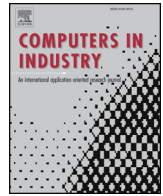




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Organisational interoperability characterisation and evaluation using enterprise modelling and graph theory

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ABSTRACT

Today, enterprises have to cooperate to survive in an increasingly competitive environment. This cooperation is carried out using networked organisations. To cooperate in the best way possible, each enterprise must be interoperable with many other ones. From an engineering point of view, it is necessary to model the enterprises and their collaboration, to detect where interoperability is considered less than expected, to evaluate the effort necessary to fill the lack of interoperability and to propose solutions to improve the situation. This paper focuses on the modelling, detection of non-interoperability and evaluation of efforts issues.

First, this paper exposes the problems of interoperability, focusing on organisational interoperability and the necessity of using enterprise modelling techniques. The second part of this paper is dedicated to the presentation of a method enabling the characterisation of organisational interoperability and the evaluation of effort needed to reach or maintain the targeted interoperability level. This method is based on enterprise modelling, graph theory and rules checking. The third part of the paper presents in detail the five main rules of the method. This presentation is proposed through a real case study to demonstrate its applicability. A discussion of the research results is presented at the end of parts two and three. Finally, a conclusion and some perspectives are presented at the end of this paper.

1. Introduction

Industrial actors of logistics management predict a future where the major brands and their network of partners are increasingly competitive [1]. According to Sanjiv Sidhu, founder of I2 Technologies [1], Western industry will steer themselves towards the adoption of a model of the organisation close to the Japanese keiretsu. A sort of conglomerate, the keiretsu is a complex ecosystem of enterprises specialised, interrelated, and linked by cross-interests and headed by a leading industrialist, itself backed by a powerful bank. However, what captured the attention of analysts in this model is the industrial integration of all and its management by a sizeable actor, which ensures visibility.

However, the problem of inertia of the whole of suppliers, subcontractors, service providers and distributors arises in its wake. Sanjiv Sidhu raised the following issues: detecting the event, being able to analyse it and being able to enforce the decision. In this context, it is therefore necessary to implement management in the service of clients; this is the concept of a supply chain (SC). Generally, the literature defines the supply chain as the set of all activities associated with the transformation and the movement of goods and services, from the extraction of materials first to the final customer. This concept, already

known from a long time, brings with it new ways of designing enterprises.

These include the establishment of cooperation at the functional level throughout the SC to improve delivery times and the flexibility and the speed of the introduction of new products. Better synchronisation allows us to bypass juridical and national boundaries. Finally, the improvement of operations throughout the SC means a better service to the end customer with lower costs for the SC in its entirety. However, the implementation of a supply chain is long and complex because several enterprises at the same time must amend their organisations, their semantics, their information systems and their systems of performance indicators to make them compatible [2]. It is this “compatibility” that we call “interoperability” [3].

We are so in a methodological context of engineering. To answer the problems that we have just quoted (establishment of cooperation, improvement of synchronisation, improvement of interoperability), it is necessary to complement this method. The principle adopted in this paper is that the basic tool is enterprise modelling. So, the method will start with the modelling of networked companies and, more particularly, of parts involved in the collaboration.

The structure of the paper is as follows:

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The second part will present the organisational interoperability and show how enterprise modelling is an efficient approach for studying it. The third part will propose a method for assessing interoperability, based on the checking of properties in graphical models. This is the main contribution of the paper, and it is illustrated by an example. It must be noticed that there is no chapter of application and validation of the method because the real industrial case is used all along the paper in order to illustrate all the steps. The last part will conclude the paper, discuss current limitations and provide some perspectives for the continuation of this research.

2. Organizational interoperability and enterprise modelling

As we have already presented in the introduction, one of the trends of the current market is the increased collaboration of businesses. The result of the collaboration can vary from a stable alliance between the different actors within a supply chain to cooperation limited in time within the framework of a virtual enterprise. This trend towards growing collaboration has several consequences for organisations and has induced the concept of interoperability.

Interoperability can be defined as “*the ability of two or more systems or components to exchange information and to use this exchanged information*” [4,5]. This definition highlights the elements essential to the understanding of what interoperability is [4,6,7]:

- the presence of multiple actors or multiple systems,
- the realisation of a collective action, and
- the ability to communicate with data specific to the actors and to use, whether they are identical or radically different.

It is then possible to consider interoperability as a performance. In this paper, we will present our vision of interoperability based on the definition of the aforementioned reference. Then, we will decompose and discuss the concept of interoperability to extract classes of performance indicators.

2.1. Types of interoperability

Speaking about interoperability makes sense only when there is an exchange between two or more systems. Indeed, in the case where two systems exchange or attempt to exchange, it is essential that they can do so without any hindrance whatsoever. The term “interoperability” is vague because it deals with several concepts, such as semantic interoperability, IT interoperability and organisational interoperability.

2.1.1. Semantic interoperability

Semantic interoperability can be defined as the ability of two or more systems to understand each other. Practically speaking, this is to give common meaning (unique semantic) to the information exchanged and to ensure that this meaning is shared by all systems involved in the collaboration. The consideration of this semantics allows these systems to combine the information received with other local information and treat them appropriately with respect to the semantics. This interoperability has two application fields: people (common language and common technical language) and computer applications [8].

2.1.2. IT interoperability

IT interoperability can be defined as the ability of two or more computing resources to mutually exchange data without loss or degradation of information. It seeks to resolve technical issues involved in the inherent complexity linking computer systems and the services they provide, describing the standards of presentation, collection, exchange, processing, security and transporting information. This interoperability has two fields of application:

- machine-to-machine communication: common programming language, common data format and common data model.
- man/machine communication: visual interface for dual understanding man/machine: common language and data format usable by man.

However, interoperability does not systematically request common exchange formats. It can accept heterogeneous formats if translation means exist.

2.1.3. Organisational interoperability

Organisational interoperability issues are related to the formalisation of business processes and decision system. Organisational interoperability is particularly important in networked organisations, inside which processes and decisions are dispatched over several organisations or several parts of one organisation [9]. Organisational interoperability addresses several issues:

- The definition of the role and responsibilities of the actors within the supply chain;
- The definition of integrity and confidentiality policy of information and of the necessary mechanisms to their location and their dissemination;
- The establishment of procedures and execution process supporting collaboration work;
- The definition of intermediate processes to make the connection between the two companies possible; and
- The allowance of collaboration between services of different companies that differ in their internal organisation and structure of their operations.

In terms of efficiency, the concept of interoperability is directly linked to the three classical operational concepts of performance [10,11]:

- lead time:
 - the information must be delivered at the right time, that is to say when the user needs it, and only at that time,
 - no intermediate step should be necessary before use of information, and
 - all the information must be used. If this is the case, it avoids a waste of time and money to the sender, who would have sent information in vain.
- cost: standardisation or translation tools and the reduction of tool use, including software tools, hardware tools (for example workshops) and communication tools (telephone, fax, courier, mail, post, etc.).
- quality: the information must be reliable, that is to say they must be complete and conform to what the sender sent (which improves the quality of trade and products), which does not exclude the manipulation of information by other persons.

A high level of organisational interoperability allows collaboration between services of enterprises different in their organisation and in the structure of their operations. This makes possible to align practices and to make decisions to control business processes at both the enterprise level and the network level.

Many research works obviously deal with IT interoperability (on which we shall not insist in this paper) and with semantic interoperability as well [12,13,8,14] for instance). Conversely, few works focus on organisational interoperability. However, as already noticed, this type of interoperability plays a key role in performances of enterprises

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