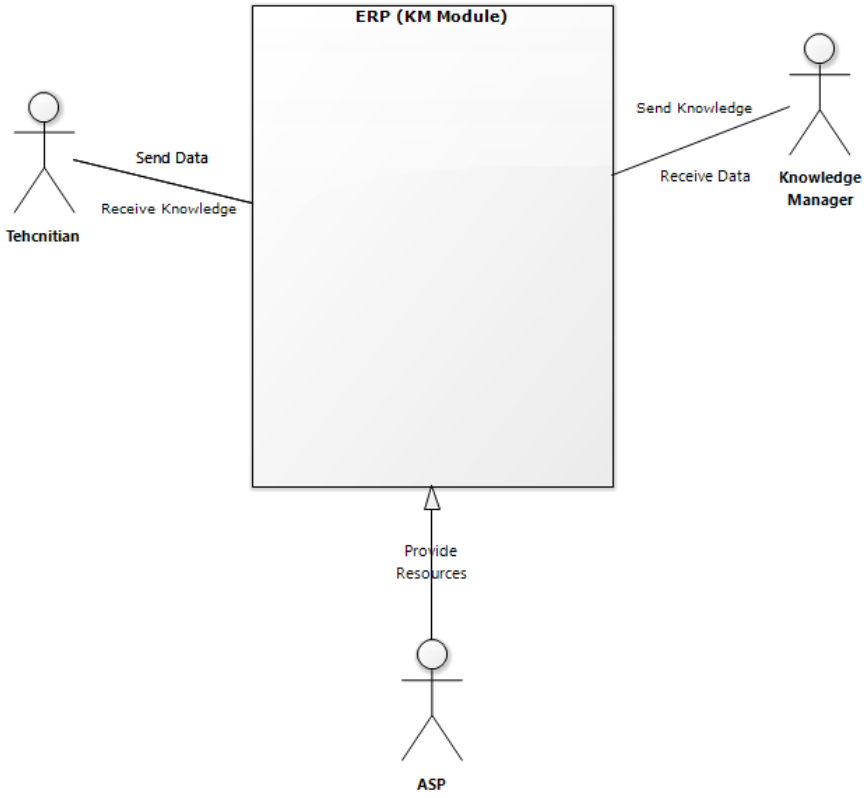

Figure 12 - Context Diagram

A Technician is an actor that introduces data or tacit knowledge into the system and receives knowledge. A Knowledge Manager is also an actor, receiving data from the system and introducing explicit knowledge in various forms, such as reports and technical documents. An ASP is the sponsor of project, providing the necessary resources for the development of this project, such as financial and human resources.

3.4.2 Software Requirements

These Functional and Non-Functional requirements derive from a detailed elicitation between Technicians, Service Manager and Knowledge Manager. Several meetings and discussions with the researcher took place, in order to pinpoint the main requirements of the prototype, which are considered the main functions of this module.

3.4.2.1 Functional Requirements

Those Functional Requirements describe the functions that software modules shall execute, for example, authentication, introduce and search data. Those are described as capabilities or features from this prototype in table 6.

Table 6 - Functional Requirements

#	Name	Description
FR01	The system should allow authentication	The system should allow technicians authentication by a 10 digits alphanumeric password.
FR02	The system should allow introducing data	The system should allow introducing data based on equipment taxonomy and information provided by the knowledge manager like technical documents and support information.
FR03	The systems should allow data searches	The systems should allow data searches based on equipment taxonomy.
FR04	The system should allow the monitoring and visualization of the knowledge information.	The system should allow the monitoring and visualization of the technical information on the main screen
FR05	The system should be able to relate information	The system should allow a field with related information based on the defined taxonomy.
FR06	The system should allow access to maps and reports.	The system should allow access to knowledge maps and reports to identify relations between knowledge.

3.4.2.2 Non-Functional Requirements

Non-Functional Requirements are the ones that act to constrain this prototype solution. These type of requirements were identified as constraints or qualities of this module according the purpose of this development. Those are detailed described as capabilities or features from this prototype in table 7.

Table 7 - Non-Functional Requirements

#	Name	Description
NFR01	The system should generate visual alerts	The system should generate visual alerts, particularly in the colour of the letter to alert users of important information.
NFR02	The system must persist the information in database.	The system must persist all data in SQL relational database.
NFR03	The system should allow printing	The system must be able to print the field information with the description of the technical information.
NFR04	The system must allow data to be exported	The system must allow data to be exported to various formats pdf, excel, word.
NFR05	The system shall allow the use of filters	The system shall allow the use of filters to explore data, order and filter by different parameters.

3.4.3 Traceability Matrix

This matrix represented in table 8 shows the traceability of the functional requirements and use cases. This matrix traces the primary functions on the test phase to verify if the requirements are fulfilled and if those are aligned with the project specifications.

Table 8 - Traceability Matrix

	FR01	**FR02**	**FR03**	**FR04**	**FR05**	**FR06**
UC01	**X**					
UC02	**X**					
UC03			**X**			
UC04			**X**			
UC05		**X**				
UC06				**X**		
UC07					**X**	
UC08				**X**		
UC09				**X**		
UC10						**X**

3.4.4 Use Cases Diagram

This diagram represented in figure 13 describes the system behaviour and the interactions with the actors. Two actors are represented, Technician and Knowledge Manager, who both have to perform an authentication through an alphanumerical password in the system, to align with company security policies. The Knowledge Manager shall search repair history and select data from the system to analyse which information is pertinent and to introduce it in a technical document.

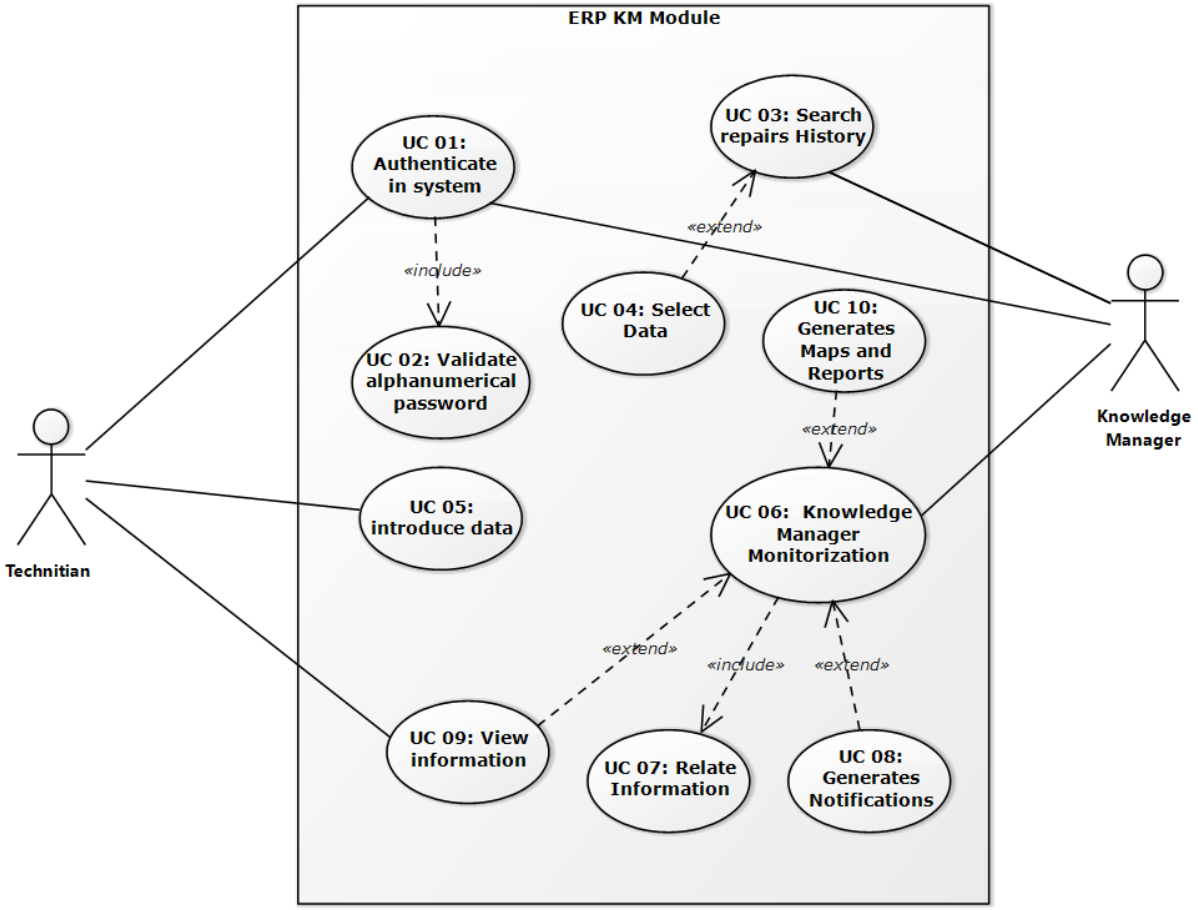

Figure 13 - Use Case Diagram

The Technician shall be able to introduce new data from their tacit knowledge, to enable future analysis. This actor must be able to view the knowledge monitor to access technical information to support their operation. The Knowledge Manager shall interact directly with the Knowledge Monitor, to relate information in the system and generate notifications through the system when technical action is mandatory for the technician to apply in the repair process.

3.4.5 Use case Description

In Table 9 is the simple description of the ten use cases defined for project with main scenarios and the alternative scenario when they exist. This use case simple description is the sequence of steps performed to accomplish the complete process transaction, as represented in figure 13.

Table 9 - Use Case Description

#	Description
UC 01	**Main Scenario:** User selects the authentication button to access in ERP KM module. **Alternative Scenario:** User cancels the authentication and doesn't access to this ERP module.
UC 02	**Main Scenario:** User introduces the Alphanumeric 10 digit password to be compliant with the company rules. **Alternative Scenario:** User Resets the password and redefines a new one.
UC 03	**Main Scenario:** Knowledge Manager searches the repair history in order to evaluate the new data introduced by the Technician, and for decision making. **Alternative Scenario:** Knowledge Manager accepts the technician's repair proposal.
UC 04	**Main Scenario:** Knowledge Manager selects data from historical registers. **Alternative Scenario:** Not available
UC 05	**Main Scenario:** The Technician shall introduce in the system new data from repairs to be delivered to the Knowledge Manager, so that data analysis is possible. **Alternative Scenario:** Technician sends an email directly to the knowledge Manager.
UC 06	**Main Scenario:** The Knowledge manager shall monitor all data from repairs and operation to introduce explicit knowledge in system. **Alternative Scenario:** Not available
UC 07	**Main Scenario:** System shall relate all information derived by the repair and operation process. **Alternative Scenario:** Not available
UC 08	**Main Scenario:** The system shall allow email notifications for technicians when configured by the Knowledge Manager. **Alternative Scenario:** system shall allow Pop Up notifications associated to repair processes
UC 09	**Main Scenario:** The Technician shall view explicit information in the system, introduced by the knowledge Manager. **Alternative Scenario:** The Technician shall export documents to external documents.
UC 10	**Main Scenario:** The Knowledge manager shall extract from the system, Maps and reports related to the knowledge process to support decision making. **Alternative Scenario:** Not available

These use cases capture the possible ways the user and the system can interact in this particular module, which results in the achievement of the proposed goals. They also identify alternative scenarios so that if the main scenario is not possible, another can be executed. This will be aligned with the structure of a system with the class diagram represented in figure 14. In this diagram are represented the attributes, operations, and relationships between the objects.

3.4.6 Class Diagram

Figure 14 represents the Knowledge Management module class diagram. This is a module integrated in the ERP used by the company. The Class Operator represents the user with two generalizations, Technician and KM Manager. Cardinality is one to one with the Technical Monitor class, because only one session could be active for a type of user. The Technical Monitor class is where main functions are represented, like creating and deleting documents,

change the type and are of the technical information, change status, create maps, set descriptions and send them by email.

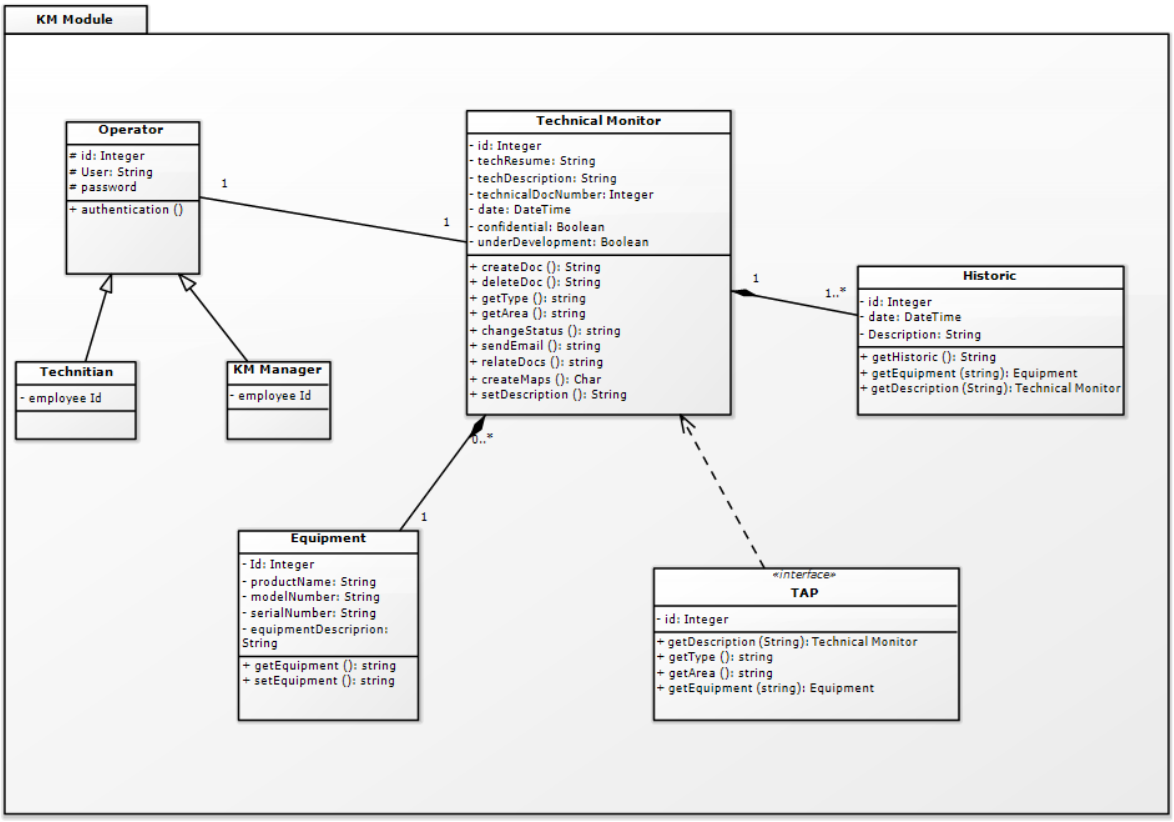

Figure 14 - KM Module Class Diagram

The Equipment class represents the equipment that is associated with the Technical Monitor information. Its attributes are the product name, model name and serial number, with getting and setting functions for the equipment, which will allow for the association of technical information to specific products.

The Historic class is the representation of the possibility of searching historical technical documents by equipment and by keywords on the description field. The Class TAP represents the interface of Technical Assistance Process where the technical information is presented in view of the process associated to the equipment under repair.

3.5 Prototype

This prototype is the realization of the project to be tested and implemented by the organization that is supporting this research. This was developed in Portuguese, to be integrated in the ERP that is also developed in the same language. Figure 15 represents the prototype's main view,

marked with numbers to describe the system's main capabilities. This is the Knowledge Manager's configuration console view, where knowledge could be introduced in the ERP. Option number 1 is where a new document could be created to initiate a new technical knowledge procedure. In the selection field number 2 is where the document type is selected based on its relevance, the selection options being (QG) representing a level 1 solution, (REP) representing a level 2 solution or (STIC) representing a level 3 solution.

This increasing specification should be determined by the information relevance, where level 1 has the least relevance and level 3 has the greatest relevance. This will determine which operators have access to this view. In the selection field number 3 is where knowledge is associated to a specific area, this could be hardware or software, depending of the problem source that will be documented.

Field 4 is where the equipment model is introduced, allowing for and facilitating future searches, regarding any technical information related to the equipment. Represented with number 5 is where the Knowledge Manager could mark information as confidential or not. In number 6, the checkbox should be marked when technical information is under development, and could be updated until is unchecked.

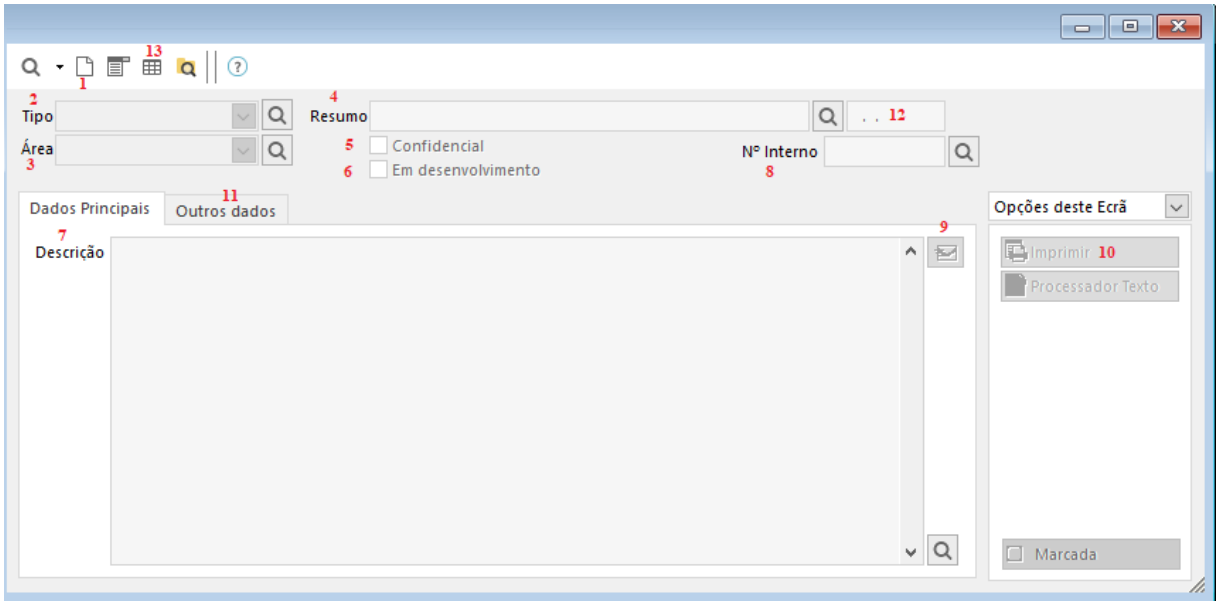

Figure 15 - Prototype console main view

Field 7 is where a detailed description about the technical information is introduced. Information in this field shall be detailed and clear as represented in figure 16, to be easily understood by users (in this specific case by technicians). In field number 8 is where a unique number is generated and associated with this document.

This field allows searches directly by the document number. Button number 9 provides the functionality of emailing individual technicians or groups depending of the relevance of the information. Button number 10 allows for the printing of technical information or exporting to PDF, which is only available for users with Knowledge Management permissions.

In the separator other data, represented with number 11, is where the possibility of relating documents is shown, as represented in figure 16, when some of them could have the same information relevance or share the same resolution issues. Box number 12 is where the solution's release date is introduced. This date shall represent the date of when the document was visible in the system. Option number 13 allows the user to define and export maps related to technical documents. It was prepared for future analysis with dashboards in real time.

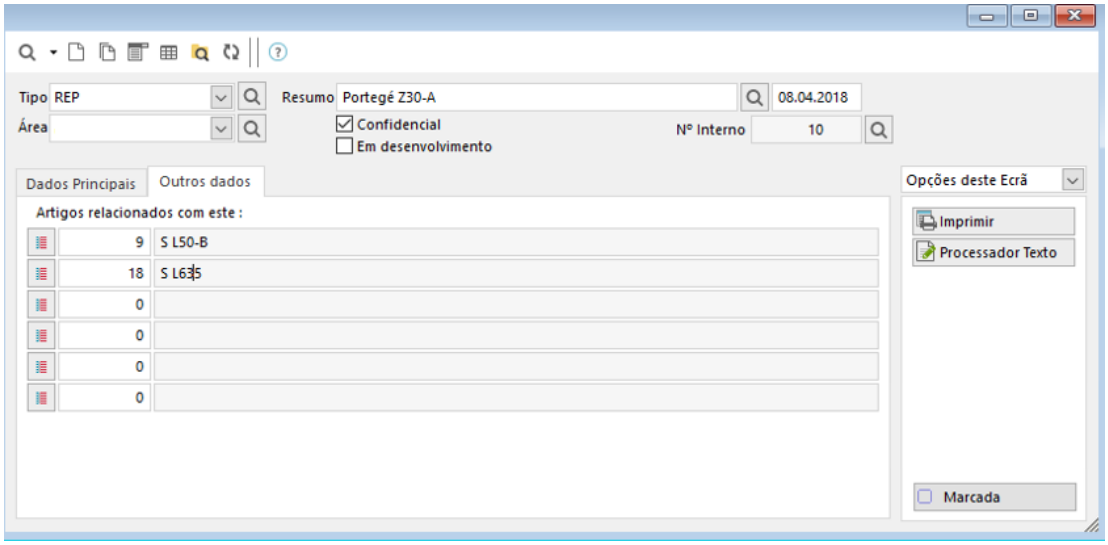

Figure 16 - Prototype console main view related documents

Figure 17 represents a case example where information is introduced to create a new technical document. This document is from type (REP), a level 2 document related with a software issue. This technical information is associated with all the equipment of the model Portégé Z30-x-xxx, and is marked as confidential, which will determine that only technicians have access to this information while others employees, like administrative operators, cannot visualize it.

The document number corresponds to 10, which is a unique reference generated automatically when the document is saved for the first time. This number enables the quick tracking of the document, when searching for the equipment's history of technical information.

The last procedure to create a technical document is using the function save presented in the button with the floppy disk icon. At this stage, after save the document, automatically,

information is associated to all models defined in field number 4. This information will appear in the ERP main view, represented in figure 18 and identified by the letter A. Information is viewed in red bold to alert the technician that important information is available to repair the equipment.

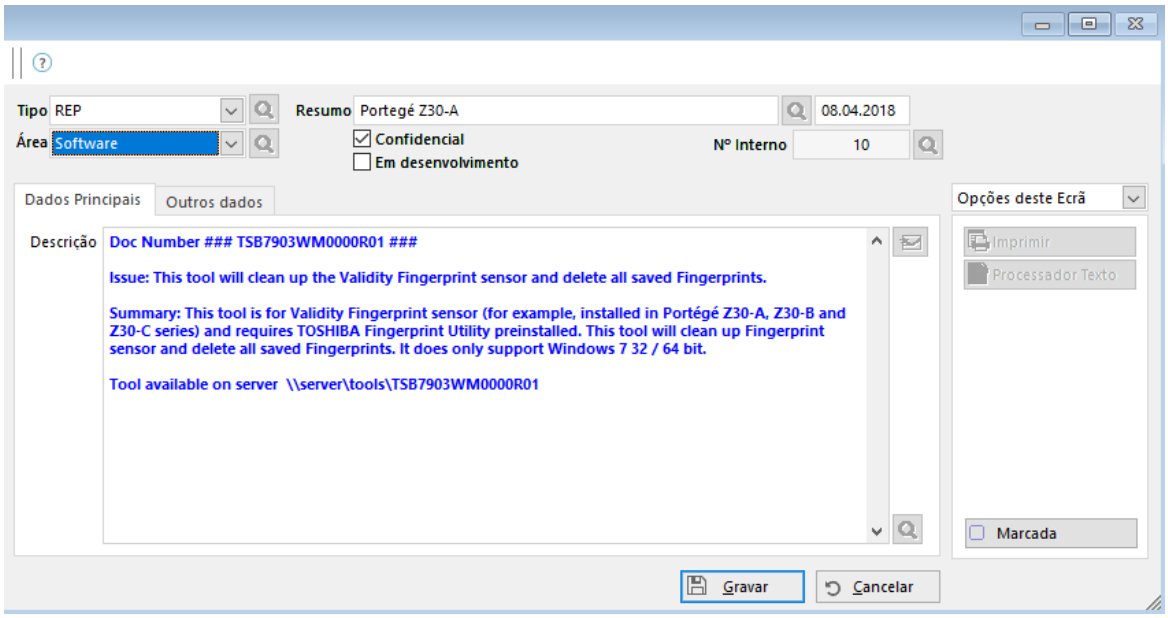

Figure 17 - Console main view with data

Figure 18 represents the ERP console main view mask used by company. When a technician introduces the number of repair process, in this case 272954, this view appears with the relevant information of the process, like the equipment description, customer and supplier information as well as the manufacture process number when the equipment is under warranty.

Other data, such as; customer reference; problem description and find solution field are also available. Find solution field represented by the letter **C** is where a technician writes a closing remark about the repair process, presenting a detailed description about the issue reported by the customer and the proposed solution to solve the problem, in order to ensure a detailed report.

The important technical information associated with this equipment will appear in the field identified by the letter A, with a character limitation because of the limited space in the ERP mask.

If a technician needs to check the detailed information, he can double click in field **A** and all the information will appear, without this limitation. With the implementation of this new prototype feature in ERP, technicians have to verify this information necessarily, because it is

mandatory in the repair process to access and fill in some of the available fields on this ERP mask to initiate and close the service.

It is expectable that with this new feature, the quality of the repair process will improve. This will be further analysed in the next topic, since the information is always checked by the ones who need it. This information presentation will support the operation and all levels of repairs.

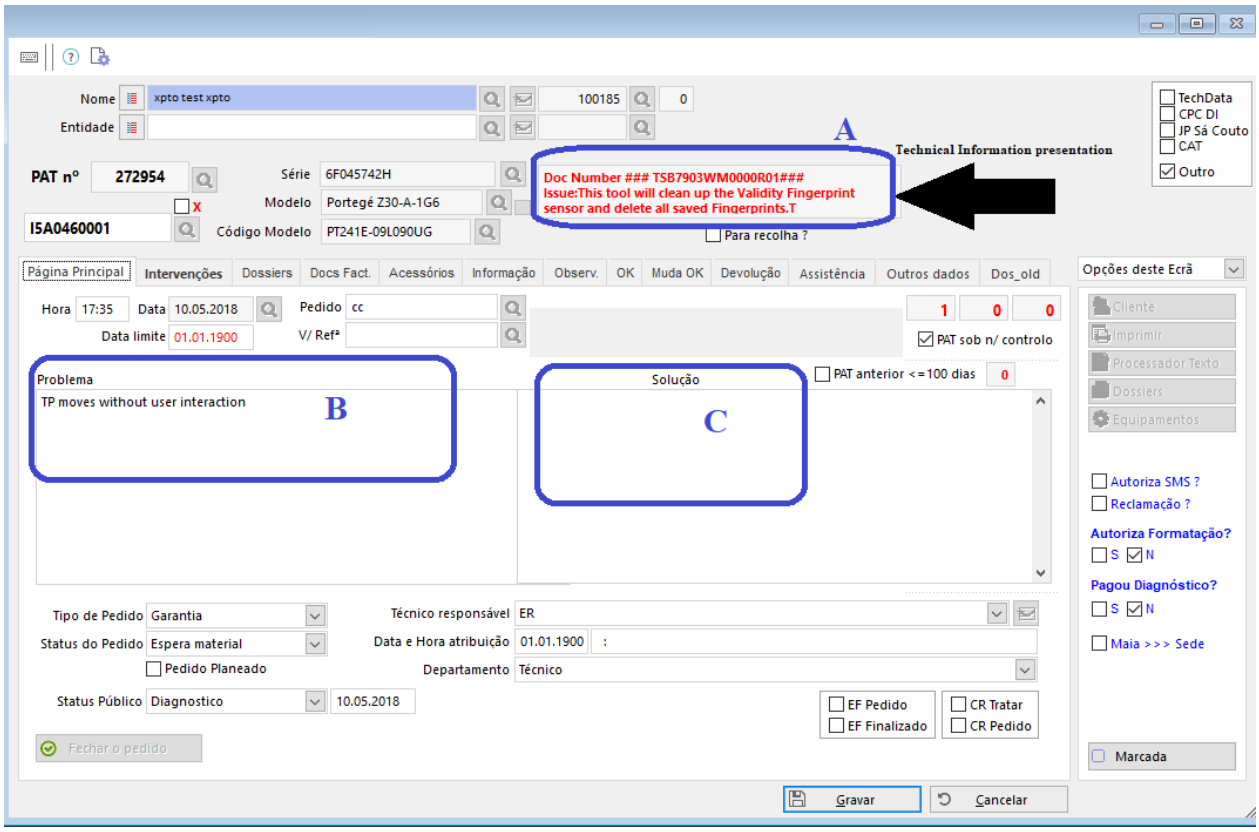

Figure 18 - ERP technical process console main view

Other ERP fields could be used for the Knowledge Management process in order to improve this prototype. Compilation of information, in core fields as the described problem, identified by letter **B,** and the solution field, identified by the letter **C,** will be used as an aggregated information to support the compilation of new information. This prototype application will be reflected as an improvement in the SLA. These results will be evaluated in the next topic, in order to understand if management's expectations are achieved.

4. Evaluation and Results

This chapter presents the research results evaluation. Results are based in the SLA results from 6 months of the operation. A comparison of the three months after the prototype's implementation with 3 months of normal operations before its implementation will be made, in order to determine the utility and the necessity of the usage of tacit knowledge transformed in explicit, presented through the prototype. Results of the survey made to the organization's employees to understand their opinion of the prototype utilization is also analysed. Finally the results are compared with the objectives described in chapter one and the main results are identified and discussed.

4.1 Results Overview

The outcome of this research will be evaluated by the interpretation and evaluation of the service level agreements (SLA) results from 6 months. These SLA are the main indicator of the organization's service level, as they are associated with the specific service of laptop repairs of an international brand. This prototype was implemented in the beginning of February, with a probation period of three months, so that we could understand if the application in the ERP main system would achieve the goals defined by the management, as identified in table 1.

To evaluate the results, two type of services will be used. First, represented in table 10, a premium onsite service from the Business to Business (B2B) segment, that consists in the laptop repaired in the next business day in customer facilities. Second, represented in table 11 as well, is the standard repair service related to the Business to Consumer (B2C) segment. This service represents the higher repair volume for the company and consequently with greater financial return.

To complement these analysis, a survey will be presented to the company staff, in order to understand their opinion about the usage of this prototype, and if they recognize its utility and added value in the development of daily work. The combination of these results shall express the importance, or not, of implementing the integration of knowledge management systems in organizations of the service provider's area as well others, since this concept could be replicated in other companies, with other different systems.

4.2 Onsite service results

The data presented in table 10 shows the operation results of the last 6 months, in the B2B segment. Since the prototype was implemented in February of 2018, with this data, it is possible to analyse the previous and following results to understand if there is any evidence of added benefits in the operation repair process. In this segment, four indicators will be analysed: Total Average Time (TAT); Customer Satisfaction Index; Repeated Repairs and Parts Per Serial Number.

Total Average Time indicates the total time in days of the repair process since it was opened until it was closed. Customer Satisfaction Index indicates the degree of customer satisfaction for the service provided on a scale of 0 to 5. Repeated Repairs indicate the number of repeated repairs in less than 30 days. Parts per Serial Number indicates the number of parts used by repair.

Table 10 - Onsite service report

Indicators	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	Total
Claim Volumes	24	31	42	18	38	26	179
TAT	3,6	3,5	2,9	1,6	0,8	0,7	2,2
TAT - Target	3,0	3,0	3,0	3,0	3,0	3,0	3,0
Customer Satisfaction Index	5,0	5,0	4,9	5,0	4,8	5,0	4,9
Customer Satisfaction Index - Target	4,5	4,5	4,5	4,5	4,5	4,5	4,5
Repeated Repairs	2	1	0	1	0	0	4
Repeated Repairs - %	8,3%	3,2%	0,0%	5,6%	0,0%	0,0%	2,2%
Repeated Repairs - Target	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%
Parts	20	28	37	12	29	20	146
Parts per Serial Number	0,8	0,9	0,9	0,7	0,8	0,8	0,8
Parts per Serial Number - Target	1	1	1	1	1	1	1

Figure 19 represents the graphic with TAT results from last 6 months, with an average of 29,8 repairs per month, where the TAT has been decreasing under one day since March. Compared with the defined target, positive results are verified, since the objective was to decrease the intervention time.

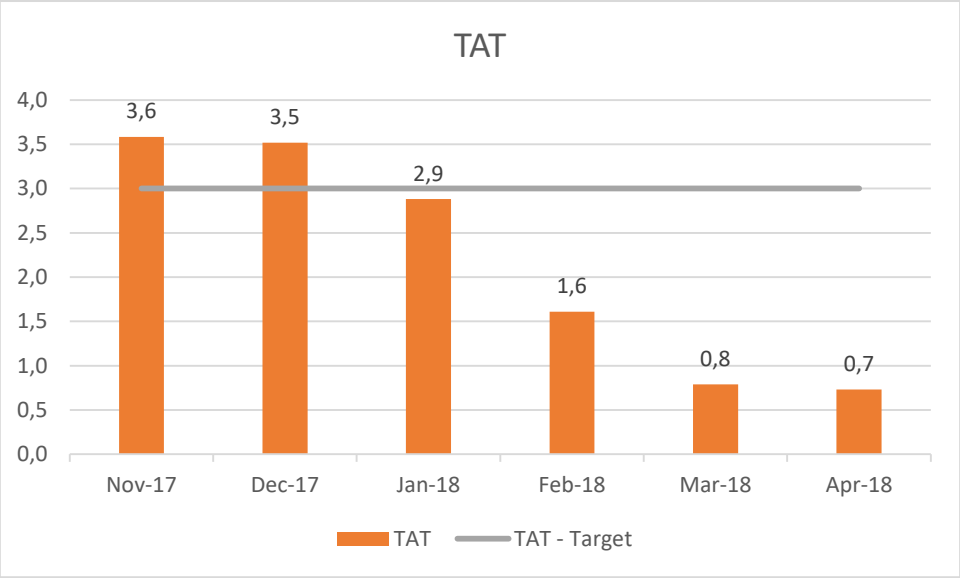

Figure 19 – Onsite TAT analysis

Figure 20 represents the graphic with Customer Satisfaction Index results from last 6 months, with an average of 29,8 repairs per month, where the index has been maintained close to five. Compared with the defined target, positive findings are verified, since the objective is close to the maximum possible.

Figure 20 – Onsite Customer Satisfaction Index

Figure 21 represents the Repeated Repairs results from last 6 months, in the last 2 months, there did not exist any case in this state. Compared with the defined target of 2%, positive results are verified, since the objective was achieved to the minimum possible.

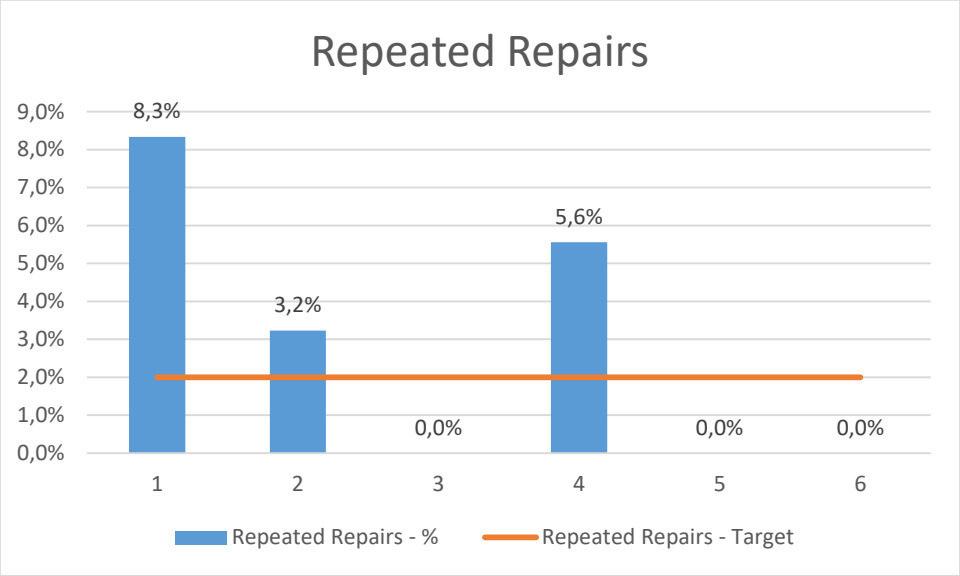

Figure 21 - Onsite Repeated repairs

Figure 22 represents the Parts Per Serial Number from last 6 months, this represents the part used per each repair. Compared with the defined target of 1, positive results are verified again. The objective of decreasing the parts per repair or serial number was achieved and result of 0,8 was verified in the last 2 months.

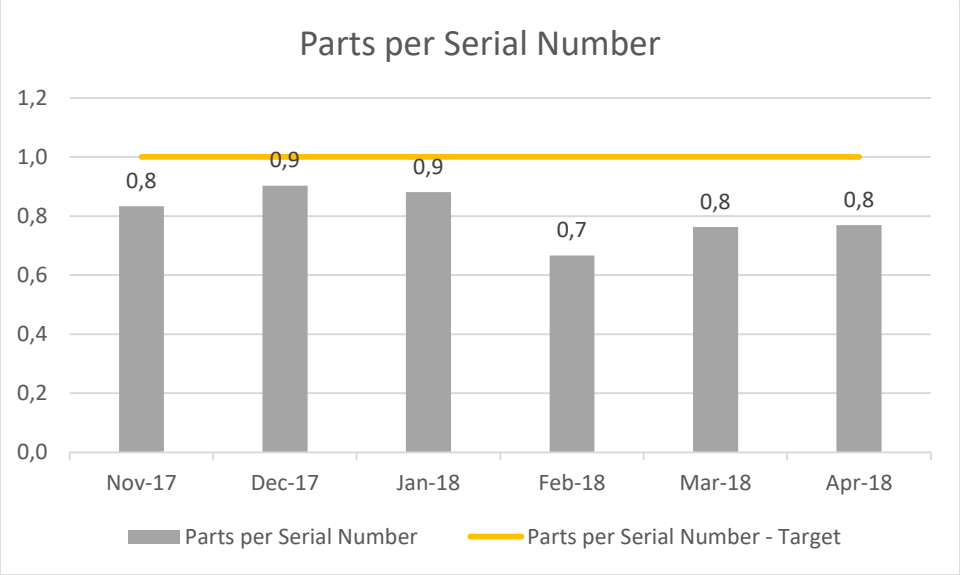

Figure 22 - Onsite Parts per Serial Number

4.3 Standard service results

Results presented in table 11 show the last 6 months operation results in this B2C segment. Since the prototype was implemented in February 2018, with this data, it is possible to analyse the previous and following results to conclude if there is any evidence of benefits in the operation's repair process. In this segment, six indicators will be analysed: Claim Volume, which indicates the number of repairs in the last six months in this business segment. Repair Turnaround Time, which indicates the time in days the repair takes with all hold phases, for example the time it took for the part to arrive to the repair office, is not considered.

Customer Satisfaction Index indicates the degree of customer satisfaction for the service provided on a scale of 0 to 5. Repeated Repairs indicate the number of repeated repairs in less than 30 days. Parts Per Serial Number indicates the number of parts used by repair. Number of Repairs made by technicians (per day) indicates the technicians' productivity per day for each month.

Table 11 - Standard service Report

Indicators	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	Total
Claim Volumes	117	72	86	70	87	80	512
Repair Turnaround Time	4,0	4,0	4,5	4,0	4,0	4,0	4,1
Repair Turnaround Time - Target	4,0	4,0	4,0	4,0	4,0	4,0	4,0
Customer Satisfaction Index	24	29	27	23	13	14	130
Customer Satisfaction	4,0	4,0	4,0	4,0	4,0	4,0	4,0
Customer Satisfaction Index - Target	4,5	4,5	4,5	4,5	4,5	4,5	4,5
Repeated Repairs	2	1	4	1	0	0	8
Repeated Repairs - %	1,7%	1,4%	4,7%	2,9%	0,0%	0,0%	1,8%
Repeated Repairs - Target	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%
Parts	113	77	88	71	87	79	515
Parts used per Repair	0,97	1,07	1,02	1,01	1,00	0,99	1,01
Parts used per Repair - Target	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Number of repairs made by technicians (per day)	10	10	10	10	10	11	10
Number of repairs made by technicians (per day) - Target	12	12	12	12	12	12	12

Figure 23 represents the graphic with volume results from last 6 months, showing a decreasing Volume of repairs, derived from the declining sales verified in the last year. This represents the segment with more volume of repairs and is the basis of analysis of the SLA results. The average verified in last 6 months was 85,3 repairs per month.

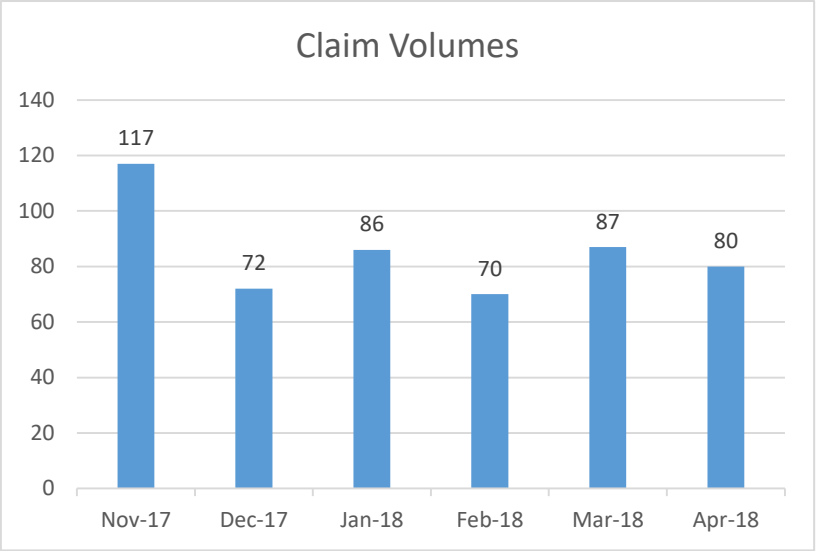

Figure 23 - Standard Claim Volumes

Figure 24 represents the Repair Turnaround Time from last 6 months, this represents the time used in each repair, considering the hold times. This graph shows the defined target of 4 days. Results shows that in January, the time set for the target was exceeded. Positive evidence is found for the last 3 months, as the results are aligned with the target but did not go under 4 as expected

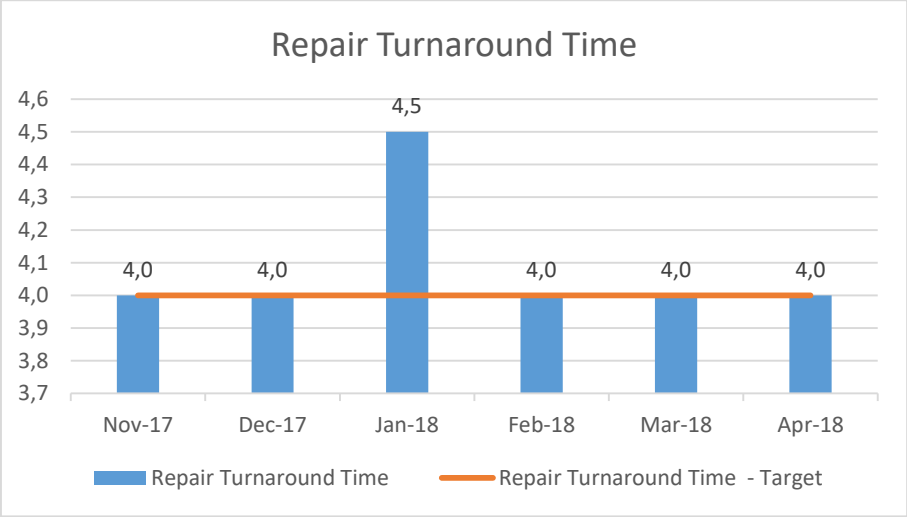

Figure 24 - Standard Repair Turnaround Time

Figure 25 represents the Customer's Satisfaction Index for this B2C segment. This represents the satisfaction degree from customers that used the company's laptop repair service. Compared with the defined target 4,5 no positive evidence is verified, since the objective is not aligned with the target.

Figure 25 - Standard Customer Satisfaction Index

Figure 26 represents the Repeated Repairs results from last 6 months, the graph analysis showing that, in last 2 months, there did not exist any case in this state. Compared with the defined target of 2%, positive evidence is verified, since the objective was achieved.

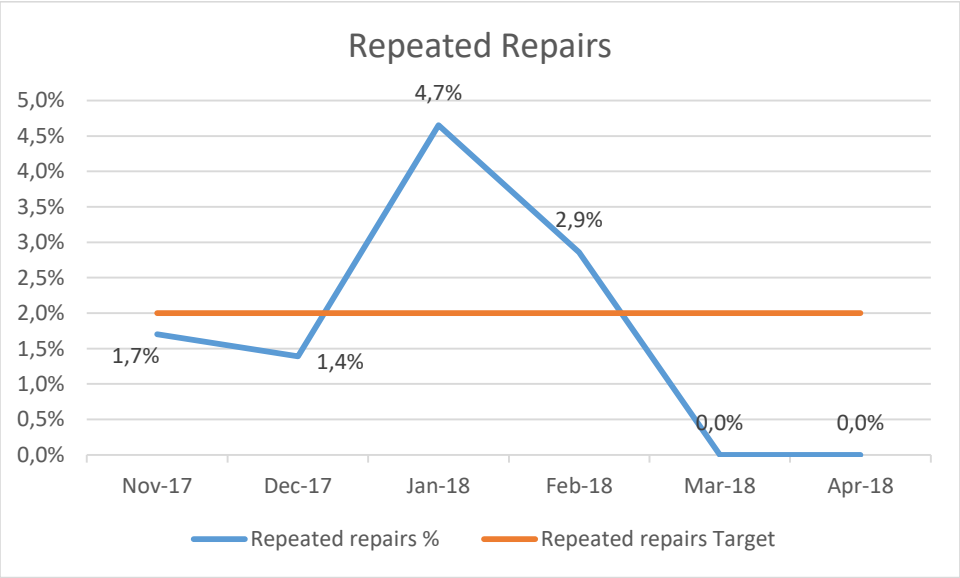

Figure 26 - Standard Repeated Repairs

Figure 27 represents the Parts per Serial Number from last 6 months, this represents the part used per each repair. This graph shows a tendency of reducing the parts used in repairs. Compared with the defined target of 1, positive evidences are verified again. The objective of decreasing the parts per repair or serial number was achieved and a result of 0,9 was verified in the last month.

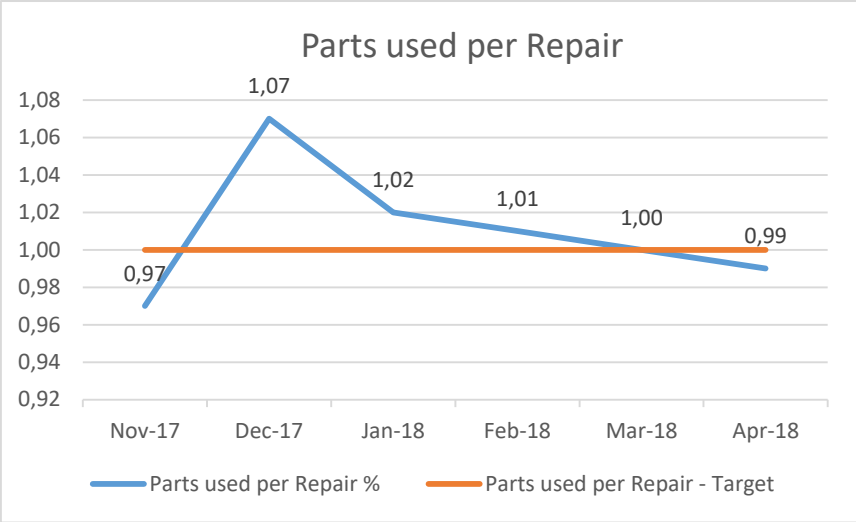

Figure 27 - Standard Parts used per Repair

Figure 28 represents the repairs made by technicians from last 6 months, this represents the average number of repairs made by technicians every day. With this indicator it is possible to monitor the daily productivity of this company's capital.

This graph shows a tendency of increasing the number of daily repairs per technician. Compared with the defined target of 12 repairs, positive evidence is verified. Last month in April, an increase of 1 equipment per technician was verified, which demonstrates an effective increase in daily productivity.

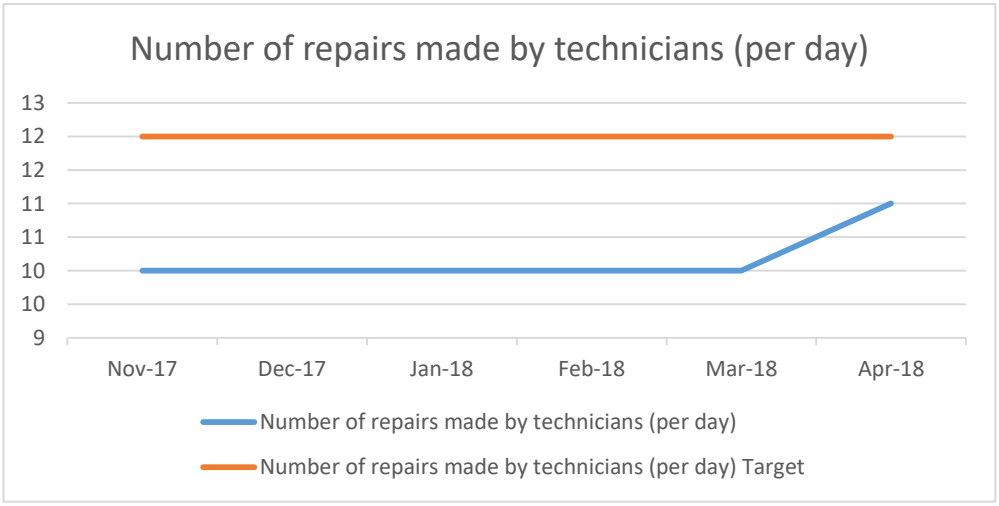

Figure 28 - Standard Number of repairs made by technicians (per day)

With the analysis of the previous results of the SLA of these two segments B2B and B2C, it can be concluded that there is evidence pointing towards a real, quantifiable improvement in the service. In B2B Onsite services, since the prototype implementation, the TAT reduces an average of 3,3% in the first 3 months to 1% in last three, where in the last month the minimum

of these last 6 months, 0,7% was achieved. The Customer Satisfaction Index data shows the improvement, since the results exceeded the targets by 0,4%.

In the Repeated Repair indicator, there is evidence that the prototype usage reduced the repeated repairs. In the last two months of testing, there was not any equipment under the aforementioned state. In the indicator Parts used per Repair or serial number, the consumption of parts reduced to 0,7% in these last 3 months.

In B2C, since the prototype implementation, the average number of claims reduces from 91,6 per month to 79 repairs per month. This reduction does not have an impact in the study, since the indicators are analysed in percentage, days and only one, the last one, is based on the quantity of repairs. In the indicator Repair Turnaround Time results are stable in these 6 months. Only in January, before the prototype implementation, we verify an increase of 0,5%.

Customer Satisfaction Index did not change in this analysed period. In Repeated Repair Indicator, evidence of improvements of less 1,6% of repeated repairs is found. The Parts used per Repairs average also improves from 1,02% above the defined target to 1 on the target. Number of Repairs made by technicians increased in the last month, yet it is not considerable since the number of claims also decreases in the last three months.

Table 12 - Research results versus defined objectives

Objectives	2017 SLA Results	Research Improvement Objective	Results after prototype implementation B2B	Results after prototype implementation B2C
Total Average Time in days (TAT)	3,3	3	1	Not applicable
Repeated Repairs	2,6%	2%	1,8%	0,9%
Repair Turnaround Time (total days)	4 Days	under 4 Days	Not applicable	4 Days
Parts used per Repair	1,2	1	0,7	1
Number of repairs made by technicians (per day)	10	12	Not applicable	10,6
Customer satisfaction index (0-5)	4	4,5	4,9	4

The results presented in table 12 demonstrate that the prototype implementation had a greater impact on the results in the B2B service. The most significant indicators were: TAT, Repeated Repairs and Customer Satisfaction Index. In the B2C segment, the most remarkable indicator was the Repeated Repairs.

4.4 Survey results

This survey is used to complement the SLA analysis to identify the company users' opinion about the prototype's functionalities and their opinion from the experience of these last three

months' test period. The survey was answered by all company employees, from all offices established in the country with google forms. The survey is described in annex B. Responses and charts are presented in annex C and correspond to each question. The total number of answers was 17, which corresponds to the total number of company employees.

In the survey's first section, the profile of company employees was identified. The profile of the organization's employee corresponds to a person with an age between 34 and 41 years old, with secondary school education level, with a technician position, with an effective contract. Most of the answers were obtained from the Lisbon office, since this is the office with the largest number of employees.

Their professional and academic background varies between all available answers, with a larger incidence in laptop, hardware and software repair. Regarding the knowledge Management area, 88,2% know the concept and 76,5% used the prototype in these last 3 months of testing.

The survey's second section focuses on detailed questions related to the experience of using the prototype. Users classified it from different parameters, like the prototype concept, where the majority of users answered that the concept, usefulness and the features available are good. The information available in the prototype's main field is qualified by users as good and excellent.

Regarding the users' classification about the prototype functionalities and interaction, interaction in ERP, position of text in the main window, font and colour of text and, integration of information, printing and email and overall functionalities are classified mostly as good. Classification of training action of the prototype usage was also requested where training methodology, trainer performance, training content and the usefulness of training in the use of functionalities are classified as good. The worst result was verified in time provided by the company for this training action.

In the request of the user opinion about the features that should be added to the prototype, the main opinion was that this tool should be integrated with other systems used by company like manufacturer system, intranet and extranet. Regarding the last question, about the continuity of the development of this prototype, users' answers indicates that development should continue.

5. Conclusions and Future Challenges

This chapter presents all considerations on the results obtained from this research work and its conclusions, to determine if this research achieved the proposed objectives. The achieved contributions are explained for this specific domain and also the contribution to the scientific community. Limitations and future work are also described to promote the development of this research area.

5.1 Conclusions

In the current context, the alignment between business and an IT strategy is essential to an organization's success, in order to not only empower new business strategies but, above all, to ensure the continuity of business operations. An organization that is prevented from fully using the available knowledge generated by daily operation, is an organization that will probably face financial losses and often the loss unrecoverable business opportunities.

The use of standards in IT Service Management supports organizations to ensure the alignment with the best practices. ITIL emerges as a globally accepted compilation of best practices and as a standard for implementing an IT Service. For this reason, this model is used by a company where a case study was developed and included in this research as an important topic.

The objective of this research was to understand if knowledge management adds value to an operation of an IT organization. The creation of a model based in ITIL SKMS to capture tacit knowledge from the daily operation, combined with a knowledge management process and a prototype development, determined the defined architecture. A survey of the state of the art was carried out with relevant topics in the areas of knowledge management, intellectual capital, organizational memories, ERP and IT service management.

After this state-of-the-art research, a meta-model was developed to support the capture of tacit data from the service operation based on ITIL SKMS. This framework added several tools like storytelling, communities of practices, action learning and other tools and functionalities that support the capture of knowledge, to be analysed by the Knowledge Manager. These topics have the main objective of supporting the other topics concerning Information, Knowledge and Wisdom and expertise so that they can support service the process and delivery and provide decision making support for other collaborators and stakeholders. This

Meta-Model shall be the base of the other architecture components, as best practices on the IT environment.

A case study was developed in a Portuguese company that is the service provider of an international Japanese laptop brand. This company uses an ERP to manage its IT services. A proof of concept was developed as a prototype, based in a process designed in BPM aligned with company tasks, using ITIL best practices. Rules and tasks were identified by the researcher in order to improve the service and capture the tacit knowledge, in order to transform it in explicit data to feed the prototype, for it to be later managed by the organization's Knowledge Manager.

For the prototype's design and architecture the UML notation was used. Context diagrams were designed to contextualize the prototype's software, and the elicitation of functional and non-functional requirements was done to support use cases and finally the class diagram. The prototype was implemented in the Company ERP according to the previously specified, so that users could start using it and thus be able to register the services with this component already associated with the main system.

The results of this use were measured by the results of the monthly SLA, with indicators previously defined as service metrics associated with performance. Two service segments were analysed, the Onsite service of the B2B segment and the consumer segment B2C. To verify the effectiveness of the prototype, the 3 months of use were compared with the 3 months previous to its implementation.

Results demonstrate that indicators TAT, repeated repairs and parts used per repair had an improvement compared to the previous period. Customer satisfaction index, repair turnaround time and Number of repairs made by technicians do not reveal any sign of improvement, since results remained the same.

A survey was used to complement the SLA analysis with the objective of identifying users' opinion about the prototype functionalities and opinions from the experience of these last three months test period. This survey was made with company collaborators from offices established in the country. Analysis shows that users had a good experience interaction with the prototype and think that it is useful for their daily work.

The survey's worst result was verified in time provided by the company for this training action, a topic that will be reviewed for further actions. Users also expressed their views towards development, where integration with the other systems used by the company represents the majority of the responses. This component will be strengthened and placed as a major requirement in future development.

The last question presented in the survey was about the continuity of the development of this prototype, all users' answers point towards its continuation based on the combination of these two results, SLA analysis and the conducted survey, it can be concluded that, effectively, the capture of tacit knowledge to promote a knowledge capital through the organization has added value. If a company uses the development of business processes based on the Meta-Model combined with the Knowledge Management and system component, it will improve the service operation, reducing costs due to the optimization of the intellectual capital resources available to deliver the service. This verified optimization will represent in both short and medium-term, a better customer service with all the benefits associated with it, both in terms of image and in terms of new business opportunities that may arise for the organization.

With all the evidence presented in the results of this research, it is concluded that the developed Knowledge Management architecture will add value for the development of IT service operations. Given that this model can be replicated in other IT companies, as well as organizations from other areas, the results of this research demonstrate that Knowledge Management should be introduced in organizations in order to promote the development of their organizational memories and corporate intranets.

5.2 Limitations and constraints

The main limitation of this research was the temporal factor, namely in the development of the prototype, in a way that represents the maximum of possible designed functionalities. The time that the company made available for user training was also quite limited. An extended training period would certainly have had a positive impact on user experience which could have been higher than it would represent a different user experience.

The sample of this research is also small, given that it was limited to the universe of active company employees, which, by itself, represents a small number of individuals given a recent company restructuration that made 40% of the workforce redundant.

5.3 Future Work

This research, given its results, provides several perspectives for future work, namely in the usage of a Meta-Model, specifically in the data capture topic, which can be developed by the usage of semantic and web 3.0 tools to capture the tacit knowledge and introduce it into the

process. This would improve the speed with which knowledge would be acquired and made available to the Knowledge Manager

In the development of the prototype, more features could be added, like integration with other systems used by company. Other functionalities improvements' should be made in the software component, like the visualization of remote desktop access as well as different access to information, since the space available in the main ERP window is limited. A conversation box to promote direct communication between technicians and the Knowledge Manager would be a good improvement, effectively stimulating the exchange of tacit information in real time. This information would then be made explicit and available for insertion in the system. Taxonomies should be expressed in detail, in order to promote more effective searches for the registered information, which shall be the base of the next prototype development. A panel of experts could gather more feedback on user experiences about prototype functionality.

To evolve this architecture, the development of an Intranet based on the design of an organizational memory, should greatly help the management of intellectual capital as well as a more accessible way to manage the knowledge of company employees.

This development would also allow extranet access to customers and suppliers, so that they could have access to some information, making it possible to capture some of their connection through platform interaction and a combination with semantic web tools.

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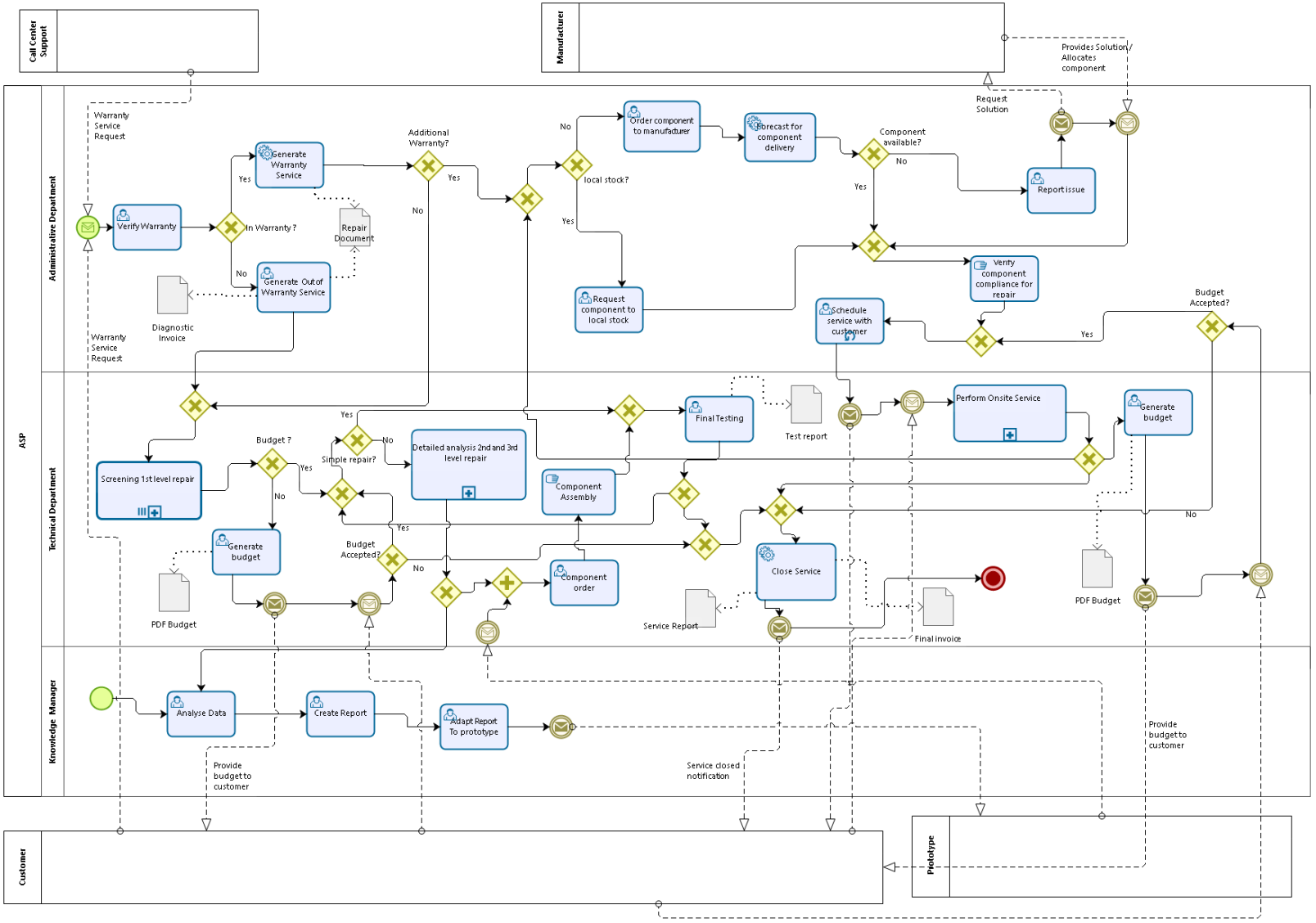
Annex A

Repair Process BPMN Model



Annex B

This annex represents the survey made by researcher was the company that case study is applied to complement the results from the SLA. This survey was created in google forms and presented to all company collaborators from all country office. After Survey structure results are also presented in annex C.

Knowledge Management Prototype

The following survey is part of a research project on the Knowledge management (KM) area consisting in the implementation of a KM prototype in the company ERP, within the framework of Masters in Information Systems for Management.

The information collected is considered to be confidential and has purely academic objectives. The data will not be used for commercial or consulting purposes.

Your participation is indispensable and I therefore ask you to respond as honestly as possible to the questions. There are no right or wrong answers. I guarantee the anonymity and confidentiality of your answers. The data will be treated in an aggregate manner and eliminated any way to identify the respondents.

The questionnaire will take up 10 minutes of your time, and your answers are crucial to the success of this study.

1. **Age (Choose one of the following options)**
   Mark only one oval.
   - ◯ Betwen 18 - 25
   - ◯ Betwen 26 - 33
   - ◯ Betwen 34 - 41
   - ◯ Betwen 42- 49
   - ◯ Betwen 50 - 57
   - ◯ Betwen 58 - 65
   - ◯ More than 66

2. **Education Level (Choose one of the following options)**
   Mark only one oval.
   - ◯ Professional Education
   - ◯ Secondary school
   - ◯ Bachelor Degree
   - ◯ Master Degree
   - ◯ P.H.D

3. **Location (Choose one of the following options)**
   Mark only one oval.
   - ◯ Oporto
   - ◯ Lisbon
   - ◯ Faro

4. **What is your training background area ? (Choose one or more options options)**
Tick all that apply.

- [ ] Hardware
- [ ] Software
- [ ] Services
- [ ] Laptop Repair
- [ ] Administrative

5. **What is your current situation in the organization ?**
Mark only one oval.

- ◯ Term Contract
- ◯ Effective contract

6. **What is you position in organization ?**
Mark only one oval.

- ◯ Technitian
- ◯ Administrative
- ◯ Manager

7. **Do you know the concept of knowledge management ?**
Mark only one oval.

- ◯ Yes
- ◯ No

8. **Do you use the knowledge prototype implemented in the ERP ?**
Mark only one oval.

- ◯ Yes
- ◯ No (If the answer is no the survey ends here) *Stop filling out this form.*

9. **In your experience how do you classify the prototype in the different parameters? (Rate the usage parameters described below from 1 to 5 where 1 is very bad and 5 is excellent)**
Mark only one oval per row.

	Very Bad	Bad	Acceptable	Good	Excellent
What is your assessment of the prototype concept ?	◯	◯	◯	◯	◯
What is your assessment of the prototype usefulness ?	◯	◯	◯	◯	◯
What is your assessment of the available features?	◯	◯	◯	◯	◯
Is the information available in the main field useful in your daily work ?	◯	◯	◯	◯	◯
Do you think this tool improves your daily productivity?	◯	◯	◯	◯	◯

10. **In your experience how do you classify the prototype functionalities/ interaction? (Rate the usage parameters described below from 1 to 5 where 1 is very bad and 5 is excellent)**

Mark only one oval per row.

	Very Bad	Bad	Acceptable	Good	Excellent
Integration in ERP	◯	◯	◯	◯	◯
Position of the text in the ERP Main window	◯	◯	◯	◯	◯
Font and color of text	◯	◯	◯	◯	◯
Integration of information	◯	◯	◯	◯	◯
Printing and Email	◯	◯	◯	◯	◯
Overall functionalities	◯	◯	◯	◯	◯

11. **How do you classify the prototype formation action ? (Rate the usage parameters described below from 1 to 5 where 1 is very bad and 5 is excellent)**

Mark only one oval per row.

	Very Bad	Bad	Acceptable	Good	Excellent
Training methodology	◯	◯	◯	◯	◯
Time provided by the company for the training action	◯	◯	◯	◯	◯
Trainer performance	◯	◯	◯	◯	◯
Content provided in the training action	◯	◯	◯	◯	◯
Usefulness of training in the use of functionalities	◯	◯	◯	◯	◯

12. **In your opinion, what features should be added ?**

_____

_____

_____

_____

_____

13. **In your opinion, do you think that is useful to the company continue to develop this prototype**

Mark only one oval.

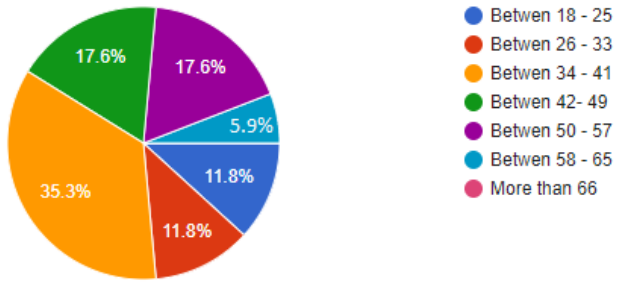
- ◯ Yes
- ◯ No
- ◯ Maybe

Annex C

Survey results charts and answers

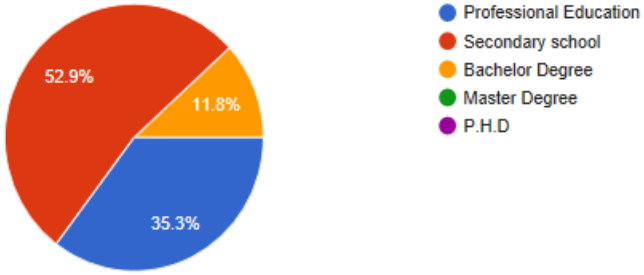
Age (Choose one of the following options)

17 responses



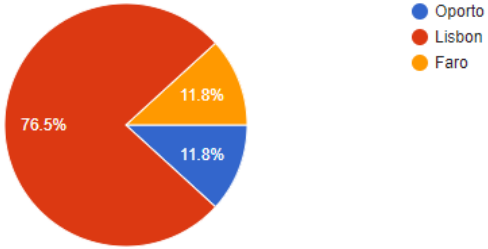
Education Level (Choose one of the following options)

17 responses



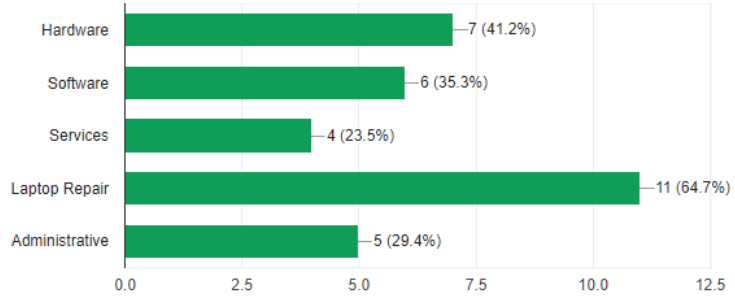
Location (Choose one of the following options)

17 responses



What is your training background area ? (Choose one or more options options)

17 responses

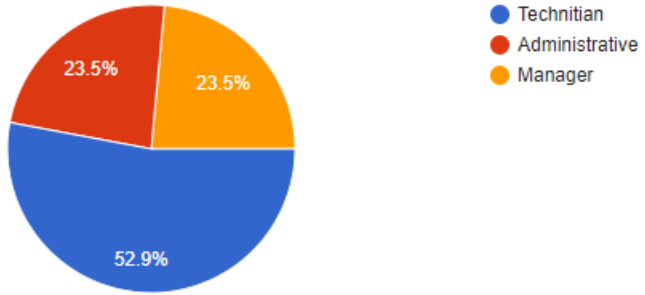


What is your current situation in the organization ?

17 responses

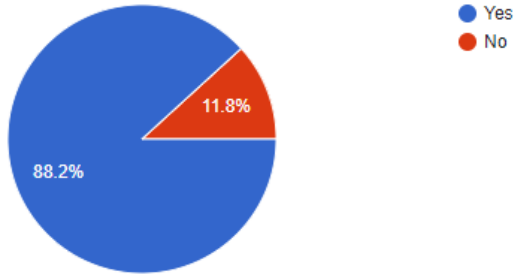
What is you position in organization ?

17 responses



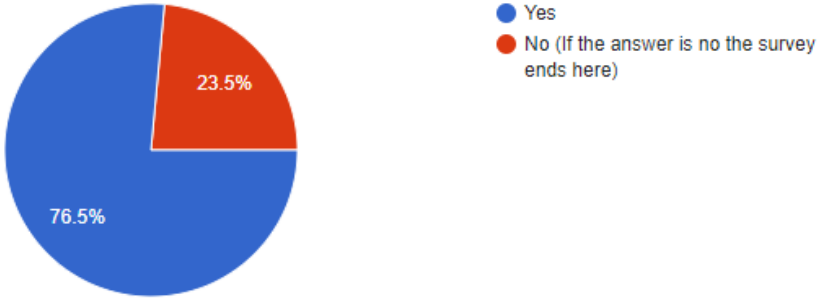
Do you know the concept of knowledge management ?

17 responses



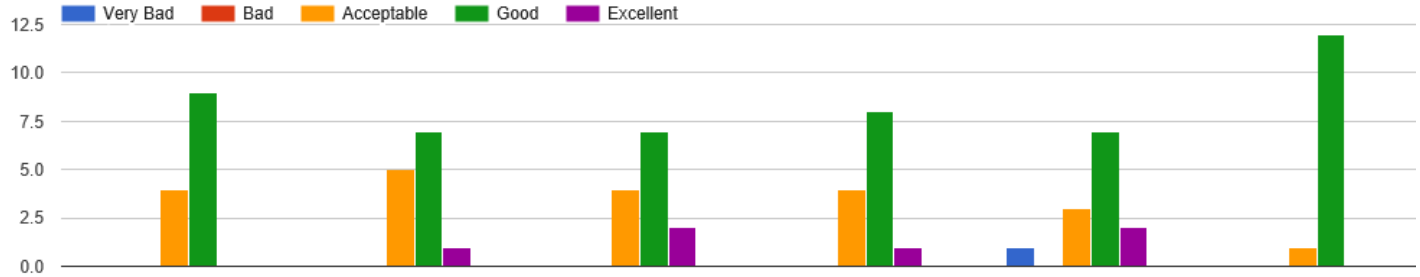
Do you use the knowledge prototype implemented in the ERP ?

17 responses



In your experience how do you classify the prototype in the different parameters? (Rate the usage parameters described below from 1 to 5 where 1 is very bad and 5 is excellent)

In your experience how do you classify the prototype functionalities/ interaction? (Rate the usage parameters described below from 1 to 5 where 1 is very bad and 5 is excellent)



How do you classify the prototype formation action ? (Rate the usage parameters described below from 1 to 5 where 1 is very bad and 5 is excellent)

In your opinion, what features should be added ?

12 responses

Integrate this prototype in manufactory App to expand knowledge data base.
Integration could still be improved to a next level...
Integration with system and extranet of the manufacturers
Automatic forward for all personal when new data is imputed.
I would like to see the availability of external links creation (internet link to database in case of TiC's for example).
Should be integrated with the intranet
The ERP tool should have in a more easy way access to the historical repairs of the laptop. More and better information about typical problems of each model.
More information should be added to prototype
In remote desktop the information appear very small
Integration with other systems
more space in comments field
Should have more fields and a conversation box.

In your opinion, do you think that is useful to the company continue to develop this prototype

13 responses