POLITECNICO DI TORINO

Management engineering

Master's degree thesis

Risks and benefits of an ERP implementation and use

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SOMMARIO

1. Introduction to the thesis

Nowadays a huge number of companies have implemented or plan to implement an ERP as their business management application. The use of an ERP, if done correctly, assures to the adopting company a competitive advantage. Nonetheless, the implementation process as well as the use phase, especially in the first months, presents several risks. This because an ERP strongly modifies the management of a company, the way in which the company works and its results. In addition, it has an impact on the allocation of power within a company and it involves a huge number of stakeholders. Consequently, the management of risks by a company before, during and after the implementation is of the utmost importance to achieve the expected profitability.

This thesis aims to understand, after a brief initial introduction to the ERPs history and their functionalities, the benefits, and the risks, with a strong focus on the latter, associated to an ERP implementation and use. The analysis will start with a review of the major risks according to the literature. Following, there will be an analysis of the effective risks and benefits faced by some companies during the implementation and use phase on an ERP. The analysis will be obtained by some interviews employees of companies who implemented ERPs and to an employee of an Italian consulting firm involved in the ERP implementation business.

The analysis of the effective implementation, despite done on a limited sample, would furnish a possibility to compare the literature risks and benefits of an ERP to the actual ones.

2. An introduction to ERP

2.1. What is an ERP?

An Enterprise Resource Planning, also known as ERP, is a software developed to support companies in the management of their business, even automating some processes. An ERP integrates all the necessary information, taken from different sub-sources, into a single system with a common database.

The possibility to have only one software where managing all the business operations, such as company's financial, supply chain, production, reporting, manufacturing and so on, allows to coordinate better the flows of information as provides a unique source of data.

In the past, ERP systems did not communicate with other systems. A company needed to have developed expensive and complex customized codes to manage all its business requirements. This, prevented a large-scale adoption of new technologies or process optimization.

A modern ERP software can, instead, communicate with other systems without having the necessity of further development. The connectivity of the whole ERP and of its parts (productive tools, e-commerce, customer engagement) is a strong growth motive for this technology.

An ERP process can improve business results in different ways:

- Drive optimal performances: by using Artificial Intelligence it is possible to improve decision-making as well as improve operational performance;

- Accelerate operational impact: by connecting processes and data employees have more flexibility, became quicker and deliver more value across the business;

- Ensure business agility: many ERP solutions are based on making the company ready to respond for any operational disruption or market change.

Moreover, an ERP solution can optimize several business functions such as:

- Commerce: an ERP allows to unify back-office, in-store and digital experiences. Moreover, customer experience can be personalized through AI recommendations improving retailers' productivity;

- Finance: ERP software increase profitability alongside compliance. Dashboards and insights give an overview of company's finances in real time;

- Human resources: an ERP allows to manage payment of employees as the assigned tasks. Moreover, it is possible, thanks to the software, to obtain information about employees' performances;

- Manufacturing: an ERP can manage manufacturing processes, optimizing them in terms of project management, cost management and production planning. An ERP automates processes allowing to fulfill customer needs and manage resources in a more efficient way;

- Supply chain: the automatization of the processes of entering information in the warehouse as the tracking of warehouses conditions drives to sensible benefits[19].

The application of an ERP inside a company is called implementation. The ERP implementation comprehends several steps:

- Business Process Research: during this phase the company defines requirements, objectives, and scope for every business process of the ERP to

be implemented. During this phase is important to define the processes in the organization, trying to find ways to optimize them. Moreover, specific targets must be set (such as cost schedule);

- Software installation: the software provider, or a partner, installs the software developing the related infrastructure (data storage, internet connection etc.);

- Data Migration: all the company's data must me migrated to the new software system which requires specific setups;

- Testing: In this phase all the system functionalities, interfaces, transaction are tested;

- User training: An ERP may be a complex software to use. A company's employees must be trained to do it;

- Total Deployment: In this the step the ERP is already implemented into the company systems. There are multiple ways to do so: Big-Bang approach (the entire transition occurs in one day, it is the fastest and cheapest method, but inefficiency may cause a big issue), Phased approach (ERP is implemented function per function or unit per unit), Parallel Operation Approach (the new and old system are temporarily managed in parallel, it is the least risky method but required high costs and time);

- Support: ERP projects' performances require to be evaluated during their whole life span, major indicators are: actual cost with respect to budgeted one, ROI, customer satisfaction, human error assessments, production or supply chain efficiency.

An ERP implementation may take from some months to a couple of years depending on company size, data size, number of users, resource, functionalities to implement.

Actually, also the cost of an ERP implementation varies a lot. Main cost drivers are: the ERP software price (it depends on renewal frequency, license type, data storage system, customization), the cost for consultants and trainers, the software maintenance, the cloud platform where data may be stored, staff[1].

2.2. ERP's invention and history

The first steps of the life of ERP software took place in the 1960s. In those years J.I.Case, a producer of tractors and machinery for construction, developed alongside IBM a Material Requirements Planning (MRP) which is considered the starting point for the ERP technologies.

Over time other large manufacturers started developing their own MRP solutions.

These first MRP solution were, actually, expensive to create, they took a lot of space and groups of experts were needed to develop them. Nonetheless, MRP helped businesses to track inventory and to produce. They were used to manage raw materials sourcing, to order the raw materials, to manage and track the delivery of materials to the factory and helped producing finished goods.

The high cost and effort drove to a limited adoption of the technology during the 1970s by medium and small businesses. In the same years the MRP market for big companies, which had the monetary and non-monetary resources to develop internally the system, saw an important growth.

During the 1970s companies started asking more from Materials Requirements Planning software, so additional features were added to enable organizations to manage purchasing, to forecast and schedule production.

A turning point in the ERP systems' history happened in the 1980s when it was developed the first Manufacturing Resource Planning system, even known as MRP II.

The MRP II provides additional functionalities for the manufacturing processes with respect to Material Requirements Planning. Thanks to the MRP II it was possible to coordinate the different departments involved in the manufacturing.

This strongly increased the companies' efficiency and the capability to coordinate production.

The benefit coming from ERPs use, despite being still in their initial forms, did not pass unobserved by companies involved in businesses different from the manufacturing. The interest for the MRP II technology of a wide variety of companies and the willingness to adapt it to make it useful for other businesses drove, after some time, to development of the ERPs.

At the end of the 1980s MRPs were used for the daily operational decision-making processes. During this decade the main MRP such as SAP, IBM, Oracle, PeopleSoft vendors were established.

In the 1990 the term Enterprise Resource Planning was coined to identify the technology used, at the time, by several businesses to increase the efficiency. In these years the ERP systems started having a unified database in order to share information across the entire company. Moreover, new functionalities were developed such as the management of accounting, sales, human resources, and engineering.

In 1990 so, ERP started being similar to the modern ones. They had a unique database, and they could be used by the majority of the employees thanks to the several functionalities developed.

The development of the market and the consequent increase in the competition among ERP providers pushed companies to search for competitive advantages. To do so providers began realizing applications to integrate the operational portion of the organization with the accounting area of the firm.

In the 1998 the ERP technology experienced a very important change, the creation of cloud ERP developed initially by NetSuite in 1998. Until that

moment ERP systems were on-premises, so installed and maintained on a local server accessible from a desktop application on the local company network.

With the development of cloud ERPs, users can access business data from anywhere thanks to an Internet connection. Thanks to the provision of the service in cloud, costs for companies decreased. It was no longer necessary, for the companies, to purchase and maintain the hardware as well as less IT staff was needed. The cost decrease has been a main driver for the adoption of ERP technology by middle and small size businesses which could partially mind the gap with big companies in terms of data accuracy, efficiency, and automation of processes.

In 2000 the idea of the ERP II was developed. In the ERP II the ERP system can get information from other sources, thanks to the internet connection, like Customer Relationship Management (CRM), ecommerce, marketing automation, Supply Chain Management (SCM) and Human Capital Management (HCM).

Thanks to the massive quantity of information feeding the ERP system its efficiency improved strongly. More data implied a higher capacity of problems identification and resolution such as capitalization of opportunities.

In the 2001 due to the dotcom bubble many big ERP providers suffered a downsizing. At the end of the crisis the remaining providers were SAP, Oracle and Infor.

Regarding the future development of ERPs three main paths have been identified, the machine learning, the Internet of Things (IoT) and the Sustainable Enterprise Resource Planning (S-ERP).

ERP systems are particularly suitable to be subject to machine learning thank to the enormous amount of information managed. Thanks to the machine

learning the system could make automated reporting, reconciliation, and error detection. It could be possible to find patterns into customers' purchases to maximize sales or managed more efficiently production.

IoT system can be an incredible source of information for an ERP system especially regarding the supply chain, the machinery maintenance, and the management of warehouses.

The birth and the development of the S-ERP has its roots in the necessity of firms to innovate being socially responsible. Thanks to S-ERP it will be possible to integrate sustainable operations, processes, and information.

According to a study made in 2016 businesses application may help companies to have a more sustainable decision making, examples of this are:

- Using a product bill of material to track the use of plastics and other chemical products;
- Tracking the duration of chemical synthesis step;
- Analyze and evaluate energy consumption of the production line.

Always in 2016 there were studies about an international food company which implemented into its ERP a Carbon Information Management, a functionality used to track carbon emissions of its products.

The implementation of an S-ERP is more difficult with respect to the implementation of a classic ERP since it involves new data and stakeholders. Moreover, a classic ERP is built in order to maximize profit achieved by centralizing data, an S-ERP is based on the sustainability Triple Bottom Line (People, Planet and Profit).

Historically ERP systems were developed for big enterprises due to the high implementation costs. Nonetheless, Small and Medium Enterprises (SME) are

more and more motivated to implement an ERP thanks to the advantages that they bring to the company.

The implementation of an ERP into SME is deeply different from the implementation into big companies. SME have different ownership type, structure, management, culture, resources, IT expertise and IS knowledge. All these aspects make the implementation into SME more difficult. According to researches an ERP implementation cost in a big company correspond to 0,82% of the annual revenues, for a SME it is instead 13,65%.

Due to the limited resources and the high cost, an ERP implementation is actually a high-risk project for a SME[2][20].

2.2.1 Cloud and on-premises ERP

Over time, thanks to the internet evolution, ERPs which once were provided only on-premises, has been supplied even by cloud.

In a classic on-premises ERP the software is installed locally on companies' computers and serves. Additional implemented features, developed for the company, are installed on the system and they are accessible directly through customer's machines.

In a cloud-based implementation the customer could access the software through technological information resources provided by the vendor itself. Obviously, this implies a prior agreement between the parties. These agreements cover a wide variety of services needed to implement the ERP such as servers' installation, firewalls, application for security, the ERP system per se and others.

Actually, some “hybrid” solutions are available too. In this last case the software is installed in a cloud environment hosted on the company private servers.

Hybrid solutions can be further decomposed into:

- Private cloud: when the ERP is hosted on a private cloud provider.
- Public cloud: when the ERP is hosted on public cloud platform of a trusted third party.

According to several research and study a cloud ERP implementation is more efficient and effective with respect to an on-premises one. Nonetheless, there are several factors to be accounted by a company to understand which implementation path is the best:

- Implementation costs: for a cloud implementation a company pays an annual or monthly subscription, this financially is considered as an operating expenditure. For a on premises implementation, the company pays for a one-time perpetual license fee based on the number of users. This is considered, financially, as a capital expenditure which face a depreciation over the years.
  An on-premises implementation involves costs for server’s hardware, licenses, firewall, antivirus, power consumption, space, maintenance, and upkeep costs. Moreover, cloud solutions, when implemented, generally, have added to themselves some modules and features, which are for free for the company.
  On the other hand, in a cloud implementation a company pays on consumption.

- Implementation process: an on-premises implementation involves the need of hardware, servers, licenses, installation and so on. A cloud installation does not need that. This makes the adoption of the technology much faster.

Moreover, in a cloud implementation a part of the customer's needs can be covered by out of the box system functions. In general, so, a cloud implementation requires less customizations.

- Customization: despite cloud installation requires less customization, those customizations needed requires much more time with respect to customizations made on on-premises installations.
  This because cloud service provider wants to maintain the original ERP code as untouched as possible to avoid conflict between the ERP code and the new functions. New functions when developed, after very accurate tests, on cloud provided ERP, are added to the code by using the so-called models. These models allow to remove anytime the functions without damaging the initial code.
  Actually, some companies like Microsoft and Oracle put restrictions on cloud ERP customization, forcing customers to have environments where testing added features.
  Moreover, fixing time of issues which require code changes are much longer on cloud solutions with respect to on-premises.
  In a on-premises ERP the company owns the code and can change anything it wants freely.

- Scalability: in a cloud ERP it is easier to make scalability of hardware. Beyond hardware scalability, a cloud ERP brings the availability of additional features, already tested on other environments on the same cloud server, which can be implemented in a company's ERP very quickly;

- Maintenance: in a cloud ERP the provider cloud environment is used, this makes the system more efficient, and makes it easier to maintain it and its

operativity. The company is, in addition, little involved in the maintenance, so less time and resources are needed.
Obviously in an on-premises implementation the company is responsible for the whole maintenance of the ERP;

- Data sharing: in an on-premises ERP the company is the only entity which has control over its own data. This implies the necessity of the creation and implementation of a very strong security policy.
In a cloud implementation a company puts its data on another company's environment which may be risky. On the other hand, the ERP providers may be more prepared and able to protect data with respect to the company itself.
Over time, thanks to the effort made by the ERP providers to mitigate the risk of security breaches, more and more companies are switching from on-premises solutions to cloud-based ones;

- Other benefits of a cloud ERP implementation are the use of an advanced technology, quicker updates, more accessibility and mobility, and costs transparency[3][21].

2.2.2 Open-source ERP

In the last years Free and Open-Source Software (FOSS) systems gained a lot of interest from the market as an available alternative to obtain and develop a software. *"FOSS systems are software whose license give users the freedom to run the program for any purpose, to study and modify the program, and to redistribute copies of either the original or modified program."*. There are two possible types of open-source software, community open source and commercial open source one. In the community open-source software, a community of users develops and updates the source code. In the commercial

open-source software, a company decides which community's implementation can be applied to the source code and it maintains the software copyrights.

In this environment, companies started implementing more and more open-source ERPs to obtain a competitive advantage with respect to other companies as well as to maximize stakeholders' benefit.

Implementing an ERP does not provide a competitive advantage per se anymore. Additionally, it involves a series of problems such as the high complexity and the misfit between business requirements and system functionalities. An answer to this problem could be the open-source ERP implementation.

To understand which is the best option for a company several parameters should be considered. Now, the most important parameters according to literature will be taken into account and confronted to highlight good and bad aspects of both types of implementations.

1) Ease/Speed of implementation: open-source solutions are generally considered less user friendly. On the other hand, ERP vendors implement their ERPs and have no need to make the ERP easy to be installed. Moreover, the ease and speed of implementation depends strongly on customizations needed;

2) Price: Despite open-source ERP are freely available on the market, installing and customizing them requires specific skills. This involves that open-source ERPs' consultants are generally quite expensive. At the same time, a newborn company can find very economically convenient to implement an open-source ERP since business processes can be adapted to the ERP and not viceversa;

3) Vendor support: in a proprietary ERP the ERP's owner can furnish the requested assistance. In an open-source ERP this should be intended as a wide community which could support the company when needed;

4) Reliability: ERP vendors put generally as much effort as possible but the number of people working and checking the code is quite limited, this makes very difficult for an ERP vendor to spot a mistake in the code. In open-source ERPs, thanks to the broad community, spotting mistakes is, generally, easier;

5) Ease of use: ERP vendors put a lot of effort into making the software as user-friendly as possible. Open-source ERP, on the other hand, are generally more difficult to manage. Nonetheless, the users community may make an ERP as ease to use as a proprietary ERP;

6) Customization/parametrization: proprietary ERP are programmed using a vendor specific code. A company can obtain customizations only by the ERP provider and its partners. Instead, in an open-source ERP, there is a greater population of potential programmers who can make the requested customizations;

7) Integration: Customers search for the possibility to integrate the ERP with other systems. Despite proprietary ERPs provide the possibility to have data warehouses, generally, open-source ERP are more used to allow communication to other systems;

8) Organization fit: Existing ERP are focused on business processes but it is not said that they fit perfectly to a company processes. Difficulties to change an

ERP adjusting it to the need of a company is quite difficult both the ERP is an open source one or a proprietary one;

9) Functionality: on average proprietary ERPs possess more functionalities than open-source one. Actually, this means that proprietary ERPs use is more difficult to master but they are more complete;

10) Vendor reputation: for companies vendors' reputation is a synonym of quality. This becomes especially relevant in case in which the customer cannot try the software before implementing it. Obviously, open-source ERPs does not bring any reputation with them;

11) Flexibility: it is a fundamental aspect in rapid changing environments. Older systems with a more robust architecture are better. Open-source ERPs could be considered, in this case, worse than proprietary ERPs being on average younger;

12) Training: the amount of training needed depends on the ERP system. For a company which decides to implement a proprietary ERP, trainers, who generally are ERP's provider and its partners, are quite easy to find. It is much more difficult, instead, to search open-source ERP trainers;

13) Information Needs: an important functionality for companies is the possibility to have a deeper access and knowledge of data through reports creation. Reports generally are created thanks to customizations, due to this open-source ERPs, since they are easier to customize, may be better;

14) Latest technologies: it is not said that proprietary ERP companies are more skilled than the community about the latest technologies. In this case, it depends on the company, and the community, itself;

15) Scalability: it is an important characteristic for companies which assume to grow strongly in the future. Actually, there are both open source and proprietary ERPs optimized for scalability so, as before, making a general distinction is impossible;

16) Upgrades: Open-source ERPs' upgrades are free for a company. This obviously is not valid for proprietary ERPs. Proprietary ERP vendors look deeper into customization when upgrades occurs but, at the same time, they try to limit the number of upgrades to minimize costs. Regarding support, for open-source ERPs the latest version is generally installed and supported while ERP vendors provide assistance for more versions;

17) Modularity: We may have numerous modules, as monolithic (with only one module) ERPs, in both the version. Even the creation of new modules does not involve particularly differences if the ERP architecture is well defined[4][5].

2.3. ERP's functionalities

ERP software have become fundamentals for companies thanks to their ability to automate critical business processes as well as being a database for the financial and operational information for the whole company.

A company which wants to manage its business on an ERP has two possible paths: it may make a brand-new application software be developed or otherwise it may purchase existing software applications.

Both paths have positive and negative aspects. A brand-new software guarantees a perfect customization and the response to what is required by the company. On the other hand, price for implementation grows significantly, since it implies the development of the solution, and there is no possibility to improve already existing technologies which are the result of market best practices.

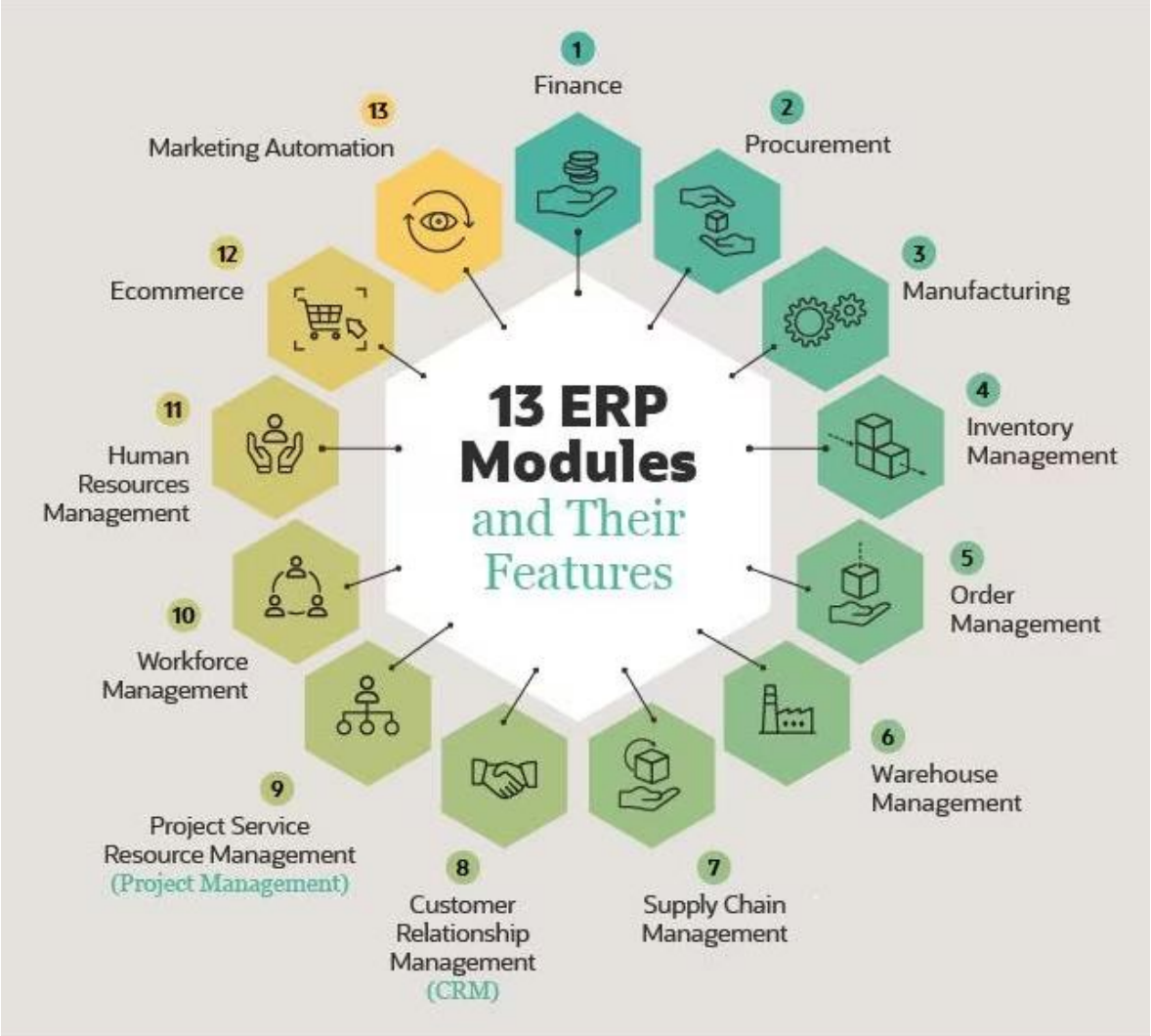
Implementing existing software surely requires less time and monetary resources but they do not fit perfectly to the company. This drives that whether the company adjust its technology to the application software or the other way around.

To solve this problem, ERP developers started dividing ERPs into modules. The modules are parts of the ERP software that can be implemented separately, despite being connected, and contain all the functions to make the required processes of a functional area. Every company manages its business in its own way but, since the functional areas among different companies are quite standard, it was possible to cover most of the business needs by creating a limited number of modules. Despite modules development, due to the different ways to perform operations of a functional area, it may still be needed by providers to make integration and modification to modules when the ERP is

implemented. This process is called verticalization of ERP. ERP verticalization is an “opposite” process with respect to the classic ERP implementation which instead is an “horizontal” process, since it involves the standardization of processes execution propagated by the ERP software.

Into an ERP, data are raised, by the software, from all the different modules. The integration of data from different modules into one system is one of the major benefits of the ERP software. It gives access to all the information to all the employees about a department performances and forecasts. Moreover, a centralized database guarantees accuracy and consistency of data as well as it helps decision-making processes.

To have a deep understanding of ERP functionalities a deeper analysis of the main modules must be done. Every module is a part of the ERP, and it is designed to satisfy a specific business function. The ERP modularity is, actually, a big advantage for a company. For example, in case in which a company wants to manage an additional business sector with an ERP already implemented for other functions, it can simply add the new modules and make setups. The main modules are thirteen, and they are:



[Fig. 2.1] An image of the main ERP modules

- Finance module: it is fundamental for a company. This module manages the current company's financial situation and its future outlook. It allows to manage the general ledger and to create and store balance sheets, tax statements and payment receipts. The functionalities implemented in this module allow to automate the billing, payments to vendors, cash management and so on. In addition, it allows to create reports about financial measures and assume different scenarios;

- Procurement module: it aims to help the company to purchase materials to be sold and/or to be manufactured. Companies can create lists of suppliers and

items adding several important information. This module gives a big help to companies for the supplier relationship management, covering all the different steps of the payable cycle from receiving the purchase quote, to the registration of the purchase invoice and the updating of the warehouse;

- Manufacturing module: these features have been managed by the ERP from the beginning. The functionalities available in this module are focused on helping planning production as assuring that raw materials and machine capability are available. It is used to oversight and update the goods status during production as well as if the production is performing as forecasted.
  A very important feature is the possibility to plan production by forecasting demand and supply starting from past data;

- Inventory management module: thanks to this module a company is able to track quantity and location of items into warehouses or production lines, in addition it is possible to take into account the incoming materials just purchased. Thanks to these features the company can manage in a much more efficient way the warehouse, improving margins and increasing inventory turnover. This would drive to higher profits and the avoidance of stockout and delays in the delivery of material, enhancing customer satisfaction;

- Order Management module: this module tracks the orders from the moment in which they are received to the moment of the delivery after the invoice creation. Moreover, it allows to distribute received orders among the warehouses and distribution centers or retail stores as it updates customers of the order status (prepared, fulfilled, shipped etc.). These features allow to improve efficiency in the delivery in terms of cost and time, improving customer satisfaction and company profit.

More developed order management modules can even suggest how to handle an order, following a cost perspective, accordingly to the available inventory, the buyer's location and the location of warehouses/retail stores;

- Warehouse Management module: the features involved in this module help the company to manage all the warehouse processes, from the store of the incoming products to the pick of them once they have to be shipped. ERPs can suggest even how picking materials from the warehouse to maximize efficiency for the specific business. These features allow a more economically convenient warehouse management as improve shipment pace;

- Supply Chain Management module: this module allows to track the movement of supplies and goods from when they are still in the hand of sub-suppliers to when they are supplied to customers. The management of all these steps make this module very wide since it covers material procurement, inventory management, manufacturing, order management and warehouse management;

- Customer Relationship Management module: thanks to these features a company can raise and store a series of information regarding its customers as well as customer's purchase and communication history. Advanced Customer Relationship Management can suggest selected customers as targets for promotions or marketing campaigns;

- Professional Services Automation module: this module aims to plan and manage projects on the ERP, it is widely used by service-based businesses. Thanks to this application it is possible to track the advancement and the status of the projects, manage resources and approve deliverables. Moreover, it creates a space where all the documents can be stored and shared among the

parties involved in the project and it can prepare and send bills to customers accordingly to billing rules setup;

- Human Resource Management module: this module is useful to manage personnel containing a wide variety of applications to do so. It is even a way to store all the document related to employees such as performance management and in general information;

- Workforce Management module: this module is actually quite similar to the Human Resource Management one, but it is thought to manage hourly employees, not salaried ones. It measures KPIs, employees' presence and productivity as it manages payrolls, sending automatically paychecks;

- E-commerce module: this module is developed to help companies launching in an easy way an e-commerce, whether a business-to-business or a business-to-consumer one. Advanced e-commerce modules allow employees to update the e-commerce look as well as its content, adding new items or changing the existing one. Actually, this module is not as common as the others in this list, since a limited number of companies needs the necessity to manage an e-commerce from their ERP;

- Marketing Automation module: this module, as the e-commerce one, is not very usual to be seen. Nonetheless, it has been developed by some software providers. It allows to create and manage marketing campaigns, via mail, SMS, social media and so on. It provides features to make customer segmentation to have a more efficient marketing and it provide reports about marketing campaigns performances in order to plan better future ones.

Obviously, a company can be run just with a limited number of modules, in dependency by its business, the functions that are going to be manage through the ERP and the available resources.

Generally, the most used module, is the accounting/financial one, since it covers a crucial company process which takes place in every company.

Modules widely used by companies involved in production and distribution of goods are those for customers management, employees management, supply chain management, inventory management and order management.

On the other hand, companies into consultancy, maintenance and repairment business generally implement project management modules.

Independently by the business needs of the specific company, according to International Data Corporation an ERP solution is a software which supports at least three of the following four business segments:

- Accounting;
- Manufacturing;
- Material management/distribution;
- HR management and payroll[6][22].

2.3.1 ERP new functionality: a literature example

An explicative example of the way in which, through customization, it is possible to add functionalities to ERPs come from the Ashok Leyland case. Ashok Leyland is an Indian company which produces commercial vehicles. In their plants they are equipped with a variety of machines such as those to produce car components, to move materials among plant's shops and so on. The machines breakdown notifications were reported by operators to line supervisors, who then log them into the ERP system. This process was excessive long and tedious. Moreover, it drove to have long downtimes and under-utilization of the machines which obviously leaded to a profit reduction.

To minimize time delays as well as to have a more user-friendly mechanism to monitor and track breakdowns, Ashok Leyland decided to develop two applications to implement on the ERP software. One application captures breakdown events, the other one monitors the events when they occur.

The two applications were developed by using resources internal to the company and open-source software in order to save money.

About the breakdown capturing application, it was implemented on shop floor dedicated computers. The application, connected to the database, represents graphically the lines and the machines into them. It leans on six master tables where codes and information about plants, shops, lines, machines, maintenance groups and faults are present and on a seventh "transaction" table which allows to pass information put into the application to the ERP. Thanks to the master tables the operator can point where is the fault and which type of fault occurred.

The operator of the capturing application can open the system and see the different lines and machines represented by some images. The machine images have different colors in dependency by the machine state. To signal a breakdown the user has simply to select the machine and assign it to a specific maintenance group in dependency by the fault type. When the breakdown is signaled the tagged maintenance group receives a notification. Once the breakdown is fixed, the operator closes the breakdown by the application and the system automatically compiles information about the breakdown. Thanks to the transaction table, breakdown information reaches the ERP.

The breakdown Monitoring application aims to monitor machine under breakdown from everywhere. This is important for managers who have to account for the lines' productivity. This application allows to see the breakdowns at different levels, from plant level (seeing how many machines are under breakdown in the plant in one moment) to machine one. Obviously,

this application, in order to show information, needs to be connected to the tables created for the other application, from which it takes data.

As for the other application, there are many levels. The operator can select a single plant and then, going deeper, it can choose to view a specific line and so on. Obviously in this application it is not possible to signal a breakdown, but on the other hand, information about past and present breakdowns are available.

The development of this application, thanks to the cost saving path decisions made during the development, drove to an appreciable reduction of costs for Ashok Leyland[7].

3. Issues regarding ERP implementation based on literature examples

3.1 Stakeholders' relationship with an ERP implementation

ERPs' purchase and implementation are pursued by numerous companies all around the world which see in the ERPs a possibility to reduce costs, increase productivity, obtain a competitive advantage and so on. These systems have a big impact on the company operations and a lot of attention should be put on their correct implementation since mistakes can drive to risks and costs which totally nullify the expected payoffs. There is a high probability, up to 70% according to literature studies, that the project of ERP's implementation does not bring to the company the benefits assumed. On average, these projects end in an over budget as well as they take much longer without providing the promised benefits.

A first reasons for which an ERP implementation project faces these problems, symptoms of an intrinsic difficulty of the project, are the numerous stakeholders impacted. The company who wants to implement the project could be influenced by the stakeholders and so it should manage them and their interests. In addition, problems derive also from the misfit between the ERP system and the characteristics of the organization. The ERP "*tends to impose its own logic on a company's strategy, culture, and organization*". This makes the ERP project a company change project rather than a "simple" technology implementation, which makes the project even more impactful for many stakeholders with respect to other projects.

The stakeholders' management is a fundamental part of any project, and it is defined as "the process of adapting the specifications, plans and approaches to the different concerns and expectations of the various stakeholders". The importance of stakeholders in the development or, in our case, adoption of a

technology is highlighted by some studies which suggest that the final form of a technology is not the technologically superior one but instead the one which is considered superior by the groups impacted by it.

The stakeholders' management starts with the definition and classification of them. A way to classify them could be dividing them into:

- Internal: they are the members of the project coalition of the ERP adopter side, and they support the project. They provide resources and direction to the project, are involved in the training, and they study the system to use it. They have a relationship, contractual of unofficial, with the adopting organization or they are involved in the decision-making process.

- External: they are not members of the project coalition but still they can influence the project, due to this they are crucial for the project success. Example of external stakeholders are vendors, consultants, who provide training and maintenance;

- Project team: it is composed by some key users (representative of the company who will teach final users), external contractors (vendors representants) and employees of the management information staff. The role of project team members is to solve problems, offer their knowledge, and assist in the configuration of the ERP.

The support and involvement of internal stakeholders, such as end user and top management, is fundamental for the ERP success. One reason is that the company's employees perceived as a good signal when top management allocates resources and provide direction and monitoring toward the project. In addition, obviously, top management involvement is crucial since it is fundamental to furnish to the project the right quantity of resources.

End users are as important as top management for the positive results of the project since they are those who are going to have trainings, make tests and use the system. Has been demonstrated that user involvement in the project has driven to a positive impact on the ERP implementation success.
Other important, despite not as crucial as the previous two, internal stakeholders are the IT specialist whose support is needed to implement the ERP.

External stakeholders are important because usually the company who wants to implement the ERP does not have enough resources and skills to do so. Consequently, external stakeholders' help is crucial. Example of tasks required to external stakeholders are generally: the provision of hardware and software, upgrade and maintenance of the ERP, training and so on.

The project team instead is created by the company's functional and IT personnel, which compose a core project team, alongside the consultant and the vendor teams. The project team, to bring a positive effect on the implementation, must be empowered. The empowerment means that activities, initiatives, and practices which involves delegating authority and responsibility should be assigned to members of the project team[8].

Dividing stakeholders into internal, external and project team is not the only possible classification. Another possible classification is based on three stakeholders' attributes: power, legitimacy and urgency.
A stakeholder has a certain degree of power in case in which it can impose its willingness on the project, legitimacy measures the perception that groups have of a certain stakeholder. In the end, urgency is intended as the time sensitivity and criticality of a stakeholder toward the implementation.

Accordingly, to these attributes different type of stakeholders can be found:

- Dormant: it has power but neither urgency nor legitimacy;
- Discretionary: it has legitimacy but neither power nor urgency;
- Demanding: it has urgency but neither legitimacy nor power;
- Dominant: it has both power and legitimacy but not urgency;
- Dependent: it has no power but both legitimacy and urgency;
- Dangerous: it has urgency and power but not legitimacy;
- Definitive: it has power, legitimacy, and urgency.

3.1.1 Stakeholders' management: a literature analysis of a real implementation

An analysis of stakeholders in an ERP implementation, following the stakeholders classification previously descripted, can be found in literature. It has been studied the implementation of an ERP in the company T, which is a European company which sells food and beverage products all over the world. The company is divided into different business units which operate quite independently from the others. The company wanted to implement an ERP to standardize procedures (trying to maintain processes as similar as possible to before) among all the different businesses which, due to past merges, are not totally integrated and aligned. They decided to start implementing the ERP into the Milk business units which were: Milk, Cheese, and Special Products. The goal was to replace all their transaction processing system. These businesses units, despite being different, were chosen because they were considered obsolete. Result of the obsolescence were the inconsistency of data in output, the difficulty to maintain the systems, the inadequate information, the provision of different financial statements and so on.

The plan was to expand, in the future, the ERP even to the other Consumer Products and Foreign Operations. The expected benefits from the ERP implementation were to reduce inventory, improve exchange of information into the company and between company and suppliers/customers, and to integrate the information system into the various divisions.

At the beginning the company planned to implement only the logistic module in the previously citated business units, then over time reporting and financial modules would have been installed.

The project started by implementing in the Milk business unit the logistic module but already in these first steps problems arose. These problems were mainly caused by key users' stress, errors, users' negative reaction due to insufficient knowledge, and by the lack of training and experience of staff and users. The project saw at the beginning a big drop in the company efficiency and employee moral but after few weeks of adaptation the new modules started working quite well.

Once this first stop was surpassed the company faced another impasse. They had to decide if implementing other modules in the Milk business unit or implementing the logistic module in the Cheese and Special Products units or, also, do both alternative at the same time. In this situation the first management problems arose. The Milk business unit pushed toward implementing the other modules to maintain the lead in the project while the other business units were not sure to implement the logistic module since the successful implementation in the Milk business unit was not considered a sufficient guarantee.

After some weeks of stagnation and absence of progresses the Board of Management decided to implement the logistic module in the Cheese and in the Special Products business units.

Tests were made to control if the logistic module, customized to be adapted in the Milk business unit, fit the other business units too. At the same time the

Milk business unit decided, independently, to implement financial modules without caring of the other business units, since it was considered easy to implement.

The three project groups, so, started working at different paces in an independent way on different tasks since no precise constraints were given due to a lack in the control of top management.

Even the implementation of the logistic module in the Cheese and Special Products business units had some problems. Representative of the IS-department wanted to implement the logistic module into those two business units as it was after the Milk customization, customizing it in a second moment accordingly to the Cheese and Special Products requirements.

This was unacceptable by Cheese and Special Products representatives which saw it as a dictation from one division to the others.

The misalignments between the business units were enhanced even by the CFO who supported the implementation of the financial module in the Milk business units, despite being not in the initial plans, seen as a way to spread the ERP all over the company giving a positive signal.

After two years from the beginning of the project the idea to implement the ERP in the whole company was abandoned, the Milk business unit was at a good point in the finance module implementation while the other business units were working independently to adapt the logistic one. Even the Board of Management allowed officially the business units to manage the project in an independent way, dividing the first initial big project into three smaller ones. Moreover, the board gave up the idea of an integrated system for the whole company, or just for those businesses units, but it puts as mandatory requirement that at least all the information to and from the Board had to be standardized.

This drove to a double-pace implementation in which the business units Cheese and Special Products went substantially slower than the Milk business unit.

The company T case is a clear example of how a bad management of, in this case internal, stakeholders could drive to a failure in the ERP implementation project. To understand better what has driven to this failure a deeper analysis on the context and on the stakeholders should be done.

The Milk Business Units has always been the company cash cow. Nonetheless, the profitability of this division in the 10 years before the ERP implementation project decreased drastically. This, which was quite hidden to those outside the division, did not impacted the perception of people inside the Milk division who still saw themselves as core for the company. They were strongly convinced that a significant cost reduction path was the right way to have back the old profitability. This drove to their high motivation to keep implementing the project without taking care of the other functional units and to implement the ERP in the more efficient way for themselves. The Milk business unit had an urgency for the development of the project which the other business units did not have thanks to their better financial situation.

Another relevant information about the context is the “clash” between the CEO and the CFO. As previously said, the company T growth a lot thanks to acquisition in the years before the ERP implementation. This heterogenous and incoherent growth had to be organized and standardized to unleash all the potential of the acquisitions. The CEO’s main goal was to make the company more homogeneous by implementing an ERP. The CFO instead did not share the same long-term vision and it was more focused on short term economic positive results. His goal was to obtained small steps victories in some focal business units.

To study properly why the implementation project failed stakeholders' behavior and intentions should be analyzed deeper:

- Boards of management: it had the long-term goal of creating a more integrated company. Despite the strong initial intentions, the Board were not consistent with its policy. At the beginning it behaved as a definitive stakeholder being very present but after the first steps were done the CEO started delegating the control and the management of the project to the Board and to the CFO. The CFO had different short-term goals which drove to changes in the management of the project;

- Milk business units: they believed strongly in the project which was seen as the possibility to improve their financial situation. To obtain as much benefits as possible the Milk management decided to have an active and dominant role into the project;

- Cheese and Special Products business units: both the business units perceived the project as something useful but not urgent. They were so dominant stakeholders, and they exercised their dominance by not implementing the Milk logistic module. Seeing the Milk business unit behavior, they decided to stop cooperating with it and to continue developing alone;

- IS department and external consultants: they were dependent stakeholders. The IS department had a lot of interest in this project since the ERP would have centralized all the IS departments. The external consultants were interested in the prestige coming from the successful adoption of the ERP by the T company.

The vacuum power left by the board created competition among the other stakeholders, the business units. Despite this, none of the business units had the power to manage the others to realize a common solution. The final solution,

in which the Milk business units made a full implementation while the other made another project, can be considered an acceptable solution, since it has been accepted by all the stakeholders, but surely it was not the expected and optimal one.

The company T case is an example of how much different stakeholders can perceive a project in different ways and how they can search something different from it. These different perceptions may change the relationship between the project and a stakeholder, and they must be managed. Moreover, as it was evident in this case, the relationship between the project and the stakeholder may vary over time, this because this ERP implementation project has more emergent and adaptive characteristics with respect to the planned ones. Due to the big impact of the project on the company it happens that decisions are not always made accordingly to logic but more on the interests of the decision makers.

The ERP implementation project becomes so more than just a technological implementation but instead more a negotiation among parties. It is clear, so, that to have a successful project it is of the utmost importance to be aware of the different opinions and influence them to advance the project[9].

3.2. Integration of ERP with other companies' management systems

In the last years ERP software are becoming more and more the major source of collection and management of information for companies, thanks to the possibility to use them for a wide variety of processes. An increasing number of companies, every year, implement an ERP software, but the ERP adoption process still represents a huge innovation for them.

Actually, ERP software are so complex to implement that not always it can be clearly stated whether it is the ERP that model the organization or the organization that model the ERP. This complexity exists because an ERP impacts the way in which a company is managed and how things are done. By constitution companies are not structured to introduce easily a new disruptive technology.

The ERP should be adapted to the organizations' components, which depends on the type of the organization and its environment. Organizations' characteristics represent, so, constraints during the ERP implementation.

The management of information done by an ERP can be used for several purposes. For example, it can be integrated with the already existing coordination methods to make them more efficient. Coordination can be defined as the tool to make all the company' parts together. Consequently, an organization can be seen as a set of mechanisms to solve the coordination problems.

It is possible to distinguish two different coordination mechanisms, the first one is related to the decision-making processes and the labor division, it can be called organizational mechanism. The second coordination mechanism refers to the rules, which defines how employees meet their commitments and solve issues.

Additionally, an organization can be divided into two coordination principles: the hierarchization of the units, which represents the authority distribution inside the company, and their interdependencies, which represents how work processes are divided among units and their autonomy. The combination of these two principles determines the different organizational architectures and, consequently, the information generated and the standardization of the latter.

When the company architecture is based on specialization, so when there are well defined activities, interdependencies among units are more frequent and an ERP may be very useful if implemented.

The crucial element to consider when an ERP is implemented is the relationship between the ERP and the coordination mechanisms, which determines the transmission of information between units. The information transmission depends on the intensity, so the information flows size, and the standardization. Obviously, in case the information flow is little, or irregular the profitability of the ERP implementation project is little if not inexistant driving to the unnecessity to integrate it with the already existing mechanisms. Moreover, it could be undesirable to formalize some information flows, like mutual adjustments since it could mean to lose the flexibility and efficiency proper of those flows.

To summarize, the integration of an ERP with the current information exchange systems could be very interesting when a company has a centralized architecture since in that case information is regular, numerous, homogeneous, and standardized.

Instead, when the architecture is decentralized, coordination is based on mutual adjustments, there is no standardization and little vertical organization an ERP would face more difficulties if implemented, and it may be wiser not to integrate it as an additional tool to exchange information.

Actually, in most of the companies a hybrid structure, in the middle between a centralized and a decentralized one, is present. In these cases, an ERP can be integrated but it is likely to face resistance to change when it comes to formalize the informal procedures.

The adoption of an ERP can push a company toward a centralized and more coordinated structure in order to maximize the positive effects coming from the use of the ERP. This push can take place in different ways:

- Changing the company's operating systems. The adoption of a new system can take place for different reasons, like the adoption of a new standard. In the decision of which operating system should be adopted the implemented ERP has a relevant place. This because companies try to search the operating system which communicates more with the ERP, in order to enjoy the maximization of the efficiency;

- Sets of Mechanisms: an ERP can be integrated in the employees control systems. They can be used to solve some problems like the compatibility of actions, and it help to control whether agents meet their commitments. The compatibility of actions requires by the system to control employees' behavior during coordination process through rules and authority. The meeting of commitments, instead, is controlled through the creation of reprisal (penalties) and incentive (bonuses) mechanisms given when the commitments are or are not respected. ERPs can be integrated with the existing controlling methods since they can alter the costs related to the alternatives and, so, which alternative is the best. Generally, the use of authority and incentives, since require a lot of information, became more efficient thanks to the ERP and can be more easily adopted. The positive impact, especially in the use of authority

with respect to rules, is even greater if the company is into a situation of great uncertainty and flexibility in which rules can not always be applied and quick information flow is needed. In the same way, incentives require more information, to control if the processes have been performed correctly, with respect to reprisal which are connected to event easily observable.

- The language and communication: the adoption of an ERP makes the company adopt a consistent and uniform language among all the functional units. This decreases difficulties related to the communication with functional units of different countries. Even the communication with the customer becomes more standardized thanks to the central repository of information about the client into the ERP. Obviously, the same concept can be applied to suppliers.

The adoption of an ERP, with all the consequent modifications and changes applied by a company, alters the organization of the activities even in other ways. Companies analyze the internal processes when they want to implement an ERP. In this way, they may find possibilities to improve efficiency changing the processes, and this is before implementing the ERP.

Still, there is more availability of information, and its use may create tensions regarding the access to it, the connection between business units and so on. To solve these tensions, the company may change some processes.

Other variables that may have an impact on the company when an ERP is implemented are the barriers to the exit, resistance to change and the occurrence of contingent events.

Obviously, the impact of the ERP implementation depends on the business area since every area would face different challenges and would integrate the ERP with the different managing tool already existing.

In general, as described in the stakeholders' management section, the main driver for a successful implementation, and so switch for existing management

systems to the ERP, is the engagement of employees and the effort put into learning to them the needed skills[10][11].

3.3. Risks related to ERP implementation and use

3.3.1 Risk of an ERP implementation with a literature analysis of a real implementation

As already said, an important percentage of ERP implementation projects incurs in over-budget or over-time. The consequences of this poor management may have a big effect on the company and so it is critical to manage properly the sources of risk for the project. The main risk sources are the stakeholders' management, the coordination of different functional units, the ERP configuration, the management of change, the leadership expression, and the development of the system. The risks in an ERP project so spread into many fields from technological to managerial, from psychological to sociological and they are all strongly interconnected. The interconnections drive to the possibility that the risks affecting one agent can have impacts on many of them, as well as risk occurred in the firsts project steps may result in problems much after. Due to this, a robust preparation by the project team regarding risks is of the utmost importance.

The risk management not only allows to make the project finish on time and within the budget, but it drives to several benefits such as: more control on resource allocation, more precise estimates, a better ability to take advantage of opportunities, avoid reworking, promoting win-win situations and so on.

For the risk management of an ERP implementation project, some general steps can be defined:

- Context analysis: when the boundaries of the risk analysis is done;
- Risk assessment: which is divided into risk identification, when potential threats or opportunities are identified, and risk quantification, when risk are prioritize through the creation of risk levels and classes;

- Risk treatment: when it is decided how to face the risk. This could include mitigating the risk, reducing its probability, accepting it or externalizing it;
- Risk control: in this case all the activities done by the company when the risk occurs, it is based on monitoring and review, and communication and consulting.

Despite there could be some techniques to solve discovered risks, in this case the focus will be put mainly on the Risk Assessment phase. A possible technique for the Risk Assessment phase is the Interpretive Structural Modelling (ISM) which allow to discover risks and the relationships among their factors and effects. The ISM technique should help project managers to identify the relationship between risks factors and risks effects and to create models based on them. In addition, it should help to interpret the results in order to have a valuable input for the risk evaluation phase.

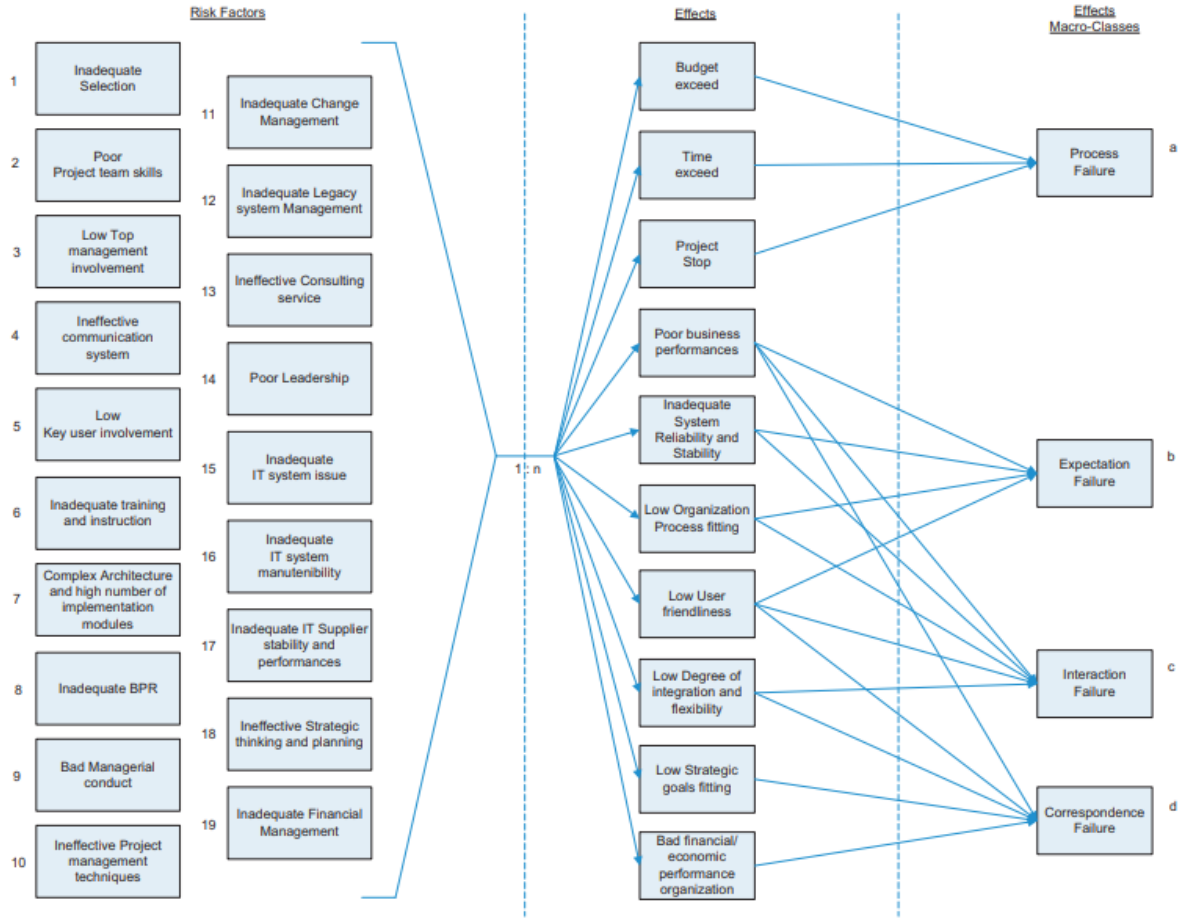
The ISM method starts with the creation of an ISM implementation group made of experts whose goal is to use their skill sets in order to identify the risks factors and effects. Once this has been done, the Structural Self-Interaction Matrix (SSIM) is done. This matrix allows to address how a risk factor can impact another one and it could be a first way to understand how the occurrence of some risk may lead to miss the project objectives. Then, factors are classified considering their dependance, so from how many factors they are influenced, and their driving power, so how many factors they influence. Lastly, a graph to represent interdependencies among risks is drawn.

To illustrate better the risk assessment phase and the use of the ISM technique a case study is the best way. In this case the case study regards a multinational company in the electrical and alternative energy business which wanted to implement Oracle as ERP. The company goal was to re-align its IT parts after the big growth of the previous years.

To collect data about risks interviews were made to a group of experts like Oracle implementation team members and even academic experts. This group of experts distinguished four different types of possible project failures:

- process failure: when the project is not completed on time or within the expected budget;
- Expectation failure: in case in which the ERP is not consistent with user expectations;
- Interaction failure: when users have a negative attitude toward the ERP;
- Correspondence failure: when the implemented ERP is not enough to satisfy the established goals.

The team of experts made a study and distinguished the risk factors interdependencies and the risk effects one via a questionnaire. After this a single SSIM was produced.



[Fig. 3.1] A representation of the risk factors, effects and macro-classes founded.

The next step done by the team of expert was the classification of risks in dependency by their dependency and driving power, this passage gave a better understanding of the risks, their occurrence probability and the response strategy.

Risks factors were divided into:

- Independent factors: with high driving power and low dependence. These risks produce a big snowball effect, and their management should be a priority. Examples of this risks include poor project team skills, low top management involvement and poor managerial conduction;

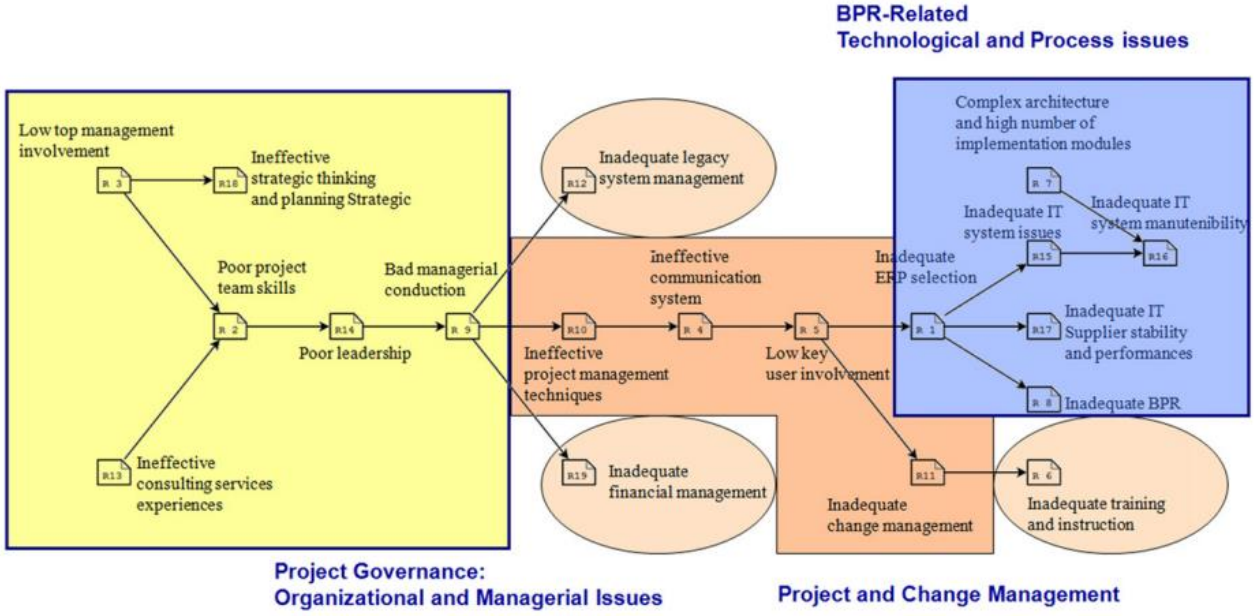
- Autonomous factors: with low driving power and low dependence. These risks are relatively “isolated” and disconnected by the others, generally they are

project management or IT technical issues such as inefficient management techniques, poor leadership, inadequate IT maintenance and so on;

- Linkage factors: with high driving power and high dependence. These risks are highly critical since any action on them would have a big effect on the project causing instability. Their management is very important, in this case study no linkage factors were identified;

- Dependent factors: with low driving power and high dependence. Examples of these risks are those related to communication systems, and they may involve key users. Examples are insufficient change management and low key-users involvement.

After the risks were defined and categorized it was possible to create a first graph in which the relationship between risks is shown. This allowed to understand better the dependency between factors and effects. Below it is shown the relationship graph where risks were divided into three categories.



[Fig. 3.2] The connections among the risks.

In this analysis Project Governance risks were considered the most important one, they are the source of every other possible risk. In the same way, experts suggested that Technological and Process issues were results of the Project and Change management issues.

Theoretically, now the ISM is completed. It is possible to use it a tool to support risk quantification. A way to make the quantification is using the FMEA approach in which to each risk is given a Risk Priority Number (RPN). The RPN is the product of the risk Severity, Occurrence and Detection. Every of these three categories can go from 1 to 10, consequently the RPN can go from 1 (the best case) to 1000 (the worst case). Actually, the RPN methodology can be integrated adding another factor, the Dependency index K, which represents the interdependency between a risk factor and the others[12].

3.3.2. Data stole risk

The risks associated to an ERP are not faced only during the implementation phase. Actually, in the use phase, companies may face important risks. This because the information is handled through the ERP and the ERP is provided through the internet or, alternatively, some internet technologies are used by an ERP such as IoT, Big data and Cloud computing. From the internet information can be stolen, consequently, there are some security requirements that must be set and met. The bigger and the more advanced are the modules implemented, the more stringent will be the security requirements needed.

To face these requirements vendors may use different methodologies such as systems architecture methods, data transfer methods, activities on data access and databases.

The fundamental steps to assure information safety is working on the system architecture. Generally, vendors' ERP are developed on three layers:

- Presentation, used for connecting users to the ERP. The users in this layer put and display data, launch processes (managed by other layers) and so on;

- Application, used to process data. It satisfies customer requests by the activation of the processes in the presentation layer;

- Database, used to store data. It manages a wide variety of data, from business information to information about the users and their operations.

These three layers are connected each other through lines and platforms, and the access to these layers is granted only to authorized processes, devices, and people.

Another security tool policy used in ERPs is the data confidentiality. Which limits the visibility of information to users accordingly to their work and functionality. In the same way the ability to add, modify or delete an information is organized. This type of security policy works assigning specific authorizations to every role and assigning consequently to every user a role. Due to this reason the security policy is called Role-Based Access Control (RBAC).

An additional security policy was needed in the moment in which the ERPs started running on the internet. In that case an Intern Protocol Security (IPsec) is needed. The IPsec protects data when they are exchange through the ERP by making IP tunneling. Basically, the information flowing between two points are encrypted using particular protocols and this is obtained by using a Virtual Private Network (VPN) connection.

Additionally, in order to protect documents exchanged between customers and ERP over the Internet, companies use other security protocols such as Secure Socket Layer (SSL) and Secure Hypertext Transfer Protocol (SHTTP).

Security policies can be applied even on the Database layer. Generally, databases can be organized in two ways: the “classic” Structured Query Language (SQL) and the NoSQL for the management of big-data and for the application running online. Recently vendors are focusing on a new way to create the database layer, through the blockchain methodology. In this way a dynamic, distributed, and decentralized database is built. The database would be safe since every blockchain’s block contains and encrypted address of the previous block and the transaction data[13].

3.3.3. Technical debt risk

The technical debt risk occurs when the ERP has been already implemented. The technical debt creation happens in the moment in which, when something challenging must be developed or when maintenance is needed, shortcuts are used to have the functionality operative sooner. This may drive to a decrease in the long-term benefits provided by the ERP. The use of shortcuts drives to a higher probability of failure as well as problems to developments in the future business strategies. Moreover, technical debt tends to accumulate over time, especially in a situation where there are limited resources and a lot of pression. This because software teams enter a downward cycle of shortcuts which lead to failures, more expensive maintenance, and again shortcuts to solve the problems.

Making technical debt reduction is not an easy procedure, not only for the complexity of the task per se but even because shortcuts are built on the underlying platforms owned by the vendor and not by the company, the code so is not totally accessible or modifiable and there is a high probability of conflicts between the developments and the underlying code.

A case study was developed by the analysis of 48 different companies which implemented a COTS (commercial off-the-shelf) ERP for 10 years. The system failures were divided into the failures caused by client customizations (client errors) and those caused by the vendor (vendor errors). Moreover, analysist distinguished among modular maintenance from architectural design maintenance. Modular maintenance occurs when modification on the code is done on just one module and interdependencies among modules are not touched. In an architectural design maintenance, instead, the focus is on the interdependencies among the modules and the overall structure system in order to simplify them. The goal of the study is to understand the impact of technical debt on the failure probability as well as the more efficient maintenance to reduce technical debt.

In this case a COTS ERP was provided. In a COTS ERP the provider furnishes to the clients the standard version of the software and the tools to allow users to make customizations and developments. In this way the providers shift risks from itself to the users which have to take care of the ongoing maintenance. Software providers take care only of the product development. Thanks to the COTS approach costs decrease and both development and maintenance activities are more efficient. Despite the benefit of this approach, final companies which do not have many resources, may take design shortcuts when maintenance is needed, maybe even violating ERP provider standards. In this way they tend to accumulate technical debt. The developed technical debt can not be seen by the ERP provider and consequently there is a misalignment between parts.

As predictable, the more changes are done on a system the more interdependencies between modules are present. Consequently, the system becomes more complex and prone to failures and errors. Technical debt may even propagate to the entire system in case there is a wide web of

interdependencies. It may cause an increase in the time needed to adopt the system, the implementation of good practices and so on.

A way to reduce the amount of technical debt could be to make and adequate and focused maintenance but this is not assured. Actually, despite the maintenance drives to a higher software quality, it is still not assured that the amount of technical debt would be reduced by it. The clients' maintenance is obviously done on their modifications to the code. Clients' knowledge allows them to recognize mistakes in the code logic and to make predictive maintenance. At the same time, they do not know the architecture of the system, and their action may have an impact on it. Another problem related to the knowledge asymmetry between ERP provider and the companies is the possibility of activating provider dormant system errors. Moreover, especially in the long term, the client maintenance may enter in conflict with the vendor's maintenance and developments causing more conflicts and technical debt. Regarding these possible problems, the architectural maintenance is suggested because it has a lower change to trigger vendor errors since it considers system level parameters.

In the COTS case study presented before, to reduce problems related to misalignment between provider and users, all the modules modified by clients did not received updates from the ERP provider. The client had to update autonomously the modules.

A case study's goal was to compute the system reliability, measured as the time between to failures, in dependency by some variables. In this way it was possible to understand which variables had an impact, and the its size, on the system reliability. The independent variables considered were:

- Technical debt: measured as the percentage of modifications on the code made by the client which did not respect the vendor prescribed standards. The

modifications were divided into customization which altered the business logic and those which altered the vendor schemas;

- Modular maintenance: computed as the percentage of source code within a module examined by clients' IT teams;

- Architectural maintenance: computed as the percentage of interfaces within modules examined by clients' IT teams;

- Source code size: it is important to measure since larger codes mean more complexity and consequently more errors;

- Volatility: a high volatility in the ERP environment means more changes and consequently more errors and possible violation of vendor standards;

- Team experience: stabler and more experienced clients IT teams produce more high quality codes;

- Use of consultants: on one hand consultants support drives to positive aspects thanks to their experience. On the other hand, different approaches may be used by clients and consultants with consequent coordination problems;
- Product age: it has been demonstrated that the older the system is the more entropy there is which causes more failures;

- Number of client sites: the more sites a company has the more maintenance practices will be divided in terms of location and modality. This should increase complexity and failures;

- Transaction volumes: the more a system is used the more customization and maintenance is needed. Consequently, its complexity increases;

- Logic and data complexity: those modules which work, even by default, with very complex data may be subject to more maintenance and errors with respect to simpler modules;

- Prior failures: System which have failed in the past have a higher tendency to fail in the future too.

The study focused so on several system failure causes which determines the hazard ratio. In this case the hazard is considered as the hazard of failure for a given cause when an event occurs. According to the study, the lower the hazard ratio the higher is the system reliability. Results evidenced that a change of 1% in the business logic made by nonstandard customization drives to a 14% increase in the system failure risk due to client errors. The same increase but of data scheme logic drive “only” to a 12% increase. A 1% increase in the Application Programming Interface (API) violation (so a violation in the communication between two computers) drives to 23% increase in the system failure probability due to client errors and of two times for vendor errors. Modular maintenance drives to a 78% reduction in the system failure probability due to client errors. At the same time, it increases of four times the probability of system failure due to vendor errors.

On the other hand, architectural maintenance reduces probability of system failure due to client errors of the 53% and it increases of “only” two times the probability of system failure due to vendor errors. This data drives to a much higher risk associated with modular maintenance with respect to architectural maintenance. It shows that failure due to vendor errors doubles for each 1%

increase in the number of interfaces altered during architectural maintenance. On the other hand, a modular maintenance without the interfaces rectifications drives to an increase in the probability of failure due to vendor errors of four times.

It has been demonstrated that volatility increases the probability of failure by both sources, vendor and client and that more experienced teams decrease of 38% the probability of failure due to client errors and increase the profitability of 12%.

About the code complexity, the results showed that for each additional KLOC (thousands of code lines) the probability of failure due to client increases of 42% and due to vendor of 45%. The same thing can be said for product age, for each additional year the probability of failure increases of 5%.

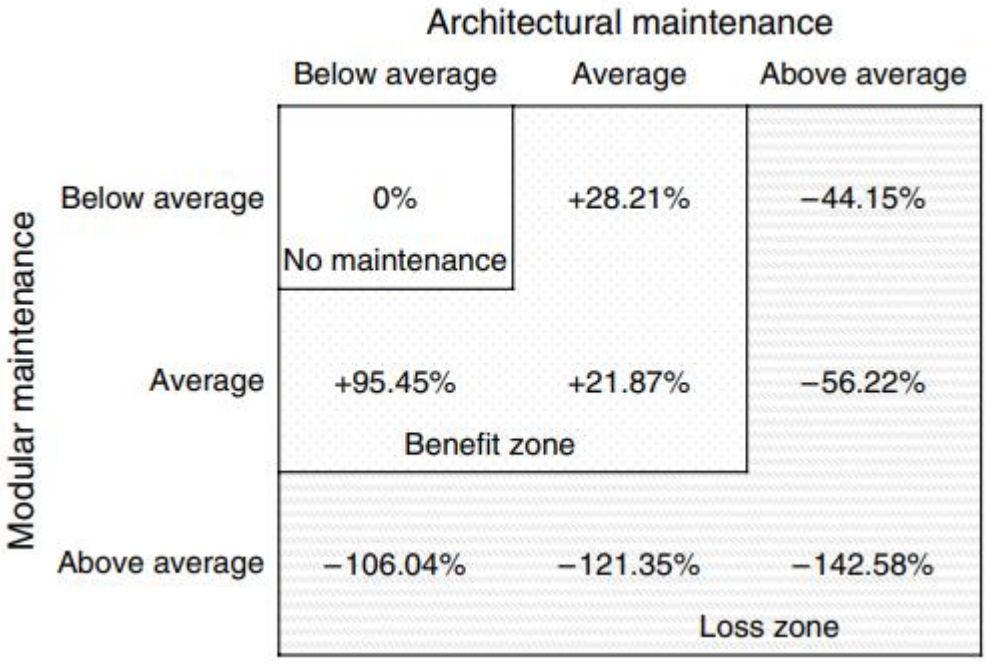
The use of consultants really helps since it reduces slightly the probability of failure while the number of clients does not seem correlated to any change in the failure probability.

The number of transactions drive to an increase in the failure probability, even if the effect is weak. Even past failure due to the vendor errors have an impact on the failure probability doubling it. This shows the possible long-term effects of vendor errors.

The final results obtained by the data tell us that overall modular maintenance is more effective than architectural maintenance in the technical debt reduction.

The next case study's step was to analyze the risk of technical debt associated to a company, even in monetary terms, to evaluate the possible best managers response. The risk exposure has been measured as the product between probability of failure and loss due to the failure (estimated using interviews). On average, the risk exposure due to technical debt were estimated to be 0,9 million of dollars per year. Consequently, always on average, the maintenance project to have sense should aim to reduce costs of significantly more than 0.9

million (considering the possibility of increasing the probability of failures due to vendor errors). To evaluate the best scenario maintenance costs were estimated by clients' maintenance projects. Nine possible scenarios were suggested as combinations of architectural and modular maintenance which could have been below average, average, and above average. The estimated maintenance project results are described in the image below.



[Fig. 3.3] Average profit of different maintenance levels

As it can be seen, not all the scenarios yield a positive effect. This is due to interdependencies and asymmetries between clients and vendors. Excessive client maintenance, maybe not aligned with ERP vendors future developments, drives to negative effect.

From this analysis two main vendors best practices may be highlighted:

- Clients who participate more actively in vendor initiatives are more able to understand the vendor path and consequently make more precise maintenance;
- It is better to modify just those fundamental, for the client, modules and not all those perceived as week. Those will be probably improved by the vendor autonomously[14].

3.4. Change management: resistance to the change and its management

Business organizations understood the importance of the technology to run efficiently a company. The successful use of a technology is, so, extremely important for the success of the company. The correct use of a technology depends strongly on the readiness of the users to adopt it, which is an individual processes since there are the single employees the one who are going to use the technology. Consequently, for the successful adoption of a technology, it is of the utmost importance to make the users feel the need of it in order to reduce their resistance to change. The change management, which can be defined as a set of basic tools used to maintain any change under control to minimize distractions and impacts, should be handled since the planning phase of the implementation project.

In the last years, according to some studies, the return obtained from technology use showed as an increase in the efficiency is due almost exclusively to the use of information technology but not to the adoption of strategic systems or informational investments. The major reason beyond these results is the human factor. Not always, in fact, operators are willing to adopt and use the technology using all its potential. A main reason for this is that, usually, operators are not involved in the technology adoption process.

The change management introduces techniques to manage soft factors and the impact of change on people.

When an ERP is implemented, usually, to measure the successfulness of the implementation not only cost and time parameters are used but even employees' satisfaction. This because employees' satisfaction is a key factor to evaluate the successfulness of a technological implementation and consequently the possible results, since satisfied users will be more productive.

In the employees' acceptance field, we can insert the concept of resistance to change, defined as a "behavior, which is intended to protect an individual from the effects of real or imagined change". In addition, resistance to change not only makes users more inefficient once the ERP has been implemented but it also can slow down the implementation project increasing time and costs of it. Some major sources of resistance to change are:

- The nature of the change has not been explained clearly to employees affected by it;
- The change may be interpretated in many ways;
- The people affected by the change feel strong motivation to deter it;
- The people affected by the change are forced to it and do not have power in the decision-making process regarding the change to implement;
- The change affects personally the operators;
- The change ignores the pre-existing processes, formal and informal, of a group of people;
- In case of an ERP implementation, the technology may change the allocation of power and resources which may drive to resistance by some operators. Or similarly, someone may think that the new technology may drive to downsizing;
- The job and the consequent tasks after the implementation are perceived as less interesting or challenging;
- Lack of trust of management choices;
- Social influence;

According to some studies other sources of resistance to change may be inadequate human resources commitment, lack of organization, business processes not redesigned to fit the ERP. Generally, resistance to change is the result of corporate culture and so it is mainly unconscious.

There are several initiatives that a company can pursue to avoid change resistance. Some of them involves making the users understand and feel the necessity of a change. Even involving final users from the design and implementation processes and not only when the ERP has to be used is a possible technique. Still, create a help desk and/or an online manual would help to meet user's needs and to reduce resistance to change.

The main goal is to reduce as much as possible the restraining forces, and to increase the driving forces. When possible, the suggested best practice involves a reduction of the restraining forces before the increase in the driving forces.

Resistance to change can be distinguished into passive or active and according to some research it is possible to make distinction even between resistance to the change process and resistance to the change outcome. Resistance to change can be divided into four groups:

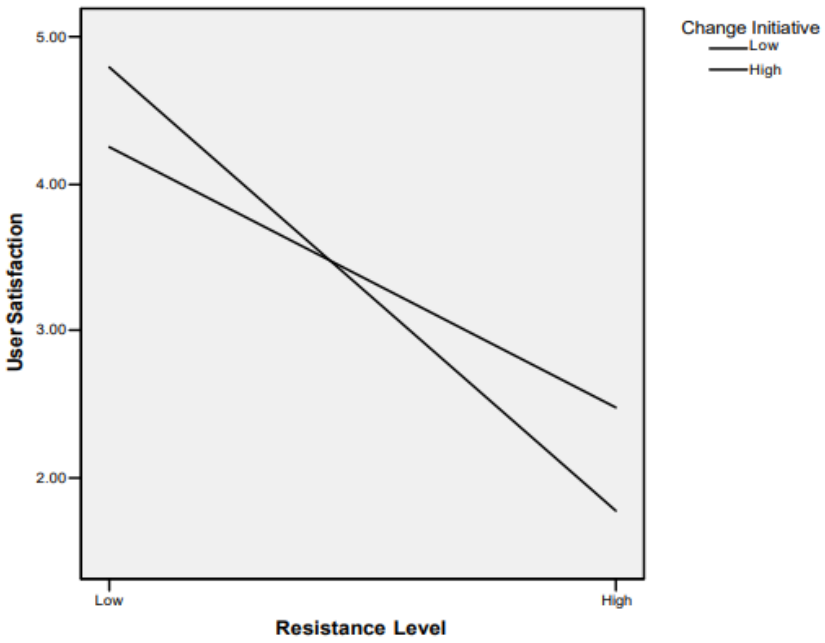
- Distrust: which involves reactions like "I don't like it" or "I don't believe it";
- Doubt: the individual is resistant to a particular change, not to changes in general sense;
- Inertia: the individual does not manifest any reaction toward the change;
- Reactance: the individual is against the change, and it is motivated to regain his/her independency and position.

According to literature it is possible to formulate four hypotheses about resistance to change and its relationship with the project which are:

- H1: Resistance to change will be negatively related to achievements of predetermined goals;
- H2: Resistance to change will be negatively related to user satisfaction;
- H3: The negative relationship between resistance to change and predetermined goals achievements will be lower when change management initiatives are higher;

- H4: The negative relationship between resistance to change and user satisfaction of predetermined goal will be lower when change management initiatives are higher.

  To check these hypotheses a case study was done in West Malaysia on local manufacturing companies which are considered the top Malaysian's electronic industries. Employees of this region are known to be high skill workers with a high technology knowledge. Questionnaires were sent to them to understand their satisfaction toward the ERP implementation occurred in their companies. Questionnaires answers were used to find relationships between implementation achievements and user satisfaction. According to the found results H1, H2 and H4 were fully supported, while there was no evidence to support the H3. In the graph below is shown the relationship between resistance level and user satisfaction for different change initiatives levels.



[Fig 3.4] Relationship between resistance levels and user satisfaction in dependency by the level of change initiatives

At the end, despite the research done is limited to a small sample of companies and employees, it provides a clue about the importance of customer satisfaction on an ERP implementation project.

What has been found thanks to this case study is that resistance to change impacts negatively on users' satisfaction and consequently on an efficient use of the technology. To reduce resistance to change measures have to be applied by the management.

In the literature it is possible to find change management models, one of this is the Kotter 8-step model, which steps are:

- Establishing a sense of urgency; in order to motivate people to change they have to perceive the change as something fundamental;
- Forming a powerful guiding coalition; to increase the probability of success a group with the right characteristics must be chosen;
- Creating a vision; it is important to develop from the beginning of the project a clear vision of what has to be achieved;
- Communicating the vision: in order to incorporate the vision at company level it has to be communicated to everybody into the company using every communication channel;
- Empowering others to act on the vision: a strong guiding coalition is as important as the involvement and the empowerment of individuals during the change phase;
- Planning for and creating short-term wins: in order to keep people motivated it is important to create short-term wins easy to achieve. In this way the initial interest and enthusiasm would not be lost;
- Consolidating improvements and producing still more change: new processes have to be improved, used, emphasized in order to maintain them without going back to the old processes;
- Institutionalizing new approaches: the new processes become the status quo in the moment in which they are the benchmark of the company work, its model. When this happens, the change is absorbed.

According to Beckard and Harris the resistance to change can be described with a formula, C = ABD > X where C = change, A = status quo dissatisfaction, B = Change desirability, D = change practicality, X = change cost. This formula can be applied to anyone involved in the project in order to understand on which areas act to reduce resistance. When the motivations to change are superior to change resistance, the change happens. As is it possible to see there are overlaps between Beckard and Harris formula and Kotter model.

There are other methodologies to compute or to face resistance to change but, overall, all of them are focused on the same focal points such as communication, training, involvement, incentives, support, raise of feedback, empowerment, top management support, vision, milestones and targets, feasible expectations, and as final resource coercion[15][16].

4. Application of ERP implementations seen from the provider point of view

4.1. Brief description of Agic Group

Agic Group is an Italian international company working in the information consultancy business. It has been founded in Rome in 1990 and over time it kept growing at an increasing rate. Nowadays Agic Group is present all over Italy, there are offices in Rome, Milan, Bologna, Naples, Brindisi, Orvieto and even in Tirana. Nowadays Agic Group has around 350 employees and 400 customers in many different sectors such as Finance, Public sector, construction, services, Media & Gaming, Pharma, and Manufacturing.

The companies which compose the Agic Group focus all on the development of information technologies and are:

- Agic Technology: it is the company involved in the Business Applications consultancies. It focuses on ERP, CRM, Power Platform, Data Analytics, Modern Work and Portals & Collaboration;
- Agic Cloud: it is focused on the development of Cloud applications and solutions for the digital transition regarding Security, Cloud infrastructure and Services;
- aiComply: a company founded in collaboration with the roman university La Sapienza. It makes high lever formation, audit and IT governance;
- Agic Innovation: it is an innovative start-up which aims to develop Machine Learning and Cognitive tools technology for artificial intelligence platforms;
- Advant: it is focused on business analytics and Corporate Performance Management solutions;
- AiCademy: it is the company in the group which organizes courses in order to train employees;

- Agic Albania: it is the group's company which develops software especially for Microsoft CRM and Data Platform;
- CRS Advisory: it provides management consulting services mainly focused on healthcare and Public Administration sector;
- Silencio: a web agency dedicated to the development of web projects, eCommerce, Mobile App, Digital Marketing and UX/UI.

The company has a really strong partnership with Microsoft from which it is recognized as one of the main Italian partners. It has been awarded several times as a member of the Microsoft's partners inner circle and as a Microsoft Gold partner thanks to the provision of consultancy for the ERPs developed by Microsoft as Business Central and NAV[23].

4.2. Dynamics NAV and Business Central description

The two ERPs for which Agic Group provides consultancy are Dynamics NAV and Business Central.

Both of them are ERP developed for small-medium enterprises which manage companies' finance, manufacturing, customer relationship management, supply chains, analytics, and electronic commerce. NAV and BC are flexible ERPs which can be applied to a wide variety of businesses. Moreover, since they are ERPs developed by Microsoft, they can easily connect with the other Microsoft programs. For example, a table of data can be imported, exported or just simply open on Excel, where it is easier to manage it. Or, also, thanks it is possible to send an invoice to a customer or to a supplier by connecting the ERP to Outlook. The ERPs can be empowered by using Power Apps (which may be developed by Microsoft itself or by consulting companies), Power Automate and Power BI to fit better to specific companies' needs. The creation of Dynamics NAV can be dated in the 1984, despite at that time it was called Navision, thanks to the work of three friends from Copenhagen. These three guys worked alongside IBM to create IBM-NAVIGATOR, which had much more functionalities with respect to the initial software. At the beginning of the 1990s NAV was used widely in Europe and it was already launched in the US too (in the US it was called Avista). In those years Microsoft launched Microsoft Developer Network, a new service useful to support commercial and corporate developers. Over time Dynamics NAV was updated and it was aligned more and more with the other Microsoft's software becoming certified as 'designed for Windows 95'. In the end of the 1990s, hyperlinks and a connection to phone system were released. In 2002 Navision was bought by Microsoft for $1.3 billion and after three years it was rebranded as Dynamics NAV. Dynamics NAV kept been implemented for all these years and in 2009

new interfaces based on roles were developed. In 2012 NAV was reconceptualized as fully integrated web application with the final goal to provide it as a cloud service. Over time NAV was improved by making it more efficient, simpler, and adding the alignment with some new technologies like the integration with Office 365, workflows, extensions, and the integration with Azure SQL.

In the 2018 Dynamics NAV saw its most important rebranding and it became Dynamics 365 Business Central. Business Central was more integrated with Office 365, had more web client features and it had private cloud as well as on-premises versions. In the 2020 Power Platform were added as well as User Interface improvements were done. Business Central kept being updated twice per year by Microsoft and in the future new functionalities will be added[24].

4.3. Steps of an ERP implementation and maintenance in Agic

The ERP implementation into a company, in Agic, starts with some calls between the client and Agic itself. These calls are important to define which ERP functionalities are needed by the customer. At the same time, Agic's consultants understand what has to be done and they start suggesting, at a high level, the possible solution to satisfy the required functionalities. These solutions may involve developing the functionality, using an already developed app or simply using the standard ERP functionalities. The output of these first meetings is a file called FRD which contains the requirements and the suggested solutions. The correct development of this document is fundamental since it works as a contract between the parties in which the work to do is defined.

After the FRD document is signed by both parties, the developments can start. The first implementation steps involve the setup of the test environment. Generally, every company has at least two environments. One in which the company runs its business and the other in which developments and tests can be done without creating risks for the customer business.

The functionalities required in the FRD, as well as those required after the implementation, are developed accordingly to a priority. The priority depends on the importance of the requirement for the customer, on the development cost and obviously on the company's resources.

To understand the cost of a development, after the customer request, a solution is suggested by the Agic's consultants. This solution is provided to the technicians which estimate the possible duration of the development. Considering the developing time and the expected time for the other activities,

like tests, a cost estimate is furnished to the customer which then can decide if it wants to develop the requirement or to postpone it.

If a requirement is approved, the technicians start developing the code, while functional units start producing the documentation to be provided to the customer. This documentation works as a guide for the customer, in order to keep it updated about the solution adopted. At the same time, it is an occasion for the client to give feedbacks about the adopted solution. In this way it is possible to modify the functionality before it is completely developed.

Once the new functionality is developed, approved by the customer, and tested by Agic consultants, another test session is scheduled. In this test session, called UAT, both Agic's consultants and client's employees participate. This meeting is useful to show to the customer how to use the new functionality as well as it works as a final test, and a final occasion to obtain feedbacks, about the development.

Once the UAT test is passed, the development can be installed into the customer's working environment.

Obviously not all the customers' requirements need developments. In that case the process is generally quicker and easier since it is enough to make setups or to download one or more apps with the required functionality.

These are the main activities done to develop either a new or an already existing ERP environment.

Obviously, when a new system is implemented customer's employees do not know how to use it. Consequently, customers require to schedule some training sessions in which it is explained how to do some activities on the ERP.

Another fundamental activity done by consultants to maintain the system is the constant fix of bugs or issues faced by ERP users. In this case the client advices Agic, through a ticket service, about the bugs found which are analyzed and solved.

4.4. Interviews to ERP users and Agic consultants

The analysis done on ERPs implementation's benefits and risks, up to now, has been based only on theoretical concepts which could be found in the literature. To have a deeper understanding of the effective risks and benefits faced by companies some interviews were done to people who daily use ERPs. Despite the little sample, by making interviews it will be possible to have a deeper understanding of the real impact of the risks and benefits associated to ERPs implementation and use. At the same time, it may be possible to discover other possible risks and benefits related to the software.

The first group of respondents is composed by ERP users. Thanks to their answers it will be possible to have the perspective of a daily ERP user who can evaluate the effective difficulties and benefits coming from the ERP use.

The second group of respondents is, instead, composed by three Agic's employees. Their job is to manage ERP implementation projects. Thanks to their answers it will be possible to have a perspective on a wider variety of implementation and/or maintenance projects.

4.4.1 Interviews to the ERP users

Q1) Why did your company decide to implement an ERP? Which were the business needs that drove to this decision?

R1) The main reason which drove us to the decision to implement the ERP is to uniform the management system of a company we have recently acquired. In this way it will be possible to manage the data of the whole company through a single system and consequently improve the group's coordination.

R2) ERP is essential to optimize the management processes and improve the productivity. It permits to rationalize information and to make it accessible in

HQ that helps to simplify business decisions and collaboration within the company.

R3) - An ERP system integrates and automates different business processes into a single platform, enabling companies to manage their daily operations more efficiently, ranging from administrative activities to production activities; from logistics to purchasing.

- Best practice: ERP specialists, thanks to their experience with multiple companies in various industries, are able to develop functionalities based on the best practices of their best customers. Therefore, by implementing an ERP system, I had the opportunity to improve my business processes.

- Data centralization: an ERP system provides a centralized database where all business data is stored and accessible to authorized users. This helps make data-driven decisions and ensures data consistency across the organization.

- Configurability, Scalability and Prescriptivity: The implementation of an ERP begins with a basic version of the system, more or less adaptable to the business reality in which it operates, according to the configurability of the information system used. Logical flows of information will be defined and control over their correctness will be maintained. In addition, this will allow the preparation of downstream activities to be brought forward in relation to upstream activities.

- Reporting and analysis: ERP systems are equipped with reporting and analysis tools that help organizations generate meaningful information from their data. This enables better decision-making and strategic planning.

Q2) Which were the benefits expected from the ERP use before the implementation? Were these expectations satisfied? Did you experience non expected benefits?

R1) We think that the benefits deriving from the ERP implementation are several. One is the efficiency of intra-company communications, thanks to the unique software and the unique database. In addition, the use of a more innovative software, with respect to the one previously used by the acquired company, can make, according to us, the company management more efficient. Lastly, the ERP implementation will allow to be compliant with the creation of reports and documentation, as well as it will allow to automatize some procedures of the accounting. We're still in the implementation phase, so it is still not possible to evaluate if the expected benefits took place or if there will be unexpected ones.

R2) The expected benefits of the ERP implementation are related to improvement in data quality, analysis and visibility, resulting in decision-making, collaboration and communication, flexibility, smooth business processes, improved regulatory compliance and increased ROI and cost savings.

In the first months after migration, it is difficult to appreciate the benefits achieved form the new ERP. Remediation after the go-live requires a lot of energy and we need to fight with resistance or reluctance to change from a legacy system.

When the new ERP does not satisfy the expectation, the implementation should be adjusted, configured, and customized accordingly. A dedicated committee is fundamental for the success. Composed of relevant stakeholders from different departments, a committee helps the business keep tabs on the ERP project.

R3) The expected benefits of implementing the ERP: improved operational efficiency, integration and digitization of internal processes, therefore more value, more control over business management and consequent reduction of costs.

It is important to note that ERP implementations can be complex and challenging and not all experiences are entirely positive, but expectations have been met and fortunately to date I can be satisfied.

Q3) Did you make a stakeholders analysis before the implementation? In case you did, which stakeholders did you consider, and which were the main activities to manage them in order to reduce ERP implementation risks?

R1) The stakeholder analysis and management phase has certainly been taken into great consideration by us. According to our analysis, the stakeholders more impacted from the implementation of are the acquired company's employees, especially accountants. To manage the more impacted stakeholders we decide to give them an active role during the implementation making them involved in every activity, providing training sessions and establishing a direct bond between they and our older employees involved in the project management.

R2) I'm working for a multinational company in Southern Europe Region. This kind of analysis are done centrally and a new ERP implementation is a top-down decision.

R3) Stakeholders were identified and the analysis phase was attended, with different tasks, by business owners and managers, process managers and key users of the system:

• The owners and managers of the company because they were responsible for the strategic and financial vision of the company and were involved in defining the objectives of the implementation.

• The contribution of the process manager has served, instead, for the evaluation of the opportunities and the possible requirements deriving from the integration of the process of own competence with other business processes.

• Key users of the system (production, sales, finance and human resources) because they certainly engaged with an active role in the phase of redefinition of the procedures and in that of evaluation of the adherence of the functionalities offered by the system with respect to the procedures subject to re-engineering.

With all stakeholders was made an assessment of needs and concerns, collecting feedback and input from all of them.

At the end there was the definition of objectives and requirements with the creation of a document of requirements that reflected the needs and objectives of stakeholders, establishing clear and measurable objectives for the implementation of the ERP.

Stakeholder analysis was a key step to reduce risks and maximize the benefits of implementing the ERP system. Actively involving stakeholders and keeping them informed helped to ensure a smoother and more successful transition.

Q4) Did the ERP implementation change your already existing employees management systems? And how?

R1) Despite the ERP provides tools and data to manage in a more efficient way employees, their management is not one of the business needs which pushed us toward the implementation of the ERP. It is not to be excluded that in the future this aspect will be explored and managed.

R2) The impact of change on employees' managements systems is significant: new things will have to be done, old things will have to be done in new ways, and tasks may even cross departmental boundaries.

R3) The implementation of the ERP system has certainly had a significant impact on existing employee management systems within a company. These changes were different depending on the area:

Production manager, who expressed a positive opinion towards the new system, highlighting how the introduction of ERP within the production area has allowed to:

- Achieving traceability of production flow

- Know the status of production in real time

- increased production efficiency by recording downtime.

- More advanced reporting tools than the current ones: In the previous business situation there were no reporting tools, except paper or Excel sheets. The introduction of ERP allowed the production manager and the company leaders to have these tools.

- Increase the certainty of information on the status of the company: For the production manager this objective has been fully achieved, in fact it is stressed, the capacity that the production area has; than before, to monitor the progress of production.

- Making repetitive, low-value tasks automatic for: Reducing human error and time and cost to repair errors

- Increase the level of synchronization between interdependent processes: The computerization of the production area allows the other business areas to know in real time the progress of production of the items.

- Increase flexibility in responding to customer requests: Reduction of human error, reporting systems and synchronization with other business areas have increased the flexibility to respond to customer needs.

Unlike the production manager, the sales department manager found negative and positive points. As we have seen the complaints concerned a slower

operation than the previous one due to: slowness of the system, frequent errors returned by the system and additional operations in performing the activities.

He expected to use more advanced reporting tools than in the past, in fact the usefulness of the new tools does not differ much from the previous ones.

They were sure to be able to reduce the times in order to carry out the activities and for the responsible commercial one, the implementation ERP has failed in reaching this point, because the set of the activities of reception of the order has suffered globally a slowdown.

The evaluation given by all the other company parties interviewed and the other company managers, are in line with that of the production manager and that of the sales manager. In fact the responsible of the administration and the shipments have found like the responsible commercial one a certain slowness in the managerial system, due is to the phases of loading of activity of elaboration is has returned errors from the system, However, all three managers agree that from the day of go-live to now the system errors have significantly reduced. It is known from the theory that in the phase of the transitory there is a reduction of the performances of the company, due to the bad operation of the managerial system, these problems will have to be resolved in order to be able to say to have reached the phase to regime.

While the interview of the IT manager is in line with that of the production manager, as he believes that the business areas have achieved greater synchronization, Automated business activities by the management system have reduced their timing and human errors and have greater certainty of company information, thanks to the traceability of the product in the production area.

Q5) Did you face resistance to change about the ERP use by your employees? In case you did, which activities did you do to cope with that?

R1) Actually yes, we faced a certain resistance to change from our employees. Probably, this resistance has been strengthened by the acquisition of the company into the group, which drove to massive changes. To mitigate this resistance, as previously said, we decided to furnish as much help as possible, as well as we organized several training sessions on the software to decrease the "scare" toward the technology.

R2) An ERP implementation involves significant changes in processes, systems, roles, behavior and culture, which can trigger resistance from different stakeholders. So, it is crucial to identify, understand, and address it effectively. Test phase is very important to shape the behavior and attitudes of the employee's limiting uncertainty, anxiety, and frustration. Leadership support is essential for setting the direction, allocating the resources and motivating the employees for the ERP project.

R3) The time horizon in which the company keeps the maximum attention on the plan is limited, in the moment in which the priority of the plan begins to decline, also the probabilities of success follow the same course. The variables that directly affect the extent of change are the extent of the functional coverage of the system and the distance between the current and the target organization.

As the number of modules implemented increases, the deeper the revision of processes becomes necessary, the greater the risk that the scale of change organizational distracts the attention of the organization from the ERP project. Given the intensity of change brought about by the adoption of an ERP system, rejection, resistance, and chaos would have been the predictable consequences of implementation if people were not properly prepared to handle such changes.

So, I tried to focus on communication first and foremost. It was essential to involve employees from the beginning, explaining the reasons for implementing the ERP, the expected benefits and how it will affect their work. Transparency was paramount by listening and responding to employee feedback on any concerns or suggestions, it was also necessary to consider system or process changes as needed.

Q6) Did you consider as a problem to manage your company, and so data, on an external platform? In case you considered it, what did you do to cope with that?

R1) Actually we did not evaluate as a problem the management of data on an external platform. Data needs to be managed and we evaluate as crucial for our business to uniform the way in which activities are done into our company. Consequently, despite the risk keep existing, we have found much more convenient to use these systems. In addition, both we already used an external software to manage data and we never faced problems related to data unsafety.

R2) Adopt healthy habits to grant data privacy and security ensuring compliance requirements, confidentiality, integrity and availability of information becomes increasingly important (GDPR, Cybersecurity, regulatory standards). Companies protect, identify, measure and mitigate their IT and security risks minimizing the risks of cyberattacks and maintaining security against outside parties' unwanted attempts to access to data protecting the privacy.

R3) One of the strengths of the implemented ERP is the feature of being fully parametric and easily adaptable to the organizational needs of the customer, with great attention to the security of the system that is guaranteed at all levels, from the parameterization of the user profiles according to a user-role-function logic, with specific management modes for single user and for single field.

It was important to verify that the platform adopted robust security measures to protect corporate data, then encryption and access based on strict roles and access controls. I have determined that it complies with applicable laws, Privacy and Control and the General Data Protection Regulation (GDPR) in Europe or other data privacy laws in other jurisdictions. Great importance was given to Backup and Data Recovery making sure that regular backup procedures were in place and that it was possible to recover data efficiently in case of accidental loss or deletion.

Q7) Did the implementation and the use of the ERP drove to changes in the company's allocation of power or authority? In case it did, how did you manage it? And how the employees involved reacted?

R1) The ERP implementation required to create a team who dealt with all the possible needs related to the project. Consequently, project team's members obtained a certain amount of decisional power and autonomy. In the same way, it is natural that these figures are seen as a reference point from colleagues outside the project team. Team member's resources have been carefully selected according to their personal and characterial skills and so long no problems among resources have been identified.

R2) Four months after implementation, changes in the company's allocation of power or authority are not yet visible.

R3) ERP has led to greater centralization of business operations, with centralized control over processes, data and resources. This has led to greater authority at the central management level and has influenced the chain of command, with new decision-making processes and workflows. It was important to involve business leaders in defining the ERP strategy by clearly communicating the decisions made.

The implementation of ERP has improved corporate transparency, allowing employees to easily access data and information relevant to their activities, and has reduced the need for manual and administrative tasks, enabling employees to focus on more strategic activities.

Q8) The ERP implementation respected the expected budget and time? In case the implementation met the expected time and cost, which were, according to you, the reasons of this results? Otherwise, why, according to you, your project did not respect the budget and the estimated duration?

R1) As previous said, in this moment we are still in the software implementation phase. It is, so, difficult to estimate the effective project costs and duration. Nonetheless, it is important to note that the implementation has been postponed few times due to the unavailability of resources able to carry on the project.

R2) Budget was out of scope from Regions. It was under HQ management. Italy tackled resource-constrained and business pressures. The ERP implementation was delayed twice in Italy. The first time, 6 months before the go-live, it was decided to migrate France first, the second time, it was postponed due to some reorganization setting of local ERPs and MVS segment. At go-live time we were not 100% ready and remediations are still in progress and new release to correct some bugs have been already planned.

R3) The implementation of the ERP system was an activity characterized by a high complexity and required my company to adopt an appropriate implementation methodology that would allow the company to get to the go-live on time and with reasonable costs trying not to exceed the project budget.

For the success of the project and to respect time and cost, the choice of supplier and ERP system was fundamental because the good correspondence between business needs and system functionalities helped to avoid costly customizations

and delays. In addition, it was important to make an in-depth analysis of the requirements immediately, also ensuring the presence of a competent project management team that was essential to identify risks in advance and take corrective measures there where necessary with timely interventions of the projecty manager and key-users.

Q9) One of the major risks associated to an ERP use is the technical debt, which is an efficiency, and so economic, loss due the creation of shortcuts in the development/maintenance of functionalities on the ERP. Have you considered or faced this risk? In case you did how did you manage it?

R1) As before, since we do not have the system implemented yet it is not possible to face this problem, at least for the ERP implementation in the new company. Nonetheless, the technical debt is a risk we are taking into account thanks to the experience obtained on other company's management software. According to our experience, the best way not to have this problem is to develop the needed functionalities without imposing excessively stringent duration/costs to the developers.

R2) Accumulation of technical debt driven by design shortcuts and other maintenance obligations is managed centrally even if the risks are faced by the Regions.

R3) Technical debt is a significant problem in the implementation and management of an ERP system and managing it requires a strategic approach and a constant commitment to improve and maintain the system. It is a continuous process that should be an integral part of ERP management to ensure that the initial investment continues to deliver value over time.

Q10) Did you take into account, during the implementation and use phase, other risks with respect to those discussed up to now?

R1) I would say that the main risks considered and analyzed in order to decide whether implementing the ERP or not are those discussed before. Then, obviously, in case in which other risks will take place we will react in the best possible way.

R2) Unexpected problems happened. The risk management plan helps to handle risk in the project. Risk assessment, risk planning, define who is responsible for doing it, and how often, guidelines help to figure out how big a risk's potential impact could be.

R3) Beyond those already indicated, one of the main risks was the possibility of overestimating the capabilities of the ERP system. This could lead to unrealistic expectations and user disappointment when the system failed to meet all their needs.

I add that the migration of data from legacy systems to ERP was a complex operation and could have led to the risk of critical data loss. It is essential to plan the migration carefully and test it thoroughly.

Over-customizing the ERP system to adapt it to business processes could have added complexity and cost, it was important to strike a balance between customization and using standard functionality.

Q11) Overall, are you satisfied of the decision to implement an ERP? Do you find it useful for your business?

R1) Regarding the implementation which is taking place in these months is impossible to express. Nonetheless, we are confident that important benefits will be obtained by using this technology.

R2) I'm really satisfied about the new ERP because all modalities and business processes have been integrated into one unique system. Processes

standardization and streamlining make them more efficient, and visibility improvement can drive profitability.

R3) You can assume a positive result for the ERP implementation project in my company, because the strengths of BMS are greater than the critical points.

The production area had a better result than the commercial area. This result is due to the fact that in the production area there were no information systems to support the flow of information, so starting from a worse situation, the benefits of the ERP were greater. While in the commercial area where there was already an information system, the benefits of the ERP were minor, because some features were already present in the old system.

In general, I can certainly say that I have had an improvement in efficiency as the new ERP system integrates different business processes, allowing a more fluid flow of information and better coordination between departments. This will increasingly improve overall operational efficiency.

I also noticed a significant improvement in visibility, the ERP provided a centralized view of business activities, allowing executives to make more informed decisions based on real-time data.

Q12) In case in which you want to change you ERP, did you see some barriers to the exit? Would this limit your possibility to change your company's management system?

R1) According to the status of the implementation I can see some barriers to the exit which would limit the possibility to change the used ERP. These barriers are represented by the costs and the duration of the new implementation project. It is important to remember that changing the ERP would imply changing the way in which processes are done into the company, and this may drive to a loss in the efficiency as well as resistance by employees.

R2) Not applicable in the Regions. We cannot choose to change an ERP. We need to accept and adapt to the ERP just implemented.

R3) Generally changing the ERP system can be a complex and expensive process. Changing the ERP system can entail significant costs related to the purchase of new software licenses, data migration, staff training and customization of the new system.

There is to consider the complexity of migrating data from the old to the new system can be complicated and time-consuming. Errors during this process can cause operational problems.

Consider that users may resist change and feel frustrated by learning a new system and that they need to be trained to use the new system, which may affect their productivity and require time and resources.

To overcome these barriers, companies must carefully plan the transition, involve staff, consider long-term costs and benefits and ensure effective project management. In addition, it might be useful to evaluate whether there are options for upgrading or improving the existing ERP system before considering a complete replacement.

4.4.2 Interview to the Agic's employees

Q1) Which are the benefits generally searched by clients when they decide to implement an ERP according to your experience? Are these benefits generally reached? Are there non-expected benefits enjoyed by the customers?

R1) The benefits usually search by clients are:

- Improving the productivity
- Improving the Control management system through a stabler, updated and more modern in security terms software.

The ability to achieve these benefits depends both on the client and on the consulting company who follows the project. It is necessary that both parties are involved and result oriented. For example, it is generally request to the customer to explicate on time its needs, not an easy task since some operations are routine and generally are perceived as obvious. At the same time, the consulting company may have a more goal-oriented approach with respect to a quality-oriented one, which would drive to a preference toward the achievement of a goal at the expense of the solution quality (i.e. necessary work-around, approximate process customization). Surely there are non-expected benefits, but this are not immediately caught, and the customer tries not to highlight them in front of the consulting company. For example:

- The possibility to integrate by standard with ECB (to update exchange rates);
- SEPA CT or DB creation to pay supplier or for customer receipts;
- Management of articulated workflows

R2) Clients usually decide to implement an ERP for two main reasons:

- Economic reason: to increase enterprise value. Due to an acquisition by an investment fund or by a big enterprise (which require a certified ERP). To get incentives (for example many manufacturing clients decided to implement ERPs to receive Industry 4.0 funds. Another example are the funds allocated for the digital transformation into companies)
- Strategic reason:

  1) Integration of the various company's functions and of the various processes into a sing informative system;

  2) Processes automation;

  3) More possibility to extrapolate statistics from data, even in real time, and consequently more control on the various company's

processes. This allows even to take strategic decisions more focused and oriented with the goal of reducing TIME and COSTS of the various companies activities;

4) Reduction of errors, especially those related to the input of data. The ERP allows to avoid mistyping and omissions;

5) More customer satisfaction.

R3) Usually a client aims to have processes improvement, to automatize processes which were manual once, and to process it data to have a better and quick vision of its business. Very often the goal is reached but the customer's perception is different from case to case. Usually, improvements arrive not with the project live, but after the customer obtain awareness of the tool. Lastly, with the SAAS, the client enjoys some automatic security systems not had previously and on which it was not focused.

Q2) Which are, according to you, the main stakeholders impacted by an ERP implementation into a company? How are they impacted? Did you have a role in their management?

R1) It depends on the project perimeter. Almost in every case of a new ERP implementation (>=90%), the new ERP will be used by the "Amministrazione, Finanza e Controllo" office which will be the main actors involved in this change. Moreover, often the project can expand even to the Warehouse (Inbound and Outbound management), Production (production orders management, assembly), and even to the Quality office, a department designed to certify a product conformity with an ISO standard. The main stakeholders are impacted in their daily activities since their old ERP is dismissed in order to use a new one. This may generate a sense of uncertainty toward the future and the staff may feel out of breath and less autonomous. In big projects, actually, figures specialized in Change Management are involved in order to

help the staff to take back its autonomy, confidence and consequently to improve productivity and efficiency.

R2) The main stakeholders are:

- The company's employees, at any level (from top management to the workman), both direct and indirect ERP users. The stakeholders more impacted are especially those who work on the project: key user, function managers, project manager on customer side and so on → they are impacted because they firstly are involved into the project and then they have to use the system. Even who is not directly involved it will be indirectly because often the ERP implementation involves even a review of processes and of working methods. Agic surely has an important role because it has to assure the complete involvement of the actors involved into the project and that the system reflects or surpasses their expectations.
- Clients → The ERP's and client's goal is to improve the customer satisfaction who consequently will be impacted during and after the project. Agic's role is to perform a correct implementation in order to respect or reduce due time of the good/service to the client. A bad implementation may bring delays/errors of shipping, invoices, receivables and so on
- Vendors → similarly to what said for clients, a bad implementation may drive to problems in the reception, passive invoice and payments phases. Moreover, as for clients, if the ERP implementation involves even the receivable and payable cycles vendors may be involved in new operation modalities
- Other minors: shareholders, other's software partners, tax offices and other regulatory entities and so on

R3) For my competences, the parties interested are the solution designer and the interfaces. The power of an ERP is based on how much it can be integrated with external elements, especially third parties' products. It is so very important the ability to design slim solutions for the customers' flows and to find in advance the solution's weak points. The initial impact is always very high, see the client pass from 100 offers per day to 2/3 per day because the remaining ones are sent to the interfaces is very important for a process. Then there is the curiosity step in which the client wonders: What can I do now? Here it is possible to answer to the other part of the question, a good consultant surely has an impact on a company's management. Bringing with success an ERP in production creates a curiosity reaction from the client.

Q3) Which are, according to you, the main risks for a company when an ERP is implemented?

R1) a) The main risk is the possible loss of data since a deep data migration activity may take even some months: a time that almost in every case the client is not willing to acknowledge to the consulting company since it is seen as a non-productive time. To limit the risk, it is a good practice to maintain "on" the old ERP (even only in reading mode), in this way eventual researches on old data can be done with a minimum effort. This is particularly useful even in auditing situation to which any society is exposed.

b) Another risk, important but less worrying, is the change done in the company processes: a document registration, the printing, or even the basic information research get turned upside down. Due to this reason, as said in the previous answer, the final user may feel less (or even not) able to carry out its tasks.

c) Last, it may happen that a client did not explicate well or not at all its needs, or, in the worst cases, the consultant misinterprets them. This drives that a process, especially if specific of a company, may, partially or at all, not being

covered. This would require a fix as soon as possible(which is not always possible)

R2) The main risk is surely a temporary business stop due to an ERP failure. Such as the impossibility to register shipping, invoices, or core documentation for the business continuity. A minor risk is the poor appreciation of the software by employees who must daily use it. This may drive to a general unhappiness which obviously does not help the business.

R3) Surely there are system regression risks, there is the risk that the ERP is implemented to reduce the work and, instead, the new processes increase the users' work. This depends on the goals, for this reason is so crucial to educate the workforce about the ERP's goals. If an ERP is implemented to improve users' life so the goals will be to make interfaces more user-friendly, instead if the goal is to have cleaner data or to gather data, it is not said that the users' experience is improved. Lastly, if on the other side there is not a structured customer and by our side there is not an expert consultant, there is the risk of totally missing the ERP goals and failing the project. This is the main reason for which Change Management processes are established when a project starts.

Q4) According to your knowledge and experience, does the implementation of an ERP in a company change its employees management systems?

R1) Surely. The ERP implementation may even have as goal to manage the workforce, activating the 'Human resource' module. This may be activated with different level of deepness, for example a company may activate one or more modules among these ones below:

- Employees register;
- Presence register;
- Payroll management, incentives, rewards;
- Management of both soft and hard competences (i.e. certifications)

and more modules get activated more the human resource management system get turned upside down.

R2) Absolutely yes, in almost every case. The goal is not to similarly reproduce the current system or processes, but instead to bring an improvement or a positive change.

R3) I did not directly experience something like this, usually the ERP is adapted to the users' management. I have seen, instead, other companies that with the motivation to change ERP, change their employees' management system, but not directly.

Q5) Did you face change resistance by companies' employees? How was this generally managed by companies? Did you have a role in its management?

R1) Yes, it's a constant. The employees of a company who daily use the ERP make a job that is mainly a routine existent by many years. The ERP implementation creates a huge distortion of this daily routine bringing feelings as scare and change resistance. Sometimes the employees may be so 'scared' by the project to ask very deep training paths, even asking to require a shift of the go-live even when it would not be necessary. For companies a very important thing is to search and select a Project Manager into the company who knows how to manage diverse teams and how to analyze rational and irrational fears. In case of more challenging projects, it may happen that more than one project manager are selected, and everyone has its own activity area (i.e. Finance, Controlling, Warehouse ect). Project Manager's role (and partially even of the consulting company) is to go deeply into the team's problems to understand which tasks are covered, and if there are how, by the new ERP or if it possible not to cover them (by using an outside system) or, still, if there are no necessary activities that can be ceased. As a consulting company, it is our role to satisfy our client's request in an efficient and effective way. It is possible

that some activities are not covered by the ERP (or they partially are) and this requires the development of ad-hoc tools for the client or even for the use of another software (i.e. the payment management through authentication with 2 or the 3 factors may not be managed by an ERP). In big projects, it is suggested to forecast even a Change Management expert with the goal to help the project manager to reach the goal.

R2) It depends strongly on the customer type. In the majority of the cases resistance is faced with older employees, both as personal age and company age, because less used to use technologies and less ready to change methods and software used by many years. For the project success it is fundamental to manage the change management process. To do so, it is necessary a strong commitment from customer's top management and a strong involvement on the project from users. To make users feel as part of the implementation and not to make perceive the implementation as something imposed and taken.

R3) Always, because is in the human nature the resistance to change. It is fundamental, when the firsts users' scare advice occur, to involve them in the implementation process, to raise feedbacks, and to make them feel part of the change. They have to say their point of view to assimilate the change. Very often companies impose the change, bringing unhappiness to the users. In these cases, sometimes we intervene participating and giving an advice.

Q6) Could there be risks for a company to manage all its data and run its business on an external platform?

R1) Yes, it could be a risk but, at the same time, manage data is risky in the same why if not more.

Especially in small-medium enterprises the IT department is full of activities and the privacy, the data security, may not be a priority (or at least it is but it

may be managed in an approximative way, enough to satisfy legal requirements, like GDPR).

In case in which this role is assigned to a partner (so in a SaaS solution), this role is delegated to the Provider which is an expert able to manage it well. Obviously, this implies a cost which could or could not be convenient for the company but surely is the safest solution.

I remember that for some clients who adopt OnPremise solutions (so when data are historicized in some physical client's database), sensitive data was not visible by GUI but it was sufficient a query through SQL management to extract them. This is not possible in case data is online and detained by the supplier. In this case the client does not have the DB and it should ask to extract the data to the supplier which has to be formally hired to execute this task. Of course, in the SaaS solutions, data are detained by the supplier who availability of them but confidentiality agreements and the implementation of crypting through Key should reduce the risk almost to zero.

R2) A minimum hacking risk is possible or, in case of on premises solutions, there could be the risk of servers damaged without a disaster recovery. Actually, both risks have been reducing thanks to the cloud solutions. In addition, I do not say any other valid alternative. In the 2023 it is not possible to manage everything on paper or Excel.

R3) Actually, thanks to cloud platforms risks are much lower than before. This because the majority of the security policies are managed externally and the client is obliged to adapt, not having, actually, the possibility to make macro errors.

Q7) Have you faced situations in which, according to your knowledge, the implementation of an ERP involved a change in the allocation of power and authority into a company?

R1) Yes, this is possible. But this is intrinsic in the project nature: as said in the point 1., what is searched principally by the client is:

- A productivity improvement
- An improvement in the control management system through the use of a stabler, updated and more modern in security terms software.

This of course implies a new internal balance which is absolutely physiologic. To make an example, it may happen that the in the past the purchase process was totally free by controls (the Purchase office emitted a Purchase Order and sent it to the supplier accordingly to the requested received by the Warehouse), while with the new ERP implementation an approval workflow, may have been set up. In this way so the Purchase office moving range, especially in case of purchase orders with high amounts, may ask the approval of several figures (starting from the Finance chief arriving to the CEO).

R2) It happened that the users more involved in the project (key users) then become a reference point for the ERP use but even for the company's processes knowledge acquired. Often, in fact, the ERP implementation brings to the customer company an improved knowledge of the company's internal processes. Then, I personally do not know if this has brought to a growth in contractual and company's term.

R3) Yes, very often a process brings to a change in the management of activities by a user. In these cases, it is necessary to define the various solutions and give them in the customer's hand to let him take its choice. It is important never to let these things fall under your responsibility because it would mean to violate customer's rights.

Q8) Does ERP implementation generally respect estimated duration and costs? Which are the main reasons for which they respect or not respect the estimated duration and cost?

R1) Unfortunately, in many cases initially set Budget/timing are not respected. This is due to different factors, the most common ones are attributable to the figures mainly involved in the process, so the accountants.

1. Project underestimated in terms of time: the project, before the sign, is discussed between the client and eventual Accountants of the consulting company.

These figures may:

- Not have clearly in mind the impact of the specific customer requirements, which may be underestimated;
- Not have understood the customer necessities (maybe due to the customer unclearness): this drives to the fact that the implementation of new activities requires additional effort in terms of time.

2. The project is underestimated in terms of budget:

- Even in this case the account may not have the knowledge of how much an activity may cost
- Or the client has a limited budget and it will try to eliminate those activities considered as 'secondary' (nice to have) which in the reality may turn into important ones which have to be made: this drives that the project timing has to be updated, costs will increase generating inefficiencies

R2) Generally yes or at best the delay is not significant or it has been agreed with the client. The reasons may be several:

- The most frequent one is the little involvement of the customer company. The project is always done in two!!!! Agic+client. If the second actor misses it is not possible to compete the project respecting the expected costs and times

- Other reasons may be technical ones due to numerous customizations. The goal must be to start with the standard ERP processes and at best with some absolutely necessary customization not covered by the system. In a second phase, after users have more confidence with the system, it is possible to think to developments who can improve and broad standard processes.
- Incorrect project estimate. Sometimes the project may be underestimated. Often in happens due to a gap between the salesperson (who underestimate the project in order to sell) and the delivery who have to respect costs and times agreed by the salesperson. To mitigate the risk during the offer phase it is fundamental the collaboration between sales office and delivery.

R3) The question is asked incorrectly, because a specification is needed. The correct question is: Are there ERP implementations that, in the defined project perimeter, respect costs and durations? The answer in this case is yes. Generally, projects that do not have BIG distortions with respect to the initial offer, start and end up in the estimated cost and time. But, in general, projects evolve, in that case is necessary to make additional offers, to develop ancillary data etc. etc.. This makes the project' cost and time to increase, so normally the reason for which a project expands is because the initial conditions do not cover the whole customer request.

Q9) One of the major risks associated to an ERP use is the technical debt, which is an efficiency, and so economic, loss due the creation of shortcuts in the development/maintenance of functionalities on the ERP. Have you ever faced it in the project followed by you? In case you have, which was the impact and how you faced it?

R1) It may happen that the functionalities developed have some problems but our goal as consultants is to control that the solutions implemented perfectly work. To do so, several test sessions are done by us with and without the customers. In case some bugs problems are spotted we generally ask to the customer more time to fix them despite this may generate write-offs in the project. Obviously, it may happen that some bugs are not found during these tests. In these cases, there are apposite services that can be purchased by the client to have assistance.

R2) Actually it has never happened to me to stop the client's business due to a technical error. Even because all the functionalities are tested both from us and from the client before going LIVE. It has happened to have some errors during the lives but thanks to the provided support they have been solved pretty quickly. In case in which it would happen, there will exist anyway some recovery plans like, for example, do a rollback to bring the situation back to how it was before the modification. This risk is proportionally direct to the modification done to the standard system. More modifications are done more the risk is present. The ideal situation should be to start always with a product as close as possible to the standard and then apply modifications in a successive phase.

R3) In the new SAAS services ecosystem the technical gap is always present because the technology runs quickly. Usually, in every project a gap is faced, it is minded involving other colleagues that have faced similar systems before us. Alternatively, it is possible to some small test about controlled developments or similar. The important thing is that anytime these difficulties are faced it is possible to rely on expert colleagues and that the development is organized planning alongside them.

Q10) Are there other risks for a company, bonded to the ERP implementation and use, that you have faced often in the project you followed?

R1) Generally the risks are those written above: resistance to change by users and loss of data.

An eventual hazard not already exploited is the "strengthening" of the business processes. Usually, a company that changes the ERP takes the opportunity to review business processes in order to increase control and efficiency → not always this is achievable/achieved. The new ERP may be more strengthen with respect to the previous one (i.e. the old system allowed cancellation operations not allowed by the new one like invoice cancellation or warehouse movement).

Or the strengthen may come from the willingness to create processes on the ERP which are not covered and/or are partially covered. For example, a manufacturing company wanted to implement in the ERP some functionalities typical of the MRP (Material Requirement Planning), which very developed functionalities. The result was that new very costly and time- consuming functionalities were created: was it better to buy and user directly an MRP?

R2) As written in the previous answers, the major technical risks take place when several customs/interfaces with other systems are done. Other risks may be those coming from a wrong project management and from a little client interest in the project. In the first case the risk is mitigated by making more tests, both internal and with the customer, and with a technical support during the live in case some anomalies show up. In the second case, it is needed to find a way to empower and engage the product users through SAL and periodical Steering Committee, and not less important, through apposite sessions to make test and training

R3) No, no one in particular.

Q11) Overall, can you say that companies are generally satisfied of the ERP implementation? According to your knowledge, were there sensible improvements in their business results?

R1) Yes, generally they are satisfied, and the improvement is evident.

Main advantages are:

- Processes efficiency → processes are faster, safer and delineated;
- Security → the new system is usually stabler, safer and updated with respect to the old one;
- Controlling → processes control is restructured and designed ex-novo.

R2) Generally yes, especially if all the risks written above have been mitigated and the ERP works correctly. In many manufacturing processes, after the implementation the customer had a much clearer idea about the item price and so about the warehouse value. In addition, it was able to obtain important statistics about production durations and costs being, consequently, able to take new production strategies and company's management.

R3) Generally yes, but I do not have direct links about the company's trend and about the company's profits.

Q12) Does the use of an ERP constitute a barrier to the exit for those companies which want to change their management systems?

R1) Changing an ERP surely requires a high budget and this may postpone but not eliminate the necessity of updating the ERP system.

This because processes change over time, as the working modalities and law requirements. This involves that the ERP update is something mandatory, especially with the company's business growth.

R2) Obviously, a minimum barrier to the exit exists and it is since the change will involve more costs and more time to dedicate to the project instead of the business. Barriers increase when the customer does not want to change ERP, but it wants to change the partner (the consulting company) who manages it.

R3) According to me no, because the change management process is always active, and it must always remain alive.

Q13) Are there any risks, due to an ERP implementation, faced by consultant companies? If there are can you briefly explain which are and how you managed them?

R1) The risks for the consultancy company are substantially two:

- Customer unsatisfaction: it may happen that the customer had in mind an application solution that is not really the one that is put in place → this may due to:
    - The consulting company did not understand well the customer's requirements and/or put in place an unstable, bugged, and rigid solution;
    - The ERP is not the adequate one. There are different ERPs and all of them have strength points and weaknesses, for example is known that SAP is suggested for big enterprises while Business Central is for small-medium one. The customer dissatisfaction may sometimes result even into conflicts between the customer and the consulting company with the involvement of legal figures and the challenge of the contract.
- Work inefficiency with losses generation: this may be due to different factors:
    - Underestimated project (so 50 days of work are sold for a project which requires 100 of them);

- Little control of the work progress and little clarity on deliveries, on things to do, on things not to do and on what is a priority and what is not;
- A team too abundant of resources which consequently generates a high cost for a project which could be managed by a smaller team;
- Unexpert team: team's resources do not have enough knowledge of the product/reference market, and this requires a constant alignment and involvement of Senior resources who guide daily the team.

R2) Generally, there are risk bonded to every project. Missed deadlines, failures ect ect. For the projects' risks new management methodologies have been developing like Agile projects. Sequential phases are no more included but instead there are iterative cycles with the release of different intermediate prototypes. This allows to give from the beginning tangible solutions to the client and to get aware of eventual problems before the project is already in an advanced phase and so before it would have been too late to solve them.

R3) Surely the project perimeter is one of the main risks, if the contract is too vague or the PM does not interpret well some concepts, the risk is that the project takes more time, more costs or even that it ends up in a lawsuit. The PM should be well informed about the existent contract, always aligned with the AC to understand what is in the project perimeter and what is not, and it should know how to say no to a client for the out of the project topics, without resulting improper or unavailable.

4.4.3 Discussion about the interviews' answers

The interviews done allowed to raise information directly by people who daily use, for different reasons, ERPs. According to the information found there are

several reasons for which an ERP can be implemented, the most important are related to the possibility to automatize and uniform processes while obtaining advantages from the centralization of information. These two aspects should drive to an efficiency improvement, to a reduction in the errors done by employees, to the possibility to create in an easier way reports, to lower processes' costs, to improvement in the intra-company communication, and to an overall increase in the business's value.

Regarding the risks associated to an ERP implementation, both group of respondents had similar opinion about the stakeholders' management, which is a fundamental aspect of an ERP implementation project management to decrease the overall project risk. The stakeholders involved are many but those more impacted, according to the interviews, are the future ERP users. Their management is crucial and the best way to do it is by raising feedbacks from them, paying attention to satisfy their needs, and making them feel as an important part of the project. In some cases, where there are the adequate resources, a change management manager could be the best option.

As previously said, the people's management is one of the main aspects to consider when an ERP is implemented. This because an implementation affects users in many ways. For example, when an ERP is implemented the employees' management system changes consequently. There is the possibility to create new processes better than the older ones, and generally this is taken by the company as a way to improve the already existing processes. These changes strongly affect the users' life into the company, and this could be a source of anxiety for them.

In addition, due to the new processes management systems, the allocation of power into the company usually varies. The project team members, as an example, became reference point for their colleagues while other employees

may lose importance if the processes assigned to them are automatized. Consequently, it becomes of the utmost importance, to have a positive implementation result, to select wisely project team members and to manage those remained outside.

Lastly, as every human being even ERPs' users tend to resist to changes. This tendency is generally stronger when users are older or more used to the old practices. The interviews highlighted that there are some measures widely adopted to cope with this problem. In fact, it is important that project managers maintain the leadership asking the commitment of everybody but, at the same time, communicating the reasons for which the implementation is taking place and why it is important. The communication transparency is important as well. Trainings are fundamental too; they allow to start letting the users taking confidence with the system before the go-live.

About the risks associated with the data management both groups of respondents provide similar answers. ERPs are considered very safe software thanks to tools and techniques used to maintain confidentiality; alongside these tools the establishment of good practices is generally done. The data management is intrinsically risky for companies which may not have the skills or the resources to do so. Despite it may appear counterintuitive, according to ERP consultants, the provision of the ERP through a third-party cloud environment may be the safest alternative thanks to their knowledge, their abundancy of resources dedicated to the data security, and the legal duties to which they are subject.

The technical debt does not seem a big threat for both group of respondents in the moment in which good practices are established. Maintenance is important to reduce the technical debt level accumulated but in the moment in which a solid testing phase is present the possibility of a technical debt increase is

strongly mitigated. Other good practices are to make only the fundamental developments and to encourage coordination among developers, especially when new technologies are involved. By following these good practices the technical debt risk should be strongly mitigated.

Other risks which often occur during the implementation are:

- ERP overestimation: there could be too many expectations from the ERP which are unrealistic;
- Data migration: when data are passed from one management system to another there are always risks (which are generally caused by companies who wants to compress processes' duration);
- Stiffening of processes: not always the implementation of processes is the best choice;
- Wrong ERP selection: every ERP has its own characteristic. It is not said that those of the selected ERP perfectly match customers' needs;
- Little customer involvement: obviously this has been signaled only by consultants.

A proper management of the risk above discussed should, theoretically, drive to a successful implementation which respects expected costs and duration. Despite this, there are situations in which the project does not respect the estimates, or even it has to be postponed. According to ERP users this may be caused by disorganization, poor resources availability, and poor consultancy. For the consultants the reasons generally are the incorrect requirements estimates, the additional customer requirements received after the project starts, and the little effort put by the client.

A final analysis could be done on the risks for the consultant. Consultancy's risks associated to the ERP implementation projects are mainly the customer unsatisfaction, due to subjective problems with the ERP or because the

requirements have not been understood and consequently developed correctly, a monetary loss due to an incorrect resource use, and errors into the estimation of the project's boundaries which may drive to unpaid work.

Despite the project's complexity, according to the feedback obtained, companies appear happy for the ERP implementation which can became much easier thanks to a proper risk management.

5. Results and discussion

5.1. Improvements and benefits coming from an ERP implementation

An ERP is a software which aims to integrate in one system all the activities done into a company. An ERP can support all the company's activities using a single information system but being able to cover all the company's requirements. The goal is to improve the efficiency of the company's operation in all the functional units such as production, R&D, financial, human resources, marketing, planning, coordination, decision making and so on, so both front-office and back-office activities. For every function a sub-system, optimized with the necessary characteristics, is developed. In an ERP all these systems are integrated into a single software program which runs on a unique database. This allows to share and spread much better information all over the company, the better communication among functional units drives to important benefits such as:

- Thanks to ERPs departments, hierarchical levels and functions create an action-response chain of events. For example, when a new order arrives, material is automatically removed from the inventory, production forecasts are updated as well as new market projections;
- Gathering all the information in one place where they are recorded, processed, and reported increase the development of tacit knowledge and the coordination of strategies to adopt toward the customers;
- Information moves faster into the company and its visibility is customized accordingly to who sees it;
- It enhances the visibility of activities' consequences and effects over the entire company. In addition, this allows to use performance tools such as balance scorecards;

- It increases the possibility of making leverage of tangible and intangible resources;
- It drives to a more efficient and flexible management of the supply chain;
- It gives the possibility to do make-to-order manufacturing and consequently to strongly reduce the need of warehouses;
- It improves the company's control over processes such as procurement, customer offers, complaints, maintenance;
- Strong cost-reduction and time-save;
- Possibility to manage service-related personnel and their costs;
- Enhance the already existing quality management system with the new information system cutting personnel's occupation time;
- Reduce project duration, raising project efficiency as well as more precise delivery;
- More control of sales and promotion activities which raises efficiency;
- More efficiency of production processes;
- Decrease the staff amount.

Thanks to ERPs, a company may strongly increase its profitability and obtain, if developed correctly, a market advantage. The competitive advantage can be obtained just in case in which the ERP is used to accomplish a distinctive outcome which would not be obtained without the ERP. Obviously, using an ERP just to manage data and some tasks, without optimizing processes, would not furnish any type of competitive advantage.

Other benefits brought by ERPs which may raise the Return On Investment of the implementation project may be:

- Smaller inventory;
- Cost reduction thanks to the decrease in the duplication effort;
- More efficiency in the process of transactions;
- Reduction of effort put in non-value adding activities;

- More employees' utilization;

  Despite this undoubtedly benefits it is still complex to misurate the real cost-effectiveness of an ERP implementation since several parameters should be consider as legal, social, psychological, managerial, economic, technical, and so on[17][18].

5.2. Challenges and issues coming from an ERP implementation and use

The implementation of an ERP is one of the toughest projects for companies. This not only due to the intrinsic complexity of the adoption of a new technology, even due to the numerous risks that this technology carries.

The effort needed to implement an ERP is huge and it starts sooner than the implementation itself. A company must start analyzing deeply its processes to find the best way to run them on the ERP. This fundamental step, despite it can be profitable to companies to find inefficiencies, not always drives to the perfect fit between the ERP and the company's processes. The risk that it is the company the one who adapts to the ERP, and not vice versa, is real and it can obviously drive to an increase in the inefficiencies during the first months after the go live.

The implementation cost is another reason for which implementing the ERP is so risky. Despite the decrease in the costs thanks to the development of new technologies, such as cloud ERPs, the implementation's cost still is equivalent to an important percentage of average companies' yearly revenues, at least for small medium enterprises. In addition, it is possible that estimated project's time and costs are not respected.

An ERP implementation project involves an important number of stakeholders which must be managed in the proper way. This because different stakeholders may have different feeling toward the project and the technology, they may have different power and authority, and different needs. An incorrect stakeholders' management drives to tensions into the project with a consequent increase in the project cost and duration. Tensions can be so high that a poor stakeholders' management could be a source of project failure.

In addition, the implementation of an ERP involves a strong variation in the way in which activities are performed inside a company and in the allocation

of power and authority. This may generate unsatisfaction among ERP users which have the natural tendency to reject changes. Users' dissatisfaction drives to less efficiency in the ERP use and consequently less economic benefits coming from the ERP implementation. The best activities a company could do to solve these problems, according to the literature, are to organize trainings, to create a sense of necessity toward the ERP, to keep users involved and not to let them feel abandoned. It is fundamental to select wisely the resources which would be part of the project team since they will become the reference points for their colleagues. Always regarding the risks related to personnel reactions, an ERP implementation means changing the way in which activities are done. This may provoke a shift in the power, in the authority and in the perception of some users and it has to be managed in order to mitigate the risks.

When a company evaluates the convenience of an ERP implementation it must consider the consequences of it even during the use phase. The ERPs are connected to the internet, or they are even directly provided in cloud. The internet connection, despite fundamental to raise and share information, may be used to stole companies' data. Over time ERP developers started building ERPs intrinsically safer thanks to the work done on the software architecture, the use of VPN and the establishment of good intra-company practices.

Another remarkable risk to consider when ERPs are used is the technical debt which takes place in the moment in which shortcuts are used during maintenance or developments. Due to these shortcuts, future developments may face several problems with an overall increase in the cost and in the time needed to do them. In addition, a system with a high technical debt level has a much higher probability of failure. To reduce the technical debt level an adequate maintenance should be done by the companies as well as by the ERP provider, which over times should strengthen weaker modules making developments less necessary.

Other important risks may be the possibility to lose data in the passage to a new system, due to the willingness of companies to do activities as fast as possible, the modification of processes which may cause the impossibility/inefficiency of the users to make their activities, the misunderstandings between companies and consultants, the possible stops of the system due to mistakes in the implementation, the excessive process formalization and the possibility, for the company, to have implemented a wrong ERP (for its needs), the possibility of regressions, and an increase of the users' activities.

6. Conclusions

An Enterprise Resource Planning (ERP) is a software used by companies to run their business. Potentially every business operation, as well as every data related to the company, can be managed, and run by using an ERP. This type of software application, born in the 1960s, was initially called MRP (Material Requirement Planning) and it could be used, at the time, to manage only the sourcing of raw material, the inventory, and the production phases. Over time the ERPs have become much more accessible for companies, even for small-medium enterprises. This because the functionalities covered by the ERPs are now more, the costs are lower and there are multiple ways to provide them. In fact, ERPs can be provided by the company who developed them, or they could be open source. Moreover, ERPs can be provided on a cloud environment, or they could be on-premises, so on companies' systems.

The goal of this thesis is of making an analysis of the major benefits and risks that a company could face in the moment in which it decides to implement an ERP. To do so both literature papers and interviews to ERP users were analyzed.

Despite it is possible to highlight some benefits and improvements obtained by companies who implemented ERP, the quantification of them is difficult. Among these benefits is possible to highlight the optimization and automatization of processes, the improvements in the decision-making process thanks to the improved data availability, an overall increase in the companies' efficiency, a reduction in the activities' cost and time and an increase in the company value.

ERP implementations are very complex and impactful projects which involve numerous risks for companies. It is possible to identify some main risks associated to the ERP implementation. The first of them is the stakeholders' management. The ERP implementation affect many stakeholders of different

functional units which consequently have different need and perceptions. In addition, the new skills needed, and the probable process modification may drive to a new allocation of power and authority into the company. Lastly, the ERP implementation represents a big change in the way in which the work is performed into the company. To manage these risks the best actions that companies could do are to follow the users by making trainings and obtaining feedbacks. It is important even to ask commitment by everybody, even by the management who must remain involved. It is important to create a common vision into everybody to convince ERP users that the project is best choice for the company, and obviously selecting wisely the project team members is fundamental since they will become reference points for the users.

An additional source of anxiety for companies may be to run the ERP on a third-party cloud environment, or in general the ERP connection to the internet, which is one of the main sources of ERP provision. Actually, this is a risk much less relevant than it seems. ERPs are built to be safe; this implies creating the ERP with a specific architecture or giving the access to data accordingly to users' role. In fact, a role with limited permissions is assigned to each user. Regarding the third parties which provide the cloud environment, they generally are very expert in terms of data management and security, even more than the companies which implement the ERP which could, instead, make important errors. Moreover, they are bonded by legal duties regarding data confidentiality.

Another major risk faced during the ERP use is the technical debt which occurs in the moment in which shortcuts are used during the developments. This practice strongly increases the probability of failures and of inefficiencies. In addition, it creates problems with the future developments since the source code is weak. This generates a vicious cycle which tends to accumulate the technical debt over time. Even in this case, according to the interviews obtained this risk

is not such a big issue if properly managed. By making several tests during the development phase, even coordinating with colleagues for the unknown technologies, the risk is strongly mitigated. Limiting the developments only the fundamental ones, being aware of the ERP provider's ones in order not to make them crash with the company's one, is important too. In case in which the technical debt is present a last resource is to make specific maintenance to reduce it.

Other risks faced by companies are the loss of data during the migration process between management systems, the loss of efficiency due to changes in the way in which activities are done, the possibility to have misunderstanding between consultant and customers which may increase project's cost and time. Still, the possibility to have selected the wrong ERP, since each ERP has its own characteristics and one may not have those searched by the company, and the barriers to the exit when the company wants to change the ERP, which may be the costs as the additional changes brought to the company.

The ERP implementation involves even, as previously said, consultants. Even for them there are risks and thanks to the interviews done it was possible to find them. Generally, the risks are the client unsatisfaction and the possibility to have monetary losses from the implementation which may be caused by a wrong interpretation of the requirements, an incorrect use of resources which may be too much expert, and so costly, or too much unexpert, or an underestimation of the activities required by the client which may cause incorrect project's estimate.

To conclude, it is important to look to the future paths that will be taken by ERPs. Thanks to the massive use of data the machine learning is an interesting path for ERPs. The systems will become able to manage production and purchases from suppliers in a more efficient way by forecasting demand of goods.

Another important path will be the Internet of Things which could be a way for the ERPs to obtain an enormous amount of data to use for managing the warehouses or to improve the maintenance processes.

Another important future ERP development will be the creation of Sustainable Enterprise Resource Planning (S-ERPs) which are ERPs used to support sustainable projects. This will require to modify the concept beyond the ERP implementation from the profit maximization to the three pillars Social, Environmental and Economic.

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Table of figures