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IMPLEMENTATION OF AN ERP SYSTEM: THE EA SAP PROJECT

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ABSTRACT

La competitività di un'azienda dipende dalla sua flessibilità in termini organizzativi e produttivi, il che significa essere capace di apprendere e adattarsi rapidamente al cambiamento imposto e, quindi, di sviluppare un alto grado di coordinamento tra le attività aziendali. In tale contesto, un grande passo avanti si è avuto negli ultimi anni grazie all'evoluzione dell'*information technology,* cioè la componente tecnologica dei sistemi informativi aziendali.

La risposta più recente a questa esigenza è trattata nel primo capitolo di questa tesi ed è costituita dai cosiddetti sistemi informativi integrati (*Enterpise Resource Planning – ERP)*. Tali sistemi nascono per la necessità di gestire le interdipendenze presenti in ogni sistema aziendale e di superare la frammentazione e la dispersione delle informazioni all'interno delle organizzazioni, integrando le varie applicazioni esistenti in azienda. Il guadagno in efficienza, il risparmio dei tempi e dei costi e soprattutto la possibilità di avere un sistema centralizzato ed integrato che tenga sotto controllo gli indicatori di *perfomance*, vitali per la competizione delle aziende, fanno dei sistemi gestionali dei supporti oramai imprescindibili nello scenario dei sistemi informativi aziendali.

Tuttavia, individuare il miglior sistema informatico per la gestione di determinati settori aziendali non è un processo semplice. L'analisi presentata nel secondo capitolo ha lo scopo di studiare le specifiche esigenze informative del processo di pianificazione delle attività di cantiere e di gestione del personale preposto per le aziende che lavorano su commessa (*Engineer To Order* – ETO) e di individuare un sistema gestionale appropriato, coerente con i requisiti emersi in fase di studio.

L'analisi verterà poi nel terzo capitolo ad individuare l'approccio migliore per implementare il sistema informatico più idoneo all'azienda oggetto del *case-study*: la EA S.r.l. L'introduzione di SAP, imposta alla EA dall'azienda madre, il gruppo

arabo Alfanar, prevede un processo complesso e costoso, con lunghi tempi di implementazione, che rimetterà in discussione anche il profilo organizzativo-aziendale. L'ultima sezione di questo lavoro di tesi approfondirà, dunque, tutti gli aspetti da tenere in considerazione nel processo di implementazione del gestionale, in particolare con riferimento a tre momenti principali: l'"*AS IS*" (che riguarda l'analisi dei processi esistenti), la "*Gap Analysis"* (che si concretizza nella misurazione dei *gaps*, cioè degli scostamenti tra la situazione attuale e i nuovi obiettivi, fase che maggiormente influenzerà la qualità della diagnosi) e il "*TO BE*" (che consiste nel disegno dei processi futuri).

Affinché un progetto di integrazione dei sistemi informativi aziendali attraverso l'adozione di un ERP abbia successo è però necessario intraprendere un percorso d'innovazione aziendale e di apprendimento organizzativo, che deve essere accompagnato da un profondo cambiamento della cultura aziendale. Saranno l'adozione delle pratiche di *Change Management* e lo studio della Curva del Cambiamento di Kubler-Ross a fornire alla EA il supporto necessario per facilitare l'adozione e l'accettazione del nuovo sistema SAP da parte di ciascun soggetto coinvolto.

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INTRODUCTION

Nowadays, every aspect in modern organizations relies heavily on information to survive and companies are adopting Enterprise Resource Planning (ERP) systems for gaining competitive advantage in all their functional areas. Organized into modules, these systems guarantee the instantaneous information availability, reduce vagueness and conjecturability and enhance communication quality along with data transparency and visibility. All these results can be achieved thanks to the informative integration, which permits the standardization and harmonization of the data processing, as well as the utilization of a unique platform for all the activities inside the company: from production planning to logistics, from accountancy to human resources management, from quality control to plant maintenance.

Notwithstanding, the real barrier against progress of a company in terms of software is the combination between the economic and the cultural approach, in particular for small and medium enterprises. The greatest hurdle is creating an information culture that today is still lacking in most business realities. In fact, little attention is given to the evaluation of software impact on the company processes, representing one of the main reasons for the failure of ERP implementation. This is why the most important and delicate phase in the implementation project is the analysis and formalization of current and future processes.

This thesis aims at studying the implementation of the integrated systems in the complex reality of the project manufacturing companies. In this context, ERP solutions can constitute the essential support for realizing an efficient quotation process and for managing the complexity and uncertainty connected with the Engineer To Order (ETO) system. In fact, they can be a useful means for feeding the database in order to define more and more precise and accurate preventives.

In particular, the third chapter focuses on the case of EA S.r.l., an Italian company located in Ascoli Piceno, working in the growing energy market, both national

and international. The reason that led EA to implement an ERP system arose from the acquisition of the company by the Alfanar group, with the necessity of creating a common IT platform across the organization: the SAP software. In fact, ERP solutions can solve the multiplatform issue among divisions, since the lack of conformity can have a detrimental effect on the process flow. With a common software in place, operational costs can be drastically reduced, as it helps automate processes, increase productivity and retire costly legacy systems.

Configuring and implementing an integrated system in every phase of the EA *Erection* process means ensuring that the structural characteristics of the package are suitable with the performed activities, in order to avoid drastic redesigns. The configuration will start with the careful description and representation of all these phases, with the scope of highlighting and exploiting the opportunities of integration with the SAP operating procedures.

The next step aims at explaining the action plan that EA will undertake in order to align their procedures to the Alfanar conduct. In this concern, one of the main problems in ERP implementation for all companies is how to align an off-the-shelf software package with the business processes. The alignment problem, also known as “gap analysis”, is the technique of listing out the steps to be taken for a company to move from its current state of operations to a future state, with the purpose of identifying and suggesting the ways to bridge the gap between the 'AS IS' and 'TO BE' scenarios.

As the number of failing ERP projects is increasing, it becomes essential to depict a model for avoiding this threat. EA will structure the SAP implementation into three main phases: the pre-implementation, where decision makers will choose whether to proceed with the project or not and prepare the company to the drastic change, the implementation, managed through a detailed Action Plan, and the post-implementation, with a support activity that will involve the intervention of the consultants and programmers.

Moreover, successful implementation of ERP systems results from effective management of the risks. EA will undertake the SAP implementation risk management in accordance with the three phases mentioned above (the pre-implementation, the implementation and the post-implementation).

As will be seen in the next paragraphs, it is worth mentioning that the success of ERP implementation is not a monolithic concept, but a multidimensional one: it will interest nearly all aspects of EA organizational and operational life and will be considered beneficial to the extent that it brings considerable advantages to the business processes and to the organization as a whole. Substantially, change is not a merely technical phenomenon but also a social one, which entails suitable change management techniques since, if not handled properly, could result in huge losses for the organization. Adhering to these practices will mitigate the challenges of adopting the ERP software, since they anticipate the acceptance and facilitate the experience for everyone involved.

CHAPTER 1

CONCEPTUAL FRAMEWORK

1.1. Enterprise Resource Planning: basic information

1.1.1. ERP system: a general definition

In recent years, many organizations have adopted Enterprise Resource Planning (ERP) systems, using software packages as SAP, Oracle, BAAN etc. The ERP system is a managerial software adopted by business companies in order to automate many back office functions entailing the whole organization, from production to sales and logistics, accountancy and human resources. It consists of a series of integrated applications addressed to manage the internal processes (purchases, orders, etc.) and essential to enhance the planning, programming and controlling activities.

"Enterprise Resource Planning systems serve as the information backbone to the core business processes of an organization"[1]. They are one of the most important developments in the application of information technology in the business world. ERP typically integrates all facets of an operation in a single database and user interface.[2] Through the implementation of this software, it is furthermore possible to process a considerable amount of data to meet the informative requirements of the various business areas. In fact, today every aspect in modern organization relies heavily on information to survive and companies are using ERP for gaining competitive edge in all functional areas.

"Enterprise systems appear to be a dream come true. These commercial software packages promise the seamless integration of all the information flowing

[1] Forger G., *ERP Goes Mid-Market* in Modern Materials Handling, 2000, p. 65.
[2] Beal V., Best ERP Software 2019: Comparison & Reviews in https://www.webopedia.com/TERM/E/ERP.html.

through a company – financial and accounting information, human resource information, supply chain information, customer information. For managers who have struggled, at great expense and with great frustration, with incompatible information systems and inconsistent operating practices, the promise of an off-the-shelf solution to the problem of business integration is enhancing".[3] In fact, integrated systems aim at supporting the business with regards to different aspects:

- standardization of the procedures, shaped on the company's features and attitudes;
- integration of the activities into processes;
- facilitation of the communication among business units;
- improvement of information flow and quality[4].

Firstly, implementing an ERP requires the formal clarification of the single activities, so as to depict a general picture of the organization and configure the informative system. Thanks to this layout, the business units have the possibility to employ standardized procedures to achieve precise purposes, even facilitating the control activity. The procedures within the integrated system are consistently linked and addressed to build relations and generate a process. In this way, every transaction that occurs in one module generates the updating of the data inherent to that transaction in all the related processes. Furthermore, the system guarantees the instantaneous information availability, therefore reducing vagueness and conjecturability. Additionally, communication quality improves along with information transparency and visibility, boosting the growth opportunities of human resources, who have the capabilities to retrace the logical path from which information arises.

[3] Davenport T.H., *Putting the Enterprise into the Enterprise system* in Harvard Business Review, 1998, p.121.
[4] Mucelli A., *I sistemi informativi integrati per il controllo dei processi aziendali*, Giappichelli, Torino, 2000, p. 215.

In spite of the presence of several ERP products on the market, it is possible to identify a series of common features embedded in every system, concerning the underlying rationale framework and the main functional properties.

As per the logical framework, each product relies on a client-server setting, which allows overcoming the traditional dilemma between responsibility centralization and decentralization. Thanks to this archetype, data are shared among the different functions and can be automatically managed, allowing a decentralized data processing and a more coherent utilization.

For what it may concern the main functional properties, ERP systems are characterized by:

- Informative Integration;
- Implementation Modularity;
- System Configurability.[5]

Informative integration permits the standardization and harmonization of the data processing methods, as well as the utilization of a unique platform for all the activities inside the company: from production planning to logistics, from accountancy to human resources management, from quality control to plant maintenance.

Besides, it reduces uncertainty. In fact, this latter is often a direct consequence of the absence of coherent information and ERP systems aim at increasing the volume of this information. However, acting on the quantity of the information is not always sufficient for ensuring the efficient rationality of the decision process because, in some cases, uncertainty comes from interpretation ambiguities. The integrated systems are able to solve this problem, boosting information quality rather than complexity.

The second common feature is related to the systems modularity. In fact, ERP are organized into modules, each of which administrates different types and parts

[5] Mucelli A., *I sistemi informativi integrati per il controllo dei processi aziendali*, op. cit. p. 218.

of the transactions. The diverse solutions characterize themselves for the extension and the weight placed upon each module. Modularity plays an essential role in the potential evolution of the system, since every innovation can be handled independently and autonomously.

The other common aspect is linked to the configurability, that guarantees flexibility to the ERP systems, as the final user can define the functional features of the active modules, in accordance with the structure of the company's operational processes. In fact, configuring and implementing an ERP system means ensuring that the structural characteristics of the acquired package are as suitable as possible to the operational processes and the structure of the company, so as to avoid drastic organizational redesigns. The configuration starts with the careful description and representation of the company state-of-art processes. This moment is crucial, as will be analyzed in the case study, because it allows the comparison between the company processes and the ERP operating procedures, with the purpose of highlighting the main divergences and the opportunities of integration.

1.1.2. From ERP to extended solutions

The next step requires a deeper analysis, with detailed focus on the diverse processes and modules rather than on the wider company overview. ERP systems are generally equipped with a series of standard parameters, able to adapt to every company's procedural structure; this is in line with the standardization philosophy typical of these technologies and has the purpose of saving time and costs during the implementation activity, with respect to the hypothesis of building a custom-made model.

Nevertheless, it may happen that the options provided do not fulfill the company requirements. In this situation, there are two viable options:

- the first possibility consists of building further links between the standard system and the company processes (this solution is qualified as external to the system);
- the second alternative is represented by the customization of the system, that is an alteration, realized by the software provider, of the specific incompatible modules.[6]

However, this second option is seldom put in practice, since it results quite expensive and likely to compromise the future adaptation of the system to the upgrades made available by the software providers after the implementation. For this motive, the customization can space within a certain range of alternatives envisaged by the providers, so as to avoid every kind of incompatibility with the upgrades.

When the diversity between the organizational structure of the company and the modular structure of the ERP solution is highly remarkable and cannot be filled by the standard modifications foreseen by the system, the customization would translate into significant variations to the coding scheme of the software. This implies an exponential cost linked to the redesign of the product, the time spent to readapt the system and the future modifications of the late upgraded versions.

Nowadays companies use to work in an extremely variable environment, therefore in many cases evaluations turn out to be demanding even in the short run. In this situation, the role of ERP software is delicate. The correct determination of the informative needs results difficult for both the increasing complexity of the market (internal and external) and the wide range of ERP solutions offered. Furthermore, it is necessary to consider the exponential growth of information and data coming from diverse sources. Consequently, the choice of the ERP system becomes far more complex than in the past, especially due to time variable.

[6] Mucelli A., *I sistemi informativi integrati per il controllo dei processi aziendali*, op. cit. p. 222.

The majority of companies often struggle to complete the implementation of the software within a given period and, as soon as they seem to have concluded, the system has to be revised and modified again according to the new circumstances. Today, the ordinary changing time of a software may not be compatible with the ordinary changing time of the business itself. In consequence of this fact, they could more be described as extended solutions rather than "simple" ERP systems.

The main feature of the extended solutions is not represented by their higher efficiency, but rather by their ability of facing the increasingly complex business. For this to be possible, it is required for the system to be versatile and, in a sense, oversized.[7]

Systems with these features occasionally represent a less efficient solution because, all other needs being equal, they present larger application areas that are not entirely exploited. This may cause a potential waste of resources. If the external environment presents well-known and unchanged features, such a solution will not provide clear benefits but costs that, especially for SMEs, could be unbearable.

However, when predictability for change is low and foreseeing the software requirements is virtually impossible, an area with disabled functions represents the winning solution both for guaranteeing flexibility and for making the extended solution more versatile.

Actually, the biggest challenge in the choice of the ERP system dimension is striking a balance between the cost of those resources to be utilized immediately and those classified as redundant. Many factors can affect this choice: corporate structure, shareholder structure, business model, level of internationalization, business sector, business strategies and so on. As an example, the degree of internationalization is a focal point to consider when selecting the proper solution. Choosing

[7] Bazzerla M., *L'implementazione di un sistema ERP in azienda,* in Controllo di gestione: la rivista di budget, reporting e strategia per l'azienda e il consulente, n. 5/2017, p. 45.

a multilingual system located in different countries could be beneficial in this situation but, being this latter feature an expensive one, that solution need to be excluded if the company has no intention to develop an internationalization project neither now nor in the future.

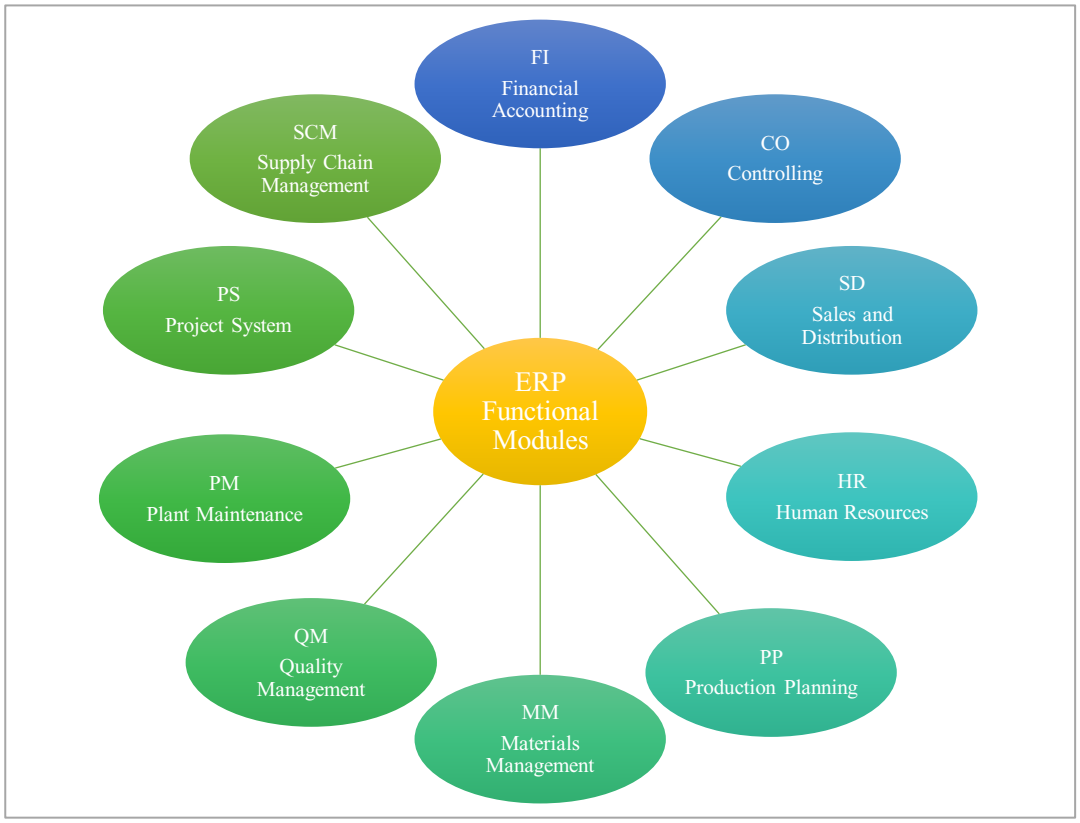
The company has not only to be driven by the current needs, since this practice could lead to prioritize the immediate efficacy at the expense of the future one, thereby making the choice a constraint for growth and development.

It clearly stands out how the real barrier against progress and evolution of a company in terms of software is the combination between the economic and the cultural approach, in particular for small and medium enterprises. Hence, the greatest hurdle for software providers is equipping companies with affordable extended solutions and, at the same time, creating an information culture that today is still lacking in most business realities.

1.1.3. Major Modules of ERP Software

Every ERP system is structured in various modules, each with a specific business task and divided in other subcategories. This paragraph aims at analyzing two types of modules: functional and technical modules.

Figure 1.1: ***Functional Modules Overview***



FI stands for Financial Accounting and it is one of the most important modules of the ERP systems. It is used to store the financial data of an organization and helps to analyze the conditions of a company in the market. It can be integrated with other modules like SD, PP, MM, SCM, etc. This module enables the company to manage financial accounting data within an international framework of multiple organizations, currencies, and languages.[8] It mainly deals with specific financial components, such as fixed assets, tax accounting, financial statements and so on. In fact, FI comprises the following sub-components:

[8] Garg V. K., Venkitakrishnan N.K., *Enterprise Resource Planning: concepts and practice*, PHI Learning Private Limited, New Delhi, 2011, p. 84.

- General Ledger (GL);
- Accounts Payable (AP);
- Accounts Receivable (AR);
- Bank and Cash Management;
- Budgeting and Monitoring;
- Withholding Tax (TDS);
- Asset Accounting (AA);
- Funds Management (FM);
- Treasury Management (TM).[9]

Controlling (CO) is another important module offered to any organization. It supports coordination, monitoring, and optimization of all the processes in an organization. It involves recording the consumption of production factors and services, as well as managing and configuring master data that cover cost and profit centers, internal orders, and other cost elements and functional areas. Notwithstanding, the main purpose of the controlling module is planning. In fact, it enables to determine variances by comparing actual data with planned data and thus allows controlling business flows in the organization. The important submodules of controlling are as follows:

- Product costing (CO-PC);
- Periodic Allocations;
- Profitability Analysis (CO-PA);
- Cost Center Accounting (CCA);
- Profit Center Accounting (PCA).[10]

[9] ERPTRAINING9: https://www.erptraining9.com/modules-sap/.
[10] Padhi S.N., *SAP ERP Financials and FICO*, Jones and Bartlett Publishers, Sudbury, 2011, p. 310.

Sales and Distribution (SD) is used to store the customer and product data of an organization. It helps to manage the shipping, billing, selling and transportation of products and services of a company. The logistics module manages customer relationship starting from raising a quotation to sales order and billing of the product or service.[11] This module is closely related to other modules like Material Management and Production Planning. The subcategories are:

- Sales Order Processing and Monitoring;
- Shipping;
- Bill/Invoice Generation;
- Credit Management;
- Bill of Material;
- Pricing and Discounts;
- Statutory Requirements.[12]

Human Resources (HR) module is a comprehensive business solution to automate, streamline and optimize the various HR processes of a company, from recruit to retire.[13] It consists of many seamlessly integrated submodules:

- Organizational Management;
- Personnel Administration;
- Recruitment Time Management;
- Management Personnel Cost;
- Planning Budget;
- Payroll Benefits Compensation;
- Management Personnel;

[11] Tutorialspoint: https://www.tutorialspoint.com/sap_sd/sap_sd_introduction.html.
[12] Nestell J. G., Olson D. L., *Successful ERP Systems: A Guide for Businesses and Executives,* Business Expert Press, New York, 2018, Table 2.1.
[13] D'Souza Tania, SAP HCM Overview in https://erproof.com/hr/sap-hr-training/sap-hcm-overview/.

- Development Training & Event Management;
- Travel Management.[14]

Production Planning (PP) is one of the key modules in ERP and deals with the planning processes: capacity planning, material planning, execution of production orders and movement of goods. This module handles with the master data required for Bill of Materials (BOMs) activity, work center and routing. Important components of PP are listed below.

- Production Order Processing;
- Demand Management (DM);
- Materials Requirement Planning (MRP);
- Shop Floor Control;
- Capacity Requirements Planning (CRP).

Material Management (MM) is a part of the logistics function managing the procurement activities of an organization. MM as a process ensures no shortage of materials or any gaps in the supply chain process of the organization. It speeds up the procurement and material management activities, making the business run smoothly with complete time and cost efficiency. At the same time, it is quite versatile to accommodate changes that are frequent in any business environment. The subcategories of this module are as follows:

- Purchasing;
- Inventory Management;
- Inventory Valuation;
- Vendor Evaluation and Rating;
- Invoice Verification;

[14] Vivek A., SAP HR and HCM Course in https://aspireit.net/Best-SAP-HR-training-institute-institute-in-pune.

- Statutory Requirements.

Quality Management (QM) is an integral part of logistic management used to perform functions such as quality planning, quality assurance, and quality control at various stages: material incoming stage, manufacturing process stage and after production as well. With Quality Management module, the company can implement the key modules of the ERP system as defined in manufacturing quality standards. The module performs the following key functions in manufacturing of goods:

1. the Quality Planning allows planning the inspection of goods from the vendor, raw materials, work-in-process, and final product;
2. the Quality Notifications includes the identification of defects and the definition of the steps to be taken by the quality department;
3. with the Quality Inspection, quality results are captured and decisions are taken to establish whether an inspection lot is to be accepted or rejected.[15]

QM includes the following subcategories:

- Incoming Inspection;
- Process Inspection;
- Final/Delivery Inspections;
- Quality Reports/Certificates;
- Quality Notifications.

Plant Maintenance (PM) application component provides a tool for all maintenance activities to be performed. Since all the activities related to the maintenance are interconnected, this module is closely integrated with others. Using PM, the company can perform automatic repairs and facilitate maintenance requests inside the organization. It allows problems recording, labor planning and cost settling for

[15] Tutorialspoint: https://www.tutorialspoint.com/sap_qm/sap_qm_quick_guide.html.

any required asset. To perform these activities, Plant Maintenance contains the following submodules:

- Maintenance Planning;
- Breakdown Maintenance;
- Preventive Maintenance;
- Predictive Maintenance.

Project System (PS) is one of the key modules to perform project and portfolio management. It ensures the management of the project life cycle starting from structuring to planning, execution, until the project completion. Project System is integrated with other modules like logistics, Material Management, Sales and Distribution, Plant Maintenance, and Production Planning.
It enables organizations to manage large and small-scale projects efficiently. The project manager has the task to ensure that projects are executed within budget and time and resources are allocated to the project as per the requirements. Before a project is initiated, the goal has to be clearly defined and the activities structured. The module comprises the following submodules:

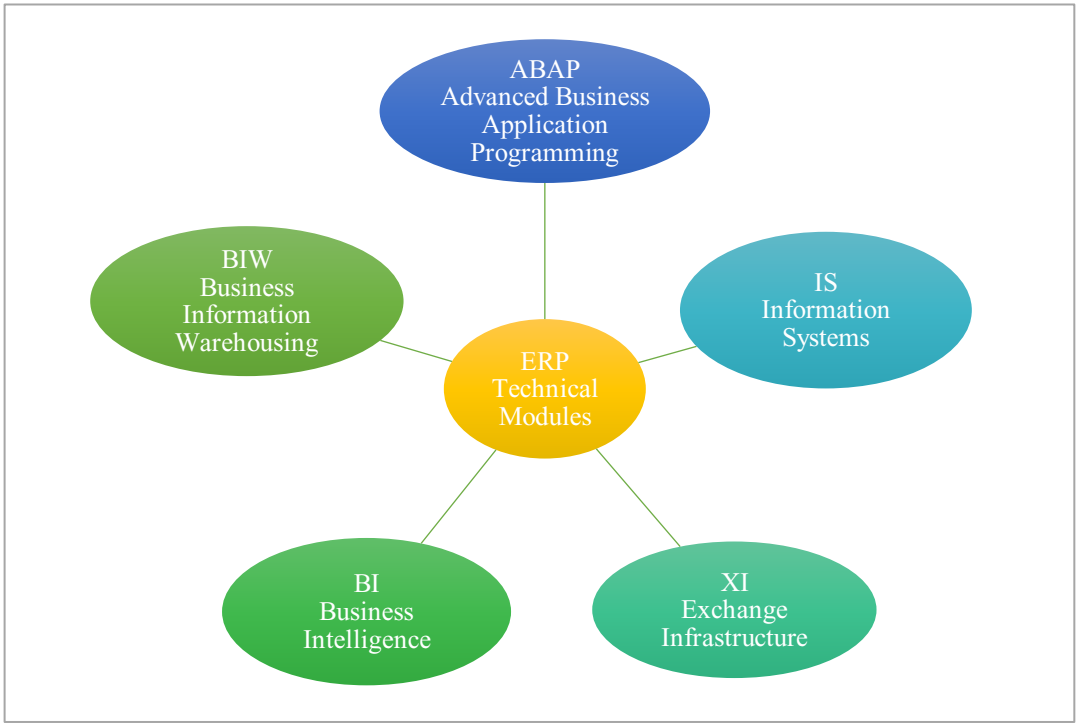
- Project Planning;
- Project Monitoring;
- Project Costing;
- Milestone based Billing;
- Handling of Work Breakdown Structure (WBS) elements.

Supply Chain Management (SCM) is an advanced planning engine, able to meet the complex challenges in demand planning, production scheduling, distribution planning and transport planning. The purpose of this module is streamlining these activities in order to form an entire supply chain. It enables forecasting the business,

handling constrains and planning costs, ensuring the maximum customer satisfaction and bearing the minimum expenses. SCM comprises the following components:

- SC Collaboration, used to help making collaborative forecasts and agreements;
- SC Planning, used to generate the operational plans as per current and relevant data in the system;
- SC Coordination, used to coordinate the exchange of data and information between different business units;
- SC Execution, used to ensure that the company is executing the supply chain plans in the best manner possible, to get the desired result.

Figure 1.2: ***Technical Modules Overview***



Advanced Business Application Programming (ABAP) is a programming language developed by ERP systems for the development of business applications. The

ABAP objects component makes object-oriented programming possible. Furthermore, the multilingual capability is enabled by the extraction of language-specific program components from the source code, which are then reloaded when the program executes in accordance with the environment. A text environment determines the precise program behavior at runtime, for example, the order in which text is sorted.

Information Systems (IS) use informative key figures to aid the rapid detection of existing problem areas and analyze their origin.[16] Business transactions that are often performed thousands of times in one day form the basis for these key figures. An information system therefore has to access aggregated data in order to gain a quick overview. The information systems in logistics are flexible tools for collecting, aggregating and analyzing data from the operative applications (Purchasing, Sales, Production, Inventory Controlling, Plant Maintenance, Quality Management/Inspection Processing). They thus enable to continually control target criteria and to react in time to exceptional situations.

Exchange Infrastructure (XI) module is used to facilitate the exchange of information among a company's internal software and systems and those of external parties. It mediates between entities with varying requirements in terms of connectivity, format, and protocols and reduces integration costs by providing a common repository for interfaces.[17] The central component of XI is the Integration Server, which facilitates interaction between diverse operating systems and applications across internal and external networked computer systems.

Business Intelligence (BI) is a platform used by ERP systems to provide the company with a flexible route to sharing information (in real time and at every

[16] SAP Help Portal: https://help.sap.com/viewer/88cad3a0306d43fd9346bf5210fd04b9/6.18.08/en-US/b00dc453f57eb44ce10000000a174cb4.html.
[17] Online Free Course: https://www.onlinefreecourse.net/sap-pi-process-integration-consultant-training-scenarios-udemy-free-download/.

level) inside the whole organization, from CEO to analysts, from higher executives to lower level employees.[18] Thanks to this feature, it enables a better decision-making process in the organization. BI offers a panoramic view of data, which can be easily accessed by anybody with valid credentials within and outside the company. It can also be customized, so that the organization can tailor the module according to their needs.

Business Information Warehousing (BIW) allows a company to have an integrated view of all the relevant data present in the data warehouse. This enhances the planning of the business activities. BIW provides not only critical information, but also a multidimensional analysis, useful for a keen understanding of the business processes. Another important aspect of BIW is how well it is integrated with BI. The integration in seamless and allows for much better reporting and analysis of the data. It also makes data warehousing more efficient and effective.[19]

1.2. ERP implementation: Cost/Benefit Analysis

1.2.1. Technology versus business organization: the strategy

As stated in paragraph 1.1.2., practical experience shows that one of the most overlooked aspects about ERP implementation is its impact on the business strategy and, more generally, on the corporate culture. Most companies, in particular small and medium enterprises, believe that this kind of projects represents the mere substitution of many technological devices with others, with the simple aim of enhancing functions and performances that previously did not exist. Little attention is given to the evaluation of their impact on the company processes, which constituted

[18] SAP Online Tutorials: https://www.saponlinetutorials.com/what-is-sap-bi-business-intelligence/.
[19] SAP Online Tutorials: https://www.saponlinetutorials.com/what-is-sap-bw-business-warehouse/.

one of the main reasons for the failure of ERP implementation. [20] In fact, due to the absence of adherence between the processes and the software that should manage those activities for which the processes have been designed, the ERP system will never work as a support to the strategy.

Despite the strong push towards ERP, there is a lack of understanding of the difficulties that can arise when the business models used by organizations clash with the business models underlying the ERP packages implemented by these organizations. "There seems to be a subtle but profound danger that the logic of the software package supplants the organizing logic of the organization as a whole. There is also significant evidence that the disruption to everyday business while ERP systems are implemented are putting undue pressure on organizations, regardless of their size and financial means".[21]

The approach should be focused on the corporate processes and on how activities have to be developed and mapped, before asking which technological devices would be more suitable according to the state-of-art circumstances. This is why the most important and delicate phase in the implementation project is the analysis and formalization of current and future processes. It is also necessary to share the project with all the people involved; this implies the adoption of a common language inside the firm to display the activities, along with a process-based vision.

The integrated system consists of the "digital materialization" of the process, as soon as data are inserted into the respective fields; the problem is related to the temporal aspect, since the moment of data collection related to an event is not always aligned with the moment in which the event itself occurs. The more chronologically distant they are, the higher the probability to have a misalignment between

[20] Stefanutti B., *Implementazione di un ERP: un'analisi costi/benefici* in Controllo di gestione: la rivista di budget, reporting e strategia per l'azienda e il consulente, 2012, p. 20.
[21] Bishnoi V., *Implementation of Enterprise Resource Planning (ERP) software and economic analysis of its implementation in Indian Multinational Organizations*, Shobhit Institute of Engineering and Technology, Modipuram, 2011, p. 7.

the real process and the mapped one, thus causing negative consequences to the overall activity.

However, it is clear that the inefficiency of the process is not due to technology, but to organizational aspects. Therefore, it is questionable whether removing the misalignment could bring evident benefits to the company, therefore the purpose is making the moment of the event as close as possible to its registration in the integrated system.

Considering for example the order of a client, its immediate availability into the system can directly activate the calculation of the requirements in terms of raw materials, spatial planning, potential purchase of external services or unavailable material at the right time and so on. These are examples of the impact that the appropriate and adequate use of an integrated system could have on the strategy and on the organization. Focusing on this aspect can lead to outstanding results, since the competitive advantage of a company does not derive from the ERP implementation activity, but from the management ability to identify the strengths and the improvements that these tools can enable: ERP is a means, not an end.[22]

1.2.2. Typical costs of ERP implementation

As previously analyzed, ERP software typically comes with embedded modules serving different business processes. The common modules with any ERP include accounting, finance, sales, manufacturing, inventory, purchases, and CRM but, depending on the business requirements, the company can add further elements to the existing ones. The more modules, the more the software costs.

The method proposes to translate the activities into items of incomes and expenses, calculating the so-called return of investment (ROI) of the project. In order

[22] Stefanutti B., *Implementazione di un ERP: un'analisi costi/benefici*, op. cit. p. 21.

to allocate the majority of the costs related to the implementation of an ERP system, experience suggests the identification of three main categories:

A = people

B = data

C = computer (hardware/software).

Concerning the category A, the company can classify the following cost items:

1) Cost of the team; this section encompasses all the expenses related to the project leader and all the other people involved in the project, as they are responsible of the various processes constituting the implementation phase and the final configuration of the modules;
2) Costs of training and education, critical success factors in the implementation of an ERP system because they are expensive, time consuming and require an accurate human resource management;
3) Travel, board and lodging expenses, as well as the eventual costs for the extraordinary management of the activities;
4) Cost of "management consulting", that could involve, especially for small and medium enterprises, designating an independent consultant to be the internal project manager; or, more simply, costs related to special interventions necessary for solving particularly critical issues, unforeseen and requiring highly specialized expertise;
5) Post start-up costs; it is reasonable to schedule a supporting team aimed at managing the new functionalities and processes configured in the first period of utilization of the informative system;
6) Costs related to new potential professionals (program manager, material manager, etc.).

Category B refers to the essential part of the project, since an existent or emerging informative system has to be fed with data; or better, data are the basic input for

every system module. The datasets, built ex-novo or migrated from the previous system, are mainly:

1) personal data of clients and suppliers;
2) article numbers of stocked goods;
3) master data of working centers;
4) article numbers of products to be realized, equipped with:
    a) bill of materials (material requirements);
    b) work cycles (labor hours, machines required in every work center);
5) inventory (quantity) of the article numbers of stocked goods.

These basic data allow the coherent registration of the sales orders and the respective production activity. Furthermore, it clearly stands out that the definition of the inventory of the article numbers of stocked goods represents an indispensable step for the system to boot. This activity requires the maximum level of accuracy, because it boosts the correct implementation of the production activity, along with the establishment of a procurement policy able to respond to the actual needs.

Overall, it can be stated that the cost items related to category B arise from the following activities:

- activities to enhance the accuracy of the storehouses in terms of data, which can involve human resources and other specific costs;
- specific activities to enhance the accuracy of the Bills of Materials and the work cycle. As stated above, these two elements represent the cornerstones of every informative system; for this reason, the implementation of a new integrated system is an ideal opportunity for analyzing the structure of the products and the work cycle for realizing the finished goods; generally, these costs can be deduced from the Request of Proposal and often are mostly addressed to the partner consultant for the ERP implementation;

- other activities for supporting the data migration from the previous system.

Category C concerns all costs related to the purely technological aspects of the project, entailing all those expenses referring to the hardware and software services. The costs in question are the following:

1) costs for new computers and, more generally, all the hardware specifically required for implementing the new ERP;
2) costs for the installation of the software modules of the ERP system and cost of the related licenses;
3) cost for the technical staff, needed to:
   a) arrange the prerequisites for installing the new solution (disk space analysis, database space analysis, number of users, network requirements, backup policies, etc.);
   b) install the modules for the solution (i.e. sales, inventory, accountancy, human resources, etc.);
   c) interface or integrate, if necessary, the standard modules with other specific software that the company intends to maintain;
4) training costs for the technical management of the system;
5) costs for the arrangement of the project technical documentation (backup procedures, service calls opening procedures, etc.);
6) costs for the general system maintenance;
7) costs for the software maintenance activity (i.e. software update release, bug fixing, etc.);
8) other costs and contingencies.[23]

[23] Stefanutti B., *Implementazione di un ERP: un'analisi costi/benefici*, op. cit. p. 24.

1.2.3. Typical benefits of ERP implementation

Having analyzed above the cost categories related to the adoption of an ERP system, an intense investigation has been conducted for examining the major benefits that this kind of solution can lead.

ERP systems are essential tools for both big companies as well as for startups and small SMEs, playing a very important role when it comes to organizing and processing financial data. With ERP, both-long term and short-term business perspectives are improved.

The core idea of implementing an ERP solution is to get tangible business benefits that would improve the performance of the organization and achieve certain objectives. These include inventory reduction, less time to market, reducing manufactory and order processing cycle times, etc. Some benefits of implementing ERP software in any organization are listed below.

1) reduction of operating costs: ERP play an active role in achieving the strategic competitive advantages. With a centralized database and analysis capabilities, ERP systems provide informational benefits to the management decision making process. As they automate business processes, an organization may expect ERP systems to offer strategic advantage through cost leadership by cycle time reduction, productivity improvement, quality enhancement, customer services melioration and so on;
2) improvement of working time. As the different parts of the organization are connected with each other, people have faster access to information and require less time to do their tasks. This allows reducing time and resources for decision-making processes;
3) centralization of the information system. As all the departments and the functions in the organization are integrated and linked to one single database, data needs to be entered only once into the system. Then, access is

allowed from different departments according to their needs. For example, before taking an order from a customer, the sales representative can have access to information regarding availability of inventory, credit rating of the customer, etc;

4) improvement of the Return on Investment (ROI). Developing an in-house software requires huge investments, experienced professionals and a significant amount of time. As ERP software packages are developed by vendors who already have the required expertise, they are off-the-shelf packages that companies purchase and do not entail an in-depth analysis. Hence, the ROI is received faster from the ERP system, with respect to an in-house software;
5) ease of use. The system of ERP is user friendly. With the correct amount of training, it results quite easy for the employees to use the system;
6) efficient business practices. ERP system helps companies to avoid erroneous activities and introduces business *best practices*. This enhances a detailed control and introduces standardized ways to execute business processes;
7) fast solutions to problems. Most of issues can be easily solved, as the vendors who develop ERP software packages collect the best ideas from all their customers and incorporate them into their products;
8) only customization is required. ERP systems are developed to suit the general businesses and ready-to-use. However, as every company has slightly different ways of operating, only few changes may be needed to customize the system, in order to better cater the company's particular requirements;
9) information sharing. Once information is introduced into the single database, everyone in the organization has access to the same information;
10) productivity increase. This is due to a better department planning and a more efficient material planning, obtainable thanks to both MRP and CRP;

11) reduction of inventory costs. The organization as a whole can align, thanks to an efficient MRP, on a strategy oriented to satisfy the net requirements (eventually adjusted with an amount of emergency stocks for certain articles). This practice boosts stability and controllability, which refrain from bearing costs for expedited orders and lead to a space reduction for storehouses;
12) cash flow improvement. The system is oriented on a material procurement strategy that allows the company to sustain purchase costs only when the production process starts, therefore they can avoid bearing costs earlier and affecting cash flow;
13) customer satisfaction. In the previous informative systems, the order moved around the organization often causing delays, errors in processing due to repeated entries by the different departments, or got lost. With the ERP system, the order moves quickly through the organization. This helps to get the orders to the customers faster and there is no waiting time;
14) sales increase. This is an indirect consequence, deriving from the better service to the client and the reduction of the lead-time, which is the period between the order and the delivery. This happens because of the higher efficiency related to the lower necessity of re-workings, due to the careful and rigorous planning activity which avoids errors and reduces WIP (Work in Progress).[24]

[24] Stefanutti B., *Implementazione di un ERP: un'analisi costi/benefici*, op. cit. p. 24.

CHAPTER 2

LITERATURE REVIEW

The aim of this chapter is digging in the specific field of application that this thesis wants to investigate, which entails the implementation of the integrated systems in the complex reality of the Project Manufacturing companies. Notwithstanding, before dwelling on the topical content, a general introduction regarding the main production systems is provided.

A production system is defined as a set of men, machines, equipment and organizations linked by a common flow of materials and information, aimed at converting raw materials into finished products. When analyzing a production system, four key production parameters are used:

- cost;
- time;
- quality;
- flexibility.

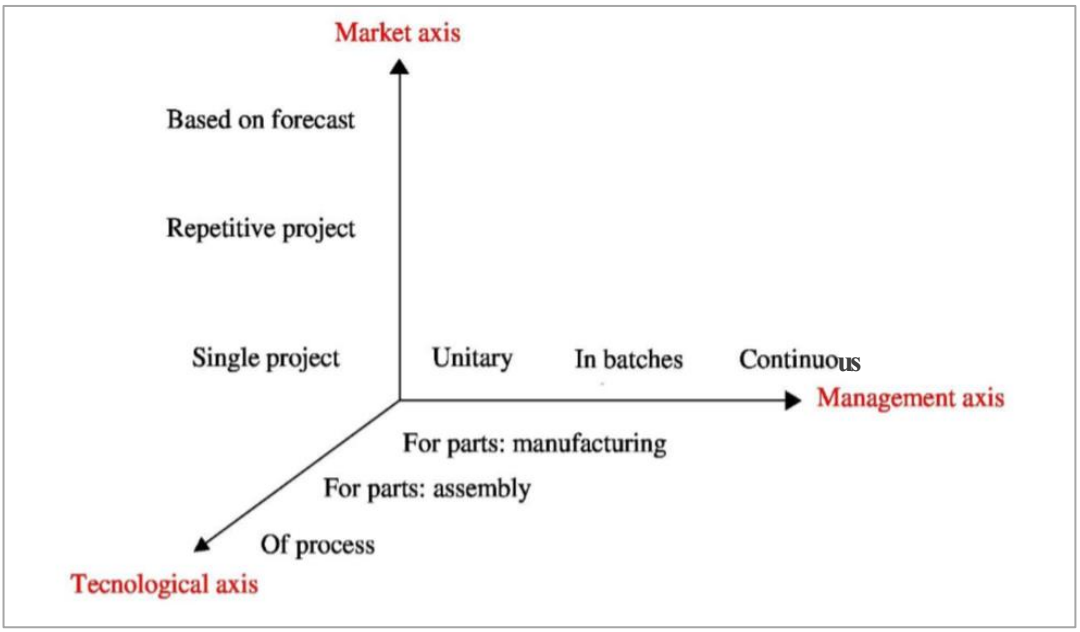
A first classification is theorized by Garetti and Brandolese (1988), who subdivide industrial plants according to the three Cartesian axes, as represented in Figure 2.1:

1. on the Market axis, the classification is made with regards to terms and conditions of sale:
    - production based on single or repetitive projects;
    - stock production based on sales forecasts.
2. on the Technological axis, the classification is made in accordance with how the product is built in:

- processing plants, where the production concerns profound chemical-physical transformations and it is not possible to easily return to the initial components starting from the final product;
- manufacturing plants, which in turn are divided into production plants and assembly plants.

3. on the Management axis, the classification is made in accordance with how the volume to produce is determined:
   - unitary production;
   - in batches;
   - continuous.

Figure 2.1: ***Three axis classification (Garetti - Brandolese)***



Another conceivable classification is envisioned by Wortmann (Figure 2.2), whose contribution results in the division of the plants according to the customer decoupling point, that is according to when the production changes from being

based on forecasts to being based on the customers' orders. In this context, plants can produce:

1. M.T.S. (Make to Stock). Production concerns standard products that can be stocked thanks to the limited complications and specifications on the basis of sales forecasts. They are generally goods with a low unit value and for which there is a vast market outlet;

2. A.T.O. (Assembly to Order). Assembly occurs when the order is actually in the hands of the company, but the component parts have already been manufactured. It has two distinct operating modes:

    - production based on forecast of standard subgroups;
    - the subsequent personalization of the finished product during the final assembly, according to what the order requires.

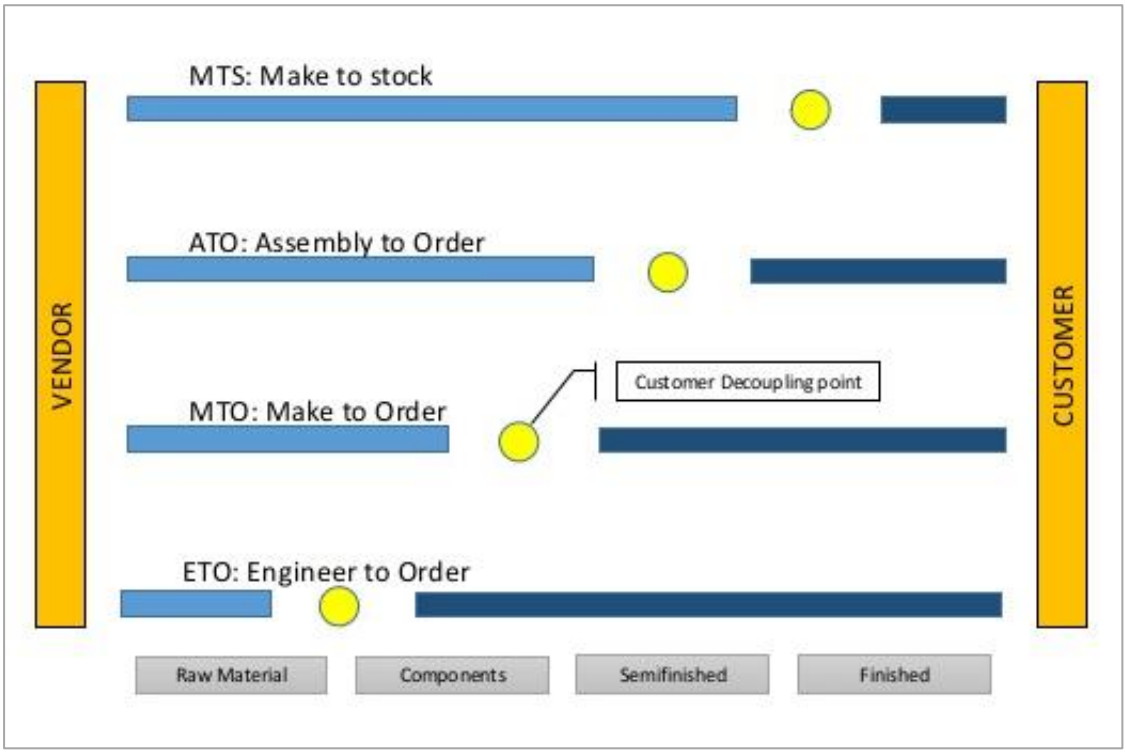
    Therefore, this category is a combination of forecast-based and project-based production;

3. M.T.O. (Make to Order). Similar to the previous category, but with the sole difference that the design and engineering activities can be completed before acquiring the order. Choosing the production method to implement depends on the company's positioning on the market;

4. E.T.O. (Engineer to Order). The manufacturing process can start only after having received the order. In this case, the typical elements of the single project, generally of high unitary value, are discernible. Moreover, in contrast to the other models, the design phase becomes an integral part of the production process. Therefore, the time required for execution may be considerably long. This latter demand-driven approach is a great technique for boosting sales and improving margins in those companies whose customers

need tailored solutions able to fit their own environment. The next section will analyze in depth the processes related to the E.T.O. manufacturing system.[25]

Figure 2.2: ***Wortmann Classification***
Source: Leonelli L., Abstract mapping of Wortmann Classification in SAP processes, 2016.



2.1. Project Management: Engineer To Order

2.1.1. Engineer To Order: project-based production

Informative requirements, finalized to the processes management and their performance evaluation, are strongly affected by the specific production system of every manufacturing company. In particular, non-standardized, customer-oriented

[25] Informetica Consulting, *Lean Production for SAP Business One*, op. cit. p. 6.

products characterize the project-based production, because each phase of the supply chain is driven by the client order, which presents precise peculiarities and cannot be simply managed based on the previous experience.

"Industrial manufacturing companies producing engineered products with an E.T.O. approach have traditionally found business opportunities. Through the design and product development expertise and an ability to respond to demands for customization with improved product performance, customers are increasingly seeking for more affordable prices and reduced lead-times, which also require improved manufacturing efficiency. These companies are thus being driven to improve the integration of the design, manufacturing and procurement functions"[26].

Engineer to order products may require a specific set of item numbers, bills of material (BOM), and routings; these are usually complex with long lead times.

Three main features outline the project-based production:

- dynamism, closely linked to customization, therefore it refers to the external flexibility, imposed by the absence of a proper stocking policy of finished goods and, sometimes, even of raw materials;
- uncertainty, referring to multiple elements, such as the specifications that derive from the customer order and the sales forecasts;
- complexity, concerning the single product or the entire production, because the acquired projects can present correlations and it is not uncommon for many problems in one project to be reflected on the realization of other projects (i.e. bottlenecks).

Additionally, it is necessary to mention that the first characteristic is physiological for project-based production companies and it partially influences the other two, which are actually more maneuverable. Furthermore, it is believed that such

[26] Eyob E., Tetteh E.G., *Customer-Oriented Global Supply Chains: Concepts for Effective Management,* Information Science Reference, Hershey, 2012, p. 113.

features, albeit common to all these companies, are amplified for multinational enterprises working in heterogeneous markets and contexts.

E.T.O. production with these properties presents two main criticisms that are strictly linked, from which the competitive advantage arises:

1. the quotation process, which entails the arrangement of preventives for the client, comprehends the most demanding activities for project-based companies, because it is crucial to offer the right product at the right price, with time and resource constraints;
2. the continuous development of new products, which requires a close coordination between sales and production activities, in order to satisfy the customer requests and prepare adequate and prompt preventives.

In this context, the implementation of an informative system can constitute the essential support for realizing an efficient quotation process and for managing the complexity and uncertainty connected with the E.T.O. system.

The utilization of an ERP system can be a useful means for feeding a database in order to define preventives, entirely or in their salient parts, without involving necessarily the engineers: in fact, thanks to these tools, the specific technical knowledge is made explicit and sharable within the organization.

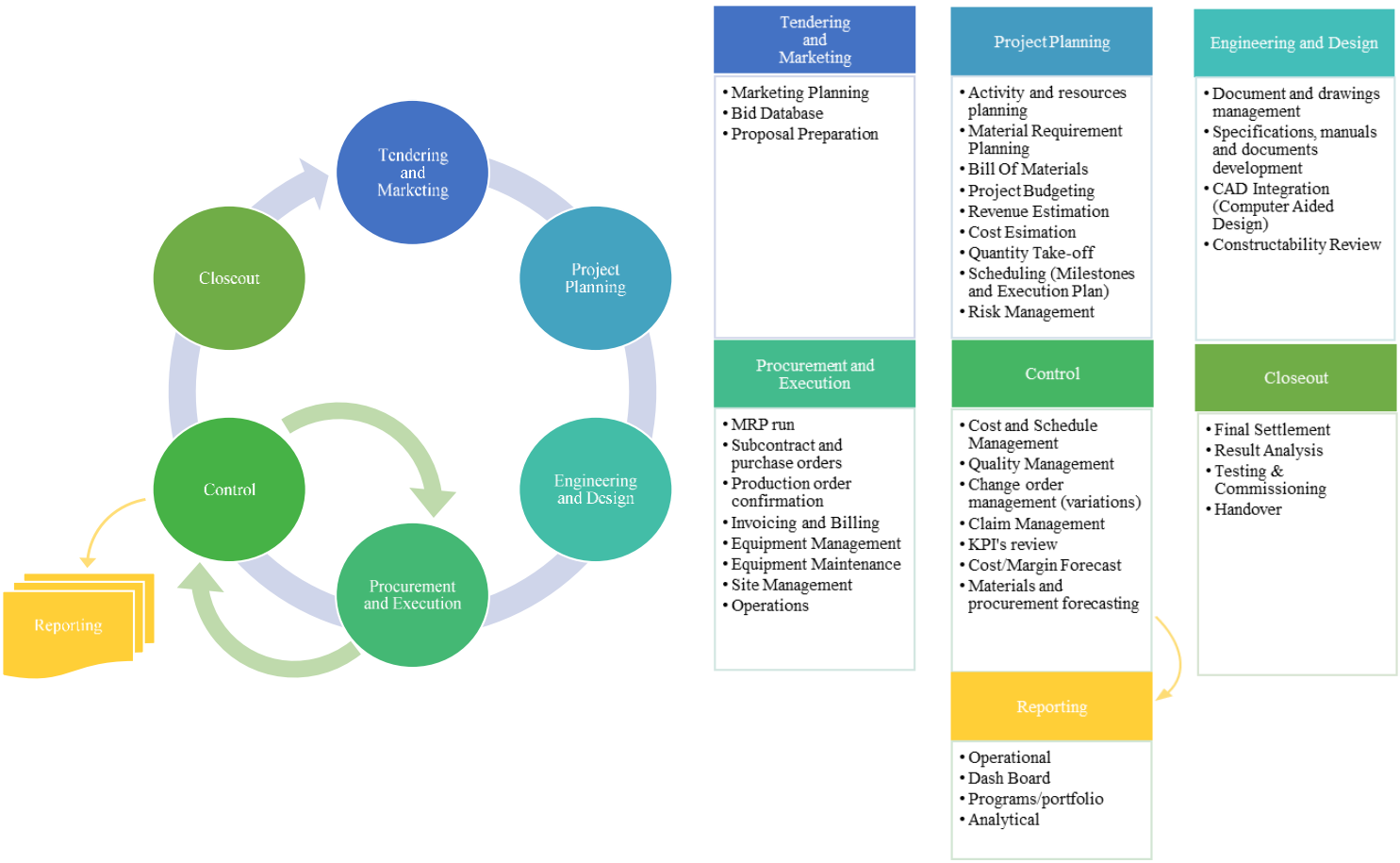
2.1.2. Project Management Life Cycle: ETO Processes

The functions of the ERP systems cover the whole project life cycle. Every project, not just those in the construction industry, goes through a series of identifiable phases, wherein it is 'born', it matures, it carries through to old age and it 'expires'.[27]

[27] PM Tips: https://pmtips.net/article/the-6-phases-of-a-construction-project-life-cycle.

Configuring and implementing an integrated system in every phase of the cycle means ensuring that the structural characteristics of the package are suitable with the processes, in order to avoid drastic redesigns. The configuration starts with the careful description and representation of all these phases, with the scope of highlighting the opportunities of integration with the ERP operating procedures.

Figure 2.3: ***Engineer to Order Process Life Cycle***



Tendering and Marketing

The aim of the tendering and marketing process is to quickly hand over a binding proposal that is attractive for the customer and justifiable from a business point of view. Companies interested in participating in any tender can download the

prequalification questionnaire from the Bid Database and submit the required information as explained in the questionnaire. The questionnaire seeks, depending on tender's nature, information on commercial registration, years of experience, quality assurance, safety and environment.

During the proposal preparation, an initial specification of the product is created in line with the customer's requirements. The proposal is checked for completeness, as well as for commercial and technical feasibility and then the importance of the customer for the company is evaluated. The next step is to process a technical solution. If required, the product can be configured with the help of existing variants or projects that have already been implemented. The quotation is completed by fixing the price, which is determined based on the price that the company expects the customer will accept, or on estimated competitor prices. Legal terms, such as delivery date and conditions are also part of the completed quotation. The proposal is created and sent to the customer and the process ends with either order placement or rejection of the quotation by the customer.

The quoted technical solution is based on estimated activity and function values, approximate measurements and weights, drawings, and brief descriptions of the main assemblies. The commercial contractual agreements indicate approximate delivery dates and general delivery terms.

On completion of tendering and marketing processing, the customer receives a quotation that may have been revised several times over. In reality, the quotation process (Quotation – Rejection – Recosting – New quotation) is repeated several times over until both the customer and the tenderer reach a satisfactory compromise. Internally, this phase is completed when the requirements are finally communicated to production and procurement or assembly.

Project Planning

Before an estimator can bid for or start a project, they need to know the types and quantities of different materials they will need to complete it. This ensures a

proper estimation of the costs and requirements for the materials and will also give an indication of the labor costs involved in the installment or construction of said materials. This process is known as takeoff, or material takeoff (MTO) and is an essential part of the estimating process.

Once the customer's down payment has been received, the company begins planning the project. A project planning enables the project manager to translate project requirements into Work Breakdown Structure (WBS), tasks list, Gantt charts, resource assignment, risk register, etc.

If the construction department has released the Bill of Materials, the next step is assigning the components of the BOM to the network activities of the project. Assembly BOMs are exploded using Material Requirements Planning (MRP). This latter is a system which employs the master production schedule, inventory and open order data to calculate requirements for materials. It makes recommendations to release replenishment orders for materials. Further, since it is time-phased, it makes recommendations to reschedule.

With regards to the revenue estimation, it is based on the percentage of completion (POC) model. This is "a basis for revenue recognition in long-term construction contracts which span over one accounting period. In case of long-term contracts, accountants need a basis to apportion the total contract revenue between the multiple accounting periods"[28]. This method determines the revenues recognized in one accounting period in accordance with the percentage of work completed, which is linked to the costs that incur in that period.

$$\text{POC \%} = \text{Actual Cost} / \text{Planned Cost}$$

$$\text{Revenue} = \text{Contract Value} * \text{POC \%}$$

The following rules are applied for the revenue recognition:

[28] Obaidullah J., Revenue Recognition: Percentage of Completion Method in https://xplaind.com/137936/percentage-of-completion-method.

- the planned cost must be released in the system (no revenue will be calculated on the initial cost);
- projects with a lower value than 500,000 SAR must reach 80% completion to start recognizing the revenue;
- projects with a higher value than 500,000 SAR must reach 30% completion to start recognizing the revenue;
- revenue recognition has a monthly basis according to the POC of the project;
- the recognized revenue must be followed by invoicing of Finished Goods for the customer within the milestones defined by the project management team;
- when the project reaches 98% of completion, all the remaining cost will be accrued, and the revenue will be closed for 100% in the specific year.

For what it concerns the project budgeting, it is the statement of the amount of money available to spend over the time-period on a specific order. It may include an outline plan for how that money will be spent and a breakdown of the items it will be spent on. In fact, the Chartered Institute of Management Accountant of London (CIMA) defines a budget as a "financial and quantitative statement, prepared and approved prior to a defined period, for the purpose of attaining a given objective for that period". Budgets for construction projects help determining what is affordable and should be set as early as possible. They shall be based on evidence and be realistic. A project budget can be established by:

- assessment of projected income and expenses through the life of the project;
- comparison with similar projects;
- assessment of the funds available;
- pre-design analysis of requirements;
- analysis of preliminary design options;

- the client, whose plan is distinct from those prepared by cost consultants, which are likely to focus on the construction cost.

The client's total project budget may include:

- the construction cost;
- land or property acquisition;
- approvals fees;
- planning costs;
- financing costs;
- site investigations;
- fixtures, fittings and equipment;
- the cost of decanting and relocating, including costs associated with moving staff;
- contracts outside of the main works;
- insurance;
- consultant fees;
- inflation;
- contingency;
- value added tax.

It is common on projects that the budget and the brief diverge over time and it is for this reason that careful cost control is important. It is crucial that the client makes clear which costs should be monitored by the cost consultant and which will remain within the control of the client organization. Construction demands flexibility and contingencies would be recommended for factors that cannot be controlled such as hidden conditions, cost escalation and the inevitable design “scope creep”.

In this context, project risk management plays a critical role, as it aims at assessing future uncertainties, which can have potential impacts on project objectives

and the exercise of creating risk management plan prepares the team for effectively managing those uncertainties.

Notwithstanding, the core activity of the project planning is the project scheduling, a tool that communicates what work needs to be performed, which resources of the organization will accomplish the activities and the timeframes in which that work needs to be realized. The project scheduling should reflect all of the work associated with delivering the project on time. Without a full and complete schedule, the project manager will be unable to communicate the complete effort, in terms of cost and resources, necessary to deliver the project. The primary document that defines how the project will be undertaken is the Project Execution Plan. It details the specific activities in the project, the resources applied and the organization of the project. The best approach is to divide the project into small units or chunks and set time bound milestones of achievements, mutually acceptable to all stakeholders.

Engineering and Design

The second phase of project development is engineering and design. This stage entails a preliminary study (feasibility study) and a definition of the requirements of the conceptual engineering project, always focused on the needs of the customer. This includes the engineering documents that define the global and conceptual scope of the project, including the type of technology and equipment specifications to be used. The design process can be sub-divided into many steps:

1. preliminary design;
2. final design;
3. cost re-evaluation or value engineering (optional);
4. construction documents and bid specifications.

The outcomes of the design phase consist of written reports, engineering drawings, more accurate construction costs, projected operational costs and schedules of construction. There are also engineering specifications for materials, machinery,

and equipment for each step. The reports will record the evolution of the design process and all criteria and assumptions used. This process can be managed with the CAD (Computer Aided Design) system, which has led to an increase in productivity. CAD is the use of computer technology to help designing a product and contains all the activities of a design process. This makes it possible to develop a concept idea into a product to be manufactured, including all the associated specifications. Engineers use this software to increase design productivity, improve design quality, enhance communication through documentation and create a database for production.

During the preliminary design stage, major emphasis is upon civil, mechanical, and architectural design. The design of all the mechanical processes will be completed in this phase to ensure that they are integrated properly into the structures. Architectural concepts (if required) are developed and structural systems identified, besides all the required site investigations are made before completing this step.

A sufficient quantity of drawings is then completed to communicate the design concepts: the number of drawings depends on the size and complexity of the project. Furthermore, a preliminary design report is prepared with the drawings, which describes all the structural components and mechanical processes of the facility, and the ways in which they interrelate. The report should include an outline of materials and equipment specifications, which are then used as a basis for revising earlier construction cost estimates. Operating cost estimates and the construction schedule are also revised at this time.

Costs and scheduling revisions are again compared with the original financial objectives and constraints to ensure that the project remains financially feasible. If it is not (because, for example, the structures were to be built with reinforced concrete instead of pre-fabricated materials) then the facility design concept has to be altered as necessary.

In some cases, during the preliminary design phase the project cannot be developed economically: it is then necessary to terminate it, or to revert back to the planning phase and revise goals. However, if the planning has been thoroughly conducted, the chances of significant conceptual or siting changes at this stage of development are remote.

During the final design stage, the detailed architectural and engineering drawings (the blueprints) of all physical components of the project are produced. Sufficient detail must be provided by the drawings to allow reasonably accurate estimates of construction and operating costs, as well as the construction scheduling. All revisions to construction materials, machinery, and equipment specifications are made. The updated schedule, cost estimates and specifications are contained in a final design report.

Once again, it is necessary to verify at the end of the final design stage that the project remains economically viable. If, by some chance it is not, then a decision must be made to revise design solutions or the original concepts, or perhaps terminate the project.

Although it is an obvious assumption, it must be pointed out that any changes at this stage are highly costly, since final design is the most expensive of the planning processes. It is therefore important that complete and detailed attention is given throughout final design. If final design drawings have to be substantially changed or repeated, the costs are disproportionately high compared with the costs of the originals. Obviously if this occurs, then substantial errors have been made during the previous stages and planning phases.

Cost re-evaluation or value engineering is an optional element in the design process. For large projects, and those that may be having difficulties with economic financial projections, it may be useful to include a value engineering stage. The value engineering process re-evaluates all the major cost centers in the project to determine if the most cost-effective design solutions have been used. A small team

is assembled, representing the major engineering disciplines. It is important that these individuals are familiar with the project but were not participants in the design process. They are supplied with all records of the project from concept through design. The objective is to verify that the project meets operational criteria and optimizes cost efficiency both in construction and system operation.
Value engineering is not a time-consuming or costly process. It can result in considerable cost savings to the project by discovering inconsistencies between operational requirements and design solutions. Recommendations made by the value engineering team should be incorporated into the final design as necessary.

The last stage of the design phase is the preparation of construction documents and bid specifications. Construction documents and bid specifications are similar throughout the construction industry for any building project. It is important that the detail provided in the construction documents and the bid specifications reflect the standards of the contractors who bid on the project. Furthermore, it should be borne in mind that these requirements have to be conveyed through detailed drawings and specifications.

In this phase, another major issue is the constructability review, a project management technique addressed to examine construction processes from start to finish during pre-construction phase. It aims at identifying obstacles before a project is actually erected, to reduce or prevent errors, delays, and cost overruns. It defines the ease and efficiency with which structures can be built: the more constructible a structure is, the more economical it will be. Moreover, constructability is in part a reflection of the quality of the design documents; if the design documents are difficult to understand and interpret, the project will be difficult to build. The term refers also to the effective and timely integration of construction knowledge into the conceptual planning, design, construction, and field operations of a project to achieve

the overall project objectives in the best possible time and accuracy at the most cost-effective levels. [29]

Procurement and Execution

In this phase the construction contractor puts into practice the detailed engineering and design of the project deriving from the previous stage, procures all the equipment and materials identified through the Material Requirement Planning and then constructs to deliver a functioning facility or asset to their clients.

Procurement is the process of purchasing and moving all items, supplies, materials, parts, finished inventory and general support services from the suppliers to the execution process, assembly plants or warehouses.[30] Competitive strategies within procurement are crucial in order to win a tender for material procurement required in projects. Effective and efficient procurement requires in fact a good integration in each procedure, from implementing a tight cost control to emphasizing the innovation process and the main purpose of procurement practices is to coordinate every step to fulfil the requirements at the right time with a minimum processing expense. Since there are serious implications when procurement procedures are not properly applied, then it is important for stakeholders, purchasing departments and others to contribute and interact with the procurement cycle. Moreover, partner selection, contract formalization, payments, subcontractor selection, collaborative tools and performance evaluation have to be carried out.[31]

Execution is the implementation phase, where the project plan is put into motion and the work of the project is performed practically on site.[32] As a rule, this phase

[29] FAO: http://www.fao.org/3/s6665e/s6665e04.htm#TopOfPage.
[30] Shah S., Hasan S., *Procurement Practices in Project Based Manufacturing Environment* in MATEC Web of Conferences, 2016, p. 1.
[31] Alexander B., Tidd J., *Perspectives On Supplier Innovation: Theories, Concepts and Empirical Insights on Open Innovation and the Integration Of Suppliers,* World Scientific Publishing Co. Pte. Ltd, Engelsk, 2012, p. 412.
[32] The Constructor: https://theconstructor.org/construction/construction-project-life-cycle-phases/14283/.

goes along with the monitoring and controlling activity, since progress should be continuously monitored and appropriate adjustments should be recorded as variances from the original plan.

The project manager is the one who spends most of the time in this step. Throughout the project implementation, people carry out their tasks and progress information are reported through regular project team meetings.

This phase comprehends, in addition to the specific operations, all the processes related to the equipment and site management and maintenance.

Control

Control is a process that encompasses the resources, procedures and tools for monitoring all the phases of the project lifecycle. This includes estimating, quality management, cost and schedule management, change order management, claim management, earned value progressing, KPI review and forecasting. The execution of a project is based on the project plan and can only be achieved through an effective cost and schedule control methodology; therefore, the development of a suitable monitoring system is an essential part of the overall project management effort and supports the achievement of the main objectives.[33] In fact, project performance can be improved if dedicated project control systems are in place, since these latter can result in more predictable costs and schedule outcomes.

Traditionally the backbone of control during the building phase of projects has focused on monitoring the project duration and the costs incurred, because they represent important performance parameters for both the customer and the firm responsible of managing the project. Monitoring time and costs has been traditionally served as a basis for control of construction projects; this is because one of the main causes of legal conflicts derived from a construction contract is the breach on delivery time of the project and because the principal goal is to get a profit that is

[33] Project Controls: https://projectcontrolsonline.com/definition-and-importance-of-project-controls.

considered appropriate. In this context, also quality management is an important system to be implemented by construction firms in order to improve the level of their performance. The cost monitoring activity occurs in six stages:

- the project starts with an initial cost, which is estimated in the tender stage and reflected in the system as version 00;
- project management develops the WBS of the project and accordingly releases the planned cost version 0;
- during the process, any component in the cost items might change; therefore, a new cost must be depicted and saved in the system. The main modifications are expected to occur after the base design approval. The new version has to be reflected in the system as version 1;
- approval from the operation manager or the business unit manager for the out of scope cost items;
- if the actual cost is higher than the tender cost, the project manager verifies and justifies the variance and the respective documents must be approved by the operation manager.

Critical in the construction industry is the so-called change order management. "A change order in construction creates a record of additional services being provided to the customer, along with costing for those services. A contractor that neglects using change orders may forget to bill additional costs related to the changes requested or forget to complete the changes altogether".[34] The owner's objectives are to minimize the impact of change orders to the greatest extent possible as a measure of control over a project's budget and schedule.[35] Comparatively, the contractor's interests may involve expanding the scope of work beyond that defined by the contract, in addition to boosting its projected revenue. Also claim management

[34] Esub Construction Software: https://esub.com/resources/what-is-a-change-order/.
[35] Bolin J. M., *Effective Change Order Management*, Long International, Inc, Littleton, 2018, p. 2.

is an inevitable step in construction project management in order to reach successfully the desired results, since the process needs efficient and effective management during the entire life cycle of a project.

Moving on the control process, construction KPIs (Key Performance Indicators) for the construction industry aim at measuring the success and achievements of the project manager and the supervisor portfolios with the primary goal of the acquisition, management and retention of customers within the construction industry. Continuous KPI tracking and measurement allows the identification of adverse short and medium-term tendencies to ensure that they don't develop into long-term crises. Furthermore, since construction projects often extend for months or even years, it is vital to know exactly how a job will influence the rest of the business and to note if it has the potential to affect other work or parts of the company.

In addition, to improve the profitability of a project, adopting a forecasting system can increase collaboration across the organization, since everyone involved in making important decisions will have access to the same information, ensuring they are all coming to the discussion equipped with the same data. To name a few, cost and margin forecasting and materials and procurement forecasting represent crucial systems for enhancing and facilitating the control activity.

Reporting

In order to ensure that projects are delivered on time, within budget and to the expectations established by the project's stakeholders, the control activity should proceed along with an effective reporting system. This latter refers to:

- operational reporting;
- analytical reporting;
- programs/portfolio;
- dash-board.

Closeout

The closeout process should include a combination of onsite and administrative tasks, as well as an extended result analysis.

Onsite closeout is coordinated by the general contractor and should include tasks such as demobilizing all temporary facilities and equipment, ensuring that permanent utilities are installed, tested and working and all project-related services and contracts are cancelled. Typically, substantial completion is reached when the erection is usable for its intended purpose, all utilities are functioning, the project has achieved approval for use and the work is more than 97.5% complete. The construction manager determines the completion milestone by issuing a certificate of substantial completion. [36]

During this phase, the activity of testing and commissioning covers an important aspect. It is the process of ensuring that all systems and components of the new facility are designed, installed, tested, operated and maintained according to the operational requirements of the final client.[37] In practice, the testing and commissioning process is the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the project. Commissioning activities in the broader sense are applicable to all phases of the project from the basic and detailed engineering, design, procurement, execution and assembly until the final handover of the unit to the owner.[38]

In fact, a formal handover procedure should be performed at the end of the project, perhaps during a meeting following an inspection of the site. Keys, fobs and other controls should be handed over along with any outstanding documentation. Defects reporting procedures should be agreed and access arrangements put in place for the contractor. Responsibility for insurance, security and so on should be transferred.

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[36] Stonemark Construction Management: https://stonemarkcm.com/blog/construction-management-closeout-procedures-processes/.
[37] Enertiv: https://www.enertiv.com/resources/faq/what-is-equipment-commissioning.
[38] Performance Commissioning: http://performancecommissioning.ca/.

For what it may concern the administrative closeout procedures, their goal is to confirm that all contractual terms have been satisfied, closeout documents provided and payments have been made by the contractor to all the subcontractors and material suppliers.

2.2. Integrated Project Management in SAP

The purpose of this paragraph is to detail the transactions executed for the ETO process in SAP ERP system.

2.2.1. Choice of the ERP system: SAP

All ERP implementations face a number of challenges related to business, project management and change management processes within an organization. However, companies operating in an Engineering to Order environment have to face additional challenges, unique to their industry, since their products are likely to be highly engineered, for which some manufacturing ERP systems are considered inappropriate.

Problems experienced by ETO manufacturers are related to different aspects, such as product configuration, material resource planning, project management, engineering changes, customer involvement and long lead times for raw materials.[39] Thus, companies operating in this complex background need software products that can handle their specific needs.

As a matter of fact, choosing the right ERP system may help companies tracking and costing all project activities, including labor, expenses and materials. In fact, ETO companies use this software for supporting their unique processes with regard to:

- resource planning;

[39] PAT Research: https://www.predictiveanalyticstoday.com/top-erp-software-engineer-to-order/.

- product design;
- communication;
- cost allocation;
- material planning;
- customer interactions.

Thanks to the right system, they can gain real-time insights into their daily manufacturing operations.

ERP solutions for ETO usually include front-office and back-office modules, but some vendors focus on production and distribution features and prefer to integrate with software such as accounting software, CRM all-in-one software, HR management suites or CAD software for product development and design. In order to be qualified appropriate for inclusion in the ETO ERP software category, a system must have some features:

- ability to provide advanced product configurations to create customized products;
- inclusion of proper features to calculate costs and prices for customized products;
- ability to determine the inventory and the human resources required to fulfill demand;
- possibility for users to create complex and multilevel Bills of Materials (BOM);
- fast implementation of engineering changes to adapt to customer requirements;
- ability to manage product installations, warranties and maintenance operations;

- possibility to monitor costs and profitability, both from an overall perspective and by project and contract.[40]

Among the alternative solutions, a special focus has been given to the SAP system. SAP stands for Systems Applications and Products in Data Processing and it is a powerful tool in the hands of projects managers to effectively control and manage their projects. First in the ERP market, SAP has more than 140,000 installations worldwide, over 25 industry-specific business solutions and more than 75,000 customers in 120 countries[41].

In addition to meeting the primary requirements of project management, such as scheduling, resource planning and progress reports, SAP provides further facilities to strengthen the insights to the project processes. With a flexible, holistic approach to managing a business, constructing on SAP connects people, processes and information in the organization for enhancing productivity and construction industry practices.

For these purposes, in SAP, companies use the Project System (PS) module to track both the phases of the project as well as the individual tasks. In an ETO environment, there is no standard cost; instead, project managers use planned costs to estimate the expenses for designing and manufacturing the product. Actual costs are addressed to the project in a second moment.

The high degree of integration between the Project System and other modules (i.e. Financial, Controlling, Human Resources, Material Management, Production Planning, Sales & Distribution, etc.) makes it possible to plan and execute projects as part of the normal commercial procedures of the enterprise. In fact, the SAP Project System has constant access to data in all the departments involved in the project.

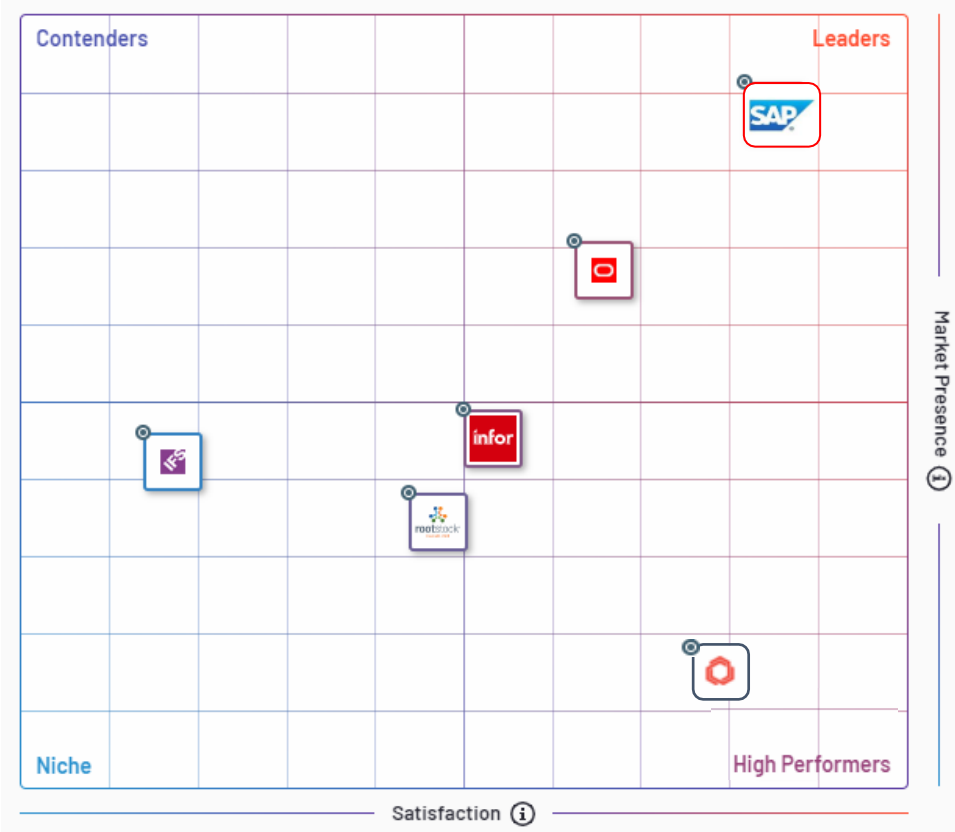
[40] G2: https://www.g2.com/categories/eto-erp.
[41] Guru99: https://www.guru99.com/what-is-sap-definition-of-sap-erp-software.html.

Modules such as PS are directly concerned with WBS, activities and milestones creation as well as with subsequent tracking and monitoring functions.

MM concerns purchases and contracts, whilst BI is related to generation of standard and customized reports. Through time, SAP modules offering for engineering and construction industry have evolved exponentially. Now, in fact, they have solutions also for the bidding department, project management activity and so on.

Figure 2.4: ***Best ETO ERP Software***

Source: ***https://www.g2.com/categories/eto-erp?segment=all***



2.2.2. ETO processes in SAP

After having analyzed in depth the processes characterizing the Engineer to Order industry, the next step consists of reflecting the business activities in the chosen

ERP system, in order to understand how to exploit properly the opportunities of integration. The purpose of this paragraph is ranking the various business activities, illustrating the required transactions to be deployed in the SAP software.

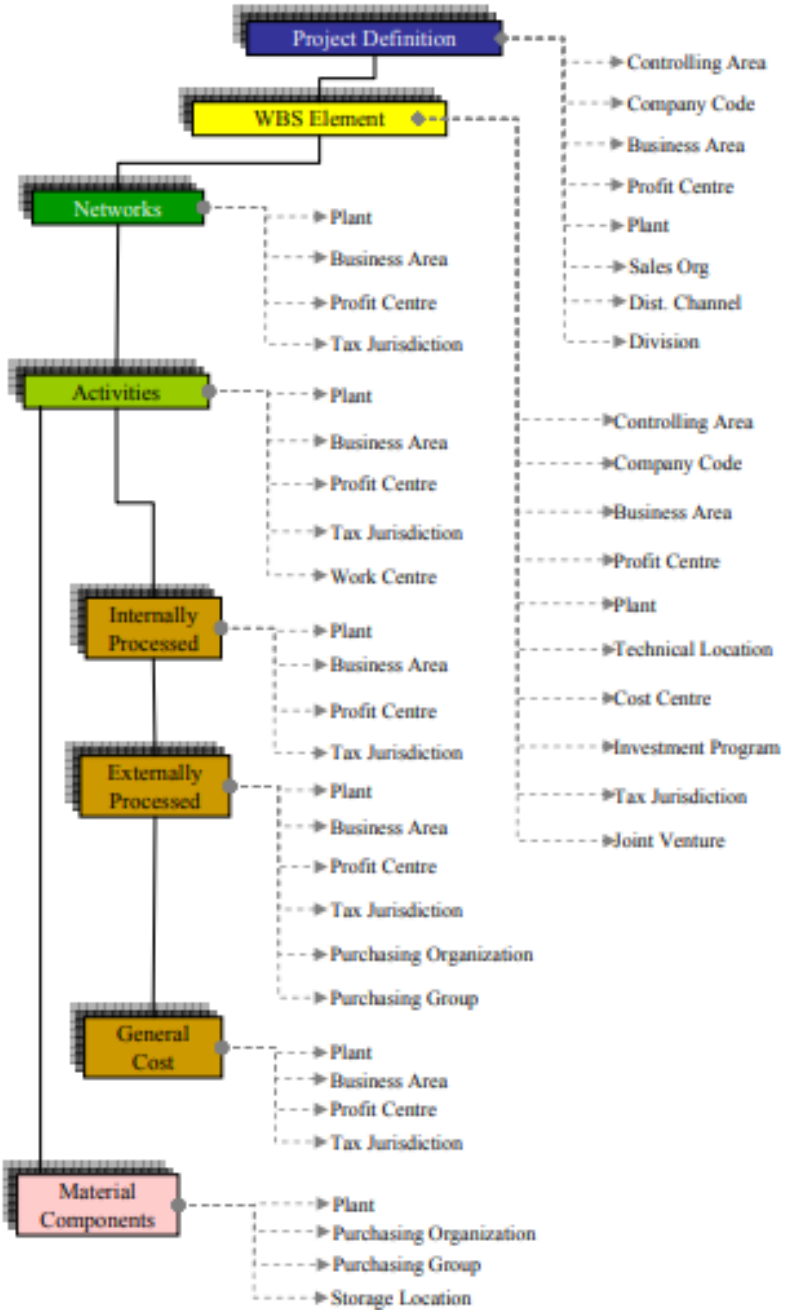
Operations related to the ETO processes are mostly performed through the SAP Project System (PS) module. As previously stated, from an organizational standpoint PS has many tentacles, which demonstrates how integrated it is with other modules:

- Controlling (CO);
- Material Management (MM);
- Plant Maintenance (PM);
- Investment Management (IM);
- Production Planning (PP);
- Sales & Distribution (SD).[42]

In the next page, figure 2.5 shows a diagram of the various organizational references of each project.

[42] Dowling K.N., *SAP Project System Handbook,* McGraw-Hill Company, New York, 2007, p. 7.

Figure 2.5: ***Organizational Elements of PS***
Source: Dowling K.N., ***SAP Project System Handbook, op. cit.*****, p. 6.**



Tendering and Marketing

The initial phase consists of creating a quotation for customer projects. The aim is to determine the sales price for a customer inquiry based on detailed project planning and create a quotation in the Sales and Distribution (SD) application component. The transaction codes for quotes are:

- VA21 – Create Quotation;
- VA22 – Change Quotation;
- VA23 – Display Quotation.[43]

When creating a quotation, some information needs to be entered in the system: the quotation type from the list, the sales organization, the distribution channel, the division, the sales office and the sales group from the list. Then click on *Create with Reference*. Moving on, other details have to be specified, such as the customer to whom the products need to be delivered in case of purchase, the purchase order number, the validity period and the order quantity. Once all these details are entered, status bar will display the successful creation of the quotation.

The system records the quotation value as planned revenue in the relevant billing element.

Project Planning

After the quotation, the program collects the data and is now able to transfer the required information to the planning divisions. This happens automatically if the company is successful and wins the tender. In this phase, the Project System module has constant access to the data entered in previous step, thanks to the integration between PS and SD.

The table below shows the main elements that need to be considered when implementing the planning phase.

[43] Tutorials Campus: https://www.tutorialscampus.com/tutorials/sap-sd/create-quotation.html.

Table 2.1: ***Elements of the SAP PS Module***

Project Structure	Provide a structure representing the main events;
Customer Order	Record the sales order and connect it to the project;
Networks	Detail which tasks need to be performed;
Materials	Provide or reserve the required materials;
Labor	Identify human resources required;
Schedule	Plan when events will occur;
Milestones	Identify key events, such as Billing, etc.;
Planned Costs	Finalize how much it will cost;
Budget	Limit expenditure;
Workforce Planning	Plan the workforce to carry out the tasks.

In a first instance, the Work Breakdown Structure (WBS) of the events must be created. Each element of the WBS is connected to the one below it, but they can be placed beside one another to form a matrix. Collectively, they are called 'Operative Projects'. A WBS can be copied from what is termed a 'Template' or 'Standard Project', or from another Operative Project. The whole structure is 'owned' by the Project Definition. Then, each WBS is created independently and given a level number, which determines where in the hierarchy it is placed. Each WBS carries lots of information, such as organization, dates, special settings, project type, who is responsible etc. The suggested transaction to use is CJ20N. When a project is manually created, it initially has a status of CRTD (created).

Secondly, it is necessary to create the sales order which is derived from the quotation. Each line item of a sales order is linked to a billing element of the project. Thanks to the integration with SD module, sales orders can automatically create projects (called Assembly Processing), as well as projects can automatically create

sales orders (called Simulated Sales Pricing). The transactions are CJ20N and VA01.

Connected to WBS elements, Networks are a collection of activities that can be split up to highlight two main components: labor and materials. The project could have activities linked to the lowest level of each WBS, which are design, construct labor, construct materials, etc. Activities contain durations and start-finish dependencies, which are the basis for project scheduling. In this phase, the useful transactions are: CJ20N, CN01, CN21, CJ27, CJ2D.

After having detailed the tasks that need to be performed, the following step entails the identification of the required materials. Here, the purpose is simply adding the components to order. The transactions to be employed are CJ20N, CJ27, CJ2D. Each line of the order list can have either 'Stock' or 'Non-stock' materials ordered. In the case of stock items, a reservation will be generated to hold the stock. In the case of non-stock, a purchase requisition will be generated (which will result in a purchase order). Further control of how the material is managed from a Material Requirements Planning (MRP) perspective can be specified in the Procurement Type, which considers lead-time strategies. In all cases, however, nothing significant will occur until the project has had its status changed to 'Released'. When the materials are entered, the cost of them (determined by the pricing policy of the business in the Control Key Parameters) and the overheads specified in the Costing Sheet are calculated and placed into the Plan Total for the Activity. These costs are used later, when we look at the Planned Costs.

Labor costs are usually determined by the activity type. Prices (costs) per unit in an activity type (e.g. per hour, per day) are maintained in the Controlling (CO) module of SAP (Planned Activity Prices) because they belong to cost centers. Activity types in association with network activities are classed as internal activities. The cost of using an activity is determined by the length of time you use it in

minutes, hours, days, weeks etc. The work center is used to determine the organization's capacity to perform the work. They are not necessarily used to represent utilization of the resource – they can represent a group of people, a machine or simply a person. Work Centers / Activity Types are static fields within the internal activity. Additionally, personnel can be assigned to internal networks to form the basis of Workforce Planning. As in materials, activity types generate a planned cost, which updates the order plan total (version 0). Transactions: CJ20N, CJ27, CJ2D, CNR1, KP26.

Date Scheduling depends on the forward scheduling rule, where the activity dates determine the WBS dates. In other words, if you say that an activity is due to be utilized on the 7th of May for 10 days, then the associated WBS will inherit those dates. However, if you have another activity under the same WBS, their combined date ranges can be moved up to the WBS. If, for instance, you tell SAP to schedule your project, it will take actual events into consideration and change dates accordingly. This may affect your whole project's critical path to the point where additional resources are required to complete the project on time, or maybe the program will tell you that you will be late. WBS's and activities carry several dates: Scheduled Start/Finish, Latest Start, Latest Finish, Forecast etc. Transactions: CJ20N, CJ27, CJ2D, VA01.

The Milestones are simple objects that can be attached to both WBS's and activities. They can represent an event you want to remember, or they can have intelligence. As an example, a milestone can be settled when the customer must be issued with an invoice, commonly referred to as Milestone Billing. This is done by specifying a percentage of the total account to be released for Billing. The Sales and Distribution term for this is 'Billing Blocks' (meaning blocked for billing). When a sales order is linked to a WBS, it is capable of finding all the milestones associated with it and creating a billing plan either in the project or in the sales order. A billing plan is blocked until it is opened for release when the milestone is

given an actual date, which is manually entered by the user. Milestones can also get clever and tell activities to perform special functions, like “Release Activity number 10 when Activity number 9 is finished”. Other functions of Milestones include Milestone Trend Analysis (MTA), a reporting tool that works with Project Versions. Transactions: CN11, CJ20N, CJ27, CJ2D, CNMT.

SAP has already generated planned costs via Materials and Activity Types. The user can, if required, generate further planned costs using General Cost Activities or if there are no Network Activities in the project, Easy Cost Planning will allow to plan costs directly against a WBS Element using Activity Types, Cost Elements or Materials. This planning process can be simple or complex, depending on how the planning profile has been configured: structured or detailed. It is furthermore possible to maintain many ‘Plan Versions’ and compare them for optimization. However, Plan Version ZERO is the one PS always uses as its baseline plan. Transactions: CJ40, CJ20N, CJ27, CJ2D, CKCM.

Even though having planned costs, now it is necessary to define the Budget. Normally, the Plan becomes the Budget, but the user can tell this to the PS module, by copying it to the Original Budget. This done, the user must then repeat the process in Release Budget. One defining difference between Planning and Budgeting is that budgets carry with them a record of changes (e.g. if you change the Original Budget manually, a record of that change is kept) that can be reported on. Another factor comes in to play here: Availability Control. This process determines the levels to which a budget can be expended and how warnings, error messages or mails to Project Managers are handled. Transaction: CJ30.

Workforce Planning process works primarily with Work Centers (which carry the capacity). Once assigned the Work Centre/Activity Types, it is time to assign people to the Internal Network Activity. Prior to doing this, you must have set up your personnel in the HR master and assigned them to the relevant Work Centers. What this achieves is the ability to select only the people who have been assigned

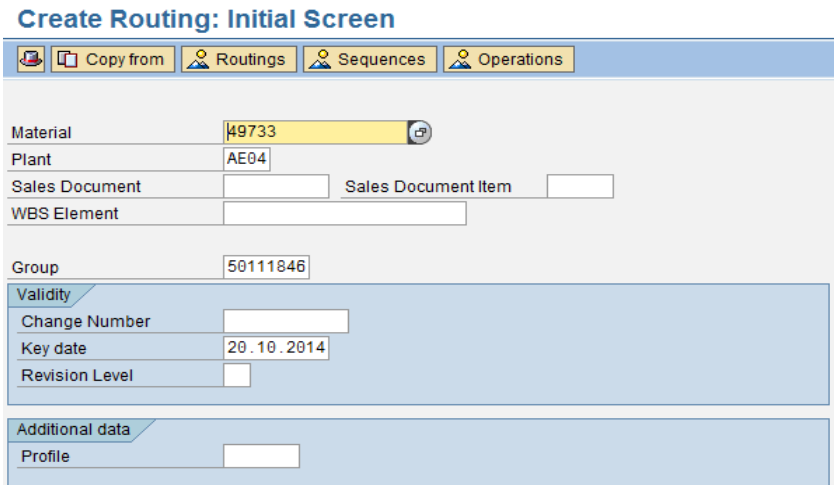
to the Work Center that is featured in the Network Activity. At the same time, you specify the amount of work the individual will contribute. The knock-on effect of this forms the basis of Capacity Planning, which can be performed by Work Centre or by Project. Transactions: CJ20N, CMP2, CMP3, CMP9.

Engineering and Design

In this phase, Design team shall create/change the BOM on each FERT (Finished Good) by using the transaction CS01 and CS02. The aim is attaching the engineer and design document created with CAD (Computer Aided Design) system to the BOM. The SAP Document Management Systems are for storing documents such as CAD drawings, materials pictures etc. With the DMS, users will be able to view the documents with ease within their SAP system. Documents can be created/managed with the transaction codes CV01N / CV02N.

Production team shall create the routing on each FERT using the transaction CA01. Then, saving the operations, the screen will appear as below.

Figure 2.7: ***Creating the FERT routing on SAP***



Procurement and Execution

To proceed with the execution and start confirming actual costs, the user has to release the project: until the project is not released, nothing can take place. When you do release the project, several things will happen, some of which are:

- the materials will be checked for availability;
- requisitions will be generated;
- reservations will be sent;
- commitments will be checked against Availability Control.

After releasing or updating the final stage BOM and routing, production team should convert the planned order to production order with reference to WBS by using transaction MD04. Moreover, it is necessary to order the materials using transaction MB21 and then check and receive it by using transaction MIGO. Within this latter transaction, production team will also consume the materials for each FERT and then make labor confirmations with transaction CO11N.

Control

To control the business functions, it is necessary to check the status in every moment of the Planning Process. In this phase, the status of the project will change from CREATED to BUDGETED, to COSTS PLANNED and maybe a few more. But until it is not RELEASED, nothing happens.

Progressively, you may want to control what business transactions can and cannot be permitted. For example, if you change the status of your project (or just one WBS) to TECHNICALLY CLOSED, this will remove any reservations and allow commitments to be finalized. After final settlement, the project can be CLOSED. If you need to control the status yourself, configure 'USER STATUS'. Transactions for this purpose are: CJ01, CJ20N, CJ27, CJ2D.

Controlling (CO) and Financial Accounting (FI) are independent components in the SAP system. The data flow between the two components takes place on a regular basis. Therefore, all data relevant to cost flows automatically to Controlling

from Financial Accounting. At the same time, the system assigns the costs and revenues to different CO account assignment objects, such as cost centers, business processes, projects or orders. The relevant accounts in Financial Accounting are managed in Controlling as cost elements or revenue elements. This enables to compare and reconcile the values from Controlling and Financial Accounting.

Controlling implementation depends on how good has been the implementation of the other components (PS, MM, SD, PP, HR), whereas it facilitates coordination, monitoring and optimization of all processes in an organization.

Some of the main components of SAP CO module are:

- Cost Element Accounting (CO-OM-CEL), the area where the user can track and structure the costs incurred during a settlement period;
- Cost Center Accounting (CO-OM-CCA), to provide transparency into the relative performance of different parts of the organization;
- Internal Orders (CO-OM-OPA), to plan, collect, and settle the costs of internal jobs and tasks, with the purpose of monitoring internal orders throughout their entire life-cycle, from initial creation, through the planning and posting of all the actual costs, to final settlement and archiving;
- Activity-Based Costing (CO-OM-ABC), to define cost allocation along the value-added chain more exactly than possible with overhead rates and to enhance product costing by assigning costs to the business processes where they originated;
- Product Cost Controlling (CO-PC), which contains the subcomponents of Product Cost Planning, Cost Object Controlling, Actual Costing/Material Ledger and Product Cost Controlling Information System;
- Profitability Analysis (CO-PA), to evaluate the company's profit or contribution margin by market segment or by strategic business unit, providing sales, marketing, product management and corporate planning departments with information to support internal accounting and decision-making;

- Overhead Cost Controlling (CO-OM), to plan, allocate, control, and monitor overhead costs. It is an important preparation for a strong profitability analysis, as well as for a precise product costing;
- Profit Center Accounting (EC-PCA), to determine profits and losses by profit center using either period accounting or the cost-of-sales approach. It also allows to analyze fixed capital and the "statistical key figures" (number of employees, square meters, etc.) by profit center. Consequently, the user can calculate all key figures commonly used in cost accounting (return on investment, cash flow, sales per employee).[44]

For what it may concern the Results Analysis, it is an essential functionality in SAP Controlling to valuate ongoing, unfinished activities, such as production orders, internal orders or projects at month-end. The underlying assumption for each of these activities is that they will add value when they are finished (a production order will yield a finished product, while a customer project will eventually be billed to the customer).

Results Analysis comes with a number of different methods to determine the value of the inventory to be capitalized at month-end. The simplest of these is the Work in Process (WIP) calculation, which is primarily used for production orders. In this scenario, you consider the capitalized inventory to be equal to the total cost of a production order minus any credits from goods receipt of finished products. For a customer project, the work in process is the difference between the total cost and the (partial) billings. There is a variety of options available to evaluate the work in process. For example, you can consider the ratio between the planned and actual costs, compared to the planned and actual revenue for a more realistic result. You could also ignore all billings and show all costs as work in process until the project is finished.

[44] SAP Brains Online: https://sapbrainsonline.com/co-tutorial.

An important variation of Results Analysis is the Percentage of Completion (POC) method. This method is primarily used in large customer projects and is used to capitalize revenue instead of costs. With the POC method, you assume that the costs incurred to a project will eventually lead to an amount of revenue equal to the costs, plus your planned margin. For example, if you have realized 25% of your planned costs, you will capitalize 25% of your planned revenue in the balance sheet.

Results Analysis thus provides a flexible toolset to determine a realistic picture of your ongoing activities at month-end closing. It can be used for production orders, internal orders, service / maintenance orders, and projects.[45]

Closeout

At the end of a project, it is necessary to close it down and collect management data for the report. Without this valuable historical information, it is difficult to plan properly the future activities. Additionally, the customer will also need an accounting of the completed project.

At different stages during the project, it may be advisable to change the status of the WBS elements. For example, some of the most common statuses are:

- active (ACTV), when, once the WBS element has been released, it is available for time recording and billing;
- work finished (WFIN), when work has been completed on a WBS and no more time is to be recorded against this element;
- all work completed (COMP), when no more activity of any kind can be applied against this WBS element.

Technically complete tasks and phases can be re-opened (if the project is still open) to allow further costs to be posted.

Then, the project manager reconciles all costs to date for the technically complete tasks, phases and zeros all future forecasts. The manager should wait a period

[45] ERP Corp: https://www.erpcorp.com/sap-controlling-blog/introduction-sap-results-analysis.

of time to ensure all outstanding costs have been processed before closing the project in SAP as a closed project can't be re-opened.

In most cases actuals will not exactly equal allocation (budget) so a Funding Variation will need to be raised.

The project manager updates the project status to "Technically Completed" to formally close it and, if the system status shows an arrow beside TECO and states "*Technically Completed*" in red text, the project has been closed (transaction CJ20N).

2.2.3. Rules for managing the change

As seen so far, facing the implementation of an ERP system inside a company requires a deep investigation and a careful attention with regards to different aspects, such as the choice of the software, the evaluation of the organization (processes, procedures, etc.) and, above all, the willingness to change.

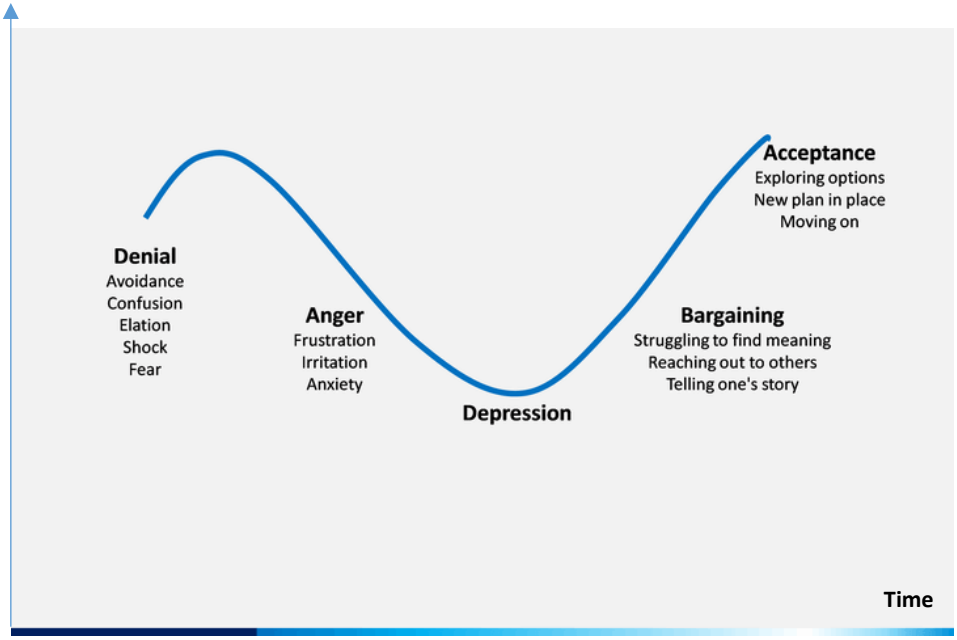
Change is not only a merely technical phenomenon but also a social one, which entails suitable management techniques since, if not handled properly, could represent a dangerous risk for the success of the implementation process and may result in huge losses for the organization. This paragraph aims at illustrating how the complexity of this process shall be faced considering, besides technical and organizational aspects, the human needs.

The implementation of an ERP software within a company can arise challenging situations that, on occasion, may erupt into a full boycott of the project itself. In this context, reference should be made to the Change Curve depicted in Figure 2.5. Developed by psychiatrist Elisabeth Kubler-Ross in the 1960s, the model is also com-

monly known as the five stages of grief, and it "can be used as a yardstick to understand employees' responses and performance changes when organizations announce a new ERP implementation".[46]

Figure 2.6: ***The Kubler - Ross Change Curve***

Source: ***https://www.sketchbubble.com/en/presentation-kubler-ross-change-curve.html***



Understanding these emotions enables a better planning for end-user training during ERP implementation.

The initial reaction to any change is denial. Employees may find the new idea unacceptable and may choose to ignore that this change is going to materialize, continuing to follow the old methods. This may lead to a dip in performance and productivity. In this stage, employees are not yet aware of the full implications of

[46] Prasad R.K., Getting Employees On Board when Implementing Change Management, in https://www.agileconnection.com/article/getting-employees-board-when-implementing-change-management.

this change. It could be a good idea to engage with the employees in an open discussion about the problems, the delays, the errors and overruns due to the existing system and explore the benefits and advantages that the new system could entail. The company should also explain how changes in the processes and systems are going to positively impact employees' work routines, making their jobs much easier. Furthermore, they have to be informed about the need for change and the organization's vision for business growth. It is also important to acknowledge the fact that change is not going to be easy but that it will be better with the support and involvement of all the employees. This result can be achieved through short video trailers, interactive online modules, poster campaigns in the workplace and so on. These measures may gently pull employees out of the denial stage and get them to start thinking about the new system.

As employees begin to realize they have to endure a new system, there may be anger and resistance coupled with a sort of fear of the unknown. In addition, there is also a natural reluctance to move out of their comfort zones. Usually, this is manifested through constant putdowns of the new system, trying to prove that the existing one is better and cheaper and questioning the efficiency and operation of the new. It is necessary that supervisors spend time making an effort to drive away the underlying anger.

Once employees finally begin to accept that change is inevitable, they will find ways to move on to the new ERP system. It is important that employees feel their voices are heard and that the organization is sensitive to their concerns. At this time, they need constant reassurance that their services are required, and they must be guided and supported at every stage of the project implementation.

The final stage is acceptance, where employees are convinced about the new system and how it is going to help them and the organization. At this point, they have begun integrating and using the new system. There will still be moments of frustration and problems during their integration into the new system and questions

might continue to arise. However, delays in addressing these issues may result in employees being frustrated and losing faith in the new system. Consequently, it is important to address concerns quickly and provide coaching, support, and reinforcement. The company can also consider creating courses where employees can watch how the program works, get first-hand experience trying out different possibilities in a fail-safe environment and do the tasks independently to test their knowledge. These online courses can be broken down into short modules and customized based on the end-users. That way, employees can access courses or modules relevant to them.

It is also important to mention that all the benefits accrued during the implementation of the new system should be made public through posters or celebrations, to provide positive reinforcement to the employees. In fact, an atmosphere of achievement shows that their efforts are appreciated and communicates the implementation's overall success.

Accepting change is hard, and constant and regular communication is the key, but technological infrastructures are cost-effective and even small organizations can create videos, interactive courses, and digital resources to facilitate easy exchange of knowledge. This helps to dispel fears about the new system being adopted.

Any ERP implementation will have its share of problems and unforeseen technological hitches: being smart and proactive about change management ensures that instead of resisting the change, employees become partners in the initiative.

The project manager is in charge of choosing the people to involve in the definition of the political aspects (cross-functional conflicts). Therefore, diplomatic skills are required, along with a strong willingness to solve conflicts as soon as they arise, in order to avoid occult resistance movements.

Dealing with the change has two main implications:

- technical aspect;
- social aspect.

From the technical point of view, as investigated in the previous chapter, the company is expected to evaluate the modifications of the internal processes, whereas, for what it may concern the social aspect, it is necessary to analyze the way people within the organization do interact.

To enhance these activities, it is advisable to apply proper change management techniques. "Change management is devalued by managers who think that they will be able to simply tell the employees to use the new ERP software and they will use it without resistance"[47]. This issue grows exponentially if the company is a global enterprise, where directors have to deal with regional and local nuances, cultures and languages.

Since a new ERP system affects an entire organization, employees' day-to-day tasks may change and with that, the implementation brings more exposure to and interaction with new processes and data. Employees "need training on three fronts: training on the changes in business processes as a result of ERP implementation, training on the actual ERP solution and, most importantly, change management training. In fact, improper handling of change is one of the major reasons for ERP failures. Therefore, training on the processes and ERP solution has to be planned in sync with change management training".[48]

Below the phases of the change management process are synthetized:

1. identify the needs;
2. analyze the expectations;
3. share the methodology;
4. identify the possible solutions;
5. value creation and training;

[47] Panorama Consulting Group: https://www.panorama-consulting.com/five-change-management-strategies-for-global-erp-implementations-2/.
[48] Prasad R.K., Getting Employees On Board when Implementing Change Management, in https://www.agileconnection.com/article/getting-employees-board-when-implementing-change-management.

6. share the knowledge;
7. assign the project benefits.[49]

Adhering to these seven change management practices will mitigate the challenges of implementing an ERP software, since they anticipate the acceptance and facilitate the experience for everyone involved.

[49] Bazzerla M., *L'implementazione di un sistema ERP in azienda*, op. cit. p.48.

CHAPTER 3

EMPIRICAL STUDY

3.1. Case study: EA S.r.l.

3.1.1. A brief company overview

EA S.r.l. is an Italian company located in Ascoli Piceno, founded in 1962 under the name of Elettromeccanica Adriatica, to respond to the significant requests for new Low Voltage and Medium Voltage electrical systems, aimed at the renewal of the entire Italian electricity distribution network in place in the 1960s.

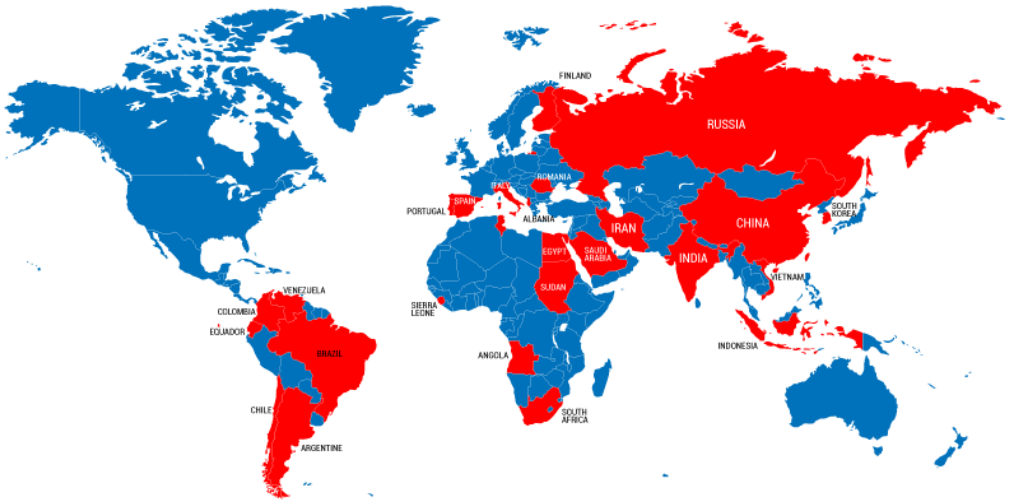
Since foundation, the company mission has been "investing in the production and distribution of electricity, looking to the future and therefore with a matured conscience for everything that has an environmental and social value". The business areas of EA are addressed to the national and international market of equipment for the distribution of MV power and the production of electricity from renewable sources.

At the end of the 70s, EA developed the first protected MV compartments, with rotary-type air insulated switch-disconnectors, of which hundreds of thousands of parts have been produced in over 30 years.

At the beginning of the 90s, the company implemented its SF6 injection process in pressurized containers and developed a new range of gas-insulated products.

The peculiarity is represented by the use of a basic equipment suitable for 24 and 36 kV voltages, both for internal use for compartments and on external over-head lines with a unique standardization on the market of MV equipment of the same type. This product has allowed EA to undertake an internationalization process that has seen the company present in over 15 foreign countries over the last 10 years (red countries in figure 3.1).

Figure 3.1: ***EA supplies and plants built in the world***
Source: ***https://www.easrlitaly.com/index.php/azienda/noi-nel-mondo?index.php/azienda/noi-nel-mondo***



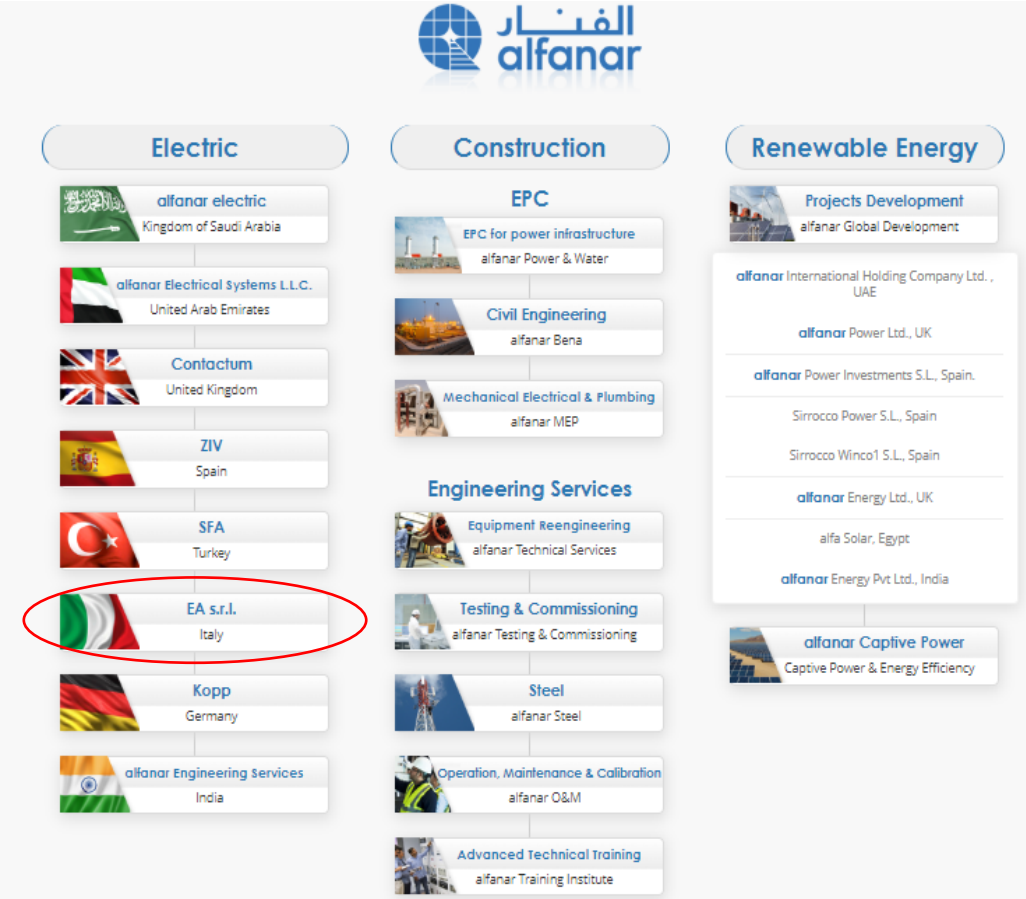
At the same time, considerable experience has been gained in the *Erection* activity, which consists in the construction of plants such as Primary Cabins, Substations up to 380 kV and Off-Shore Platforms, which allowed EA to establish itself both nationally and internationally with over 1000 plants built.

Furthermore, the certifications of the Quality System according to ISO 9000, of the Environmental System according to ISO 14001 and of the Safety System according to Standard 18001 underline the efforts to maintain a strong position and increase it in the future. Through the company Policy, they are constantly committed to ensuring compliance with the applicable mandatory regulations, the principles of social responsibility, protection of the integrity, health and well-being of workers, protection and attention to the environment and complete customer satisfaction.[50]

[50] EA S.r.l.: https://www.easrlitaly.com/index.php/azienda/storia?index.php/azienda/storia.

In 2016 EA S.r.l. became part of the Arab group "Alfanar", acquiring a further capacity for development both in terms of product, services and markets (figure 3.2).

Figure 3.2: ***Alfanar divisions in the world***
Source: ***https://www.alfanar.com/divisions***



Constant technological research and continuous innovation are now the corner-stones that lead EA S.r.l. within the energy distribution market, to exceed normal quality standards and provide a series of reliable and innovative products at the same time.

The production of "green" energy through plants on flowing water or on aqueducts represents the other core-business.

Through a continuous process of investments and acquisitions, today the company is able to propose itself as partner of institutions or individuals or to provide turnkey projects to all those customers who share an economically convenient and environmentally friendly business vision. Alfanar's vision, in fact, seeks to provide the "power of excellence", since they believe in bringing a spirit of high quality to everything they do. In constantly striving to be the best in their field, they remain at the cutting edge of electrical technology while supplying the growing demand for energy around the world.[51]

3.1.2. Current scenario

After having provided a general overview of the company, this thesis wants to focus on the activities performed by EA in the *Erection* process. The aim of this paragraph is providing a scenario of the current procedures performed by the various departments of the company, in order to have a clear representation and exploit the opportunities of integration between the everyday operations and the SAP system.

The first step is the tendering process. As soon as the e-mail with the invitation is received, the tender department registers all the necessary information into an Excel file. This includes:

- the protocol number;
- the client (ENEL, TERNA, etc.);
- the division (Erection, Hydro, Low Voltage, Medium Voltage);
- the tender responsible;

[51] Alfanar: https://www.alfanar.com/vision.

- the date of receipt;
- the SOA (*Società Organismi di Accettazione*) documentation;
- the identification number;
- the object;
- the expiration date;
- eventual specifications about the participation with other companies as an RTI *(Raggruppamento Temporaneo di Imprese)*;
- tender status (in progress, awaiting communication, awarded, lost, not-participated);
- closure year;
- financial offered value (information derived from the model 87, a document that specifies all the tender references concerning the materials, the working hours and the total estimated costs);
- total tender amount within the RTI, comprehensive of EA and other companies;
- other notes;
- the successful tenderer;
- the financial offer of the successful tenderer (if present).

The submission of a tender in response to an invitation implies that the tenderer accepts all the conditions laid down in the invitation to tender and the contract. Since tenderers will be judged on the content of their written offers, they must clearly state to be able to meet the requirements of the specifications and capable of carrying out the work.

The tendering process is generally composed of three main parts: administrative, technical and financial. During the first stage, the tenderer has to submit all the documents containing the basic data required to evaluate the tender in accordance with the specifications of the invitation and will be processed solely for that purpose

by the unit involved. The second stage entails writing the technical relation, which guarantees the main technical requirements (i.e. revenues, # of responsible people, dimension of the company, etc.). In this phase, tenderers are assessed with non-price criteria, that is, based on their technical merits: each merit has a score, the higher the total score, the higher the probability of winning the tender. The last stage concerns the mere financial evaluation of the price quoted. This latter results from an estimation of the costs to be borne for the project, which are summarized into a document that depicts the description, the quantities and the total amounts linked to each cost object (materials, designing hours, factory manufacturing hours, outdoor hours, temporary hours and so on).

A comparison of technical worth and price will be undertaken by the customer in accordance with the criteria established in the tender document, to analyze the quotation and determine which tenderer has the best combined offer. This stage will establish the final ranking of the tenderers and the one with the highest total will be awarded the contract.

Once the order has been acquired, the client asks for all the necessary documentation in order to finalize the contract (i.e. the administrative and technical documents). This phase generally requires about 20-30 days and then operations can start.

The Project Manager has the financial estimates, the technical documents and the development of the offer, with the details concerning all the evaluated aspects.

When the tendering process occurs, there is not an executive project, but a preliminary outline project (EA calls it Model 87). Afterwards, the executive project has to be developed, either by the company or by the client and, in this context, all the details regarding materials and activities will be defined. In fact, the initial program will be edited, as activities may change. When the company has the final contract, they define the specific executive project, which is the work to be carried out.

Then, the materials to be purchased are identified, as well as the required staff to perform the tasks.
The final contract can be:

- a "Lump-Sum" contract, for which the remuneration is the one envisioned by the contract, net of the project variations;
- a "Time and Materials" contract, where all the operations are identified, registered and approved by the client, based on the price that the contract establishes for each single activity. For this kind of contracts, EA uses a price list, which presents, for a specific client, all the possible activities that can be performed on a plant. Based on what the client has planned and what the company executes during the work, the employed price items are determined and then recorded.

Another classification subdivides the contracts in two main typologies:

- closed contracts, for which the project is defined during the tendering phase and activities are defined preliminarily;
- open contracts (also called framework contracts), for which the client defines all the possible activities, each of which has a price that will be applied time to time to the specific project. In these cases, the company does not know in the specific the activity that they have to perform and the client has to issue the LCL (*Lettera di Consegna Lavori*) or the LA (*Lettera di Attivazione*), which designates the company to perform the specific work.

The first step is the calculation of the total hours necessary to deploy the activities. Usually, when EA gets the order for the tender, the two Project Managers of the *Erection* division can intuitively understand the requirements in terms of people and working hours. Notwithstanding, the PM uses as a basis the technical document, which describes carefully the single activities that need to be performed.

These latter, for what it may concern the main client, ENEL, are often well defined, therefore the margin of error is relatively low. With reference to other types of activities, however, it is difficult to define intuitively the requirements regarding hours and workers. This is the main problem for the *Erection* division within EA: the only uncontrollable variable is linked to the human capital.

Going into the detail of the process, once the email with the acceptance of the LCL (Lettera di Consegna Lavori) or the contract arrives, the two PMs fill in the *Tender*. This is a preventive document, which defines activities, personnel, hours and the profit margin, identified with *k*: it consists of a percentage to stick to, in order to make the participation to the tender profitable for the company. If the two PMs encounter from the beginning a low value for *k*, they immediately understand that the project will be unprofitable.

This process entails the creation of an Excel file that encloses all the projects of the *Erection* division. For every project, the following data is identified:

- estimated revenues;
- estimated expenses for materials;
- estimated total hours;
- hourly cost, defined for the specific division earlier in the year;
- estimated profit margin *k*.

In the same file, the project updates, which occur monthly, are highlighted on different columns and, on the right-hand column, the consumptive values are calculated after every revision.

The next step is the purchase of the required materials, with a schedule of deliveries based on the demand of the time-schedule of the work site. Concerning the orders for the materials, the EA uses two different models:

1. the OFI models. They are the internal orders and can materialize in immediate purchases, for which the invoice is instantaneous. These models will never exit the company;
2. the OF1 models. They are the external orders to suppliers. These models are the basis for the framework of the managerial software used by EA, DBwin.

Given the material requirements for a certain kind of activity, the PMs ask for different offers from the various suppliers and prepare the preventives. The comparison is done by ranking the preventive data of each supplier (price, quantity, discounts, shipping method, date of shipping and so on) on an Excel file, the PMs choose the most convenient and start a negotiation. Once the agreement is reached, the order is issued through DBwin.

The PM uses another Excel file, which is not shared within the company but, being a non-official document, it is managed autonomously. It reports all the projects on which the PM is working and, for each project, it specifies the orders issued. This file comes out from DBwin: it is a sort of standard proforma, that contains the type of order (OFI or OF1), the order description and the item identification code.

In addition, DBwin allows the creation of new items. The PM enters the Items Master Data, creates a new code for the item and enters the description, supplier, procurement policies (it can be periodic and automatic; however, this policy is more appropriate for MV production, rather than for Erection), work cycles etc.

Once the item has been created, the PM manages the order through DBwin. He defines again the supplier and the envisioned delivery date (settled by a telephone agreement between supplier and PM), the PM responsible of creating the order, the EA warehouse (called IMPI), the shipping method, the packaging and, at the end, the identification code of the article, the price, the quantity and possible discounts.

After creating the order, the OF1 follows a specific *iter* within the company. First, the process entails the acceptance of the CEO and the CFO. Then, it passes

through the purchasing department and it is sent officially to the supplier, via certified mail.

After having issued the order and received the materials necessary for performing the activities, the company proceeds with the operations. The executive staff follows a time-scheduled program deployed by the company and the PM executes an ongoing control (*in cursu* reviews), with the purpose of verifying if every plan has been respected.

Subsequently, there is the phase of the accounting procedures linked to the operations. The person in charge of the accounting compiles a daily report, specifying the activities which have been executed. This latter includes all the contractual and non-contractual activities. In case of request of non-contractual activities from the client, the PM must authorize the foreman or obtain the authorization from the client himself. These are the ongoing variations.

For what it may concern the accounting procedures for ENEL, the main client, the company uses a software called Emax, a non-official site that entails all the necessary functionalities and communicates with the official site of ENEL, called SCM. Emax is, *de facto*, a transitional software used exclusively for simplifying the activities that will be implemented later on SCM. EA requires both because for many activities, such as the administration of the transport vehicles and the presences at the construction site, they use only SCM. These tools classify all the operations starting from the number of the procurement contract.

Once all the operations have been executed, there is an inspection by the client, to verify whether all the work specified in the technical document has been performed. It may be necessary to proceed also with a testing phase, either with the client or with the staff. Afterwards, there is a meeting between the PM and the ENEL representative for finding an agreement concerning:

- the number of hours to allocate to the activities; the people to interview in this phase are the foreman or the responsible that represents the EA in the work site;
- the number of pieces used, in case of items with a high economic value. The discussion, in this case, involves mandatorily the ENEL representative.

Once the model for the accounting procedures has been compiled with Emax and SCM, the accounting procedure can be closed. All the information are transferred to the administrative office, which proceeds with the invoice issue that is sent to ENEL.

The PM, to have a general picture of the operations and to better organize the procedures, uses another Excel file called *Cost Control*. It is employed also for having a wide understanding of the project progress. This file classifies chronologically the various LCL (sub-contracts) and for each one identifies:

- the amount estimated in the LCL in terms of cost. This is the maximum billable price at the end of the operations, except for particular cases for which the activities performed have been higher than the ones envisioned in the LCL, with consequent recalculation of activities and amounts;
- the estimated turnover, in term of revenues; this is not defined in a single shot, but the EA works with SALs (*Stato Avanzamento Lavori*). If an activity is complex and entails long processing or suspensions due to the client, it can be billed partially;
- the estimated invoice dates.

In the same file, a table depicts the final data, updated monthly from the beginning of the project, regarding:

- revenues;
- costs for direct materials, which determine the progress of the project;

- actual working hours, spread on the different departments;
- "project" hours, that are the office hours for the project.

Furthermore, a precise section of this file details the main data of every project: the WIP. It represents the *Work in Process*, or inventory. The definition of the WIP requires the calculation of the preventive costs of all materials and hours (multiplied times the hourly cost defined *ex ante* for the division) divided by the cost "up to" (the final cost for materials and hours). This ratio gives the percentage of completion of the project. At this point, having the actual order, which comes from the initial tender updated monthly and multiplying it times the percentage of completion, the PM can find the accrued turnover. The WIP can be calculated by subtracting from this latter the effective turnover. As a rule, the WIP must be as low as possible: if it is equal to zero, it means that all the procured resources (materials and hours) have been used and have generated revenues.

Regarding the staff planning, the PM uses another Excel file, where roles are assigned to each person for each work site. The role can consist in:

- *Preposto* (P);
- *Guida* (G);
- *Guida Camion* (GC).

This file is updated every day by the administrative staff. A table shows the different workers on the columns and the working days on the rows. For each worker, the table assigns, every day, the work site of reference, the number of the sub-contract and the role (P, G or GC). The prospectus is essential for defining the daily presences in the work site and entering them in the SCM software, with the purpose of programming properly the staff management.

The quality control is performed by the *Preposto* in the work site, which applies the rules envisioned by the ISO 9000.

For confirming the hours consumed, some interviews are carried out in order to ask if the initial preventive for the project has to be updated or not. On a monthly basis, the Cost-Controller reports the cost changes and provides the PM with the sheet of changes.

3.1.3. Problem identification and motivations for change

ERP implementation is not an easy task since it is expensive and time-consuming. Implementation duration depends on the companies' size; it might take few months for small companies whereas it can take years for large ones and sometimes the process is delayed because of faulty planning and execution. As for the costs, it varies and can range from a few hundred dollars to 1 million dollars or more for small companies and up to 10 million dollars for large international realities.

The reason that led EA S.r.l. to adopt this change arose from the acquisition of the company by the Alfanar group, with the necessity of creating a common IT platform across the organization: the SAP ERP system. In fact, ERP solutions can solve the multiplatform issue, since the lack of conformity can have a detrimental effect on the process flow. With a common IT platform in place, operational costs can be drastically reduced, as it helps automate processes, increase productivity, reduce headcount and retire costly legacy systems. Disconnections between finance, sales and production caused by multiple software platforms, allow for increased errors and wasted time trying to fix problems, or find needed information. ERP system functionality permits streamlining sales processes and stopping work redundancy throughout the firm. Running the same instance of an enterprise application is one way to ensure that consistent processes are used to achieve consistent quality results. The global instance also provides senior management with visibility of the organization through one data model across all enterprises and entities. To simplify, achieving a unique ERP is one way for a CEO to drive down costs while driving up business value.

With this change, businesses rarely remain static and try to solve the problems in the right way; however, most of them loose control over the project.

So far, the Project Manager and the other departments of EA have been working and managing the activities either through DbWin and SCM or through complex Excel papers, with no concern of using a common standard. The former is a managerial tool created by the Harvard Group, integrated by another software, since it did not permit to handle and share huge amounts of data and to monitor complex activities and processes. For this reason, the company has been using Excel for those functions which could not be supported by the programs. Notwithstanding, the Microsoft Office software is, *de facto*, the most widespread and common system ever used. For the majority of the companies, Excel has become an extremely functional tool, but it is important to highlight that, in this way, information is not structured and, above all, cannot be shared.

This trend led to the overabundance of the same information within the company, waste of time and a huge risk of mistake: Excel has not been created to serve complex activities, as it is nothing more than a paper which contains data to process. As a matter of fact, it consists of an extremely powerful means, but it has to be considered as a mere device useful to integrate and assist a good managerial software, not as a substitute of this latter.

All these aspects made it difficult to understand, for those who are not expert of the process, the exchange of data and where fundamental information is kept. In fact, in order to be completely interpreted, Excel files often require to be translated by their authors; without this codification, it is impossible to read and exploit data.

To solve some issues related to the situation analyzed above such as:

- different imputations of the same data, due to the autonomy of every informative subsystem, which led to redundancy, duplications and possible misalignments;
- low controllability and possible uncertainty of data;

- lack of a common dictionary to interpret data and difficulty to create a full vision of the information;
- long elaboration times, due to the necessity of interacting and integrating data. Information has to flow from one department to another and for this reason the informative system has to connect all the subsystems;
- long times for updating data;

there has been the necessity to change something in the way EA has been operating so far. Hence, the need of adopting a tool for homogenizing information production and for harmonizing and simplifying the management of data. Doing so, accuracy can enhance, as well as the quality of the produced information, throughout the adoption of standard common procedures. The next section aims at explaining the action plan undertaken by EA S.r.l. in order to align their procedures to the Alfanar conduct.

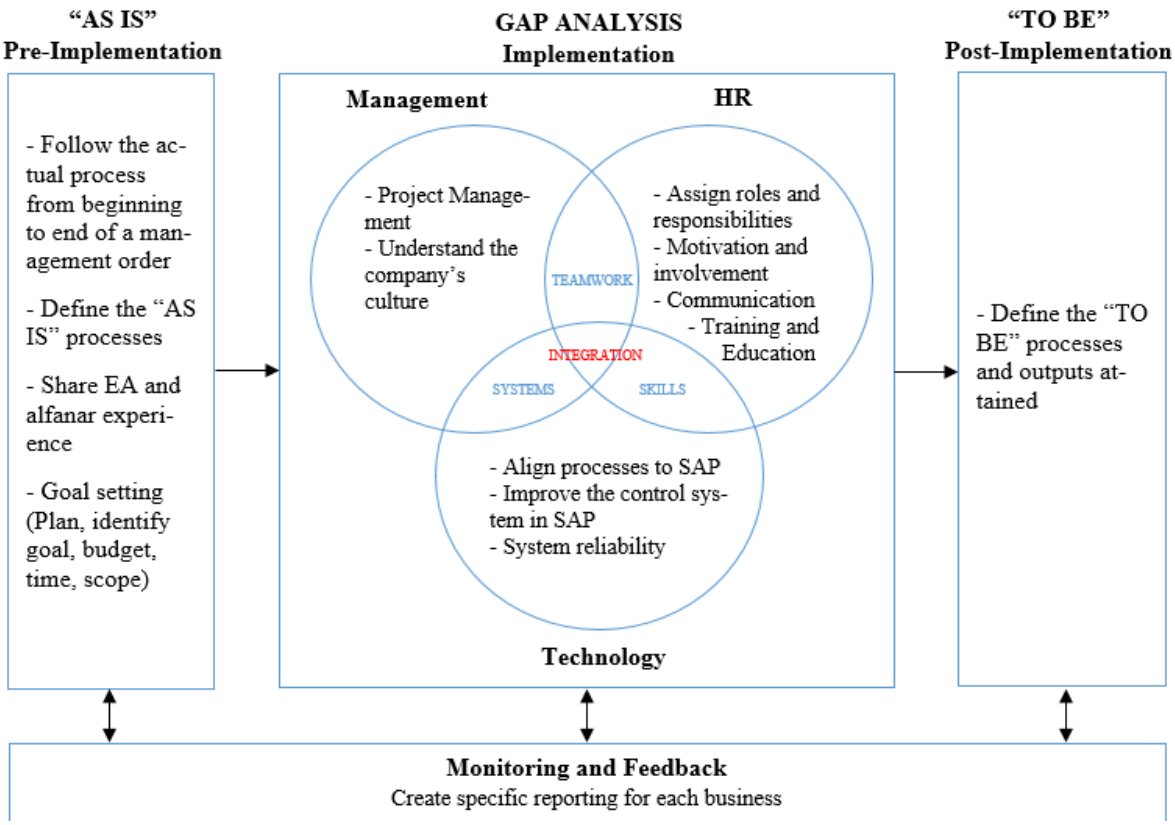
3.2. Project Planning

3.2.1. Action Plan

As the number of failing ERP projects is increasing, it becomes essential to depict a model that helps businesses avoiding this threat. EA has structured the SAP implementation into three main phases. First, the pre-implementation, in which decision makers chose whether to proceed with the project or not. This is followed by the second stage, the implementation, which is made up of three subcategories: management, human resources, and technology. These categories are interrelated with each other, because SAP software implementation is not a simple project but instead has a very complex framework. A monitoring and feedback process will be done periodically throughout the whole stages, in order to achieve the expected result. Finally, the post-implementation, with a support phase that will involve the

intervention of the consultants and programmers. Based on the above-mentioned literature review, the model depicted in Figure 3.3 has been proposed.

Figure 3.3: ***SAP Implementation Model***



From this general model, the next step entails the creation of a detailed Action Plan, for highlighting the initiatives, each of which is structured in a series of milestones. For each event, the company has defined the priority, the start and due date, the person responsible and the one in charge of approving the activity. Below, table 3.1 reports every aspect that needs to be considered in the SAP implementation.

Table 3.1: ***Action Plan***

INITIATIVES AND MILESTONES	PRIORITY	START DATE	DUE DATE	RESPON-SIBLE	AP-PROVAL
1. Improve the project and financial control also based on Alfanar experience					
1.1. Share our and Alfanar experience	Normal	Apr-2019	May-2019	CFO	CEO
1.2. Follow the actual process from begin to end of management order (planning, purchasing, production)	Important	May-2019	Jul-2019	CFO	CEO
1.3. Analyze the “as is” situation	Normal	May-2019	Jul-2019	CFO	CEO
1.4. Improve the control system in our ERP	Normal	Jul-2019	Jan-2020	CFO	CEO
2. Create specific reporting for each business to better share all the information					
2.1. Define the "as is" situation	Normal	Jun-2019	Jul-2019	CFO	CEO
2.2. Define the standard report and information that we need for each department	Important	Jul-2019	Aug-2019	CFO	CEO
3. Define the owner of each division and general SAP awareness					
3.1. First meeting with the managers in order to explain the SAP project	Important	Sept-2019	Sept-2019	CFO	CEO
3.2. Share the SAP project and discuss about priorities and risks	Important	Oct-2019	Nov-2019	CFO	CEO
3.3. Define the owner for each division and communication matrix	Major Event	Nov-2019	Nov-2019	CFO	CEO
3.4. Define the final plan	Important	Dec-2019	Jan-2020	CFO	CEO
4. Analyze the Tendering stage					
4.1. Define the "as is" situation	Normal	May-2019	Jun-2019	Tender Manager	CFO
4.2. Function and job description assessment	Normal	Jun-2019	Jul-2019	HR Manager	CFO
4.3. Gap Analysis	Important	Jun-2019	Aug-2019	CFO	CEO
4.4. Define the "to be" process	Major Event	Sept-2019	Sept-2019	CFO	CEO
5. Analyze the Sales Order stage					
5.1. Define the "as is" situation	Normal	May-2019	Jun-2019	Sales Manager	CFO
5.2. Function and job description assessment	Normal	Jun-2019	Jul-2019	HR Manager	CFO
5.3. Gap Analysis	Important	Jun-2019	Aug-2019	CFO	CEO
5.4. Define the "to be" process	Major Event	Sept-2019	Sept-2019	CFO	CEO

6. Analyze the Project Planning stage					
6.1. Define the "as is" situation for: • Cost Planning • Project Scheduling • Production Planning • WBS Creation • Activity Definition • Progress Milestones Creation	Normal	Jun-2019	Jul-2019	Project Manager	CFO
6.2. Function and job description assessment	Normal	Jul-2019	Aug-2019	HR Manager	CFO
6.3. Quality Management (QM) process review	Normal			Project Manager	CFO
6.4. Gap Analysis	Important	Jul-2019	Aug-2019	CFO	CEO
6.5. Define the "to be" process: • Cost Planning • Project Scheduling • Production Planning • WBS Creation • Activity Definition • Progress Milestones Creation	Major Event	Sept-2019	Sept-2019	CFO	CEO
7. Analyze the Production stage					
7.1. Define the "as is" situation	Normal	Jun-2019	Jul-2019	Project Manager and Foreman	CFO
7.2. Function and job description assessment	Normal	Jul-2019	Aug-2019	HR Manager	CFO
7.3. Gap Analysis	Important	Jul-2019	Aug-2019	CFO	CEO
7.4. Define the "to be" process	Major Event	Sept-2019	Sept-2019	CFO	CEO

3.2.2. Risk Analysis

Despite the significant benefits that ERP software packages provide, they often cost millions of dollars to buy and require disruptive organizational changes. Thus, some companies have experienced considerable advantages while others have had to reduce their initiatives and accept minimum payoffs.

Successful implementation of ERP systems can result from effective management of the risks. EA S.r.l. has decided to undertake the SAP implementation risk

management in accordance with the three phases mentioned in the previous paragraph – the pre-implementation, the implementation and the post-implementation – as depicted in Table 3.2 below.

Table 3.2: ***Risk factors in accordance with the project phase and risk category***

Project Phases	Risk category		
	Management	**Human Resources**	**Technology**
Pre-Implementation	• Inaccurate Planning • Unclear Objectives • Weak Implementation Team	• Lack of commitment • Lack of synergy between IT strategy and organizational strategy • Unclear change strategy	• Lack of communication with the end-users • Inadequate training plan for the end-users
Implementation	• Inappropriate management of scope • Lack of communication between SAP implementation team, SAP provider and SAP users • Poor contract management	• Inappropriate change management • Inappropriate management of culture and structure	• Business process reengineering incompetence • SAP installation incompetence • Inappropriate selection of ERP software • Inappropriate system integration • Inaccurate performance data • Inappropriate users training
Post-Implementation	• Inappropriate contract closeout	• Inadequate organizational readiness • Resistance to change • Lack of user training	• Inappropriate system testing and commissioning • Multi-site issues • Lack of clarity on inspection and maintenance • Inaccurate performance measurement and management framework

First, selecting the most suitable software package solution was a key concern: if wrong choices were made, the company would be faced with either a mismatch between the package and business processes and strategies, or the need for major modifications, which are time-consuming, costly and risky. Both vendor and package have been evaluated through a structured multi-criterial approach (functionality, technology, support, costs). Moreover, the team's size, skills and experience are critical for correct project management, since bottlenecks (which can cause slowdowns and schedule slippages) as well communication problems can occur. Cross-functional and interdisciplinary skills are necessary.

An essential role is covered by the top management involvement, as well as an effective communication system: it is critical to communicate what is happening, including the scope, objectives and activities of the project. The team members will participate in regularly scheduled meetings, draft regular status reports, and utilize a common repository for knowledge objects. Standards for submitting information will be developed along with a formal knowledge coordination procedure. Furthermore, key users must be convinced of the SAP system's usefulness; they must develop confidence and expertise, so that they can aid future users in training sessions. In this context, adequate change management techniques will be performed, since SAP implementation requires changing behaviors within EA. Users may be fearful of what the changes mean for them, so it is essential that change will be proactively managed to minimize the impact of the associated risks.

However, the key factor to reap the full benefits of SAP system implies that the entire EA business processes are aligned with the software, since the literature on both reengineering and ERP implementation have shown that the managerial software cannot improve the firm performance unless the company reengineers properly its business processes for the ERP system. Thus, the managers in charge of the various business processes will align their activities to the ones compatible

with SAP. Even though this approach will help, it does not entirely eliminate the risk of gaps in new process understanding.

In addition, the organization has to define what critical business goals the system will affect. Senior executive support is necessary in every moment in order to enable aligning the IT strategy with the organization's business strategy.

Incorrect global costs analysis might impact on SAP adoption and lead to failure of the system implementation or even bankruptcy: an adequate and competent financial management is essential for the company to undertake this path.

3.3. Project Implementation

3.3.1. Application Deployment, Process Alignment and People Ownership

In light of what has emerged from the interviews with the managing directors and the people responsible of the main divisions, EA's project managers have decided to propose a model of value creation which constitutes a guide for implementing the SAP software. In this respect, three levels have been identified, each of which represents a maneuverable aspect during the implementation and is responsible of the success or the failure of the project itself:

1) Application Deployment;
2) Process Alignment;
3) People Ownership.

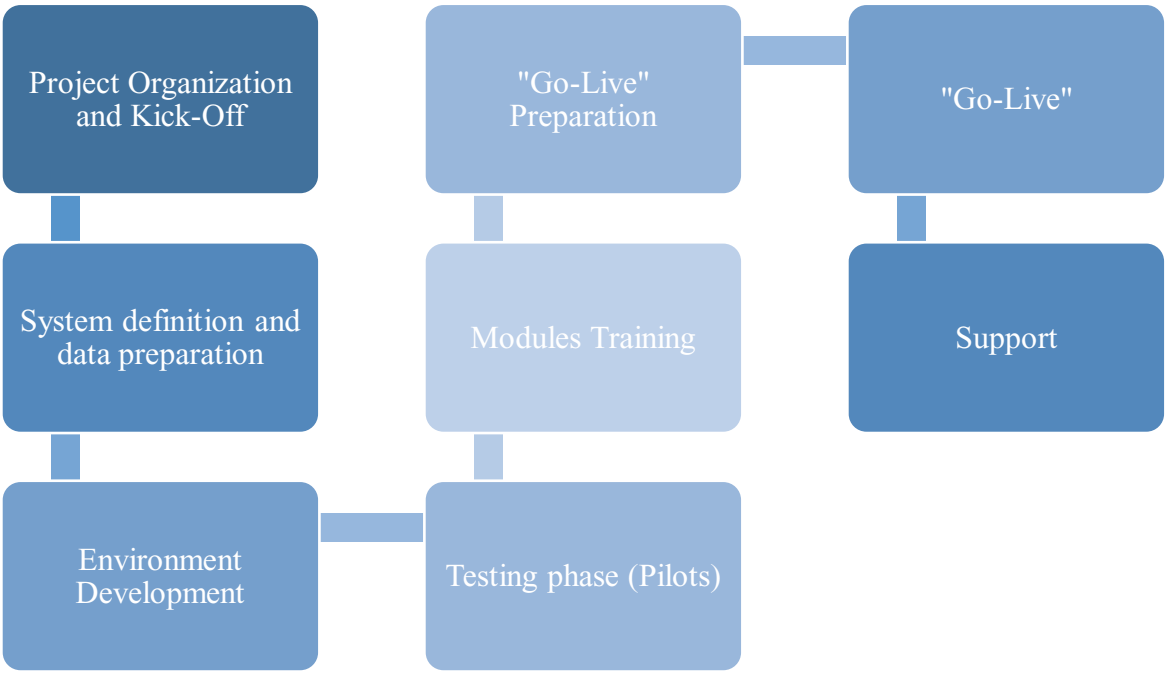
For what it may concern the first aspect, the focus is on the technical features of the informative solution, as described from the project team, and on its capacity to satisfy the defined necessities.

The second point refers to the divergence between EA processes and what effectively the software imposes to the users: the alignment is possible only if the solution comprises all the operations they are interested in and permits all the activities under their responsibility.

The third variable can be defined as the way in which the software is understood and accepted from the employees.

Bearing in mind these three main aspects, the implementation will be carried out through several phases. Figure 3.4 details the implementation model.

Figure 3.4: ***SAP Implementation Model***



The first phase of the implementation process will be the preparation of the Action Plan, as already seen in paragraph 3.2.1., to set the scope of the project and provide an outline plan and costing. A steering committee will be formed to administer the financial guidance of the project and a 'SAP Core Team' will be set up to control and oversee the actual implementation process. The main output obtained from this phase will be the Project Charter document, composed by:

1) Project plan:

- the project scope and the budget (repeated from the contract);

- the project phases and their descriptions;
- definition of products for each project phase;
- a definition of project milestones;
- a detailed project schedule (based on the general schedule from the contract).

2) Definition of the project organizational structure:
- a definition of project roles and responsibilities;
- the assignment of project participants to their respective roles.

3) Project procedures:
- communication, i.e., communication means, frequency and communication paths;
- documentation, i.e., project repository and document templates;
- risk management, i.e., identification, reporting, mitigation and escalation of risks;
- change management, i.e., identification, reporting, approval, and escalation of change;
- management of open items, i.e., identification, reporting, management, and escalation of open items;
- status reporting, i.e., frequency, logistics (physical meeting or teleconference) and reporting document templates of status reports.

Activities performed during the second phase of this process will include reviewing the information flow, defining external system interfaces, developing prototypes of modules and defining new policies and procedures. During this stage, the project's core structures will be identified. As a result of this phase, the Business Blueprint documents will be produced for each of the functional areas. These documents will contain the "translation" of the adopting company's requirements into

SAP language. They describe the way in which the company structure will be reflected in SAP and the structure of the master data. They also include a brief description of the business processes, followed by a detailed description of how these will be executed in SAP, using the standard functionality i.e., how the system will be configured. This is the basis for the actual system configuration in the subsequent project phases. The Business Blueprint documents also contain a high-level description of the system customizations: enhancements, interfaces with other systems, non-standard reports, and printouts.

The third phase, concerning environment development, will regard the physical implementation of the SAP system and its architecture as well as the change of working practices within the company. The aim of this phase is to prepare the project environment from formal and organizational perspectives so that the work in the subsequent phases will be performed in a structured way.

Testing phase will be carried out in three steps:

- unit testing, done by consultants alone, in each of the functional areas (modules) separately;
- modular tests, done by the key-users with the assistance of the consultants for each of the functional areas (modules) separately;
- integration tests, done by the key-users with the assistance of the consultants and the whole business process will be tested, involving multiple functional areas (modules).

Modular and integration tests will be carried out with the use of test scenarios, prepared by the key-users. They include standard and non-standard situations, as well as negative scenarios (erroneous transactions and their corrections).

The pilots of the system will be run for three months and, throughout this period, the purpose will be demonstrating business principles, processes, procedures, role definitions and behaviors, software, hardware and data transfers.

The objectives of the training phase will be to enable users get a better picture of global system's features, to enhance the capability and confidence of users in running the system and to enhance the ability of users to relate the system with daily operations. Accompanying users in their learning curve is essential to bring them into the desired level of skills and understanding. The training will cover finance modules, HR modules, distribution modules, manufacturing modules, project system modules, service modules and general system training.

The final phases of implementation, typically known as "final preparation" and "go-live," can be among the most stressful periods of the project. This is where months of hard work will be put to the ultimate test: production begins using the software. Final preparation and "go-live" entail a number of issues requiring the careful attention of the whole project team. The main activities considered in EA's SAP implementation project will be data live preparation, data reconciliation and live database initialization. After the system "go-live", it will begin to be used for daily operations. However, as the system can be complicated to operate, especially at the beginning, the users will certainly require help from the consultants during the first months. The support phase will involve the intervention of the consultants and programmers.

3.3.2. Gap Analysis

One of the main problems in ERP implementation for all companies is how to align an off-the-shelf software package with the business processes of the enterprise implementing it. In fact, the alignment problem, also known as "gap analysis", exists in every ERP implementation project. Gap analysis is the technique of listing out the steps to be taken for a company to move from its current state of operations

to a desired future state[52], with the purpose of identifying and suggesting the ways to bridge the gap between the 'AS IS' and 'TO BE' scenarios. When any enterprise decides to implement ERP, it means their data will be integrated under one platform and this brings radical changes in the present system. GAP analysis suggests the steps to be taken for these changes.

EA S.r.l. has undertaken the process of alignment to SAP after having received directives from their parent Alfanar, whose staff has been trained for using this software in every step of the production process. With this purpose, Alfanar has provided the Italian company with the necessary documentation to implement properly the ERP system, as well as with a detail of the transactions to be executed in the Engineer To Order process, in order to have a homogeneous IT procedure.

The first step regards the quotation creation, previously managed with different Excel files. With SAP, this process is carried out in the Sales and Distribution (SD) application component. When submitting the quotation, data must be immediately entered in the system, without creating the huge Excel file with all the information. Here, all the details have to be specified: the client in case of purchase, the order number, the validity period, the object of the quotation, the financial offered value and other eventual specifications. Once all this information is entered, the status bar displays the successful submission and the system records the quotation value as Planned Revenue in the billing element.

After quotation, the program is able to collect data and transfers it to the project team. This happens automatically when the company wins the tender. In this phase, the Project System module of SAP has constant access to data entered in the previous step, thanks to the integration between PS and SD. This feature of the software avoids the comings and goings of unclear Excel papers from one company department to another.

[52] Shareef Y., GAP Analysis in ERP implementation in https://www.fingent.com/blog/gap-analysis-in-erp-implementation.

At this point, the tender team uploads the tender cost, making it the R00 version and the Project Manager creates the project definition for the accepted new order.

In this context, the Work Breakdown Structure is shaped. It can be copied from a 'template' or from a 'standard project', instead of setting up a new framework. The standard model shall enclose all the possible configurations that plants could assume. This solution is adopted for two main reasons:

- disposing of a reference structure, which helps the PMs in the project definition, highlighting the main guidelines and the mandatory points to satisfy in order to facilitate the upstream activities;
- creating a record of the historical database, organized in a detailed manner for obtaining all the necessary information to make a more and more reliable and precise preventive.

The introduction of a standard template is the first step for creating a tool able to plan the actual material and financial requirements.

Each WBS element is created independently and given a level number, which determines a hierarchy among the activities. Furthermore, for every element, some information needs to be entered: the project type, who is responsible, the milestones, special settings and so on.

Linked to the lowest level of each WBS element, activities are ranked and can be split up to highlight two main components: working hours and materials. They contain durations and start-finish dependencies, which are the basis for project scheduling.

Then, it is necessary to create the sales order that derives from the quotation. Each line item of a sales order is linked to a billing element of the project. Thanks to the integration with the SD module, the project can automatically create the sales order. In this phase, the PM transforms the tender cost into plan cost version R0 and creates the milestone for invoicing issue.

After having detailed the tasks that need to be performed, the following step entails the identification of the required materials. Here, the purpose is simply adding, on each WBS element, the components to order.

The PM runs the Material Requirement Planning in the system to generate an order: he enters the material and the plant. Each line of the order list can have either 'Stock' or 'Non-stock' materials ordered. The planning team shall check the demand in the system and, in the first case, a reservation is generated to hold the stock. In the latter case, the planned order is converted in a purchase requisition. The purchase requisition generates a planned cost that updates version R0. This part of the process remains quite similar to the previous one managed through DBwin, with the difference that data of material requirement are entered only once in the system and the order is automatically sent to the supplier. When materials arrive in the warehouse, production team shall check and receive it.

Additionally, personnel must be assigned to each activity. As in materials, this procedure generates automatically a planned cost, which updates version R0. Workforce planning process works with work centers. Once assigned the work center, it is time to assign people to the activity. Notwithstanding, prior to doing this, the PM must have set up personnel in the HR master and assigned them to the relevant work centers. What this achieves is the ability to select only the people who have been assigned to the work center that is featured in the specific activity. At the same time, the program specifies the amount of work the individual will contribute.

Afterwards, the Project Manager releases the project for execution.

During the operations, all the departments have to enter the man hours consumed against each activity and the departments' managers must check and approve the entered hours on weekly or monthly basis. To control the business functions, it is necessary to check the status on the software in every moment of the planning process.

For what it may concern the results analysis, the PM will use, also with SAP, the *Work in Process* (WIP) calculation.

At the end of a project, the project manager updates the project status to "Technically Completed" to formally close it.

3.3.3. Future Scenario

After having studied in depth the "AS IS" situation and the existent gap with the SAP processes, this paragraph aims at analyzing the "TO BE" scenario of EA S.r.l., highlighting the major opportunities and the strengths that the software can arise. In fact, a project like this can be considered successful to the extent that it brings considerable advantages to the business processes and to the organization as a whole.

Starting from the interviews to the managerial directors, it clearly stands out that the decision of implementing SAP emerged from the accurate evaluation of the potential benefits the software is likely to generate. First, automating the business procedures, especially in the ETO process, will lead to a massive reduction of costs: in this context, cost leadership will be achieved by cycle time reduction, quality enhancement and productivity improvement. Increase in productivity is possible, as manual tasks will be automated, helping to increase speed of delivery, boost accuracy and reduce the pressure on employees. This is also due to a better department planning and a more efficient material planning.

As the different parts of the organization are connected with each other, people will have faster access to information and will require less time to do their tasks. This allows reducing resources for the decision-making processes and improving working time.

A large portion of cost reduction is represented by the inventory. EA can align, thanks to an efficient MRP, on a strategy oriented to satisfy the net requirements.

This practice will boost stability and controllability, which prevent bearing huge costs for expedited orders and lead to a space reduction in storehouses.

In addition, SAP system will be oriented on a material procurement strategy that allows sustaining purchase costs only when the production process starts. In this way, EA will avoid bearing costs earlier and affecting cash flow.

Furthermore, one of the main benefits that the SAP software will lead consists of the integration of all the departments and the functions into one single database. In fact, data will be entered only once into the system and access will be allowed from the different departments according to the specific needs. This feature will avoid information redundancy and the creation of complicated Excel files, which can be edited autonomously by the single employee and thus result heterogeneous within the company. On the contrary, with SAP, everyone in the organization will have access to the same information. This will generate a greater reliability, as the system will flag up inaccuracies and errors, allowing decisions to be based on more relevant and accurate data.

To avoid erroneous activities, SAP system will introduce the business best practices, streamlined procedures that allow a detailed control and introduce standardized ways to execute business processes. Moreover, the company will exploit the possibility of finding fast solutions to problems, since the vendors who developed the software package collected ideas from all the customers and incorporated them into their product.

Additionally, thanks to the software, benchmarking will certainly be easier, as the system makes it simpler to record and report data. Monitoring the business process will become effortless, enabling earlier troubleshooting and improved reporting.

Focusing on the project-driven approach (concerning the EA *Erection* department) a significant improvement of project margins is envisioned. This starts with a more reliable pre-calculation based on better visibility in resource loadings and

historical data. During the project execution, the margin improves through better procurement performance, more efficient capacity loading and better control of extra-billable work. It also reduces synchronization errors between material delivery dates and changing production schedules. Unplanned extra work assignments will be identified quicker, and finished work orders will be reported very easily. Finally, the implementation of SAP PS will make it possible to see the realized margin in every phase of the project, plus the estimated margin at completion. This is possible because the architecture of SAP PS bundles all hours and materials in a common project framework.

An important aspect linked to a higher efficiency will be the improvement of the utilization levels as a result of a better visibility in the department loadings. Automatically, this will lead to reduction of outsourcing and hiring of temporary workforce.

Other benefits will consist in a reduction of coordination meetings and expensive last minute actions, because of workflow support and alerts. A reduction of project administration is expected by cutting double inputs, implying less mistakes, quicker searches and facilitated procurement and invoicing procedures.

SAP PS module will have a healthy effect also on the reliability of deadlines. This is because EA ETO processes are driven by project WBSs with milestones. In case a deadline is in danger, an alert will be processed immediately.

Finally, the quality will improve with a more controlled process, preventing mistakes and giving more time to absorb engineering changes in procurement and production.

The growth path generated by SAP adoption is a key element for the development strategy of EA S.r.l., in accordance with the vision of Alfanar Company whose main issues are represented by:

- the internationalization, with a pervasive presence within a growing number of foreign markets;

- the technological innovation, to which the company is allocating considerable resources.

Recent research on the impacts of ERP systems on companies' performances has found some evidence that this software enables achieving faster returns on investment.

"Brenda Jameson of Richart Distributors, a manufacturer of the Flomore line of pumps and accessories for the oil industry, explains it this way: "We realized immediate benefits in individual areas such as an improvement in our ability to manage accounts receivable and to be proactive in planning for purchasing and manufacturing. But, our implementation also positioned us for the long term and the tremendous growth we are now experiencing". Mark Lindberg, Operations Manager for Admotec, Inc., manufacturer of advanced technology motion and positioning sensors, echoes these ideas in his approach to ERP and its benefits: "Implementing ERP in a small company forces you to do things in ways that will eventually be required as the firm grows, and workflows must be integrated across departments. Growth means that individuals can no longer wear so many hats. Having a system in place that accommodates this, makes the transition much easier". Both firms have demonstrated a proactive approach to implementing business systems that provide immediate and tangible benefits while positioning them well for the future. ERP is the cornerstone to that approach"[53].

The foregoing discussion makes it clear that the success of ERP systems is not a monolithic concept. Rather, it is multidimensional. It will interest nearly all aspects of EA organizational and operational life.

For what it may concern the main topic of this specific case-study, so the EA ETO process, all the benefits generated will heighten, in the short run, the precision

[53] Atherton M., How to enhance the value of your enterprise with ERP in https://www.xtuple.com/blog/matherton/how-to-enhance-the-value-of-your-enterprise-erp.

and accuracy of the project preventives that, being increasingly adherent to the consumptive reality, will permit to EA S.r.l. to play a leading role within the national and international markets. Thanks to the IT advancements, in fact, the company will remain at the cutting edge of the electrical technology market while supplying a continuously growing demand around the world.

CONCLUSIONS

The study presented in this paper analyzed the activities, products and efforts needed to perform a full-scope ERP project.

The first chapter has provided a conceptual framework of the main topic, highlighting how systems like these aim at supporting the business throughout:

- standardization of the procedures, shaped on the company's features and attitudes;
- integration of the activities into processes;
- facilitation of communication among business units;
- improvement of information flow and quality.

Therefore, ERP systems are essential tools for both big companies and SMEs, playing a very important role when it comes to organizing and processing data. This thesis has investigated how, with ERP, both-long term and short-term business perspectives can be improved, due to performance enhancement and the achievement of certain objectives. These include inventory reduction, less time to market, reducing manufactory and order processing cycle times.

The analysis proposed to translate the activities into items of incomes and expenses. In order to allocate the majority of the costs related to the implementation of an ERP system, three macro-categories have been identified: people, data and computer. Furthermore, an intense investigation has been conducted for examining the major benefits that this kind of solution can lead:

1) reduction of operating costs;
2) improvement of working time;
3) centralization of the information system;
4) improvement of the Return on Investment (ROI);
5) ease of use;

6) more efficient business practices;
7) faster solutions to problems;
8) only customization is required;
9) information sharing;
10) increase of productivity;
11) reduction of inventory costs;
12) improvement of cash flow;
13) customer satisfaction;
14) sales increase.

The second chapter has analyzed in depth the processes related to the E.T.O. manufacturing system, with the purpose of delving into the demand-driven approach that marks out the company examined in the following section.

The approach has been focused on the corporate processes and on how activities have to be developed and mapped, before asking which technological devices would be more suitable according to the state-of-art circumstances.

The next step consisted in reflecting the business activities of the Engineer To Order industry in the chosen ERP system: SAP. For this purpose, companies use the Project System (PS) module of SAP, to track both the phases of the project as well as the individual tasks. In an ETO environment, there is no standard cost; instead, project managers use planned costs to estimate the expenses for designing and manufacturing the product. The high degree of integration between the Project System and other modules (Financial, Controlling, Human Resources, Material Management, Production Planning, Sales & Distribution, etc.) makes it possible to plan and execute projects as part of the normal commercial procedures of the enterprise. In fact, the SAP Project System has constant access to data in all the departments involved in the project. Modules such as PS work with WBSs, activities and milestones creation, allowing easy and immediate tracking and monitoring functions.

Notwithstanding, it is also mentioned the necessity to share the project with all the people involved; this implies the adoption of a common language inside the firm to display the activities, along with a process-based vision. In fact, it is commonly conceived that the implementation of an ERP software within a company can arise challenging situations that, on occasion, may erupt into full boycott of the project itself. In this context, reference has been made to the Change Curve. Understanding employees' emotions enables a better planning for end-user training during ERP implementation.

However, it is clear that the inefficiency of the implementation process is mostly due neither to technology nor to ineffective change management practices, but to organizational aspects. Focusing on this latter can lead to outstanding results, since the competitive advantage of a company does not derive from the ERP implementation activity, but from the ability to identify the strengths and the improvements that these tools can incentivize when the misalignment is removed: ERP is a means, not an end.

The third and last chapter of this work has regarded the actions performed by the company EA S.r.l. during the implementation process of SAP. To solve some issues related to:

- different imputations of the same data, due to the autonomy of every informative subsystem, which led to redundancy, duplications and possible misalignments;
- low controllability and possible uncertainty of data;
- lack of a common dictionary to interpret data and difficulty to create a full vision of the information;
- long elaboration times, due to the necessity of interacting and integrating data;
- long times for updating data,

there has been the necessity to change something in the way EA has been operating so far.

After having provided the current scenario of the *Erection* process managed by the project managers of the company, an action plan has been depicted in order to align their procedures to the conduct of their Arab parent, Alfanar. In the action plan, the various initiatives have been ranked, each of which is structured in a series of milestones. For each event, the company has defined the priority, the start and due date, the person responsible and the one in charge of approving the activity. In addition, EA has decided to carry out the implementation through several phases: Project Organization and Kick-Off; System definition and data preparation; Environment Development; Testing phase; Modules Training; "Go-Live" Preparation; "Go-Live" and Support.

Besides, EA has undertaken the SAP implementation risk management, which has allowed the individuation of some dangerous behaviors, among which:

- inaccurate planning;
- unclear objectives;
- weak implementation team;
- lack of commitment;
- lack of synergy between IT strategy and organizational strategy;
- unclear change strategy;
- lack of communication with the end-users;
- inadequate training for the end-users;
- lack of communication between SAP implementation team, SAP provider and SAP users;
- inappropriate change management techniques;
- business process reengineering incompetence;
- SAP installation incompetence;
- inappropriate system testing and commissioning;

- lack of clarity on inspection and maintenance.

Afterwards, the company has undertaken the process of alignment to SAP procedures after having received from Alfanar the necessary documentation to implement properly the ERP system, as well as a detail of the transactions to be executed in the Engineer To Order process, in order to have a homogeneous IT procedure (Gap Analysis).

Finally, after having studied in depth the "AS IS" situation and bridging the gap with the SAP processes, the "TO BE" scenario has been depicted, highlighting the opportunities and the strengths that the software can arise. Among these latter, the most significant are: massive reduction of costs, quality enhancement, productivity improvement, faster access to information, greater stability and controllability of both inventory and cash flow, absence of information redundancy and complicated Excel files, greater reliability, faster solutions to problems, easier benchmarking, effortless monitoring and a significant improvement of project margins.

In conclusion, the growth path that the implementation will trigger is a key element for the development strategy of the company, whose primary concerns are the internationalization and the technological innovation. With regard to the EA ETO process, the utilization of the SAP PS module will enhance the precision and accuracy of the project preventives that, adhering more and more to the concrete reality, will make the company a leader within national and international markets.

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