DOI 10.2298/CSIS101110041I

An Enterprise Information System Agility Assessment Model

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Abstract. The enterprise strategy is influenced by the environment changes: socio economic, legislative, technology, and the globalization. This makes its Information System more complex and competition increasingly fierce. In order for an enterprise to ensure its place in this hard context characterized by rapid and random changes of the internal and external environments, it must have fast adapting policy of its strategy and drive quickly important changes at all levels of its Information System in order to align it to its strategy and vice versa; that's, it must always be agile. Therefore, agility of the Enterprise Information System can be considered as a primary objective of an enterprise. This paper deals with agility assessment in the context of POIRE project. It proposes a fuzzy logic based assessment approach in order to measure, regulate and preserve continuously the Information System agility. It also proposes a prototype implementation and an application of the proposed approach to a tour operator enterprise.

Keywords: Enterprise Information Systems (EIS), fuzzy logic, continuous improvement, urbanization, governance, reactivity, POIRE framework, agility dimensions, agility evaluation, regulation and preservation.

1. Introduction

The work of an enterprise as a system might be considered in terms of goals and objectives such as revenues, profits, market share, budgets, and all enterprises face similar challenges: growth, value, focus, change, future, knowledge, and time [38], and security problems and/or attacks. Information system is often considered as the heart of any organization; hence, the performance of the enterprise depends on the efficiency of its information system. The enterprise strategy is influenced by the socio economic, legislative and technology changes. Moreover, the globalization of the economy makes the enterprise information systems more complex and competition increasingly fierce. So the enterprise, in order to ensure its survival and its sustainability, it must be agile permanently; that's, an enterprise must have fast adapting policy of its strategy and drive quickly important changes at all levels of all its dimensions in order to align them to its strategy and vice versa. This can be achieved by first getting an urbanization plan [28], [40] and continuously, the enterprise must be driven according to a governance framework [3], relying on an appropriate set of best practices and/or standards. Actually, the information system is becoming a tool of strategy for most of organizations**.**

To bring to its full potential, any enterprise requires various categories of applications at its various levels; such as: (1) computer-aided design (CAD) systems that are used for design of manufacturing products; (2) enterprise resource planning (ERP) systems that are used to manage the marketing and sales, inventory control, procurement, distribution, human resources,… ; (3) engineering document management (EDM) systems that are used to manage and leverage the enterprise digital design data investment; (4) materials requirements planning systems (MRP) that are used to manage manufacturing processes, (5) manufacturing execution system (MES) that are used to manage and monitor work-in-process on the factory floor; (6) computer-aided management and manufacturing (CAMM) systems that are used for mechanical, electrical or electronic engineering, and analysis and manufacturing; (7) product data management systems (PDM) that are used to manage the product's data; (8) product life cycle management (PLM) systems that are used to manage the entire life cycle of a product; (9) enterprise asset management (EAM) systems that are used to manage maintenance operations on capital equipment and other assets and properties [44].

A general characterization of enterprise applications in today's context is that they are HAD (Heterogeneous, Autonomous and Distributed) systems [2], [16]. Heterogeneous means that each enterprise application implements its own data and process model using different languages, interfaces, and platforms; which may result in different levels of heterogeneity: technical, syntactic and semantic. Autonomous refers to the fact that enterprise applications run independently of any other enterprise application. Distributed means that, enterprise applications locally implement their data model which they generally do not share with other enterprise applications.

Furthermore, today's industrial information systems have other specific characteristics:

- A strong automation of processes: this implies a strong dependence on the computing. This requires to extract all the knowledge embedded by the automated systems in order to make possible or to favor knowledge transfer, learning or simply maintenance;
- A strong evolution of systems: the systems are strongly changing because of the permanent evolution of the enterprise business that

implies that these systems must be relatively autonomous and loosely coupled to get more flexible information systems;

- An imperative cooperation: systems have to operate together to achieve business enterprise objectives. Each of these systems manages specific information using specific processes.

In such systems, we can conceive that the representation of the information and the processes is specific. On the other hand, it is imperative that these systems cooperate in a flexible way to allow exchanges, facilitate the reuse of their services and facilitate their modernization. Moreover, it is imperative that the enterprise will be agile in order to correctly face changes.

Nowadays, the above agility requirement constitutes a major preoccupation of organizations, which look for more flexibility and reactivity to respond to diverse changes. The main reasons of these constantly evolution and changes are generally the organization evolution, the evolution of regulations in force, business evolution, IT evolution, and cost containment [33]. As a consequence of all these evolutions, it becomes necessary to structure, develop and integrate the EIS in an agile way to facilitate its evolution and adaptation with respect to the enterprise strategy within the scope of the EIS governance on the basis of best practices and/or standards.

However, in practice, information systems have experienced anarchic growth and their complexity increases with time. Moreover, sustaining high performance in a flat world characterized with an irregular competitive landscape raises questions, such as**:** what is driving enterprise transformation, and what will happen if we do not respond? What will the future enterprise information system look like, how it will be different from the actual one? And how to get the future information system that ensures enterprise efficiency and sustainability?

The purpose of this work is to suggest an enterprise information system fuzzy logic agility assessment model and ensures its preservation and regulation within an acceptable range with time and with respect to environments random changes. It will offer an easy and simple framework for enterprises willing to handle changes permanently and efficiently in order to be competitive in the market. Hence, this paper is organized as follows: section 2 deals with the related work. Section 3 presents the details of our proposition. Section 4 describes the implementation of the software tool. Section 5 deals with the case study. And finally section 6 outlines some conclusions and perspectives.

2. Related Work

The concept of agility originated at the end of the eighties and the early nineties in the manufacturing area in the Unites States. Agile Manufacturing was first introduced with the publication of a report by Goldman [14] entitled "21st Century Manufacturing Enterprise Strategy". Since then, the concept was extended to supply chains and business networks [1], [42], and also to enterprise information systems [31], [32] and also to software development [9].

Despite the age of the concept, there is no consensus yet on a definition of agility. According to Conboy and Fitzgerald [10], most of the agility concepts are adaptations of elements such as flexibility and leanness, which originated earlier. In developing their definitions, they draw on the concepts of flexibility and leanness to define agility as the continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change, through high quality, simplistic, economical components and relationships with its environment. According to Dessouza [12], being agile, generally, results in the ability to (1) sense signals in the environment; (2) process them adequately; (3) mobilize resources and processes to take advantage of future opportunities; and (4) continuously learn and improve the operations of the enterprise. In the same idea, Goranson [15] interpreted agility as creativity and defined the enterprise agility as the ability to understand the environment and react creatively to both external and internal changes. In the same way, Houghton and his collaborators [17] interpret agility of information systems as the ability to become vigilant. Agility can also be defined in terms of characteristics of the agile enterprise [41]: (1) sensing, (2) learning, (3) adaptability, (4) resilience, (5) quickness, (6) innovation, (7) flexibility, (8) concurrency, and (9) efficiency. Recently, [36] studied the advantage of positioning agility in order to help enterprises to better align their agile practices with stakeholder values.

As we can see, agile is a quality for both enterprises and information systems. The question which must be answered is: are agile enterprises and agile information systems distinct, or do they signify the same thing? The answer depends on two perspectives. On the one hand, the information management perspective, we can consider them as one and the same, because the concept of agile information system is used to denote an agile enterprise, or in a general manner an agile business. On the other hand, the technological perspective, we can consider them as different, because agile information systems is used to denote only instantiations of technological solutions that help the processing of information; in this case technology (i.e., the agile information system) constitutes only a component of the agile enterprise. In this paper, we mainly focus on the first perspective because it is more comprehensive and integrated. Moreover the information system is considered as the mirror of the enterprise.

From the point of view measuring agility, there are some works that treat the agility issues within enterprises and they mainly concern the strategizing of IS for agility [13], the identification of the capabilities of agility [39], the identification of the agility sources [30], and the proposition of conceptual agility framework [35], and the measurement of the agility [45].

Galliers [39] studied the agility in the strategy point of view by suggesting a framework for IS strategizing, and mentions that there are three main points for strategizing agility: (1) the exploitation strategy: concerns the environmental and organizational analysis, the enterprise information and knowledge systems, the standardized procedures and rules, and the information services; (2) the exploration strategy: it is related on the alternative futures of information systems, the existing communities of practice, the flexibility of project teams, the existence of knowledge brokers, and the possibility of cross-project learning; and (3) the change management strategy: it depends on the ability to incorporate the ongoing learning and review. In fact this framework concerns mainly the global approach of identifying the strategizing elements of the IS and it does not deal with agility evaluation and preservation. However, this work is a part of the POIRE framework, we proposed.

Sambamurthy et al. [39] distinguish three interrelated capabilities of agility: (1) operational agility: is the ability to execute the identification and implementation of business opportunities quickly, accurately, and cost-efficiently; (2) customer agility: is the ability to learn from customers, identify new business opportunities and implement these opportunities together with customers; and (3) Partnership agility: is the ability to leverage business partner's knowledge, competencies, and assets in order to identify and implement new business opportunities. These capabilities of agility are included in our approach which identifies five capabilities of agility with respect to POIRE conceptualization. Moreover, [39] do not study the agility assessment and regulation which are a main part of our work.

Concerning the identification of agility sources, Martenson [30] argues that systems can be agile in three different ways: (1) by being versatile, (2) by reconfiguration, and (3) by reconstruction. Being versatile implies that an information system is flexible enough to cope with changing conditions as it is currently set up. If current solutions are not versatile enough, reconfiguration will be needed; this can be interpreted as pent-up agility being released by a new configuration. If reconfiguration is not enough, reconstruction will be needed; this means that changes or additions have to be made to the information system. Furthermore, [30] proposed a framework that discusses how agility is produced and consumed. This is closely related to the level of agility that can be interpreted as a result of an agility production process to which resources are allocated. These agility levels are then used in order to consume agility when seizing business opportunities. Additionally, he outlines that when consuming agility within a business development effort, in many situations agility is reduced. This means that we are confronted to negative feedback that indicates how much enterprise's agility is reduced by this business development effort. [30] identifies three main sources of agility in the following order: versatility, reconfiguration and reconstruction. In our case, we deal mainly with versatility and reconfiguration. Reconstruction is not recommended for the sake of continuity of service. Moreover, Martenson [30] mentioned the fact that when consuming agility, it is reduced; but he does not study the agility regulation and preservation. This point is considered in our approach in which a cyclic life cycle and a cyclic methodology for agility assessment, regulation and preservation are proposed.

An important agility framework, which concerns the management perspective, is that proposed by Oosterhout et al. [35]. In this framework, we begin with the analyses of the change factors, where a required response of the enterprise is related to the enterprise's IT capability. Then, an enterprise's agility readiness is determined by its business agility capabilities. These latter are the reasons behind the existence or non existence of agility gaps. If there is a mismatch between the business agility needs and the business agility readiness, there is a business agility gap. This has implications for the business agility IT strategy. This framework concerns mainly agility analysis, but not agility production, regulation and preservation; however, this work is included in our framework without any contradiction.

Another important work is by Lui and Piccoli [29] who studied the agility in the socio-technical perspective and proposed a theoretical framework. In this latter, the information system is considered as composed of two sub-systems: a technical system and social system. The technical subsystem encompasses both technology and process. The social subsystem encompasses the people who are directly involved in the information systems and reporting structure in which these people are embedded. To measure information system agility using the socio-technical perspective, Lui and Piccoli [29] use the agility of the four components: technology agility, process agility, people agility, and structure agility. Hence, they argue that the agility is not a simple summing of the agility of the four components, but it depends on their nonlinear relationship and suggest the use of fuzzy logic measurement for IS agility. This framework is theoretical, but coherent; whereas our framework is practical and detailed.

Furthermore, Winsley and Stijin [46] mention the importance of preservation of agility through audits and people education. This latter aspect is important because most of organizations continually need education for continuous agility. Even though this work is theoretical, it is taken into account in our approach.

Finally, Tsourveloudis et al. [45] proposed a fuzzy logic knowledge-based framework to evaluate the manufacturing agility. The value of agility is given by an approximate reasoning method taking into account the knowledge that is included in fuzzy IF-THEN rules. By utilizing these measures, decision-makers have the opportunity to examine and compare different systems at different agility levels. For this purpose, the agility is evaluated accordingly to four aspects: (1) production infrastructure, (2) market infrastructure, (3) people infrastructure and (4) information infrastructure. [45] showed the importance of fuzzy logic in agility evaluation and consider four aspects of the IS, which are included in our POIRE framework. Moreover, our work is in line with this framework since it is based on the use of fuzzy logic evaluation.

Although all these works are important, they are either theoretical or address partially the EIS. Our work is in line with the existing approaches and is mostly close to those proposed by Lui and Piccoli [29] and Tsourveloudis et al. [45].We propose to extend these last researches to the evaluation of the agility of enterprise information system. Hence, we suggested a detailed and practical framework which, after identifying the need for agility of an urbanized EIS, will allow evaluating and regulating the global agility by maintaining the agility of each dimension within an acceptable range. Moreover, it includes the configuration management which gives the possibility of keeping track of the

EIS evolution, and the concept of good governance of EIS which are sources of agility production.

3. Proposition: the Poire Framework

This section describes the details of our proposition that are proposed in the context of the POIRE project. It extends the work of [23] in which the scope and principles of POIRE framework are presented.

3.1. Main principles

POIRE project concerns the information system agility in the context of large and complex enterprises with the aim to define agile best-practices. Within this project, agility assessment constitutes an important point that allows evaluating EIS agility maturity in order to determine the pertinent points that must be improved. Our agility approach is based on two main principles: urbanization and continuous improvement.

3.1.1. Urbanization

Information systems have several dimensions which can be analyzed with the typologies of the enterprise, and a complexity reflecting the human organization they must serve. Urbanization is necessary for two reasons: (1) maintain and manage at best a heritage until its effective obsolescence, and (2) have an agile information system able to evolve quickly and efficiently, according to the changing needs [28]. Hence, in our work, we consider urbanization as one of the agility production sources.

Due to their complexity, information systems are compared to urban systems or cities; hence the need of their urbanization. The main triggers of urbanization are: organizational changes, demand business, the IT market evolution, technological developments, the search for interoperability, and agility. Hence, urbanization makes an information system best suited to serve the enterprise strategy and anticipate changes in the business environment.

In order to reach these objectives, first, we have to define what should be the target information system, the one which will best serve the strategy of the enterprise, and satisfy the business process, in short an aligned information system; second, set the construction rules allowing the system to avoid repeating shortcomings of the former information system, and to anticipate changes, in short an agile information system; finally, determine the path to follow from the actual information system to get the new one, this needs knowing well the old information system in order to set appropriate criteria to know when to start and when finishing [6]. In fact, urbanization allows obtaining predictable information systems for which we can consider their evolution with serenity [37], allows adapting the enterprise strategies to environments 'changes [11], and identifies the boundaries between its sub systems, which is not trivial [43]. It must combine three problematic sets to reach rules and a path of urbanization: the conduct of processing, necessary security and the expected optimization.

According to [26], [28] and [40], the process of urbanization is based on three main phases: (1) identify the business strategy which determines the need, (2) definition of functional and specific requirements maps, and (3) technology orientation identification. In our case, we consider urbanization as a basis to reach alignment [7] and agility production at different levels of each dimension of the suggested POIRE conceptualization of the EIS (Fig.1). First urbanization is realized for each dimension of the EIS, this reveals the dimensions' interactions, and then the process of alignment will be executed accordingly with respect to the governance directives which are defined from the enterprise strategy. Hence the process of urbanization and alignment is first top down (analysis and design of strategy) then bottom up (execution and validation). This will increase the flexibility and alignment of the EIS, hence its agility. In this context, our proposition includes a life cycle with an urbanization phase which is, actually, being developed as further work.

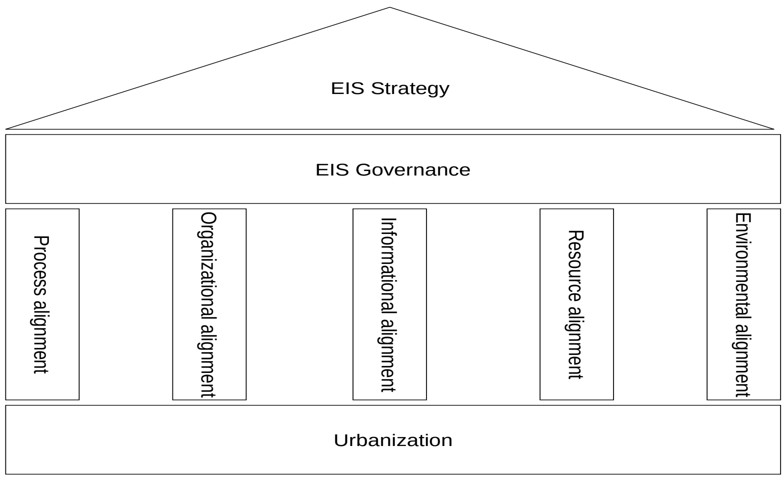


Fig.1. Urbanization and Alignment. Adapted from [7]

3.1.2. Agility and Continuous Improvement

Another aspect that's related to enterprise and then EIS agility is the continuous improvement of the products and services' quality [8], [18]. Hence, continuous improvement is the basis for achieving EIS agility regulation and preservation. In fact, improvement must be permanent, pervasive and structured in order to continuously improve the effectiveness of the EIS in the scope of agility production and consumption. Moreover, the need for improvement must be proactive. Indeed, one of the basic principles of agility as quality is prevention and continuous improvement to achieve the agility objectives that are defined and updated to reflect changes in business strategy. This means that continuous improvement is an endless project which aims to take into account failures and strategy orientation changes as early as possible with agile practices.

Agility encourages participation, because it is impossible to expect a total commitment of employees without creating an appropriate working environment, agility also means motivation and responsibility of each employee. Agility is the driver of competitiveness. The agility chain unites and connects all economic and social actors, so it is a matter of everyone and requires the participation of all.

To achieve the agility objectives and ensure continuous improvement of the EIS in order to meet the competition and conquer new markets, the enterprise must be driven according to a governance framework [3], relying on an appropriate set of best practices and/or standards combined with agile practices. Governance of the EIS ensures its management and it is considered as a management process based on best practices [25] allowing the enterprise to optimize its investments in order to achieve its agility objectives that are defined by the enterprise strategy. EIS governance allows [5]: (1) better decision-making: this can increase the efficiency of IS; (2) a clarification of the roles of different actors: it can create synergies; (3) better definition of responsibilities of the actors: this allows knowing the rights and duties of each employee; and (4) a better understanding of key processes related to the IS: this allows sharing the understanding of the complexity of processes and their implementation. Hence, good governance increases the degree of agility of the EIS. Standards and/or best practices allow: (1) the implementation of governance and improve controls of the IS; (2) evaluation, in the form of scale, of the level of achievement of one or more objectives; (3) manage the IS at all levels; (4) Audit of the IS; and (5) ensure the conformity of the IS.

Among the best practices and/or standards on EIS governance, we mainly find: COBIT (Control Objectives for Information and related Technology): dedicated to governance and audit of information systems [20]; ITIL (Information Technology Infrastructure Library) dedicated to optimize information technology services within the company [34]; ISO 27001 dedicated to audit and improve IS security [19]; CMMi (Capability Maturity Model Integration): dedicated to developing systems and software [4]; ISO 9001: dedicated to help organizations in developing general quality management systems [18].

Our contribution is based on an iterative life cycle for agility production and consumption, and a feedback loop regulation and preservation methodology in the scope of continuous improvement. Moreover, there is no contradiction in combining the POIRE approach with the best practices frameworks such as COBIT, ITIL, CMMI, and PRINCE.

3.2. Agility dimensions

In order to evaluate the overall agility of an EIS, first the IS is urbanized, in a top-down approach by successive refinements, into dimensions and components; then the process of agility evaluation is carried out in the bottom-up approach taking into account the mutual influences between the different components and dimensions of the EIS. In this context, POIRE framework suggested the following EIS conceptualization [23]:

Process dimension (P): This dimension deals with the enterprise behavior i.e. business processes. It can be measured in terms of time and cost needed to counter unexpected changes in the process of the enterprise. Agile process infrastructure enables in-time response to unexpected events such as correction and reconfiguration. It can be measured by their precision, exhaustively, non redundancy, utility, reliability, security, integrity, actuality, efficiency, effectiveness, and feasibility.

Organization dimension (O): This dimension deals with all the organizational elements involved in industry, i.e. structure, organization chart… It can be measured by their hierarchy type, management type, range of subordination, organizational specialization, intensity of their head quarter, redundancy, flexibility, turnover, and exploitability.

Information dimension (I): This dimension deals with all the stored and manipulated information within the enterprise. It concerns the internal and external movements of information. It can be measured from the level of information management tasks, i.e. the ability to collect, share and exploit structured data. It can be measured by their accuracy, exhaustively, non redundancy, utility, reliability, security, integrity, actuality, publication, and accessibility. Information represents a key factor for an enterprise to maintain competitiveness.

Resource dimension (R): This dimension is about the used resources within the enterprise. It can mainly concern people, IT resources, and organizational infrastructures. It can be measured by their usefulness, necessity, use, reliability, connectivity and flexibility. Concerning the people, which constitute in our opinion the main key in achieving agility within an enterprise, it can be assessed by the level of training of the personnel, the motivation/inspiration of employees and the data accessible to them. The adequateness and quality of perception, actions, decisions, and the time response represent a basis for achieving goals according to the enterprise strategy. So, people must be provided with adequate support while maintaining and strengthening their qualities through motivation and implication in the enterprise objectives.

Environment dimension (E): This dimension deals with the external factors of the enterprise, including customer service (B2C), regulations, global restrictions, and marketing feedback. It can be measured by the ability of the enterprise to identify and exploit opportunities, customize products, enhance services, deliver them on time and at lower cost and expand its market scope. It deals mainly with the interoperability; hence of the agility of the shared software and technology resources within a network of enterprises (B2B) and with customers (B2C).Moreover, agility in the context of B2B and B2C will allow to improve permanently, the quality of the supply chain management (SCM). It can be measured by their reactivity, proactivity, and accuracy.

3.3. POIRE life cycle

For the sake of continuous improvement allowing agility production and consumption regulation and preservation, we suggest an iterative life cycle (Fig. 2) in the scope of the proposed POIRE framework.

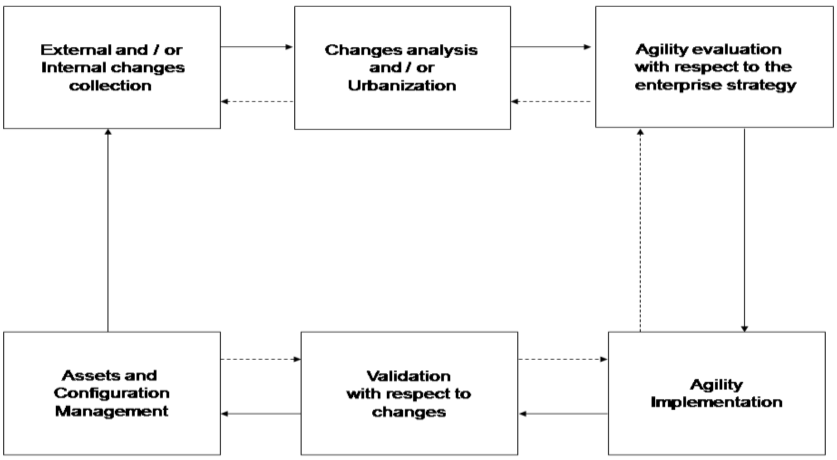


Fig.2. POIRE life cycle

First, the eve mission collects external and/or internal changes. Second, these changes are analyzed in the scope of the urbanization of the information system in order to have a better view and identify the dimensions' overlapping. Third the agility of the influenced components of the information system is evaluated with respect to the enterprise strategy. Forth, the necessary adjustments are implemented at each identified level of each POIRE dimension, to meet the required agility taking into account the mutual effects and/or interfaces between the EIS dimensions. Fifth, the designed changes are validated With respect to the collected changes. Finally, the assets and configuration management phase resumes the life cycle before taking into consideration any eventual external and/or internal new changes and the process of continuous improvement recycles. We notice that dot line arrows show the possible feedback in order to ensure coherence and validation.

Let us notice that the POIRE life cycle is iterative, and is based on two main principles: urbanization which allows structuring better, a priori, the enterprise information system architecture; and continuous improvement of the EIS. This will allow obtaining an agile information system that supports the enterprise strategy and adapt to its changes (mergers, reconfigurations, new laws...) and keep its traceability by the configuration management.

3.4. POIRE metamodel

Fig.3 shows the POIRE metamodel [23]. It shows the result of the EIS decomposition, into dimensions, which are composed of factors and these factors are composed of criteria, in the context of the overall agility evaluation with respect to the appropriate metrics, in bottom-up approach.

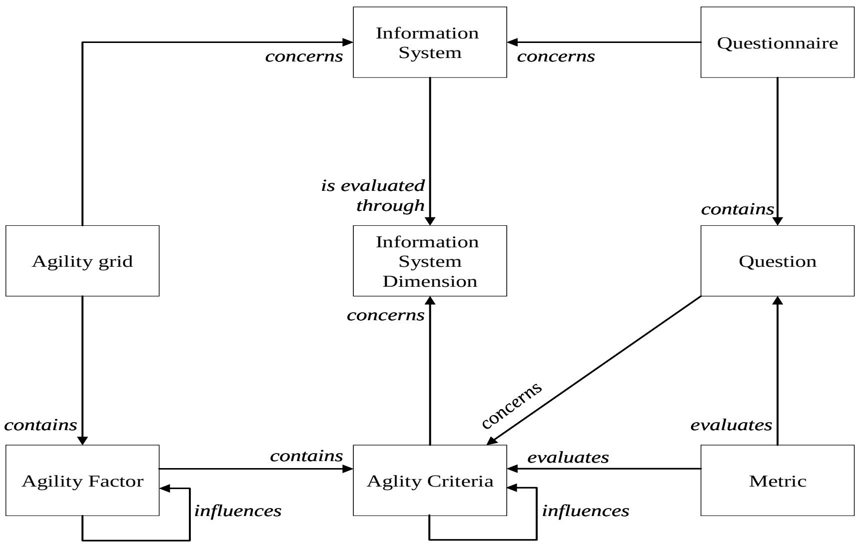


Fig.3. POIRE metamodel

An agility grid is established for each dimension of the EIS. The agility of the information system is then evaluated through the evaluation of the agility of its dimensions. This metamodel is used in order to generate the appropriate grids and questionnaires for a given EIS according to the culture of the enterprise and the context.

This is done according to a maturity grid that we proposed: this maturity grid is based on the perception of users and managers and aims to enable enterprises, especially the directions of information systems and IT managers to analyze and audit their information systems to assess their maturity and mainly the overall agility according to POIRE conceptualization, and it consists of five questionnaires, each for each POIRE dimension which are summarized in table 1 of section 3.5 below and a set of reference indicators. These indicators concern the scope of reference: listening to the influence sources, governance: permanent alignment of the EIS to the enterprise strategy, enterprise culture: promoting the best practices, technology investment: provide sustainable development technologies, and projects and applications: optimize applications and technologies.

The development process followed for determining the criteria can be summarized as follows:

- Step 1: Construction of a fairly comprehensive list of criteria obtained after synthesis of the literature, that could possibly characterize the different concepts and / or aspects of an information system;
- Step 2: Determination of the external attributes of the evaluation: factors, which are obtained by combinations of criteria;
- Step 3: Purification of the previously obtained model by eliminating the factors or criteria considered unimportant, synonyms or polysemes;
- Step 4: Identification and normalization of metrics for each criterion. Identifying metrics for a criterion allows defining the quantitative measures for this criterion, while the normalization is to transform theses measures so that they belong to the interval [1- 5].

The obtained criteria are grouped into agility factors. The retained factors are: coherence, commodity, conformity, exploitability, flexibility, optimality, responsiveness, and security.

3.5. Agility evaluation approach

The concept of agility is somehow subjective; this makes difficult the definition of agility metrics. In addition the enterprise information system is multidimensional. So in order to evaluate the overall or global agility of an EIS, after the process of urbanization of the information system, we proceed as follows (FIG.4):

- Step 1: Collect internal and external information, this action depends on the adequateness of perception and quality of interpretation of the changes.
- Step 2: Define a set of quantitative agility factors, composed of criteria, which constitutes a questionnaire for each dimension defined in the POIRE framework, and set the criteria agility values.
- Step 3: Evaluate the agility of each dimension by combining the factors agility values.

- Step 4: Combine the obtained results in order to get the overall or global agility of the EIS.

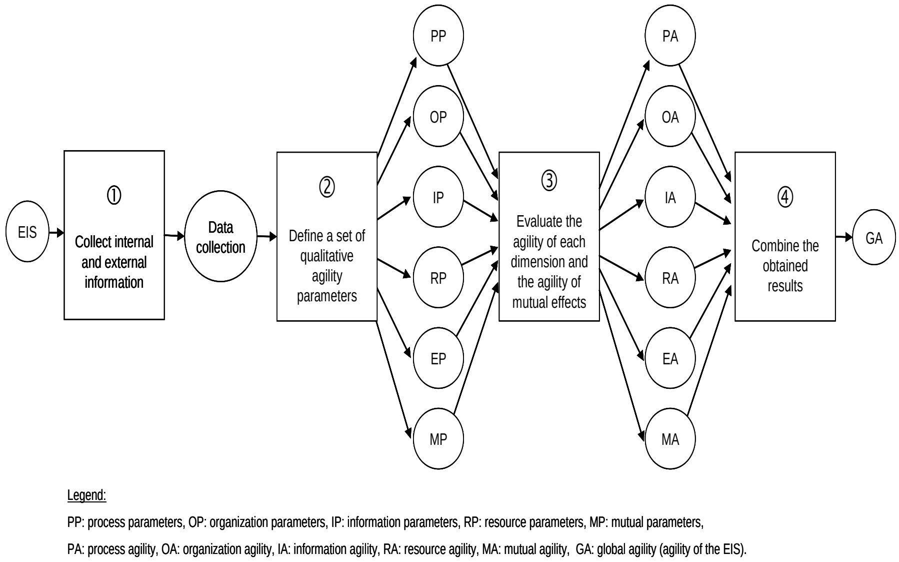


Fig.4. POIRE agility evaluation approach.

Our approach, in order to apprehend the complexity of EIS, defines three levels of complexity for agility evaluation:

- A simplified level which assumes that all the dimensions have the same weight and all the criteria of each dimension have the same weight too;
- An extended level which refines the results obtained by the simplified model, takes into account the weights of the dimensions in a given context and type of EIS;
- And the detailed level which takes into account the weights of dimensions, the weights of the factors, and the weights of the criteria. Hence, for each level of complexity we develop its corresponding assessment model and according to the complexity of a given EIS, we can use one, two or three of them sequentially.

In the present work, we deal with the high level of abstraction; that's the simplified model corresponding to the simplified level of complexity and the extended level which takes into account the weights of the dimensions. This model assumes that all the criteria and factors of the dimensions have the same weight. It is applicable for EIS corresponding to this configuration, such as a tour operator. The calculations will be as follows:

The agility of any factor (FA_i) of any dimension is given by:

$$FA_i = \left(\sum_{j=1}^{NC} Cj \right) / NC \qquad (1)$$

Where Cj : j^{th} criterion of the factor i

NC : number of criteria of the factor i

The agility of any of the five dimensions (DA) of the POIRE conceptualization is given by:

$$DA = \left(\sum_{j=1}^{NF} FA_j \right) / NF \qquad (2)$$

Where FA_j : jth factor of the dimension D

NF : nombre de facteurs de la dimension DThe overall or global agility (GA) of the EIS is given by:

$$GA = \left(\sum_{j=1}^{5} \lambda_j DA_j \right) / \sum_{j=1}^{5} \lambda_j \qquad (3)$$

Where GA: Global Agility of the EIS

DA: Dimension Agility, with D = [P/O/I/R/E]

λ_j: weight of dimension j which is set by managers and users.According to the preceding section, agility evaluation concerns all the dimensions of the EIS; hence, for each agility dimension, we suggest a list of pertinent criteria grouped in a list of factors, as shown in table 1 bellow for the resource dimension. Each dimension list is presented to users as questionnaire in order to set the appropriate value for each criterion. The value of agility of each criterion is expressed using the fuzzy logic variables which take values in the following set {Very low, Low, Average, High, Very High}, which in our opinion reflects the enterprise jargon and fuzziness is closer to the way of human thinking [24]; moreover, these values appear as comment for each calculated agility factor. For the sake of calculation, implied people associate numerical values to these variables in the following ranges: Very Low≤1, low≤2, Average≤3, High≤4, Very high≤5, and X if the criterion is not applicable in a given EIS, then it is not taken into account in the calculation process.

Table 1. Resource dimension grid

Factor	**Factor and its criteria designation**		**Criterion agility**	**Comment**
R1	What is the role of the personnel in the company?			
	$R1_1$	What is the level of training of the personnel?		

	$R1_2$	Is the personnel considered the most important resource?		
	$R1_3$	Do employees understand their roles?		
	$R1_4$	Are employees involved in management and decision making?		
	Factor agility			
R2	How human resources are managed?			
	$R2_1$	Does the personnel considered as an important resource?		
	$R2_2$	Is the direction encourages and inspires employees by example?		
	$R2_3$	Are the employees motivated?		
	$R2_4$	Is the personnel potentialities quantified and valued?		
	Factor agility			
R3	How human resources are organized?			
	$R3_1$	Does employee's assignment done according to their skills?		
	$R3_2$	Does the assignment of employees is done according to the context?		
	$R3_3$	Do you use cross-functional teams?		
	$R3_4$	Is the range of subordination respected?		
	$R3_5$	Do we use expert systems to improve performance and efficiency of our decisions and of our employees?		
	Factor agility			
R4	What are the characteristics of employees?			
	$R4_1$	Are employees agile and they adapt easily to changes?		
	$R4_2$	Do employees have the initiative and creativity spirit?		
	$R4_3$	Are employees involved in the enterprise management?		
	$R4_4$	Are employees versatile?		
	Factor agility			
R5	Are the hardware and software resources known?			
	$R5_1$	Are the hardware and software potentialities evaluated?		

	$R5_2$	Are the hardware and software resources used?		
	$R5_3$	Are the hardware and software resources known?		
	$R5_4$	Are the hardware and software resources are useful?		
	Factor agility			
R6	How hardware and software resources are managed?			
	$R6_1$	Are the hardware and software resources shared?		
	$R6_2$	Are the hardware and software resources updated?		
	$R6_3$	Are the hardware and software resources accessible?		
	$R6_4$	Are the hardware and software resources secured?		
	Factor agility			
R7	Are the hardware and software resources evolutionary?			
	$R7_1$	Are they interoperable?		
	$R7_2$	Are they integrated at all levels of the EIS?		
	$R7_3$	Can they be adapted to the context?		
	$R7_4$	Are they easily expandable?		
	Factor agility			
R8	What are the characteristics of hardware and software resources?			
	$R8_1$	Are they new?		
	$R8_2$	Is their use is easy?		
	$R8_3$	Are they maintainable easily?		
	$R8_4$	What is the degree of flexibility of the overall structure of hardware and software resources?		
	Factor agility			
R9	What is the lifespan of hardware and software resources?			
	$R9_1$	Are the hardware and software resources type of Sustainable Development (SD)?		
	$R9_2$	Are They robust?		

	$R9_3$	Are they flexible?		
	$R9_4$	Can they be guaranteed?		
	$R9_5$	Do we promote actively the technology allowing change?		
	Factor agility			
R10	Do employees have a privileged place?			
	$R10_1$	Is the intellectual property of employees has more value than physical products?		
	$R10_2$	Do employees have an environment allowing their evolution and development?		
	$R10_3$	Are the employees potentialities are exploited on the overall strategy basis?		
	$R10_4$	Do employees have access to all information necessary to perform their tasks?		
	$R10_5$	Is innovation considered as a main weapon of competitiveness?		
	Factor agility			
R11	How technology is exploited?			
	$R11_1$	Are new ways to use science and technology explored to produce new services and improve existing products?		
	$R11_2$	Is technology used as a means and not as an engine of change?		
	$R11_3$	Do we understand the positive and negative impacts of emerging technologies on our enterprise?		
	$R11_4$	Do we use more and more, technology of e-commerce to achieve our strategic objectives?		
	$R11_5$	Are products dependent on technology or are they based on the technology?		
	Factor agility			
	Agility of resources dimension			

Once the agility of each dimension is calculated, the users set the weights λ_j of the dimensions in order to calculate the overall agility of the EIS.

In order to help users and managers to fix the criteria value, for each applicable question it is associated a five levels scale ranging from 1 to 5. Let's consider the example of $R11_5$. The evaluation is based on the following levels' notes: (1) dependent on proprietary technologies, (2) dependent on standard technologies, (3) based on proprietary technologies, (4) based on standard and proprietary technologies, and (5) based on standard technologies.

3.6. Agility preservation and regulation methodology

An old information system which is not maintained within the logic of preservation of its agility is not a good candidate for important transformation. Hence; in our opinion, it is not sufficient to just make some parts of each dimension of the EIS agile for a given situation or context, but it is important to maintain them agile with time and for any situation; that is, the hardest task begins after the victory. Hence, there is a need of a continuous improvement of the EIS in order to update its agility: may be some previous parts will loose, increase, or decrease their level of agility, and/or some rigid parts will become agile, and so on. For, we suggest a continuous approach of evaluation, regulation and preservation of agility of the EIS within the allowed limits. These limits may be imposed by the technology limits (laws of physics), regulations, global restrictions, or human limits. This supposes that a priori the enterprise managers install an eve mission and define a flexible and revealing or efficient scoreboard in the scope of the EIS governance framework. This later is based on the enterprise strategy. Winsley and Stijin [46] mention the importance of preservation of agility through audits and people education.

Agility is non deterministic; hence, in order to evaluate the agility parameters, we propose to use the linguistic variables concept of fuzzy logic which has the advantage of being adjusted by the user. In order to evaluate the agility of an EIS, we begin with the analysis of the information system and the determination of the target information system grid. Then, we customize the questionnaire and we evaluate the different metrics that allow determining the agility criteria and also the real agility grid. Once the real agility is obtained according to the enterprise potentialities' exploitation and the target agility is obtained according to the existing enterprise potentialities evaluation, using the evaluation approach given in the previous section, they are compared with respect of the allowed error ε, and we conclude with an EAIS (Enough Agility of the Information System) message to the evaluator user, or we make the necessary recommendations and adjustments in the case where there is NEAIS (Not Enough Agility of the Information System) in such a way to converge the real agility value to the target agility value such that: (Real GA ≥ Target GA - ε).

We note that the allowed error ε is a positive real number and depends on the type of EIS. Fig. 5 illustrates the main principle of the proposed methodology, which guarantees a continuous improvement of the EIS agility.

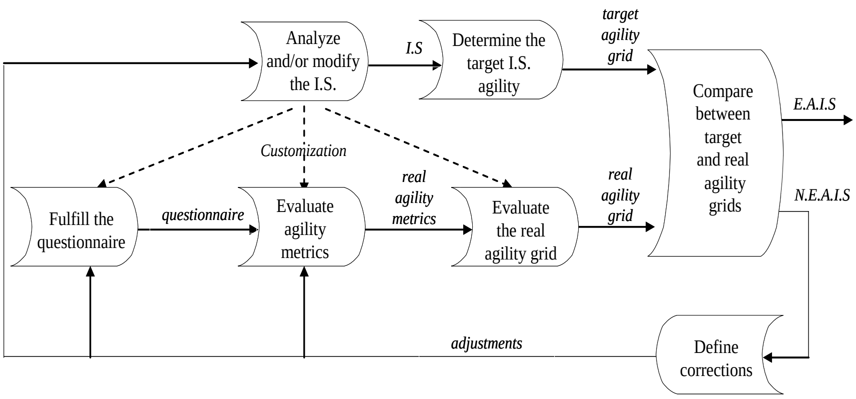


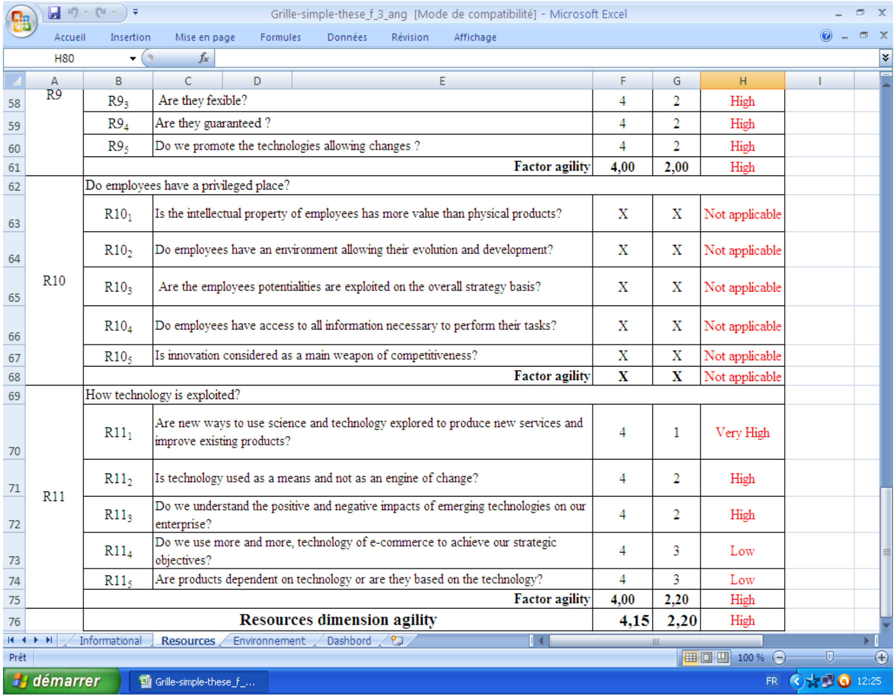
Fig.5. POIRE methodology for fagility evaluation, preservation and regulation.

4. Practical Implementation

4.1. Prototype implementation description

The prototype implementation is carried out using the MS Excel environment, and the tool interface looks like shown in Fig.6 bellow; it is characterized by its practicability and easy of use. The obtained results are given below. Equations (1) , (2) and (3), given in section 3-5 above, are used to calculate the approximate values of the agility of each dimension and the overall agility of the EIS in terms of the existing potentialities, then of their real exploitation. We note that the managers assume that all the dimensions have equal weight λ.

This prototype is used in order to evaluate the target agility on the basis of the EIS analysis in terms of existing potentialities evaluation, and the real agility by evaluating the real exploitation of the existing potentialities. The users and managers set the criteria target and real agility values within the range [1 – 5] if applicable, else X; then the target and real factor agility and the dimension target agility are estimated, automatically, using equations 1 and 2 respectively Once the target and the real agility values of each POIRE dimension are calculated, the target and real overall agility values of the EIS are generated automatically using equation 3; and the results are given in a dashboard form. This later allows, though its analysis to conclude and, eventually, generate the appropriate recommendations in order to improve the agility degree of the EIS.



	A	B	C–E	F	G	H
58	R9	$R9_3$	Are they fexible?	4	2	High
59		$R9_4$	Are they guaranteed ?	4	2	High
60		$R9_5$	Do we promote the technologies allowing changes ?	4	2	High
61			**Factor agility**	**4,00**	**2,00**	High
62	R10	Do employees have a privileged place?				
63		$R10_1$	Is the intellectual property of employees has more value than physical products?	X	X	Not applicable
64		$R10_2$	Do employees have an environment allowing their evolution and development?	X	X	Not applicable
65		$R10_3$	Are the employees potentialities are exploited on the overall strategy basis?	X	X	Not applicable
66		$R10_4$	Do employees have access to all information necessary to perform their tasks?	X	X	Not applicable
67		$R10_5$	Is innovation considered as a main weapon of competitiveness?	X	X	Not applicable
68			**Factor agility**	**X**	**X**	Not applicable
69	R11	How technology is exploited?				
70		$R11_1$	Are new ways to use science and technology explored to produce new services and improve existing products?	4	1	Very High
71		$R11_2$	Is technology used as a means and not as an engine of change?	4	2	High
72		$R11_3$	Do we understand the positive and negative impacts of emerging technologies on our enterprise?	4	2	High
73		$R11_4$	Do we use more and more, technology of e-commerce to achieve our strategic objectives?	4	3	Low
74		$R11_5$	Are products dependent on technology or are they based on the technology?	4	3	Low
75			**Factor agility**	**4,00**	**2,20**	High
76			**Resources dimension agility**	**4,15**	**2,20**	High

Fig.6. Software prototype resource dimension interface

4.2. Tour operator EIS agility assessment

4.2.1. General description

The main mission of a tour operator enterprise is to organize trips throughout the world for its clients. There are three types of destinations: sea, mountains and cities, and for each destination, there are three types of accommodations: hotels, bungalows, or residences. All trips offer many activities, such as swimming, diving, tennis, golf, sailing, water skiing, climbing, cycling, and so on. The enterprise is organized around six departments: financial, marketing, commercial, exploitation, and organization, which depend from the general direction. Travel agencies which are spread through several countries depend from the commercial department. Moreover, the enterprise has collaborating agencies. The role of an agency is to help customers choose the appropriate voyage upon several parameters, such as the country, season, destination, accommodation, activities, prices, and so on. The operation of the enterprise depends on the efficiency of its networks and of its employees, its degree of competitiveness, and the general regulation.

4.2.2. Results and discussion

The application of the POIRE methodology and use of the software prototype in order to assess the agility of the Tour operator IS has yield the following results (table2) and (Fig.7) bellow.

Table 2: Results

Dimension	Target agility	Real agility
PA	4.20	2.45
OA	4.05	1.95
IA	4.05	2.15
RA	4.15	2.20
EA	4.05	2.30
GA	4.10	2.20

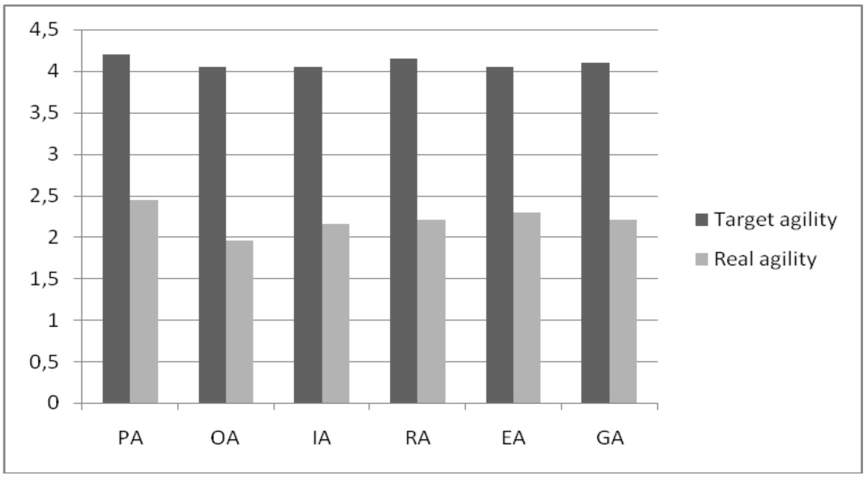


Fig.7. Graphical representation of the results

After being calculated, the real agility of the EIS, it is compared to the target agility in order to define, if any, the necessary actions which will bring the real value at least near the target one according to the allowed error ε that is set by the managers to 1.0 in this case study.

In our case, the estimated target global agility value is about 4.10, and the real value of the global agility is around 2.20; this means that managers and employees of the tour operator enterprise have to define the necessary adjustments, at the level of each dimension of the EIS in order to improve its real global agility such that (Real GA ≥ Target GA – ε); that's (Real GA ≥ 3.1). This will allow the enterprise to be competitive, sustainable, and increase its benefit. In this scope, the main recommendations, for the managers and users in order to increase the EIS effectiveness and maturity by increasing its agility are as follows: increase customers' integration, increase collaborative work, enhance publication and sharing of the vision and strategy of the enterprise, increase people agility, increase degree of precision and exhaustiveness of information, enhance training level of personnel, and exploit more the flexibility of resources.

5. Conclusion

This paper deals with agility in the context of POIRE project. It describes the need for enterprise information system agility and proposes an agility fuzzy logic evaluation, regulation and preservation framework based on two main principles: urbanization and continuous improvement that any enterprise should consider in order to manage changes and uncertainties in a competitive environment. Our assessment model is based on the evaluation of the agility of five dimensions that constitute any EIS and that are the result of the urbanization process. This allows organizations strategizing for agility production, consumption, and preservation. In addition this results in creating recoverable and secure architectures in different contexts and the enterprise will be continuously mirrored by its IS, then its sustainability is ensured as long as its agility is preserved. Moreover, our approach can be used to audit EIS agility and helps in defining recommendations for managers and users in order to increase the capabilities of the organization. Furthermore, there is, in our opinion, no contradiction in combining the POIRE approach with the best practices frameworks such as COBIT, ITIL, CMMI, PRINCE...and that each of the agility frameworks described in the related work covers certain parts of the EIS, whereas POIRE covers all levels of the EIS. The POIRE approach promotes individuals and interactions over processes and tools, and fosters collaboration with customers on contract negotiations. Moreover, it allows enterprises to be premonitory and assess their agility degree easily with the software prototype and generate the appropriate recommendations in order to initiate or handle any change rapidly and efficiently.

The application of the proposed model, to estimate the agility of a tour operator enterprise, shows the correlation and the coherence of the different models of the POIRE conceptualization and its practicability. For the managers of the enterprise, this experiment showed them the hidden faces of the different components of the EIS, and highlighted the way they would manage and govern better, in a collaborative manner, the enterprise to increase the benefit and evolve continuously smoothly with internal and external changes.

Finally, this presented model neglects the mutual interactions between the different dimensions factors and criteria of the EIS; so, the obtained values of the agility are not necessary the best ones. In order to improve the precision of calculation, actually, we are studying the interactions between the POIRE dimensions, factors and criteria which are represented by saturated graphs and defining mutual matrices which will define the heterogeneous and homogeneous links [27] between the dimensions and factors respectively, according to the type and the context of evolution of the EIS; then mutual effects will be included in the mathematical model as product factors that may result in a negative, neutral or positive influence. Finally, we are planning their application to industrial enterprises information systems and e-government information systems. Moreover, further work is under study in parallel, such as studying the different ways of producing agility at different levels of the EIS, and one of the obtained results deals with the agility production by the integration of SOA with ITSM [21], and use the developed prototype to specify and develop the industrial software tool that will be used to generate automatically the recommendations and statistical analysis.

References

1. Adrian E., Coronado M., and Lyons A. C.(2007) "Investigating the Role of Information Systems in contributing to the Agility of Modern supply Chains", In Desouza K. C. editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 150-162.
2. Bussler C.(2003) ''Semantic Web Services: Reflections on web service mediation and composition'', Proceedings of the Forth International Conference on Web Information Systems Engineering (WISE 2003) December 10-12, IEEE computer science editor, Roma, Italy, pp 253.
3. Chamfrault T. And Durand C.(2006) ''ITIL and services management: methods, implementation and best practices'', Dunod editions, Paris, France.
4. Chrissis Mary Beth, Mike Konrad, and Sandy Shrum,(2006) ''CMMI(R): Guidelines for process Integration and Product Improvement'', Second Edition, SEI Series in Software Engineering.
5. Cigref (2004) ''Information system governance'', Cigref. (Available at: http://www.cigref.fr)
6. Cigref (2003) '' Increase information system agility'', Cigref.(Available at www.cigref.fr.)
7. Cigref (2002) ''Information system governance: issues and approach'', Cigref .(Available at www.cigref.fr.)
8. Claude Y Bernard (2000), ''Management by the total quality'', AFNOR, Paris, France.
9. Cohen, D., Lindvall, M., and Costa, P.(2004) "An introduction to agile methods", In Advances in Computers, New York: Elsevier Science, pp. 1-66.
10. Conboy K. and Fitzgerald B. (2004) ''Towards a Conceptual Framework of Agile Methods: A Study of Agility in Different Disciplines", In proceedings of the 2004 ACM Workshop on Interdisciplinary Software Engineering Research (WISER), Newport Beach, CA, USA, November. ACM Press NY. Pp 37-44.
11. Denny, Williams G. J. and Christen P. (2009) ''Visualizing temporal cluster changes using relative density self-organizing maps'' Knowledge and Information Systems Journal, DOI 10.1007/s10115-009-0264-5. www.springerlink.com
12. Desouza, K. C (2007) "Preface", In Desouza K. C. editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3.
13. Galliers R. D. (2007) ''strategizing for agility: Confronting Information Systems Inflexibility in Dynamic Environments''. In Desouza K. C. Editor (2007), Agile

Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 1-14.
14. Goldman S. L. and Preiss K; (1991), "21st Century Manufacturing Enterprise Strategy", Bethlehem, PA: Iacocca Institute, Lehigh University.
15. Goranson H. T.(1999) ''The Agile Virtual Enterprise: Cases, Metrics, Tools''. Quorum Books editions, 1999. ISBN 1-567-20264-0.
16. Hasselbring W. (2000) ''Information system integration'', Communications of the ACM, Vol. 43, N° 6, pp. 33-38..
17. Houghton R. J. et al., (2007) "Vigilant Information Systems: The Western Digital Experience", In Desouza K. C. editor, "Agile Information Systems: Conceptualization, Construction, and Management", Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 222-238.
18. ISO (2005), ''ISO 9000, Quality management Systems, Fundamentals and Vocabulary''.
19. ISO/IEC (2005), ''ISO 27001, Information Technology Security Techniques, Information Security Management Systems, Requirements''.
20. IT Governance Institute (2007), ''COBIT 4.1 Framework Control Objectives Management Guidelines Maturity Model'',.
21. Izza S. and Imache R. (2010) ''An approach to achieve IT agility by combining SOA with ITSM'', Int. J. Information Technology and Management, Vol. 9, N°. 4, pp. 423-445. ISSN: 1461-4111. Underscience publishers. www.underscience.com
22. Izza S.(2000) ''Information systems modelling: proposition of a formalism for analysis and evaluation'', Magister thesis, University of Tizi-Ouzou, Algeria, April.
23. Izza S., Imache R., Vincent L., and Lounis Y.(2008) ''An approach for the evaluation of the agility in the context of enterprise interoperability''. In interoperability for enterprise software and applications conference (I-ESA'08). In Mertins K., Ruggaber R., Popplewell K., and Xiafei X. editors, Enterprise interoperability III: new challenges and industrial approaches. Springer Verlag, London, ISBN 978-1-84800-220-3. Pp. 3-14.
24. Kianmehr K., Alshalalfa M. And Alhajj R. (2009) ''Fuzzy clustering-based discretization for gene expression classification'' Knowledge and Information Systems Journal, DOI 10.1007/s10115-009-0214-2. www.springerlink.com
25. Leignel, J. L.(2006) ''Information systems governance'', CIO Strategy, Nice, France, june 12.
26. Leroux B. (2004) ''Urbanization and modernization of information system'', Lavoisier, Paris, france.
27. Long B., Zhang Z. And Yu P. S. (2009) '' A general framework for relation graph clustering'' Knowledge and Information Systems Journal, DOI 10.1007/s10115-009-0255-6. www.springerlink.com
28. Longépé C.(2002) ''The project of information system urbanization'', Dunod, editions, Paris, France.
29. Lui T-W., and Piccoli G.(2007) "Degrees of agility: Imlications from Information systems Desigh and Firm Strategy", In Desouza K. C. editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3 pp. 122-133.
30. Martenson A. (2007) ''Producing and Consuming Agility''. In Desouza K. C. Editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 41-51.
31. Mitra A. (2006) "Agile systems with reusable patterns of business knowledge: a component-based approach", Lavoisier, Paris, France

32. Mooney J. G. and Ganley D. (2007) "Enabling Strategic Agility Through Agile Information Systems", In Desouza K. C. editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 97-109.
33. Octo Technology (2005) ''Service-Oriented Architecture (SOA): a policy of interoperability'', White Book, Octo Technology.
34. OGC (Office of Government Commerce) (2007) ''ITIL Lifecycle Publication Suite, Version 3: Continual Service Improvement, Service Operation, Service Strategy, Service Transition, and Service Design''..
35. Oosterhout M. V., Waarts E. V, Heck E. V., and Hillegersberg J. V. (2007) ''Business Agility : need, readiness and alignment with its strategies''. In Desouza K. C. Editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 52-69.
36. Oza N., Abrahamsson P. and Conboy K. (2009) ''Positioning Agility'' In Pekka Abrahamsson, Michele Marchesi and Frank Maurer editors, Agile processes in software engineering and extreme programming. Vol. 31, pp. 206-208. DOI 10.1007/978-3-642-01853-4_33. www.springerlink.com
37. Pascot D., Bouslama F. and Mellouli S. (2010) ''Architecturing large integrated complex information systems: an application to healthcare''. Knowledge and Information Systems Journal, DOI 10.1007/s10115-010-0292-1. www.springerlink.com
38. Rouse W. B. (2007) "Agile Information Systems for Agile Decision Making", In Desouza K. C. editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 16-30.
39. Sambamurthy V., Bharadwaj A., and Grover V. (2003) ''Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms''. MIS Quarterly, 27 (2): 237-262
40. Sassoon J. (1998), ''Information systems urbanization'', Hermes, Paris, France.
41. Stamos E. and Galanou E.(2006) ''How to evaluate the agility of your organization: Practical guidelines for SMEs'' VERITAS.
42. Swafford P. M.(2003) "Theoretical development and empirical investigation of supply chain agility", Dissertation, Georgia Institute of Technology, Atlanta, USA, April.
43. Takacs B. and Demiris Y. (2009) ''Spectral clustering in multi-agent systems'' Knowledge and Information Systems Journal, DOI 10.1007/s10115-009-0272-5. www.springerlink.com
44. Toublant P. J., Crepet S., Rafii N., and Graton Y. (2002) ''Microcomputer industrial data processing'', Techniques de l'ingénieur, S8190, pp. 1-13.
45. Tsourveloudis N , Valavanis K, Garacanin D, and Matijasevic M. (2002) "On the Measurement of Agility in Manufacturing Systems", Journal of Intelligent and Robotic Systems, Kluwer Academic Publishers Hingham, MA, USA, 33 (3), pp. 329 – 342.
46. Wensley A and Stijin E. V. (2007) ''Enterprise information systems and the preservation of agility''. In Desouza K. C. Editor, Agile Information Systems: Conceptualization, Construction, and Management, Elsevier, Burlington, USA, ISBN 10: 0-7506-8235-3, pp. 178-187.

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Received: November 10, 2010; Accepted: July 1, 2011.