A Maturity Model for an ERP Implementation

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Abstract
In recent years the ERP project implementation has become one of the most investments in IT for firms. Given its complexity and the massive use of resources needed, the ERP implementation project is subject to a high risk of failure. Therefore the adoption of an approach based on risk management appears to be essential, but considerably difficult and uncertain.

The general objective of this study was to develop a model that aims to assess the readiness of organization to implement the ERP system. Based on articles collected from the main trends of literature, it was possible to identify the key dimensions of analysis and create a simple framework for evaluating companies. Measuring their current level of maturity, the model provides information about their strengths and weaknesses and encourage them to implement actions to raise their degree of maturity and thus to increase the probability of success of ERP.

Sommario
Negli ultimi anni l’introduzione dei sistemi ERP sta diventando uno dei maggiori investimenti in IT per le aziende. Data la complessità e il gravoso impiego di risorse, il progetto di implementazione di un sistema ERP è soggetto ad un elevato rischio di fallimento. Di conseguenza l’adozione di un approccio basato sul Risk Management risulta essere indispensabile, ma notevolmente difficile e incerto.

L’obiettivo generale di questo studio è sviluppare un modello per valutare quanto un’azienda, definito il project scope, è in grado di affrontare tale progetto di introduzione. Basandosi su articoli raccolti dai principali filoni della letteratura, è stato possibile individuare le dimensioni chiave di analisi e creare un semplice frame work per la valutazione delle aziende. Misurando il loro livello di maturità attuale, il modello fornisce informazioni circa i loro punti di forza e di debolezza, incoraggiandoli ad attuare azioni per incrementare il loro grado di maturità e aumentare così la probabilità di successo del progetto ERP.
0. Introduction

Maturity Models (MM) are decision support tools that allow to assess the current level of maturity reached by organization in the analyzed process and suggest actions to be taken to progress from one level to another in order of continuous improvement.

MMs follow a top down structure and are divided in maturity levels that represent a different stage of maturity; each maturity level is composed of several key process areas organized into sections called common features and this common features specify key practices, which, when collectively addressed, accomplish the goals of the key process area. The general scheme is shown in fig.1.

The Maturity Model method has its origin in the Capability Maturity Model (CMM) developed by Software Engineering Institute of the Carnegie-Mellon University in 1986. Following its success in the software industry, CMMs have been adopted in many other disciplines. Today, maturity models address a wide range of topics, one of these is on the risk management process that led to the development of RMMM (Risk Management Maturity Models).

In spite of the wide range of Maturity Model applications there is still no uses on ERP implementation process. ERP Maturity assessments could provide organizations with the necessary information to understand their processes and skills and enable them to identify the weaknesses and limits of their process management, encouraging to improvement.

ERP systems are comprehensive packaged software solutions which aim for total integration of all business processes and functions with a unified architecture enabled by a single shared database.

The introduction of such system deeply impacts on activities, roles and responsibilities of all people involved. These projects are strongly resource consuming and are characterized by high managerial complexity. Due to that many ERP projects are interpreted to be failures. In
this context, Risk Management appears to be the best approach to a successful implementation of an ERP project.

Despite the extensive theoretical and practical development of risk management methods in ERP implementation projects, there has been no development of assessment framework for evaluating the organizational attitude to support these processes.

The aim of this work is to design a clear guide for all companies that want to undertake an ERP project to develop or improve their approach to ERP implementation.

The model purpose is to help the organizations, allowing them to:

- Assess their current level of maturity.
- Develop action plans for increasing their efficiency and the likelihood of project success.

1. Theoretical Foundations

To develop the following thesis was necessary to deepen the following topics:

- ERP Systems
- ERP Implementation process
- Risk Management
- CMM (Capability Maturity Model) and RMMM (Risk Management Maturity Model)

1.1 Previous Knowledge

Before starting with this thesis work my previous knowledge already provided a broad culture on ERP systems, the process of ERP implementation and risk management. This knowledge has been learned in my previous thesis work: "A methodology for the quantification of risk in the projects of introduction of ERP systems" and during the course of “Tecnologie Informatiche per la Gestione Aziendale”.

2. Model Development

2.1 Research objective and methodology

Undertaking an ERP implementation project is particularly difficult and risky because of numerous risk factors that can exist during the lifecycle of the project. It is clear that it is fundamental to adopt an approach based on a Risk Management.

Objective of this study is to develop a model to evaluate the maturity of the firm that wont to embark on ERP implementation project.
The model will provide the following output:

- Indication of the probability of success in relation to the level of maturity reached by the organization.
- Evidence of the strengths and weaknesses of the organizational areas that affect the implementation process.
- Suggestions and indications on how to tackle the implementation process in relation to the level of maturity and the weaknesses highlighted.
- Clear strategic guidance for top management to evaluate all organizational issues that may hinder the project success and to indicate any necessary actions for improving organizational attitude to ERP implementation project.

In order to develop this framework, it was necessary to make an accurate review of literature for comprehending the characteristics of an ERP system, the structure and applicability of CMM/RMMM, the dynamics that guide an ERP implementation project and the risk management process.

The research is based on the analysis of articles collected from the main scientific editors: Emerald, Science Direct (Elsevier), IEEE-Xplore.

The first step was to conduct cross-sectional study of literary reviews and case studies, extracting from these databases, on ERP implementation process with the analysis of CMM and RMMM to assess the applicability of the latter for the construction of a maturity model.

After defining the model, the papers were organized in four categories to better identify relevant factors and how to asses them:

1. characteristics of ERP project
2. Organizational factors that influence the ERP implementation process
3. ERP implementation process and the relative CSFs
4. ERP Risk management and RMMM

After identified all the factors that determine the maturity areas, a questionnaire and an evaluation framework was designed to assign the maturity level reached by company.

Finally a case study was examined in order to evaluate the practical applicability of the model and to test its effectiveness in a practical context.

2.3 Model Structure

The model’s frame has a top-down structure and it follows the same logics of CMM/RMMM’s models.
The model starts from the definition of the **maturity** concept that is defined as “the capacity or basic condition of an organization’s sector, which determines a possible increase or decrease in the implementation of an ERP system’s probability of success”, which is composed of two factors: **complexity** “any project or organizational basic characteristic which adversely influences the process of implementation” and **capacity** “the organizational skills and capabilities which are necessary in order to plan, control and manage all the processes concerned all aspects of the ERP system introduction”. Once these have been defined, the factors which determine whether the system can be successfully implemented were indentified. These factors constitute the key maturity areas which are themselves composed of a variety of key dimensions (which are defined by a series of variables) identified to determine their value. This scheme is illustrated in **fig.2**. A bottom-up approach will be utilized for the evaluation phase. This approach considers each variable, moving from the lower ones, in order to define the organization’s maturity level.

2.4 Parameter Individuation

The individuation of key maturity areas starts with the observation that the success of any complex project that lead radical organizational change, such as the introduction of the ERP system, depends on the following characteristics:

- The object of the change
- The contest in which this change operates
- The process through which it operates
- The management of the events which could lead to any unexpected outputs

This observation allows to define four areas of maturity: **Project, Organization context, ERP implementation Process, Risk management Process**.
The first two areas of maturity represent the condition which the process is placed on, consequently, their evaluation leads to the determination of the *Complexity* level. The other two areas allow to determine the *Capacity* level.

To identify the key dimensions and variables that characterize the key areas an extensive research has been done on scientific articles about the main topics listed above. In addition to that a practical case study was analyzed to get feedback about their significance and relevance.

Key dimensions and the relative variables are shown in the following table (**Table1**).

<table>
<thead>
<tr>
<th>Key Maturity area</th>
<th>Dimension</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROJECT</strong></td>
<td>Implementation strategy</td>
<td>Implementation typology Module implementation strategy</td>
</tr>
<tr>
<td></td>
<td>Dimension</td>
<td>Physical scope Resource scope</td>
</tr>
<tr>
<td></td>
<td>Impact</td>
<td>BPR scope Technical scope</td>
</tr>
<tr>
<td><strong>ORGANIZATION CONTEXT</strong></td>
<td>Culture</td>
<td>Type of culture Change Attitude Risk awareness Senior management attitude to risk management process</td>
</tr>
<tr>
<td></td>
<td>ICT Governance</td>
<td>Business-IT strategic alignment Decision-making mechanism &amp; governance style Outsourcing ICT ICT function</td>
</tr>
<tr>
<td></td>
<td>Structure</td>
<td>Formalization Structural difference Decentralization</td>
</tr>
<tr>
<td></td>
<td>Technology</td>
<td>Legacy systems integration S.I. Architecture Legacy systems management</td>
</tr>
<tr>
<td></td>
<td>Financial</td>
<td>Resource saturation Budget Financial stability</td>
</tr>
<tr>
<td><strong>ERP IMPLEMENTATION PROCESS</strong></td>
<td>Skills</td>
<td>Project management skills Experience in managing complex project Technical skills Managerial skills Leadership</td>
</tr>
<tr>
<td></td>
<td>Resources</td>
<td>Information of the packages offered by the market Support implementation technology Human resource allocation Communication systems and information sharing Process support tools</td>
</tr>
<tr>
<td></td>
<td>Methods</td>
<td>Change management practices Top management commitment Stakeholder coalition BPR approach Vendor selection practices Training practices Project team selection and definition</td>
</tr>
<tr>
<td><strong>RISK MANAGEMENT PROCESS</strong></td>
<td>Skills</td>
<td>Qualified staff in the organization Range &amp; depth of people-experience in risk management Skills &amp; capabilities of people responsible for risk Management Training</td>
</tr>
<tr>
<td></td>
<td>Resources</td>
<td>Resource allocation personnel Adequate risk management tools Use of policies/standard</td>
</tr>
<tr>
<td></td>
<td>Methods</td>
<td>Risk response strategy Risk assessment strategy Responsibility definition Risk management plan &amp; procedure Integration with ERP implementation process Communication of risk strategy Use of Metrics / Performance Management</td>
</tr>
</tbody>
</table>

Table 1: key dimensions and variables of the model
2.5 Evaluation Method

A questionnaire has been designed in order to assess the maturity level. The evaluation follows a bottom-up approach: the interview is required to consider the lowest level variables and to aggregate these evaluations, with arithmetic average, in order to define the complexity and capacity levels (The model structure is presented in Fig.3).

The complexity and capacity’s factors are divided in 4 qualitative levels. The determination of complexity and capacity levels is calculated through their key areas evaluation, while the maturity is evaluated by aggregating them. The maturity levels are represented by a matrix called ‘Maturity Matrix’ (fig.4), which relates the two factors.

The relation which exists between complexity and maturity is in inverse proportion. Conversely, the relation between capacity and maturity is directly proportional.

By defining the organization’s maturity level and placing the results in one of the categories it is possible to have an idea of the project’s probability of success and the measures which could be taken in order to increase its level.

![Evaluation framework](image)

Figure 3: Evaluation framework

Thanks to the analysis of this matrix, it is possible to assemble a number of clusters representing a great number of similarities concerning the project’s probability of success and the intensity of the actions which would be recommended to undertake before starting with the operative phases of the project.

All the actions must be evaluated according to the cost/benefit principle; the organization should consider the differential costs of all the different possible actions relating them to the potential benefits of every intention.
2.6 Clusters description and improvement actions

Cluster A:

- High probability of project success.
- Corrective actions are not necessary before beginning with the operational phases of the project. The organization already has the adequate capacity to cope with project complexity.

Cluster B:

- Good probability of project success.
- Organization, despite the capacity is at the same level of complexity, “may consider” the possibility to increase the probability of success analyzing the dimensions and related variables that have shown major weaknesses and bridge the gap with possible improvement actions:
  - To re-analyzing and reducing the project’s scope if there are no corporate constraints.
  - Acting on the context, reducing the negative impact on project results that organizational context variables may have.
  - Analysis of the skills and abilities to manage the project.
  - Acquisition of new competences in project management, ERP implementation process and risk management.
Cluster C

- The probability of project success is very poor.
- The organization is obliged to enroll in some interventions which could better balancing the relation between capacity and skills in order to avoid great losses in the consecutive project’s operations. The possible actions that should be made are the same as underlined in cluster B even though in this case the interventions are necessary and of a greater impact.

Cluster D:

- Very high probability of project failure.
- The possible actions which could be undertaken are as the following:
  - Project abandoning
    If the conditions inside and outside the organization requiring the implementation of the new system and the project cannot be abandoned, the alternative operations are:
    - Drastically reducing the project’s scope.
    - Drastically reducing the negative impact that organizational context variables may have on the project.
    - Acquiring a great amount of external skills for every spotted dimension.

3. Case Study
The purpose of this case study is to evidence the utility and the practical applicability of the ERP maturity model developed in this thesis and to assess the relevance of the model parameters that have been identified.

An external consultant, with considerable experience in ERP systems implementation, has been involved in an interview in which all aspects of the model were analyzed.

To support this review a successful ERP implementation, carried out by a multinational transportation company, is used as a practical reference.

3.1 Project overview
The ERP implementation project examined in this case study has been achieved by a global technology leader company for the railroad, marine, drilling, wind and mining industries.
The project involves three sites in Italy, England and Holland. The purpose was the entire replacement of the current legacy systems with all modules of Oracle ERP business suite which is the corporate standard for the company. This project was a corporate headquarter imposition to globally standardize the information systems of all business units worldwide. A big bang approach has been decided as the strategy for the ERP implementation.

3.2 Case Study result and analysis

With the help of external consultant all parameters of the ERP maturity model were evaluated, tested and refined. Moreover, to test the effectiveness of the model, the evaluation questionnaire was filled in; the result is shown in the maturity matrix (Fig. 5).

<table>
<thead>
<tr>
<th>C O M P L E X I T Y</th>
<th>Low 1</th>
<th>Medium 2</th>
<th>High 3</th>
<th>Very high 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>C A P A C I T Y</td>
<td>Excellent 4</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acceptable 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inadequate 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Maturity level of GE Transportation

The company is placed in the cluster A, this means that organization have the adequate capacity to dominate the complexity of ERP implementation project. The ERP maturity model suggests that the likelihood of success is good and no any improvement actions are suggested before the operational phase of the project. Effectively, the transportation company has successfully completed the project achieving all the planned objectives, respecting budget and time.

4. Conclusion and future research

The framework proposed in this work is an innovative integrative approach that proves to be helpful in assessing the organizations in term of maturity level.

Using this model, the current state of readiness of the organization to implement an ERP project and possible areas of improvements prior to implementation can be identified. The use of Maturity model provides managers with useful contributions for improving the management of implementation process in a disciplined and consistent way. Each company, at the end of assessment will have a profile that will reflect its status. The output of this
assessment model is a set of strengths and weaknesses, which will show areas where improvement is required or advisable, in order to obtain higher maturity level.

To make the proposed framework more effective and diagnostic, the model should be validated and used on a wide range of real cases; moreover a lot of work is needed on the questionnaire to make sure that every aspect of the organization concerning the ERP implementation project is covered. Finally, it could be develop a “weighed” model identifying the relative importance of individual factors in relation to the overall process.