Risk assessment in technology acquisitions: 
The case of ERP systems

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Abstract

To stay alive and competitive, organisations need to provide adequate responses to demand and changes in their business environment. This means organisations need to keep up with the pace at which their environment moves forward. Inevitably, organisations need to adopt technologies which are strategic to them.

However, it is important to understand that organisations, as complex systems, only need certain technologies/functionalities to perform effectively. Acquiring unneeded technologies is a waste of resources.

We applied a system dynamics’ approach to technology adoption processes, focusing on enterprise resource planning (ERP) systems as a case study. By doing so, we have identified three important risks that sometimes get overlooked. The risk mismatched requirements, when the adopted technology’s requirements don’t accurately mirror the organisation’s needed requirements. The risk of “playing it safe”, when managers aren’t properly equipped to make decisions that require a technical background and protect themselves by choosing the technology’s main vendor, or by outsourcing the decisions. And the risk of long life cycles, when the organisation’s culture drags down the adoption process making it possible for the technology to be implemented too late to solve the problem that motivated its acquisition.

Our work concluded that further information is needed to study the issue at hand. Nevertheless, the system dynamics model allowed arriving at two important conclusions regarding the ERP vendors. ERP main vendors’ exponential growth is not sustainable in the long run unless they sell more products to the same clients. Small alternative vendors will systematically lose market share unless they bring in disruptive innovations.
1 Introduction

An organisation’s mission describes its purpose, that is, its reason to exist and what it aims to achieve. Strategy is a widely used term that most of the times refers only to vague orientations to an organisation’s actions. In management systems engineering, strategy is the specification, design and execution of the sequence of actions that allows the organisation to perform its mission when subjected to disturbances from its environment. This definition emphasises that the strategy’s results are specified beforehand and not just hoped for, as it is implicit in current practice.

Technology is the means the organisation deploys in the service of its purpose. Some of these means are easily replaced or discarded at the end of their life cycle. Examples are the cell phone or the personal computer, which can be considered commodities. In an organisation of significant size, the purchasing department is in charge of acquiring these “commodity” technologies.

In contrast, strategic technology implies a substantial investment, it is hard to replace, and its failure means interrupting business processes. Strategic technology is the means that enable mission performance, its late adoption jeopardises the organisation’s competitiveness. Examples are a manufacturing robot or an ERP system (used in this work as case study). Strategic technology adoption is the duty of top management and can’t be delegated (Mendes & Marques, 2012).

2 ERP systems

The term ERP (enterprise resource planning) was coined by the Gartner Group to refer to integrated business software (Mabert et al., 2001; Kumar et al., 2002). To Watson & Schneider (1999), the definition of ERP reads as follows:

A generic term for integrated, customised, packaged enterprise computing software that handles the majority of an enterprise’s system requirements in all functional areas such as finance, human resources, planning of manufacturing, sales and marketing. An ERP’s software architecture aims to facilitate the flow of information among all functions within an enterprise and sits on a common database.

ERP evolved from 1960s’ production information systems. At that time, the concern was controlling large inventories, because it was possible to maintain them and still remain competitive, and software packages were, in general, customised (Umble et al., 2003).

In the 1970s, MRP systems (material requirements planning) were the response to a need for more efficient inventory management. Computers started calculating net material requirements by using the master production schedule (MPS), the product’s bill of materials, the available inventory and estimated deliveries. Later on, tools for capacity planning, sales forecasting and support, resource analysis and financial activity, were added (MRP II, manufacturing resource planning).

At the beginning of the 1990s, MRP II systems already included storage, materials planning, product design, communications systems, human resources, finance and project management (Umble et al., 2003). ERP systems kept evolving, in terms of functionality and architecture, including processes
between different organisations, for customer/supplier relationship management (Somers & Nelson, 2001). The ERP market became one of fastest growing segments in the software industry, and its vendors became stories of success: SAP, Oracle, Baan, PeopleSoft, JD Edwards (Kumar & Hillegersberg, 2000).

The term “dominant design” applies to solutions that end up becoming an industry standard when their market penetration becomes significant (Utterback, 2006). The more organisations choose market leader solutions, the more their suppliers are considered a safe choice and even more organisations choose them. Senge (1990) called this effect “success to the successful”.

SAP and Oracle are currently the market leaders. Oracle acquired some of the late 1990s important brands (Siebel, JD Edwards, PeopleSoft), Microsoft claimed a considerable part of the market and some other vendors came into place (PCG, 2011).

In 1998, the list of organisations that had implemented ERP included 40% of companies with annual revenues of over a billion dollars (Caldwell & Stein, 1998). These big companies saw the advantage of such systems because they are designed to solve the fragmentation of information, simplify the flow of data and provide managers access to real-time business information (Davenport, 1998).

ERP systems have even been considered the entry price for running a business. An ERP system presents a new paradigm that changes how business processes work.

3 ERP issues

“ERP systems are complex, and implementing one can be a difficult, time consuming and expensive project for an organisation. Implementation can take years to complete and cost tens of millions of dollars for a medium-sized organisation and 300 to 500 million for large international corporations. (…) And there is no guarantee of the outcome” (Mabert et al., 2001: pp. 69). Markus et al. (2000) make a clear point in explaining that, by inbedding itself so thoroughly inside an organisation’s internal and external operations, the ERP software and platform becomes crucial because the implementation costs and risks rival its potential pay-offs. They also point out that waiting for the symptoms to present themselves may be very dangerous, remedial actions may not solve the problems.

4 Study framework

Financial analysis techniques are inadequate metrics to properly assist managers with technology adoption decisions because they dismiss technical and organisational aspects. Risk management assumes the adoption was the right choice in the first place and focuses on meeting time and budget objectives. Decision analysis disregards the important dynamic complexity of technology adoptions and must be preceded by thorough understanding of the problem. These limitations led us to believe that a more holistic approach to the whole problem was lacking.
The “whole” we refer to is what we call a system. A system is a whole that cannot be divided into independent parts because the parts are interconnected in a web of feedback loops. The interactions between parts are characterised by delays and the behaviour of complex systems is, consequently, counterintuitive because cause and effect are far apart in time and space (Forrester, 1971).

The approach we then suggest to tackle the issue is a systems thinking approach, and the tool for dealing with dynamic complexity a system dynamics model.

5 Identification of strategic risk factors – Conceptual Model

5.1 Risk 1 – Risk of mismatched requirements

Typical motivations for adopting ERP are:

1. Fear of not keeping up with the competition.
2. Difficulties in the access to critical management information because of the use of independent and incompatible systems (legacy systems).
3. Slow business processes faced against more demanding needs and business requirements.
4. Break in the organisation’s reputation due to mistakes in business processes.
5. Loss of competitiveness because of the excessive use of resources.

The combination of the elements in this list presents us with the most pressing threats, or potential problems, for organisations. This is where the concept of external threat comes into place. As the functionality gap between the systems still in use by the organisation and the systems currently available in the market widens, the perception of threat severity increases. The adoption of systems that can increase the functionality in use responds to the threat (Figure 1 – notation explained in Mendes & Água, 2012).

Figure 1: The reaction is useful before threats become actual problems

Before it can be said that the technological solution responds to the threat, it is necessary to build a requirements list. This requires deep knowledge of the organisation and of the available technologies, which can rarely be found in the same person. As such, top managers tend to fail in the process of technology adoption.

The reason for this may also be found in communication problems. The evaluation and interpretation of information on future technologies means dealing with people with knowledge in areas where managers
are not experts. The avoidance of such matters might lead to the investment in inadequate technologies, or in technologies on route to become obsolete (Antoniou and Ansoff, 2004). The necessary requirements are those that respond to the real needs of the organisation. However, the lack of technical knowledge makes managers more likely to be influenced by main ERP vendors, who tend to influence the building of the requirements list (specified requirements) in order to make it fit the solutions they themselves provide. The larger the discrepancy between specified and necessary requirements, the larger the risk of adopting technology based on mismatched requirements.

5.2 Risk 2 – Risk of “playing it safe”

Placed in a position of having to make a decision without the needed safety and backup, managers tend to “play it safe”, adopting a general solution from a market leader. Allegedly, such solutions have an effectiveness track record. However, there may be an alternative vendor whose solution fits more adequately the organisation’s requirements.

Disruptive technologies are revolutionary innovations; precursors of future patterns, originating in alternative vendors that end up overthrowing established ones (Christensen, 1997). However, not all organisations are prepared to seize the opportunity of these possible competitive advantages. An organisational culture that values stability tends to use a defensive acquisition process, favouring the choice of a main vendor. A culture that values change tends to use an aggressive acquisition process, favouring alternative choices. A second source of risk is the practice of “playing it safe”, which creates dependence on main vendors, and on complex and slow implementation processes.

5.3 Risk 3 – Risk of long life cycles

Adopting an ERP system means making a significant investment and the statistics aren’t very reassuring (Table 1).

**Table 1: ERP project risk factors (PCG, 2011)**

<table>
<thead>
<tr>
<th>RISK FACTOR</th>
<th>2010 AVERAGE</th>
<th>2009 AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Take Longer Than Expected</td>
<td>61.1%</td>
<td>35.5%</td>
</tr>
<tr>
<td>% Cost Exceeds Budget</td>
<td>74.1%</td>
<td>51.4%</td>
</tr>
<tr>
<td>% Benefits Realisation &lt;50%</td>
<td>48.0%</td>
<td>67.0%</td>
</tr>
</tbody>
</table>

Once an ERP system is installed, its use and maintenance are part of the organisation’s business policies. But, until that happens, opportunity costs (normally unaccounted for) associated with the duration of the adoption processes have to be added. These processes compose the adoption life cycle that has two components. The *time to acquire*, proportional to the functionality gap, is the time interval between the threat identification and the acquisition of the technological solution chosen to face it. A bureaucratic culture removes agility and flexibility from acquisition processes. Also, the harder it is to release the necessary funds for the adoption, the longer the acquisition process will take. On top of that, the perception of other threats creates competition over the same funds, inducing financial restrictions.

The *time to implement* is the time interval between the technology’s acquisition and the moment when the system goes live and the benefits realisation begins. It lasts, on average, 14 months but it can take years (Table 2).
Table 2: ERP project cost (PCG, 2011)

<table>
<thead>
<tr>
<th>METRIC</th>
<th>2010 AVERAGE</th>
<th>2009 AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cost</td>
<td>$5.48 million</td>
<td>$6.2 million</td>
</tr>
<tr>
<td>Project Duration</td>
<td>14.3 months</td>
<td>18.4 months</td>
</tr>
<tr>
<td>Payback Period</td>
<td>2.5 years</td>
<td>2.7 years</td>
</tr>
<tr>
<td>% ERP Cost/Revenue</td>
<td>4.1%</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

It is affected by the specified requirements (the more complex they are, the longer the implementation) and the aversion to change (the higher, the more difficulties will be encountered during implementation). The more the organisational culture values stability and also the higher the mismatched requirements risk is, the higher the aversion to change will be, because organisational members will doubt the technology’s usefulness. On the other hand, the higher the functionality gap is, the lower the aversion to change will be, because organisational members will be aware of the need for change and, therefore, be more receptive.

The longer the adoption life cycle is, the longer it will take to reap benefits, making it possible for those to arrive too late to resolve the problem that originated the acquisition. This being said, a third source of risk are life cycles in the adoption of technology that are too long.

Figure 2: Conceptual model form ERP adoption

Figure 2 shows the conceptual model derived from the explanation of the risks involved, slightly updated from what can be found in Mendes & Marques (2012). It is the starting point for the process of engineering strategies for ERP systems’ adoptions. The requirements definition is central to understand the systemic configuration of the risk factors for these adoptions. In this work, the next step is evolving the conceptual model into a system dynamics simulator where several different scenarios can be studied. This is a tool that would allow for an improvement of the sequence of decisions in each scenario, with the intent to reach the desired results, showing the probable consequences in the long run of inconsistent decisions, or non-existent decisions even.
To build a system dynamics model, one needs to define the reference mode. That is, the behaviour pattern from the real world that the model intends to replicate. We lacked data to create a reference mode for the adoption process in order to model the entire system, so we started by modelling the behaviour of ERP vendors’ growth.

The reference mode is the main vendors’ accumulated revenues over time (Figure 3) which shows an exponential growth.

The model’s behaviour grows out of its dynamic hypothesis, in this case the success to the successful archetype, as it is combined with the remaining variables of the model’s boundary.

In terms of stock and flow structuring for the dynamic hypothesis, the model was based in the formulation found in Bourguet-Díaz & Pérez-Salazar (2003), which incorporates two reinforcing loops.

Figure 4 shows the dynamic model. The perceived value stocks correspond to the brand attributed factors and other notions of value that make people choose a certain ERP vendor. The underlying assumption in the model is that the more perceived value a certain vendor has in the market, the more likely it will sell his product.

The willingness to buy flows are the flows that change perceived value stocks depending on the market’s preferences.

The market growth is modelled thanks to a stock of customers which is fed by the flow of new customers influenced by the market’s growth rate. Because the market’s growth rate applies to the size of the market in the previous year, the market growth’s loop is a third reinforcing loop in the model.

The details regarding the model’s formulation can be found in this work’s complete thesis.
7 Results and interpretation

As the behaviours produced by the model show, the exponential nature of behaviour is replicated for main vendors’ revenues (Figure 5).

However, even though alternative vendors’ growth is also exponential at first, at some point it stagnates because their market value becomes residual (Figure 5).

Two important conclusions can be drawn from the study.
Main vendors: Exponential growth is not sustainable in a world with a limited number of potential clients

This effect could also be modelled by creating a stock and flow structure for customers as defined by another system archetype called “limits to growth”.

One of the best ways to delay market stagnation is to remove the limits slowing down or preventing growth. In this case, since eventually there cannot be more ERP customers than there are organisations, the way to try to sustain growth is to sell more functionality to the same customers.

Alternative vendors: You either disrupt or just try to survive

If an alternative vendor is selling pretty much the same solutions as the main vendors, he will eventually either be out of business or just conditioned to working in a small niche.

However, if an alternative vendor successfully brings to market a disruptive technology, that is, something that substitutes traditional ERP systems, the market can change in ways that overthrow the established main vendors (Chistensen, 1997).

8 Conclusions and future research

The literature review confirmed that there is a problem with how organisations have been trying to upgrade and update their management systems’ infrastructures. And, even though a lot of research has been carried out on the subject of selection and implementation of ERP systems, not much work has been found trying to deal with the decision of whether to adopt an ERP or not.

By building a causal diagram, we have surfaced three crucial risks in ERP adoption, risks that can be mirrored to any strategic technology adoption:

- The risk of mismatched requirements,
- The risk of “playing it safe”,
- And the risk of long life cycles.

These risks are a source for reduced effectiveness of adopted technologies, they create situations where technologies are adopted and then abandoned halfway into their implementations, and they severely hurt alternative vendor’s chances to succeed in highly competitive technological markets even if they don’t lack the operational competence to do so.

By directly observing the behaviours produced by the model, we have gained two important insights into the ERP market:

- The exponential growth of main ERP vendors is not sustainable in the long run. ERP vendors will, and most likely already do, have to sell more products to their clients in order to try to sustain growth.
- Alternative vendors are doomed to small market niches unless they bring in some form of disruptive technology.

For future research, we suggest developing a functionality scale to allow building a reference mode for the model’s Functionality in use variable. As orientation for future work, the complete thesis also presents a suggestion of how to develop the whole system’s dynamic model starting from the one that was built and presented here.
Bibliography


