An Approach for the Evaluation of the Agility in the Context of Enterprise Interoperability

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Abstract. Today the concept of agility has become popular and is still growing in popularity in the management and technology literatures. How do we really define an agile information system? How do we know if an information system is agile? And how do we evaluate the agility in the context of enterprise information systems? This paper tries to answer some of these questions. It precisely aims to present the concept of agility of information systems and also provides an approach for the evaluation of this agility, namely POIRE approach that evaluates the agility as an amalgamation function that combines the agility measure of five complementary aspects that are Process, Organizational, Informational, Resource and Environmental aspects. Finally, this paper studies the role of interoperability in achieving agility and also the rapprochement of the concept of interoperability with the concept of agility.

Keywords: Enterprise Information System; Business; Information Technology; Agility; POIRE; Agility Evaluation; Fuzzy Logic; Interoperability.

1 Introduction

In the last few years, the concept of agility has become popular and is still growing in popularity in the management and technology literatures. On the management front, enterprises are daily facing pressures to demonstrate agile behaviour according to the dynamic environment. On the technology front, resources deployed to manage and automate information systems are facing flexibility and leanness issues in order to make easier the first front.

The purpose of this paper is to investigate the notion of agility and the role of interoperability in achieving business agility. Also, this paper provides some measuring agility principles that can be exploited in the context of enterprise interoperability and some discussions on the relation between interoperability and agility. This paper is organized as follows: Section 2 introduces some of the important related work on the concept of agility. Section 3 presents the POIRE (Process, Organization, Information, Resource and Environment) approach for measuring agility in general, with a focus on the relation that exists between interoperability and agility. Section 4 describes the agility evaluation in the context of enterprise interoperability. Finally, section 5 presents some conclusions and outlines some important future work.

2 Related Work

2.1 The Concept of Agility

The concept of agility originated at the end of the eighties and the early nineties in the manufacturing area in the United States. Agile Manufacturing was first introduced with the publication of a report by [8] entitled "21st Century Manufacturing Enterprise Strategy". Since then, the concept was used for agile manufacturing and agile corporations. The concept was extended to supply chains and business networks [2], to enterprise information systems [15] and also to software development [1].

Despite the age of the concept, there is no consensus yet on a definition of agility. According to [4], most of the agility concepts are adaptations of elements such as flexibility and leanness, which originated earlier. In developing their definitions, [4] 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 [5], being agile is generally result in the ability to (i) sense signals in the environment, (ii) process them adequately, (iii) mobilize resources and processes to take advantage of future opportunities, and (iv) continuously learn and improve the operations of the enterprise. In the same idea, [9] 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, [11] interpret agility of information systems as the ability to become vigilant. Agility can also be defined in terms of the characteristics of the agile enterprise [20]: (i) sensing: the ability to perceive environmental conditions; gather useful information from the system and readily detect changes and the ability to anticipate changes; (ii) learning: the ability to effectively modify organizational behaviours and beliefs through experience and the ability to use information to improve the organization; (iii) adaptability: the ability to effect changes in systems and structures in response to (or in anticipation of) changes in environmental condition; (iv) resilience: robustness to diversity and variability, and the ability to recover from changes; (v) quickness: the ability to

accomplish objectives in a short period of time; pace at which changes are accomplished, and the rate of movement within organizational systems; (vi) innovation: the ability to generate many solutions to a problem; (vii) concurrency: the ability to effectively perform related activities at the same time with the same assets; and (viii) efficiency: the ability to use minimal resources to accomplish desired results.

Currently it is well established that the agility can be studied through two complementary perspectives: the management (or business) perspective and the IT (information technology) perspective [3] [5]. First, the concept of agility in the management perspective is often synonym of the concept of alignment, of effective and efficient execution of business processes [7]. Another view of agility can be expressed in terms of an enterprise's abilities to continually improve business processes [18], or as "the capacity to anticipate changing market dynamics, adapt to those dynamics and accelerate change faster than the rate of change in the market, to create economic value".

Second, in the IT perspective, agility of information systems is often studied through IT solutions that compose information systems. Currently, it is well established that IT and business are related and enterprises invest more and more in IT to drive current business performance, enable future business initiatives, and create business agility [17]. There are many works, in both academia and industry, that studied the impact of IT on business agility [17]. These works present two distinct and opposing views in relation to the impact of IT investment on business agility. The first view is that IT can stabilize and facilitate business processes but can also obstruct the functional flexibility of organizations, making them slow and cumbersome in the face of emerging opportunities. In such systems, business processes are often hardwired by rigid predefined process flows. The second view portrays IT applications as disruptive influences, often dislodging efficiently working processes and leading to widespread instability that reduces the effectiveness of the organization's competitive efforts [13]. These two opposing views need resolution for managers who face a continually changing IT-driven business environment. Being agile is a compelling catch cry but may lead to a complex and confusing interaction between stability and flexibility [17].

2.2 Approaches for Characterizing and Measuring Agility

There are also some works that treats the agility issues within enterprises and they mainly concern the strategizing of agility [7], the identification of the capabilities of agility [19], the identification of the agility levels [14], and the proposition of conceptual agility frameworks [16], and the measurement of the agility [21].

[7] studied the agility in the strategy point of view and mentions that there are three main points for strategizing agility: (i) the exploitation strategy, (ii) the exploration strategy, and (iii) the change management strategy. The exploitation strategy concerns the environmental and organizational analysis, the enterprise information and knowledge systems, the standardized procedures and rules, and the information services. The exploration strategy 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. The change management strategy depends on the ability to incorporate the ongoing learning and review.

[19] distinguish three interrelated capabilities of agility: (i) operational agility: is the ability to execute the identification and implementation of business opportunities quickly, accurately, and cost-efficiently; (ii) customer agility: is the ability to learn from customers, identify new business opportunities and implement these opportunities together with customers; and (iii) Partnership agility: is the ability to leverage business partner's knowledge, competencies, and assets in order to identify and implement new business opportunities. This distinction is in line with the multiple initiatives proposed in the literature: (i) internally focused initiatives (operational agility), (ii) demand-side initiatives (customer agility), and (iii) supply-side initiatives (partnership agility).

Concerning the identification of agility levels, [14] argues that systems can be agile in three different ways: (i) by being versatile, (ii) by reconfiguration, and (iii) 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 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, [14] 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.

An important agility framework, which concerns the management perspective, is that proposed by [16]. 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.

Another important work is by [12] who studied the agility in the socio-technical perspective. 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, [12] use the agility of the four components: technology agility, process agility, people agility, and structure agility. Hence, [12] argue that the agility is not a simple summing of the agility of the four components, but it depends on their nonlinear relationship. Furthermore, [22] 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.

Finally, [21] 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: (i) production infrastructure, (ii) market infrastructure, (iii) people infrastructure and (iv) information infrastructure.

Although all these works are important, our work is mostly closed to those proposed by [12] and [21]. In the following, we propose to extend these last researches to the evaluation of the agility of information system, and in particular in the context of enterprise interoperability perspective.

3 The POIRE Framework

Based our research on the work of [12] and [21], we suggest the following framework, called POIRE (Process, Organization, Information, Resource and Environment). In the following, we will briefly expose the main dimensions of POIRE and then we will focus on the evaluation of the agility in the context of enterprise interoperability.

3.1 POIRE Dimensions

We suggest for our agility framework (POIRE) the following dimensions that are necessary in the context of measuring the agility of enterprise information systems (Figure 1):

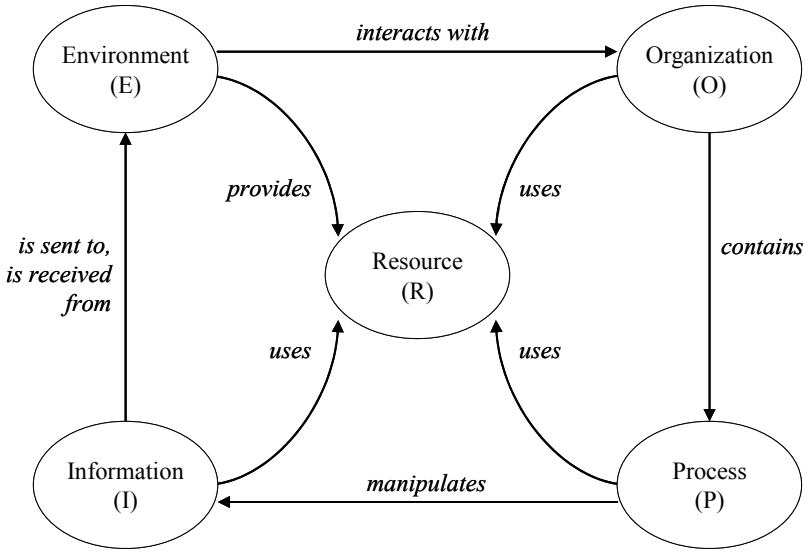

Fig. 1. POIRE dimensions for enterprise information system agility

- Process dimension (**P**): This dimension deals with the enterprise behaviour 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, etc. It can be measured by their hierarchy type, management type, range of subordination, organizational specialization, intensity of their head quarter, nun 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 circulation 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.
- 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.

- Environment dimension (**E**): This dimension deals with the external factors of the enterprise, including customer service 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 can be measured by their reactivity, proactivity and accuracy.

3.2 POIRE Metamodel

Figure 2 shows the POIRE metamodel. As illustrated, the agility is evaluated according to a certain number of agility factors which are determined using a set of agility evaluation criteria for each dimension of the information system. These criteria are measured thanks to some identified metrics, that concern a given aspect (or dimension) of the information system. The evaluation of the metrics is practically based on the evaluation of a certain number of questions that are defined within a questionnaire of the corresponding dimension. Furthermore, agility factors and criteria are not independent in the way that they may mutually influence each other.

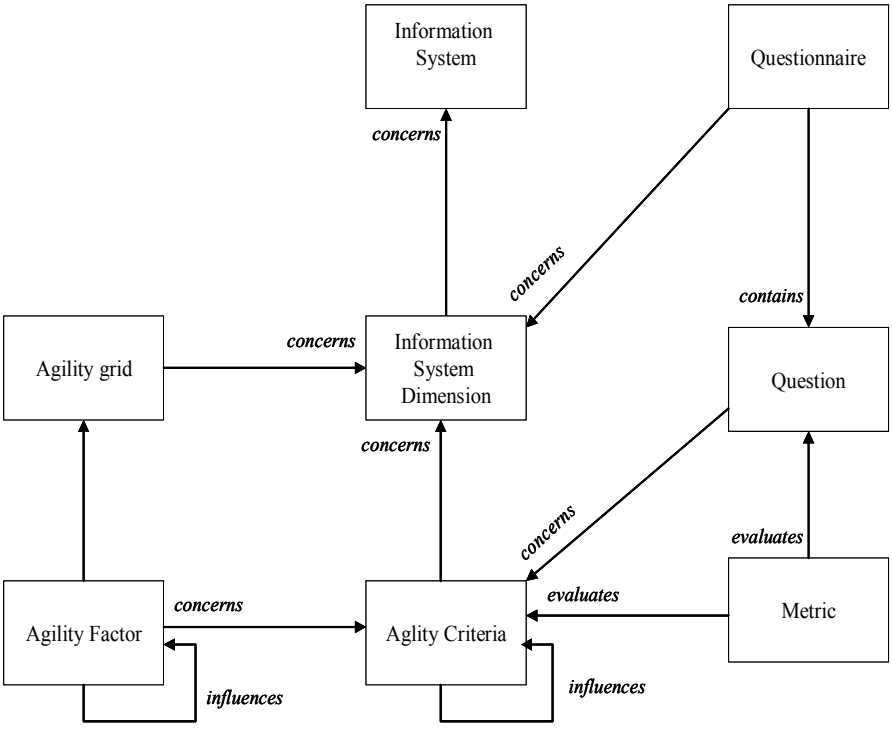

Fig. 2. POIRE metamodel

3.3 POIRE Methodology

In order to evaluate the agility, 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 apply the linguistic variable concept of fuzzy logic to evaluate the different metrics that allows determining the agility criteria and also the real agility grid. Once the real and target grids are compared, we conclude with an HAIS (High Agility of the Information System) message, or we make the necessary adjustments in the case where there is an AAIS (Average Agility of the Information System) or LAIS (Low Agility of the Information System). Figure 3 briefly illustrates the main principle of the proposed methodology.

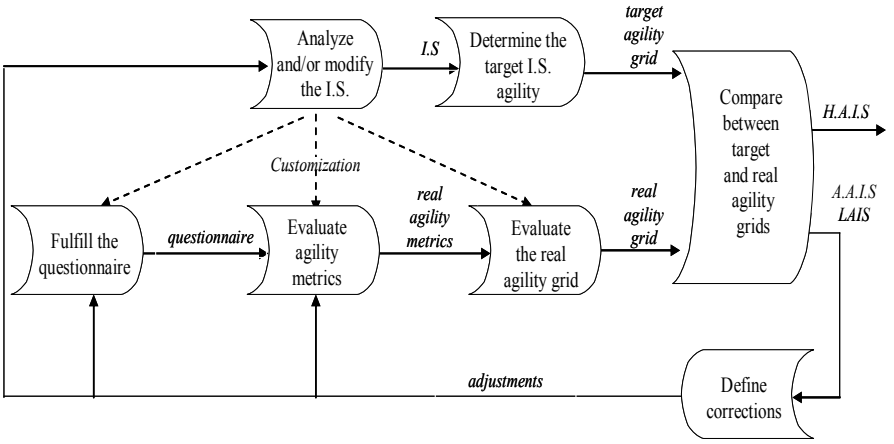

Fig. 3. POIRE methodology

4 Agility Evaluation in the Context of Enterprise Interoperability

A basis for assessing agility in a context of interoperability is still at its beginning; hence, we notice the fact that the concept of agility is still being investigated and refined with time and context of the enterprise. In the present work, according to the preceding sections, agility evaluation concerns all the dimensions of agility; hence, for each agility dimension, we suggested a list of pertinent points that must be considered in order to evaluate the agility of enterprise information systems. In the same way, we conducted a study in order to learn about the role of interoperability in achieving the agility, and also in order to better identify the rapprochement that may exist between these two concepts and that is not yet discussed in our opinion in the literature.

Let's recall that interoperability is the ability for two heterogeneous components to communicate and cooperate with one another despite differences in languages, interfaces, and platforms [23] [24]. In order to insure true

interoperability between components or systems, the syntactic interoperability [25] and the semantic interoperability [10] [23] must be specified.

For the purpose of studying the rapprochement between agility and interoperability, we identified several metrics within the five above dimensions that are related to the interoperability aspect. Then we evaluated them using maturity grids, basing on CMMI model (with five maturity levels) and using sample examples taken from industrial realities. The idea is to understand how to endow the enterprise with the ability to maintain and adjust its interfaces, in terms of agility of interoperability, at different levels of abstraction of its dimensions under unexpected changes and conditions. Figure 4 illustrates the principle of the rapprochement between interoperability and agility using maturity grids.

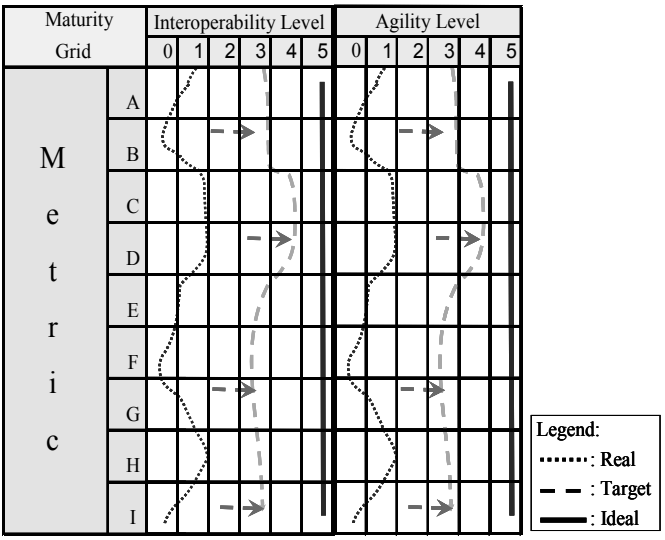

Fig. 4. Evaluating the role of interoperability in achieving the agility with grids

Due to the data complexity and the large number of details concerning the conducted experiment, we briefly describe the main obtained results. First of all, we can retain that interoperability can be seen as one important property of agility. Furthermore, agility can be considered as a non linear function of interoperability. This may be explained in theory by the fact that the interoperability which is correlated to complexity influences the agility in two ways. First, with no interoperability there will be no agility, while with excessive interoperability, and thus with excessive complexity, agility will also decline as illustrated in figure 5. We also notice that there is an asymptotic equilibrium that is defined as the tendency of the agility of the system during its life cycle.

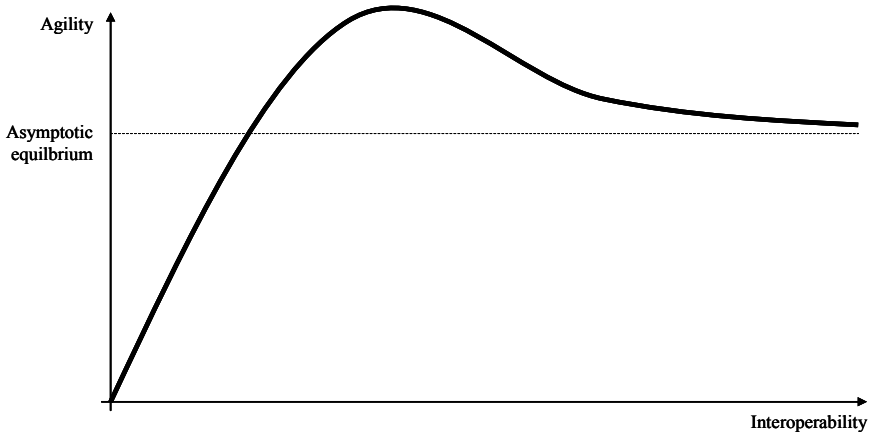

Fig. 5. Relating agility and interoperability - theoretical tendency

In addition, we can notice that practically we have some turbulence in the agility grids due to the happening of some changes (technology changes, business changes, strategic changes, organizational changes) in the enterprise (Figure 6). These changes lead to breaking zones that need appropriate management in order to conduct the enterprise during this state of transition.

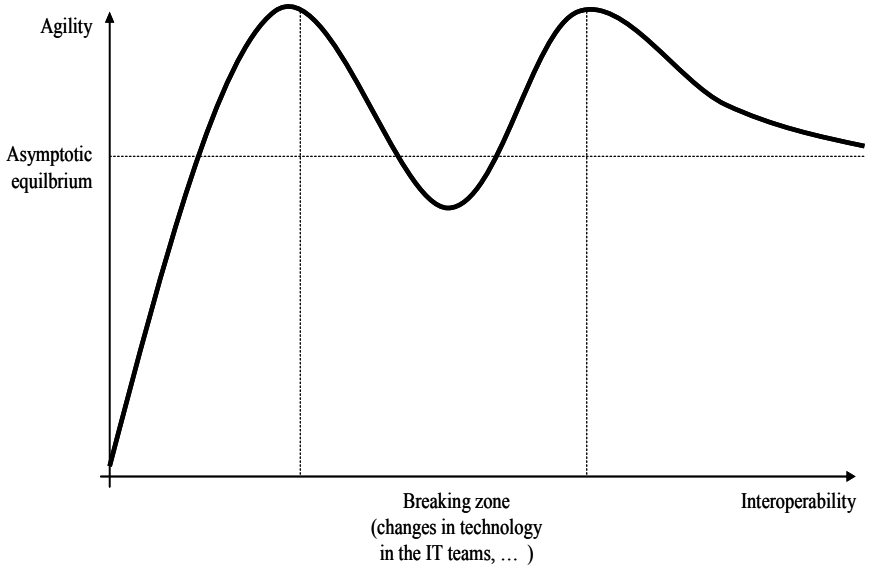

Fig. 6. Relating agility and interoperability – practical tendency

5 Conclusions

We have presented in this paper an approach of the evaluation of the agility in the context of enterprise interoperability. We have precisely presented the main principles of POIRE framework. We also studied the role of interoperability and also its rapprochement with agility. We notice that implementing syntactic and semantic interoperability yields in an increase in agility by making easier the process of reconfiguration when adapting the information system to unpredictable changes. However, there is an asymptotic equilibrium for the agility level after a certain degree of interoperability.

The future work will concern the exploitation of this framework in large realities in order to validate it and will also concern the investigation in more details of other forms of agility properties such as vigilant information systems, lean information systems, outsourced information systems and also information systems in the context of the Enterprise 2.0 wave.

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