An operational ”Risk Factor Driven” approach for the mitigation and monitoring of the ”Misalignment Risk” in Enterprise Resource Planning projects

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Abstract

Enterprise Resource Planning (ERP) systems offer standard functionnality that have to be configured and customized by a specific company depending on its own requirements. A consistent alignment is therefore an essential success factor of ERP projects. For this purpose, we propose an operational "Risk Factor Driven" approach that allows for the mitigation and monitoring of what we call the "Misalignment Risk". This risk corresponds to the probability of the occurrence of misalignment, associated with the loss due to misalignment if it occurs. The mitigation aims to identify and treat the "Misalignment Risk Factors" (MRFs) influencing the Misalignment Risk. We suggest four steps to deal with MRFs, based on: (i) their classification according to the ERP project stages, (ii) the definition of their mutual influences, (iii) variables detailing them and (iv) related management practices to treat them. The monitoring assesses the evolution of the Misalignment Risk. From an academic point of view, the approach constitutes real progress for alignment problem solving. By managing it as a risk, it guides researchers in the understanding of this major issue. The approach furthermore provides effective support and guidance to companies implementing ERP systems. It is illustrated through the application to the ERP project of a Small and Medium Enterprise. This application shows that it can be used in contexts where the ERP project expertise level is low.

Keywords: Misalignment Risk, ERP project, risk factor, success factor, management, control, monitoring

1. Introduction

In the current context of fierce competition, manufacturing companies' Information Systems (IS) are increasingly based on "off-the shelf" products such as ERP - Enterprise Resource Planning - systems. If implemented effectively, these systems can provide business benefits such as real-time data availability, improved visibility, and increased task automation [1-4]. However, ERP projects are risky and present a high rate of failure [3, 5-7]. One of the main reasons for failure is the inability to manage the "fit" or alignment between the standard functionalities of the ERP system and the company's real needs [1, 8-13]. When the ERP system does not meet the requirements, misalignment appears as an unsatisfactory outcome of the project.

From this point of view, misalignment can be managed as a risk. A risk in Information System projects is defined by [14] as the probability of an unsatisfactory outcome and the loss to the parties affected if the outcome is unsatisfactory. [14] illustrates this definition through the example of a satellite-platform project. The manager of this project calculated (i) a probability of 40% that the software will have a critical error, (ii) and an associated loss of $20 million investment in the case of the error occurrence. Based on the definition of [14], it is proposed in this paper to define the "Misalignment Risk". This is the probability of misalignment occurring, associated with the loss if misalignment occurs. Even though alignment management has gained some interest in the past years, the notion of Misalignment Risk has never actually been defined or studied as such in the literature. It is generally decomposed and merged with all other risk components of an ERP project, under several terms such as: "process failure", "correspondence failure" [15], or even "organizational impact" [16].

According to the ISO/IEC Guide 73 [17], risk management consists in risk identification, treatment and monitoring. Risk treatment is "the process of risk modification" [17] whereas risk monitoring consists in continually "checking, supervising, critically observing or determining the status [of the risk] in order to identify change from the performance level required or expected". The Misalignment Risk has to be treated through mitigation, which decreases the risk probablity. This involves: (i) the identification of the features of the project, defined as risk factors in [18], that influence the probability value; and (ii) the definition of actions to treat them.

In the literature, risk factors are directly linked to project failure, and their relation to a specific risk is not detailed. ERP risk management approaches like [19-22] are moreover useful for identifying and assessing the risks of an ERP project in general, but remain too general to treat and monitor the risks efficiently.

The aim of this paper is therefore to provide operational means for the mitigation and monitoring of the Misalignment Risk during ERP projects. We propose an operational "Risk Factor Driven" approach (see Figure 1) that establishes the link between the Misalignment Risk and its influencing Risk Factors. Then, in order to mitigate the Misalignment Risk, we suggest four steps to deal with the Misalignment Risk Factors, based on: (i) their classification according to the ERP project stages, (ii) the definition of their mutual influences, (iii) the variables detailing them, and (iv) related management practices to treat them. For the risk monitoring, we propose two monitoring steps. The first one takes place at the beginning of the project and enables to anticipatively avoid the Misalignment Risk. The second step takes place at the beginning of each stage of the ERP project life cycle, until the "business blueprint" stage. This second step enables to reactively optimize or avoid the Misalignment Risk.

---Insert here the Figure 1---

The structure of the remainder of this paper is as follows. Section 2 discusses the literature on risk factor characterization in ERP projects and selects the risk factors that influence the Misalignment Risk. Section 3 presents the operational "Risk Factor Driven" approach we propose, and Section 4 details its illustration on the case study of a French SME implementing an ERP system. Finally, Section 5 concludes on the usefulness of such an approach and proposes some research perspectives.

2. Related studies on risk factor characterization

The literature review draws on specific search facilities like ScienceDirect, ISI Web Of Science, Scopus, Springer, IEEE-Xplore. The following keywords guided our research, bearing in mind that SFs and RFs are close concepts: "Risk Factor" (RF), "Success Factor" (SF), "risk management", "ERP project", "ERP implementation", "identification", "treatment". Whereas a RF leads to project failure, a SF leads to the exact opposite as it makes the project successful [23, 24].

We selected 83 papers that were published from 1999 to 2013, including 70 % published during the last five years. These papers propose four kinds of contributions (see Table 1): (i) lists or sub-lists of RF/SF, and (ii) classifications according to the RF/SF nature (internal/external to the ERP project), (iii) classifications of the RF/SF according to the ERP project life cycle stages and (iv) influences between RF/SF (causality, co-variance, and residuality). We then exploited these papers to define the set of RFs linked to the Misalignment Risk.

---Insert here the Table 1---

2.1. Risk factor lists

Because of the high number of papers proposing RF/SF lists, and by unifying the vocabulary, we obtain our own list of 29 RFs (see Table 2). We group the RFs by synonymous and complementary notions. For example the notions of "incomprehensive requirements" and "incomplete requirements" complete each other to form the "Poor requirement definition" factor. This list thus constitues a kernel of ERP project RFs that can be exploited to mitigate the Misalignment Risk.

---Insert here the Table 2---

We remove the RF "Difficulty of managing multi-sites aspects". Indeed, the underlying difficulty of this aspect is the difficulty to manage different specific needs from a site to another. Thus, this RF can be managed through the RF "Poor requirement definition".

2.2. Classification by nature

The first way to classify RFs / SFs is by their nature, e.g. internal vs. external to the ERP project team [25-27], and project management vs. system aspects [25, 28-33]. The first classification enables us to ascertain whether the project team can act or not on a given RF during the ERP project. We therefore consider this classification as a way to define the RFs that can be treated.

For the Misalignment Risk management, we therefore focus only on the internal RFs, as the external ones are not in charge of the ERP project team. As a result, we remove the external RF "Organizational instability / lack of expertise / involvement of the company".

An inadequate treatment of this external RF can affect the ERP project. In turn it will impact the internal RFs that we mitigate. Thus, excluding this external RF does not mean that we rule out this possible effect.

2.3. Classification depending on ERP project life cycle

Researchers have described ERP project life cycles using different models according the target application. These models like these proposed in [15, 34, 35] contain different phases that vary in number and vocabulary used. It is generally assumed that the project life cycle has three main phases: pre-implementation, implementation and post-implementation [15, 36]. One of the most accepted frameworks is the SAP roadmap (see Figure 2). Like [5, 37], we rely on this latter roadmap which consists in five stages:

- The pre-implementation phase corresponds to the *"project preparation"* stage. This stage is about the project approval and funding process. This includes among others the definition of the project scope, the definition of the project team and the selection of the package.
- The implementation phase is composed of the three following stages:
    - The *"business blueprint"* develops a detailed documentation about how the business processes should be managed and supported by the ERP system. It is during this stage that a gap analysis is completed leading potentially to misalignment between the ERP system and the company's needs.
    - The *"realization"* covers several activities: system configuration, hardware – network connection, reengineering of processes, execution of the change management plan.
    - The *"final preparation"* includes: testing the system on critical processes, conducting end-users training, setting up the Help Desk, bugs – fixing, tuning and optimization of data and parameters, ending the data migration from legacy systems, setting the Go Live.
- The post-implementation phase corresponds to the " *"GoLive & support"* stage. This stage starts from system activation and ends when "normal operations" have been achieved.

---Insert the Figure 2 here---

Using the ERP project life cycle as a key classification of RFs enables us to know when a given RF has to be considered. [38-40] make this classification according to the importance of a factor for a given stage. The evaluation of the importance is based on experts' perceptions. [15, 41-44] evaluate this importance according to the possibility of a RF occurring at each stage. We can deduce from these works that there are two kinds of RF (see Figure 3):

- Horizontal RFs that must be taken into account throughout the project life cycle, such as the RF "Problem with the project manager".
- Vertical RFs that concern some isolated stages of the project life cycle.

---Insert the Figure 3 here---

Alignment management is performed during the "Businesss blueprint" stage, particularly when the gaps between the ERP system and the company's needs are identified and treated by configuration of the ERP system. Thus, in order to mitigate the Misalignment Risk, we consider the 4 vertical RFs of the "business blueprint" stage. The next sub-section allows considering the RFs influencing these 4 RFs.

2.4. Influences

The studies dealing with the influences between factors detail three kinds of influence: causality, co-variance, and residuality. The causality influence means that the occurrence of one RF can generate the occurrence of another one [24, 45-50]. The residuality influence exists when a RF that is not treated during an ERP project phase impacts the following phases. This RF either occurs again, or implies the occurence of another RF. The co-variance influence means that, alone, the occurrence of a given RF cannot lead to the failure of the ERP project. This failure is more likely to be the result of the occurrence of several RFs together. The residual influence could be useful to identify the RFs that influence the four RFs of the "business blueprint" stage, and that we have already identified as being linked to the Misalignment Risk. In our approach, this may further our understanding of the source of the occurrence of these four RFs. Indeed, the inadequate treatment of the influencing RFs can affect the occurrence of one of the four influenced RFs. For example, a systems integrator with a lack of expertise (F12) may manage the ERP system customization inadequatly (F20). In this case F12 is the influencing RF and F20 the influenced one.

We therefore build a residual link matrix that decribes the link existing between RFs (see Table 3). Each line lists the influencing RFs and each row the influenced one. A grey cell in the matrix means that there is a residual link between two RFs. The definition of these links stems: (i) from the studied works, giving examples of residual influences [49-51] and, (ii) from studies that list and define RFs [15, 29, 39, 43, 52-58], based on keywords like "affect", "enable", or "influences".

---Insert here the Table 3---

As a result, to the four vertical RFs of the "business blueprint" stage, we add eleven horizontal RFs and four vertical RFs from the pre-implementation phase. These 19 RFs constitute the "Misalignment" RFs (MRFs) (see Figure 3, MRFs are in bold face).

3. Operational "Risk Factor Driven" approach

The operational "Risk Factor Driven" approach (see Figure 1) exploits the nineteen MRFs defined in Section 2. We consider the vertical RFs of the "business blueprint" stage, and those influencing them (horizontal RFs and vertical RFs from the pre-iimplementation phase). Indeed, misalignment is managed during the "business blueprint" stage and influenced by the pre-implementation phase. As a result the approach is dedicated to the pre-implementation phase and the "business blueprint" stage of an ERP project.

The following sections detail the Misalignment Risk mitigation and monitoring activities. The mitigation has four steps: identification of (i) the MRFs concerned, identification of (ii) the MRFs that occurred and (iii) identification of the residual MRFs and (iv) their treatment.

3.1. Identification of the Misalignment RFs concerned

This step enables a company to define, according to the current stage of the ERP project, the potential MRFs that may have occured. To this end, we propose to exploit the ERP project life cycle classification (see Figure 3). The MRFs concerned are the horizontal MRFs and the vertical ones from the past and current stages.

For example, if the current stage of the ERP project is the "project preparation" of the pre-implementation phase, then the MRFs concerned are the horizontal ones and the vertical ones from this satge (F15, F16, F17a and F18).

This sub-set of MRFs will be used as a basis for the identification of the MRFs that occurred.

3.2. Identification of Misalignment RFs that occurred

This step consists in the identification of the MRFs that occurred among those concerned, and that have already been identified during the previous step of the approach. The identification exploits a set of variables detailing each MRF (see Appendix A). To define them we rely: (i) on our own field experience and (ii) on the seventy studied works that list and define RFs in ERP projects. More exactly, we extract the variables on the basis of key words like "is linked to", "is defined as" or even "in this RF, we also include".

A MRF can be considered as having occurred if one of its variables is true. For example, if the variable "Different cultures" is true, the MRF "Inadequate misalignment management" has occurred.

3.3. Identification of Residual Misalignment RFs

This step consists in identifying the additional MRFs that should be considered in order to avoid the Misalignment Risk. In other words, we look for the four vertical MRFs of the "business blueprint" stage that are likely to occur. Before the "business blueprint" stage this enables us to anticipate their occurrence. During the "business blueprint" stage it enables us to identify additional MRFs that must be treated.

To do this, the MRF residual link matrix (see Table 3) is exploited. We focus on the MRFs that have already been identified as having occurred (lines of the matrix). We then look for the grey cells in the matrix corresponding, in the column, to the four MRFs of the "business blueprint" stage that are likely to occur. For example, if the MRF "Problem with the project manager" has been identified as having occurred, this means that the MRF "Poor requirement expression" has a high probability of occurring and has to be taken into account.

3.4. Treatment of Misalignment RFs

To succeed in the treatment of the MRFs, we identify appropriate "management practices". According to the Oxford Dictionnary a practice is "the actual application or use of an idea, belief or method, as opposed to theories relating to it". In our context, a management practice is an activity that is relevant to treating a MRF.

Thus, we formulate 37 management practices (see Appendix B) based on: (i) our own field experience; (ii) actions that are merged into the RFs definitions; (iii) studies focusing on particular activities of the ERP project like Business Process Reegineering; and (iv) ERP project management books.

Finally, we associate each of the 37 management practices with the 19 MRFs that they treat (see Appendix C). For example, the practice P20 ("Write and validate the reports during the meetings") contributes to the treatment of the MRF F2 ("Ineffective project management").

3.5. Misalignment Risk monitoring

Misalignment Risk monitoring assesses the evolution of the Misalignment Risk. In order to highlight and manage the risk evolution, we propose two steps to apply the mitigation process during the ERP project (see Figure 1).

3.5.1 Misalignment Risk monitoring process

The first step consists in applying all the management practices by anticipation at the beginning of the pre-implementation phase of the ERP project. This allows the anticipative avoidance of the Misalignment MRFs, and consequently of the Misalignment Risk as well.

The second step is the application of the mitigation process – identification of the concerned, occurred and residual MRFs, and treatment of the MRFs – at least at the beginning of each of the ERP project stages that we consider (project preparation and business blueprint). Through this step, the MRFs can be:

(a) Either reatively avoided : this case takes place when all the management practices associated with a MRF that has occurred can be applied and allow its avoidance.

(b) or reactively optimized: this case takes place when at least one identified management practice associated with a MRF that occurred: (i) cannot be applied – meaning that the practice is linked to a past activity of the project – and (ii) has not been effectively implemented in the past. In this case, the practices that can be implemented during the current stage do not allow the MRF to be avoided, but only to be optimized.

3.5.2 Misalignment Risk evolution monitoring

The implementation of the two monitoring steps enables a project manager to better unserstand the state of the Misalignment Risk.The following points can be highlighted in the evolution of the risk:

- First, at a specific time during the ERP project, one can determine whether the Misalignment Risk can be avoided or only optimized. If at least one of its related MRFs is reactively optimized, the Misalignment Risk will also be optimized.
- Secondly, one can determine the evolution of the occurrence probability of the Misalignment Risk. If, between two applications of the mitigation process, additional MRF(s) are identified as having occurred, the probability occurrence of the Misalignment Risk increases.

4. Case study

This section illustrates the use of the“Operational Risk Factor Driven” approach through the case study of a french Small and Medium Enterprise (SME) of 120 persons. This SME is specialized in the manufacturing and marketing of height access and personal safety equipment for the building and manufacturing industries. The company decided in 2008 to change its ERP system. As the as-is system had reached “the end of life”, its maintenance was no longer insured. At the end of 2008, the company selected a new ERP system for which the “business blueprint” stage began in January 2009..

4.1. Methodology

We apply the mitigation steps of the “Operational Risk Factor Driven” approach “afterwards” on two periods of the “business blueprint” stage of the ERP project:

(i) The “global gap analysis period” from january 2009 to june 2009. This consisted in the identification of the gaps between the ERP system and the company’s real needs and the corresponding decision-making

(ii) The“detailed gap analysis period” from november 2009 to february 2010. In fact, after completing the gap analysis in june 2009, the company did not directly moved to the “realization” stage. Indeed, the project team realized that the gap analysis performed until june 2009 was performed at a too global level. Thus, it was impossible to customize and parameterize the ERP system to the real need of the company. Therefore, the project team performed a more detailed gap analysis from november 2009.

We then monitor the risk through the analysis of the evolution between the two periods analyzed.

The data were collected through: (i) the analysis of the documentation provided by the company (project specifications, meeting reports), and (ii) our attendance at the business blueprint meetings.

This ex post research approach was an opportunity for the company to analyze the way it mitigated and monitored the Misalignment Risk of its ERP project. This highlights the evolution of the Misalignment Risk occurrence and the management practices implementation between the two periods.

4.2. Misalignment Risk mitigation

The results of the risk mitigation for the “global gap analysis period” and “detailed gap analysis period” are detailed in Tables 4 and 5.

---Insert here the Table 4---

---Insert here the Table 5---

4.2.1 Identification of the Misalignment RFs concerned

As the Misalignment Risk mitigation is applied in this case study to the "business blueprint" stage, the MRFs concerned are the nineteen MRFs (see Figure 1 RFs in bold type).

4.2.2 Identification of the Misalignment RFs that occurred

The MRFs that occurred for the two periods have been identified by means of the variables defining each MRF (see Appendix A). Tables 4 and 5 highlight them in bold type and detail each of the associated variables identified as true.

For the pre-implementation phase, we identify the "Inadequate BPR ("Business Process Reengineering")" RF as having occured. The variables "Incomplete redesign" and "BPR made at the wrong time" have been identified as true. The BPR has been applied to only a few business processes. Moreover, the BPR was done not before the requirements formulation, but rather in parallel with the "business blueprint" stage.

Six horizontal MRFs are identified as having occurred for the "global gap analysis period", and eight for the "detailed gap analysis period".

Three vertical MRFs of the "business blueprint" stage are identified as being acknowledged for the two periods.

4.2.3 Identification of Residual Misalignment RFs

The MRFs that were likely to occur have been identified by means of the residual link matrix in Table 3. They are highlighted in grey in Tables 4 and 5.

The MRF "High degree of the software package complexity" (F21) has been identified as likely to occur during the two periods. There is a cell in grey, in the residual link matrix (see Table 3, at the intersection of this MRF with F7 "Problem with the project manager" and F12 "Lack of expertise of the integrator").

4.2.3 Treatment of "Misalignment RFs"

For the MRFs identified as having occurred, Tables 4 and 5 detail the practices that the company should have applied. They have been identified thanks to the management practices / MRF matrix (see Appendix C). The identified management practices are the following:

- The management practices associated with the MRF that occurred in the pre-implementation phase – "Inadequate BPR ("Business Process Reengineering")" (F15) – could not have been implemented during the two analyzed periods. The BPR is related to the pre-implementation phase of the ERP project and not to the implementation phase.
- All the management practices associated with the MRFs that occurred in the "global gap analysis period" could have been applied.
- All the management practices associated with the MRFs that occurred in the "detailed gap analysis period" could have been applied except those associated with the MRF "Lack of expertise of the integrator". Thus, these practices concern the selection of a new systems integrator. They were linked to past activities during the "detailed gap analysis period".
- Finally, the management practices associated with the residual MRF ("High degree of the software package complexity") could all have been applied for the two periods.

4.3. Misalignment Risk monitoring

Tables 4 and 5 present the modes the company should have applied for each MRF that occurred or was residual. Table 5 also details the evolution between the two periods of: (i) the MRFs occurence, (ii) their acknowledged variables, and (iii) the management practices' implementation.

We first notice that anticipative avoidance has not been applied. Thus, none of the management practices has been implemented at the beginning of the ERP project.

Reactive avoidance could have taken place for all MRFs identified as having occurred, except for the MRF "Lack of expertise of the systems integrator" that could have been optimized. In other words, the Misalignment Risk could not have been avoided anymore.

The analysis of the evolution between the two periods enables us to highlight the evolution of the Misalignment Risk. The occurrence probability of the Misalignment Risk increased between the "global gap analysis period" and the "detailed gap analysis period". We identified nine MRFs that occurred in the "global gap analysis period", against 11 in the "detailed gap analysis period".

The number of MRFs that occurred increased because of the management pratices that had not been implemented. More precisely:

- Only one horizontal MRF ("Lack of expertise / involvement / absence of external consultants") was reactively avoided between the two periods. An external consultant had been selected (P29) and the P22 practice had been partially applied (only the roles and responsibilities of the external consultant were defined, and not those of the rest of the project team).
- The other horizontal MRFs still remained as having occurred. For two horizontal MRFs – F2: "Ineffective project management" and F11: "Lack of expertise / involvement of key users" – more variables were identified as true.

This resulted from the application of only one practice – P20 practice associated with the F2 MRF: "Write and validate the reports during the meetings" – of the ten management practices associated with the F2 and F11 MRFs.

- Furthermore, three additional horizontal MRFs have been identified as having occurred in the "detailed gap analysis period". These factors are: F8: "Inadequate estimation of the planning time project", F10: "Joint work difficulties between the company and the external members" and F12: "Lack of expertise of the integrator". The corresponding management practices – P18: "Confidence of the project team"; P19: "Project team retrospective" and P26: "Conduct teamwork exercises" – were already identified during the "global gap analysis period", for other MRFs that had occurred but were not implemented.
- All the vertical MRFs of the "business blueprint" stage remained as having occurred between the two periods analyzed. The associated variables remained identical between the two periods. Only three of the eight practices identified during the "global gap analysis period" were implemented: P6 "Formalize, using a simple and intuitive formalism, the business processes wished by the company and the ERP system standard functionality"; P12 "Organize meetings to validate ERP system customization requests according to economic, functional and budgetary issues criteria"; and P15 "Make the project manager the primary contact to take both technical and business-related decisions that are impediments".

4.4. Discussion

The case study shows that the company became intuitively aware of the misaligment risk of its project, especially by applying management practices between the two periods analyzed (like P22 and P29 practices corresponding respectively to: "Determine, in writing at the outset of the project, the roles and responsibilities of each project team member" and "Select external consultants based on experience and skills criteria"). However, this was not enough to mitigate the misalignment risk. The company faced the occurrence of the misalignment at the beginning of the "realization" stage. In turn, the company was forced to repeat the "business blueprint" meetings. Several conclusions can be drawn from the application of the "Operational Risk Factor Driven" approach.

First, the ERP project life cycle classification enables a company to save time by focusing on the most critical MRF at a specific point during the project. If the approach were applied during the "Project preparation" stage, trying to identify the MRFs of the other stages would be a waste of time.

The residual link matrix highlights residual links and points out the additional MRFs, of the "business blueprint" stage, that should be taken into account. In the case study, this is the case of the factor related to the modules' complexity. The F12 MRF "Lack of expertise of the systems integrator" occurred and influenced the module complexity factor. As a result, the systems integrator could take care of the modules' complexity.

Furthermore, the case study shows that the variables we define for each MRF enable a practitioner to build a picture of the MRFs. This removes subjectivity and misinterpretations and increases the likelihood of identifying the occurrence of MRFs. For example in the case study, without the variables, the MRF "Poor composition of the project team" could not have been identified as having occurred. Without the variables, it is difficult to point out the problem in the project team's composition.

For the MRF treatment, the table that associates the MRFs to the associated managemend pratices serve to implement concrete actions that guide the team work effectively.

The misalignment risk monitoring itself is well supported by the proposed modes. The case study shows that the repeated implementation of the mitigation process enables the project team to draw up an historic account of the Misalignment Risk mitigation. Highlighting which management practices have been implemented or not between the two periods furthermore enables one to define what must be improved from one anlyzed period to another.

The company of our case study can still benefit from the proposed approach. Since the "realization" stage of the company's customer and maintenance services modules have not begun yet, the company can alrealdy apply the proposed approach for these modules.

5. Conclusions and perspectives

The alignment management between the standard functionality of the ERP system and the real company's needs is a critical issue in ERP projects. In this paper, we propose the "Operational Risk Factors Driven" approach to manage this alignment. This approach serves to mitigate and monitor what we call the "Misalignment Risk", that is, the probability that the ERP system does not meet the requirements of the company, once the ERP is implemented.

Contrary to existing approaches, this approach: (i) lists the risk factors that influence the Misalignment Risk and (ii) guides the MRFs mitigation and monitoring activities by providing operational means to implement them. The mitigation is divided into four steps: (i) identification of the MRFs concerned, by means of the ERP project life cycle classification; (ii) identification of the MRFs that occurred, by the definition of variables detailing each MRF; (iii) identification of the residual MRFs, by means of the residual link matrix; and (iv) treatment of the MRFs through the management practices / MRFs table. The monitoring activity consists in two steps: (i) application of all the management practices at the beginning of the ERP project in order to avoid the MRFs and therefore the Misalignment Risk; (ii) application of the the four monitoring steps at least once at the beginning of each stage of the ERP project until the "business blueprint" stage. This enables the avoidance or reactive optimization of the MRFs. This repeated application of the mitigation steps enables the monitoring of the Misalignment Risk.

From an academic point of view, the "Operational Risk Factor Driven" approach constitutes real progress for alignment problem solving. By managing it as a risk, it guides researchers in the understanding of major issues. The highlighting of MRFs, including residual influences, furthers our understanding of the sources of the misalignment problem. The MRFs of the "business blueprint" stage are those directly linked to this problem. Nevertheless, focusing on the treatment of these RFs is not enough to manage the misalignment problem. Indentifying the RFs influencing them makes it possible to anticipate their occurrence.

Apart from its research implications, the approach can help a company to efficiently steer its alignment problem management. This has been illustrated through the application of the approach in two periods of a small company ERP project. This application highlighted the occurrence of MRFs, and ways to treat them, that the company had not identified. In this context, the use of the approach could help the company to increase its internal expertise and limit external expertise support.

The application of the approach to other ERP projects will allow for its consolidation and enhance its benefits for companies.

From a research point of view, this method is a first step towards an "Operational Risk Factor Driven" optimized approach. Completing the identification of the MRFs with metrics to assess them and their impact on the probability of occurrence of the Misalignment Risk would increase the risk mitigation and monitoring efficency. This could be based on the work of [37, 59] which assesses the RFs criticality. Further research also has to be done in order to improve the set of management practices. A best pratices repository like the SCOR [60] for supply chain management would improve treatment efficiency.

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7. Figure captions

Figure 1- ERP project life cycle
Figure 2- Classification of the 27 risk factors according to the ERP project life cycle
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8. Tables captions

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9. Appendices captions

Appendix A- Variables of the « Misalignment Risk Factors »
Appendix B- Management practices associated with the « Misalignment Risk Factors »
Appendix C- Management practices (Ps) / « Misalignment Risk Factors » (MRFs) association

Table 1- 83 studied works' contributions classification and the associated references

Year	Lists and sublists	Classifications / nature	Classifications / ERP project life cycle	Influences
1999	[25]	[25]		
2000	[26-28]			
2001	[29, 30]		[29]	
2002	[31, 32]			[33]
2003	[34-38]		[34]	
2004	[39-43]			
2005	[5, 44-50]	[51]	[44]	
2006	[52, 53]		[52, 54]	[55, 56]
2007	[15, 57-62]	[58]	[15, 61, 63]	
2008	[64]	[65, 66]		[24, 67, 68]
2009	[69-73]			[72]
2010	[74-82]		[79]	[80]
2011	[83-86]	[87]		
2012	[88-95]	[93]		[89, 93, 96, 97]
2013	[23, 98-102]	[22, 101, 102]	[98]	

Table 2- List of 29 risk factors

Risk factors – Number of quotations	Number of quotations	Nature : Internal (I) / External (E)	ERP project life cycle: Horizontal (H) / Vertical (V)
Inadequate misalignment management	37	I	V (business blueprint stage)
Steering committee's lack of expertise / involvement	36	I	H
Poor composition of the project team	30	I	H
Ineffective project management	29	I	H
Inadequate software package selection	26	I	V (pre-implementation phase)
End-users' lack of / inadequate training	24	I	H
End-users' lack of expertise and/or involvement / resistance to change	24	I	H
Lack of expertise and/or involvement / absence of external consultants	23	I	H
Technical problems	22	I	H
Inadequate organizational change management	21	I	H
Inadequate data conversion management	20	I	H
Organizational instability / lack of expertise / involvement of the company**	20	E	N.S.
Inadequate ERP system customization management	19	I	V (business blueprint stage)
Ineffective communication inside the work team	18	I	H
Inadequate BPR (“Business Process Reengineering”)	17	I	V (pre-implementation phase)
Problem with the project manager	17	I	H
Inadequate estimation of the financial and material resources management	16	I	H
Inadequate estimation of the project time planning	13	I	H
Work difficulties between the company and external members	13	I	H
Lack of expertise / involvement of key users	12	I	H
Lack of expertise of the systems integrator	11	I	H
Strategic goals not correctly defined	10	I	V (pre-implementation phase)
Poor requirement expression	9	I	V (business blueprint stage)
Ineffective communication between the project team and the rest of the company	9	I	H
Inadequate test achievement	6	I	H
Poor risk management	5	I	V (business blueprint stage)
High degree of the software package complexity	4	I	H
Inadequate maintenance management	4	I	H
Difficulty of managing multi-sites aspect **	2	N.S.	N.S.

Legend: ** not selected (N.S.) risk factors

Table 3- Residual link matrix between the "Misalignment Risk Factors" (MRFs)

Influencing MRFs			Influenced MRFs			
			Poor requirement expression (F17b)	Inadequate misalignment management (F19)	Inadequate ERP system customization management (F20)	High degree of software package complexity (F21)
Horizontal	(F1)	Steering committee's lack of expertise / involvement	[75]	[28]	[75]	
	(F2)	Ineffective project management	[15]	[29, 80]		
	(F3)	Poor composition of the project team	[33]	[38]		
	(F5)	Lack of expertise and/or involvement / absence of the external consultants	[29, 58, 69]	[29]		[15, 29]
	(F7)	Problem with the project manager	[29]	[29, 44]		
	(F8)	Inadequate estimation of the project time planning		[111]		
	(F9)	Inadequate estimation of the financial and material resources management		[69]		
	(F10)	Work difficulties between the company and external members (systems integrators and / or consultants)		[41]		
	(F11)	Lack of expertise / involvement of key users	[29, 38]	[38]	[75]	[27]
	(F12)	Lack of expertise of the systems integrator	[111]	[15]	[38, 75]	[38]
	(F14)	Poor risk management		[58]		
Vertical	(F15)	Inadequate BPR		[15, 27, 29]	[15, 27]	
	(F16)	Strategic goals not correctly defined	[33]	[38]		
	(F17a)	Poor requirement expression		[29]	[29]	
	(F18)	Inadequate software package selection		[29]	[29]	

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Table 4- Case study results for the "global gap analysis period"

Life cycle	Acknowledged variables	"Misalignment Risk Factors" (in bold face: occurred MRF, in grey: residual MRF)	Identified practices	MRF treatment
Vertical, pre-implementation phase	-Incomplete redesign -BPR made at the wrong time	**F15: Inadequate BPR**	-	No mode
	/	F16: Strategic goals not correctly defined	-	-
	/	F17a: Poor requirement definition	-	-
	/	F18: Inadequate software package selection	-	-
Horizontal	/	F1: Steering committee's lack of involvement / expertise	-	-
	-Lack of project management methods -Lack of project management tools	**F2: Ineffective project management**	P11, P17, P19, P20	React. av.
	-Inadequate distribution of roles and responsibilities	**F3: Poor composition of the project team**	P22	React. av.
	-No external consultants	**F5: Lack of expertise and/or involvement / absence of external consultants**	P22, P29	React. av.
	-No project manager	**F7: Problem with the project manager**	P4, P15, P17, P22, P24, P25	React. av.
	/	F8: Inadequate estimation of the project time planning	-	-
	/	F9: Inadequate estimation of the financial and material resources management	-	-
	/	F10: Work difficulties between the company and external members	-	-
	-Lack of business expertise	**F11: Key users' lack of expertise / involvement**	P5, P8, P18, P19, P22, P25, P26	React. av.
	/	F12: Lack of expertise of the systems integrator	-	-
	-Partial risk management process	**F14: Poor risk management**	P30	React. av.
Vertical, "business blueprint" stage from the implementation phase	-Lack of modelling of the business processes wished by the company -Lack of formalization of the ERP system business processes -Poor management of the adequacy meetings - Decisions taken lightly	**F19: Inadequate misalignment management**	P6, P14, P15, P31	React. av.
	-No analysis of the need to customize according to the company's objectives -No analysis of the customization costs	**F20: Inadequate ERP system customization management**	P12, P14, P15, P23	Reactive av.
	-Incomplete formulated requirements -Incomprehensible formulated requirements -Level of granularity not sufficiently high -Lack of formalization of the formulated requirements	**F17b: Poor requirement expression**	P6	React. av.
	/	**F21: High degree of software package complexity**	P9, P15	React. av.

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Table 5- Case study results for the "detailed gap analysis period "

Life cycle	**True variables**	**Variable evolution**	**“Misalignment Risk Factors” (in bold face: MRF that occurred, in grey: residual MRF, in italics: new MRF that occurred)**	**Practices implemented?**	**Identified practices**	**MRF treatment**
Horizontal	/	-	F1: Lack of involvement / expertise of the steering committee	-	-	-
	-Lack of project management methods -Lack of project management tools -No compliance of the schedule	One more	**F2: Ineffective project management**	P20	P11, P17, P19	React. av.
	-Inadequate distribution of roles and responsibilities	Same	**F3: Poor composition of the project team**	P22 (partially)		React. av.
	/	One less	F5: Lack of expertise and/or involvement / absence of external consultants	P22 (partially for the external consultants), P29	-	-
	-No project manager	Same	**F7: Problem with the project manager**	-	P4, P15, P17, P22, P24, P25	React. av.
	-Unrealistic schedule	New factor	***F8: Inadequate estimation of the project time planning***	**-**	**P33**	**React. av.**
	/	/	F9: Inadequate estimation of the financial and material resources management	-	-	-
	-Different work methodologies	New factor	***F10: Work difficulties between the company and external members***	**P11**	**P18, P19, P26**	-
	-Lack of business expertise -Lack of presence -Work not done	Two more	**F11: Key-users' lack of expertise / involvement**	-	P5, P8, P18, P19, P22, P25, P26	React av.
	-Lack of expertise -Lack of project management skills	New factor	***F12: Lack of expertise of the integrator***	-	**P18, P19, P22, P26**	**React. opt.**
	-Partial risk management process	Same	**F14: Poor risk management**	-	P30	React. av.
Vertical, “business blueprint” stage from the implementation phase	-Lack of modelling of the business processes wished by the company -Lack of formalization of the ERP system business processes -Poor management of the adequacy meetings -Decisions taken lightly	Same	**F19: Inadequate misalignment management**	P6 (partially)	P14, P15, P31	React. av.
	-No analysis of the need to customize according to the company's objectives of -No analysis of the customization costs	Same	**F20: Inadequate ERP system customization management**	P12, P15 (partially)	P14, P23	React. av.

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Life cycle	True variables	Variable evolution	"Misalignment Risk Factors" (in bold face: MRF that occurred, in grey: residual MRF, in italics: new MRF that occurred)	Practices implemented?	Identified practices	MRF treatment
	-Incomplete formulated requirements -Incomprehensible formulated requirements -Lack of formalization of the formulated requirements	One less	**F17b: Poor requirement expression**	P6 (partially)		React. av.
	/	-	**F21: High degree of software package complexity**	-	P9, P15	React. av.

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Appendix A: Variables of the « Misalignment Risk Factors »

F1: Lack of expertise / involvement of the steering committee
-Lack of involvement
-Lack of project members' expertise
-Lack of support from the management of the company
-Poor decision-making
-Lack of involvement of the management of the company

F2: Ineffective project management
-Lack of project management methods
-Lack of project management tools
-Inadequate project management methods
-Ineffective project management tools
-Inadequate use of project management methods
-Inadequate use of project management tools
-No compliance of the schedule

F3: Poor composition of the project team
-Inadequate distribution of roles and responsibilities
-Unbalanced skills
-Members' turnover
-Insufficient number of members

F5: Lack of expertise / involvement / absence of external consultants
No contribution of expertise to the company
-Lack of involvement
-Lack of business expertise
-Lack of experience
-Lack of technical skills
-No external consultants

F7: Problem with the project manager
-No project manager
-Poor unifying
-No authority
-Lack of availability
-No will to succeed
-Lack of participation
-Lack of involvement
-Poor planner
-Work delegated
-Lack of business expertise
-Lack of technical skills

F8: Inadequate estimation of the project time planning
-Unrealistic schedule
-Activities precedence not taken into account
-Incompatible schedule

F14: Poor risk management
-Partial risk management process
-Risk management tools not used correctly

F9: Inadequate estimation of the financial and material resources management
-Inadequate estimation of financial resources
-Inadequate allocation of financial resources
-No release of material resources

F10: Joint work difficulties between the company and external members (integrators and / or consultants)
-Different cultures
-Different work methodologies
-Disagreements between members of the integrator team

F11: Lack of expertise / involvement of key users
-Lack of business expertise
-Lack of project management skills
-Lack of presence
-Work not done
-Little confidence in himself?
-Lack of technical skills

F12: Lack of expertise of the integrator
-Lack of expertise
-Lack of experience
-Lack of project management skills

F15: Inadequate BPR
-No BPR
-Failure in the business process redesign
-Incomplete redesign

F16: Strategic goals not correctly defined -
Disagreement on goals
-Fuzzy goals
-Reason to change the I.S. not taken into account

F18: Inadequate software package selection
-No selection according to the budget
-No selection according to the delivery
-No selection according to the functional aspect
-No selection according to the technical aspect
-No selection according to the editor
-Poor editor's service quality

F17a: Poor requirements expression
Wrong formulated requirements
-Incomplete formulated requirements
-Incomprehensible formulated requirements
-No formalization of high level requirements
-Requirements formulation not based on the as-is of the company
-No stabilized formulated requirements
-Inadequate level of granularity
-Poor consideration of the functional perimeter
-Lack of formalization for the formulated requirements

F19: Inadequate misalignment management
-Different cultures
-Lack of modelling of the business processes wished by the company
-Lack of formalization of the ERP system business processes
-Poor management of the adequacy meetings
-Pressure on the decision-making
- Lightly taken decisions
-Integrity of the integration not taken into account

F20: Inadequate ERP system customization management
-No analysis of the need to customize according to objectives of the company
-No analysis of the customization costs
-No integrity of the integration management

F17b: Poor requirement expression
- Wrong formulated requirements
-Formulated requirements not stabilized
-Incomplete formulated requirements
-Incomprehensible formulated requirements
-Level of granularity of what? not sufficiently high
-Requirements formulation not based on the as-is of the company
-Lack of formalization for the formulated requirements

F21: High degree of the software package complexity
-No estimation of the modules' complexity
-Module complexity not taken into account

Pre-implementation, Project preparation stage → Implementation, business blueprint stage

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Appendix B- Management practices associated with the “Misalignment Risk Factors”

Num	Practice
P1	Select the software package in two steps: make a "short list" of two or three software package candidates then make the final selection. The "short list" must be drawn up in the space of a few days to a few weeks, depending on the competitors' choice and on geographical, technical, longevity, reputation and international coverage criteria. The final choice should be made on the basis of the functional coverage.
P2	Select the company which integrates the software package, based on criteria of experience and skills.
P3	Select the company which integrates the software package, based on geographical criteria and on management proposals and recognition from the publisher.
P4	Appoint a project manager, based on legitimacy, charisma and skills.
P5	Select key users, based on experience, skills, integration, adaptation and motivation.
P6	Using a simple and intuitive method to formalize the business processes wished by the company and the ERP system's standard functionality.
P7	Model and analyse the as-is of the company in terms of business processes. This will be a basis for modelling the business processes wished by the company.
P8	Establish the training plan for key users.
P9	Establish the deployment of the modules.
P10	Organize short weekly meetings of the steering committee. These should be chaired by the project manager with a report written quickly after the meeting.
P11	Organize short weekly information meetings to report the meetings of the steering committee to the project team, with a report written shortly after the meeting.
P12	Organize meetings to validate ERP system customization requests according to economic, functional and budgetary criteria.
P13	Provide the budget for the following major budgetary items: equipment and infrastructure, internal business team, internal Information System team and external team.
P14	Based on the nature of the decision, identify project members who have a say in it.
P15	Make the project manager the primary contact for both technical and business decisions when there is deadlock.
P16	From the beginning of the project, and based on the characteristics and habits of the company, choose a suitable control mode: open, closed, or bitmap.
P17	Establish an ad hoc relationship between the project manager and each the project stakeholder to make the project progress.
P18	Implement the dynamic spiral process to build the confidence of members of the project team.
P19	Apply the project team retrospective by taking a break during the operating activities to talk about the team itself.
P20	Write and validate the reports during the meetings.
P21	Do not include the potential ERP system customizations in the fixed-price contract.
P22	Determine, in writing at the outset of the project, the roles and responsibilities of each project team member.
P23	Establish, at the outset of the project, the attitude/ philosophy towards the ERP system customization and hold it until the end of the project.
P24	Keep the project manager informed of everything that happened during the project through a formal procedure.
P25	Officially release the project members of their daily tasks.

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Num	**Practice**
P26	Conduct teamwork exercises.
P27	Define the project's contribution to the strategic goals of the company.
P28	Align the strategic objectives of the project with those of the company.
P29	Select external consultants, based on experience and skills.
P30	Establish a risk management process.
P31	Prepare business blueprint meetings by modelling the business processes that must be aligned with the standard business processes and stick to it.
P32	Make available to the project team the necessary hardware.
P33	Plan the project stages in detail.
P34	Choose between making a radical, pragmatic or opportunistic BPR, based on company’s objectives in terms of cost, time and expected returns on investment.
P35	Perform the BPR before selecting the software package and define the company’s needs.
P36	Determine the most appropriate granularity level for the company’s requirements formulation, before selecting the software package.
P37	Determine the functional perimeter concerned by the macroscopic requirements modelling.

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Appendix C- Management practices (Ps) / "Misalignment Risk Factors" (MRFs) association

Misalignment Risk Factors	Management practices associated to the MRFs
F1	P10
F2	P11, P16, P17, P19, P20, P26
F3	P22
F5	P18, P19, P22, P26, P29
F7	P4, P15, P17, P18, P19, P22, P24, P25, P26
F8	P33
F9	P13, P32
F10	P11, P18, P19, P26
F11	P5, P8, P18, P19, P22, P25, P26
F12	P2, P3, P18, P19, P22, P26
F14	P30
F15	P34, P35
F16	P27, P28
F17	P6, P7, P36, P37
F18	P1
F19	P6, P14, P15, P31
F20	P12, P14, P15, P21, P23
F21	P9, P15