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Systemic approach for optimizing information technology resource as a contribution of information system governance

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ABSTRACT

Information technology (IT) resource management is considered as one of the main pillars of Information System (IS) governance in the company. In this article, we propose a systemic approach from the structural paradigm based essentially on the formal extension of the ISO 19440 Meta-model. This structure contains specific constructs from the Cobit framework and systemic tools as the Galois lattices, likely to bring a better vision of the use of IT resource in the company. This technique allows a systemic analysis applied to special structural matrices to evaluate the deployment policy of IT resource in order to achieve the business processes. The proposed approach allows a good optimization of IT resource as a pragmatic and effective contribution to Information System governance.

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1. INTRODUCTION

The contemporary company is structured by IT processes that respond to business processes to improve business performance. The Information System (IS) guarantees the communication between the operating system and the decision-making system as well as the exchange with the environment. A management information system (MIS) is a variety of systems or processes which provide information needed to manage organizations effectively [1]. For this purpose, the Information System Audit and Control Association (ISACA) defined a pentagon of IS governance based on five main pillars: strategic alignment, value delivery, performance measurement, risk management and IT resource management [2]. In this work, we are particularly interested to the IT resource management as one of the major components of IS governance. Other axes have already been evoqued in some works, especially the strategic IS alignment [3] and the measurement of the IS performance in the company [4]. Moreover, according to the Information Technology Governance Institute (ITGI), an essential criterion for the performance of information systems is the optimal use of its resources (hardware, software, networks, human resources, information). IT resources are playing an increasingly critical role in organization [5]. Several papers have been written about the strategic role of the IT resource in the organizations [6] and [7]. Indeed, the major challenge regarding human resources management in any IS project is the definition of roles and the application of an HR policy which make it possible to put different skills at the service of the strategic and operational objectives aiming at good IS governance (IS Business plan, urbanization, strategic alignment etc.). Otherwise, In order to plan for an effective IT resource management, it can be helpful to implement a five-step framework based on industry best practices: plot out resource capacity, allocate resources to meet demand for proposed projects; match internal resources with tasks that will lead to the best overall results for the company; focus on team dynamics and encourage employees to manage their own performance [8]. Thus, one of the first steps towards IT resource management is to have tools to measure it [9]. However, current evaluation approaches, although focused primarily on the strategic level, provide little finesse at the technical and tactical levels, which are identified as important areas for good optimization of IT resource. In addition, most existing approaches are examined in large organizations and there is not much research enabling to assess technically the effectiveness of these approaches in small and medium-sized companies. In this paper, we propose a systemic approach based mainly on the extension of the ISO 19440 Meta-model enriched by the formal addition of some specific constructs from Cobit, as well as systemic tools and algebraic structures allowing a relevant analysis of some structural matrices providing multi-views of the company. In this work, we are interested especially to the structural matrix (Resource/Activity) that we integrate into a specific platform called (Galicia) to generate some lattices with closed, giving an opportunity for a specific analysis methodology offering a better visibility of IT resource management. The remaining sections of this paper are organized as follows. Section 2 presents the overview of the proposed systemic approach for optimizing IT resource in the company. So, we recall the different facets and views of the ISO 19440 enterprise Meta-model illustrating some tracks for more improvement. Then, we propose the integration of a structural and holistic view by adding some systemic tools and algebraic structures contributing to evaluate tactically the IT resource management. In section 3, we present the obtained results from a specific methodology likely to detect anomalies and inconsistencies helping to suggest some notes and recommendations to decision makers for the IT resources optimization. The conclusion of this work gives the add value and the limits of this approach as well as the avenues to be pursued in this area.

2. RESEARCH METHOD

The proposed approach is based mainly on the formal extension of the ISO 19440 enterprise Metamodel. In the following section, we give an overview of this standard with an explanation of the roles and semantics of its constructs.

2.1. The ISO 19440 Enterprise Metamodel

The standard "ISO 19440" specifies the characteristics of the constructs necessary for the modeling of the company according to the ISO 19439 [10]. The ISO 19440 Metamodel proposes four views of the company: The information view (representation of the IS data); the organizational view (corporation strategy); the functional view (process) and the resource view regarding to the resources used by the business processes [11]. The Figure 1 gives an overview of this Metamodel highlighting the boundaries of all views. We also present in Table 1 the role of each construct of the Metamodel. The semantic of each of the constructs of the ISO/19440 is given in the following Table 1 [11].

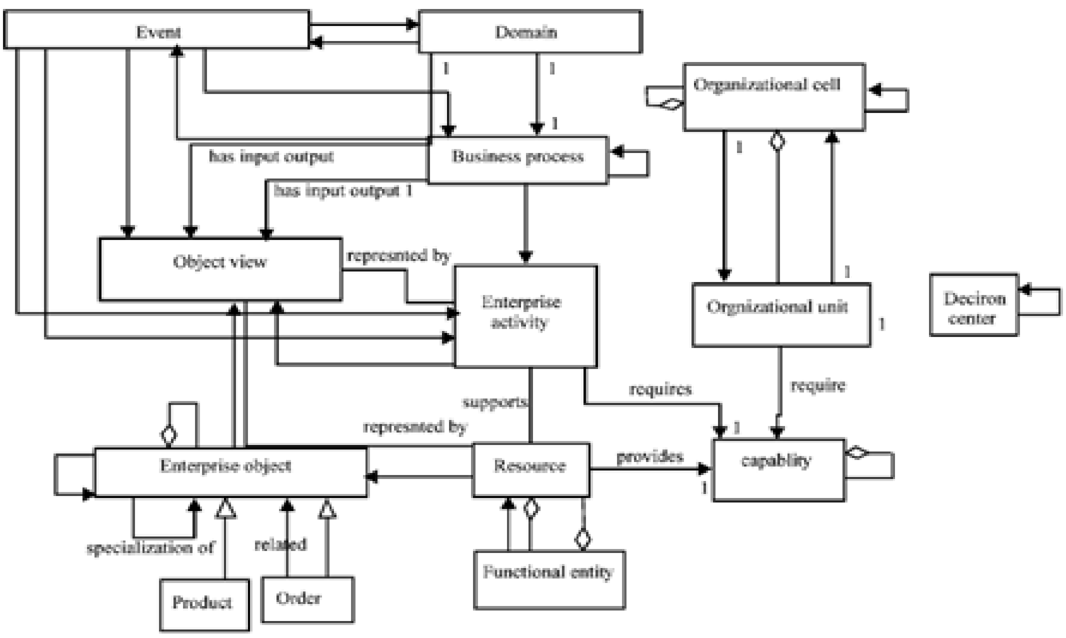

Figure 1. The four views of the ISO 19440 enterprise Metamodel

Table 1. Semantic of each construct of the ISO/19440 Meta-model

	Construct	Semantic/Role	Construct	Semantic/Role
Functional view	Domain	The boundary and the content of an enterprise or a portion of it	Enterprise activity	It has to achieve a transformation of inputs to outputs by specific resources.
	Business process	A part of enterprise behavior. There is an aggregation of BP and/or Enterprise Activity together with information described by Behavior Rule.	Event	Starts the execution of a business process or activity of the company.
Informational view	Object view	A subset of Enterprise Object.	Product	Another special kind of an Enterprise Object.
	Enterprise Object	The characteristics of the thing(s) being modeled during its(their) life-cycle(s)	Order	A special type of class event. It is an instruction for the execution of an activity.
Organizational view	Organizational Cell	Provides identification of its contents and the contents positions in the hierarchy.	Decision Center	It's an elaborated concept to capture the decision structure in a company.
	Organizational Unit	Describes the roles and responsibilities in the hierarchical structure of an enterprise.	Capability	It is any device, tool or means of the enterprise to produce products or services.
View of resource	Resource	Represents some or all of the capabilities required for the execution of an Enterprise Activity.	Functional Entity	Any resource that can provide certain functions.

The ISO 19440/2007 is not ultimately perfect, especially the articulation of the systemic view with other views of the Meta-model, hence our interest in improving this framework justified by some remarks and suggestions that we find useful to improve the framework through the integration of specific constructs and systemic tools. So, we note that:

a) The concept "domain" representing the limit and the content of a company is a very general concept. A domain contains several concepts, for example, business objectives or performance indicators which are important enough to model them into classes in their own right.
b) It is not intuitive to talk about inputs and outputs for a domain. For example, in the field of health care, what would be the inputs and outputs? If a patient who has been fully treated in a hospital can be considered as entering and leaving some medical care processes, it certainly cannot be considered as an entry and exit to the field of health care.
c) Regarding the purpose of a domain name, if a high-level goal for the health care field is specified as "to provide citizens with good health care services", it may be understood that is really a goal for health care providers rather than an objective for the field. Goals' setting is a characteristic of companies and organizations, rather than the field to which they belong. This raises the question of whether the concept of domain has been presented as a generic / general term for companies and organizations and if so, what is its relation with other organizational concepts in the Metamodel, "Organizational Cell", "organizational" Unit "and" Decision Center "?
d) The concepts "Organizational Cell", "organizational unit" and "Decision Center" are introduced to define the organizational structure of a company. However, the text specifications and the graphic model do not provide a completely clear semantics. For example, Organizational cells describe the formal hierarchical administrative structure of a company" and the "organizational unit" represents the Roles and Responsibilities within a given hierarchical structure.
e) The concept "Decision Center" as well as its relation with "organizational unit" or role/responsibility as suggested above is unclear. It is mentioned to define the decision-making structure in a company, but it should also be related to the notion of "Organizational Cell" (or "Organizational Unit" as described above).

f) The "Resource" construct is used in the specification, design and later phase. His model must allow entering all relevant information for decision support and monitoring business processes and giving a presentation with a clear form which is understandable by man and machine [12].

2.2. Extended Metamodeling through specific constructs of Cobit

In this section, we propose to build an extension of the ISO 19440 Meta-model, where we can highlight IT resource management as one of the key factors of IS governance. For this purpose, we integrate a variety of constructs likely to give a holistic view of all the Metamodel components. Indeed, an interpretation of the basic structure of the Metamodel reveals coherence between assorted constructs. The fundamental boundaries of this coherence can be found in the interactions and couplings between the different views of the Meta-model. For example, the interaction between "enterprise activity" and "resource" shows the coherence <process, activity | resource>; the coupling between "business process", "enterprise activity" and "object view" reveals an alignment <process, activity | information>; the interdependence of "resource" and "enterprise object" ensures <resource | Information> synergy; the coupling between "capability" and "resource" represents the alignment <organization | Resource>, etc. Consequently, the basic structure of the Metamodel therefore enjoys a partial harmony of some components of the information system, in the forms described above. However, the formulation of this harmony in the decision-making context according to the strategic orientations such as resource management is not explicit at this level of the modeling. For this purpose, we borrow from Cobit some useful components to complete this vision. We remember that Cobit is an ISACA framework providing an end-to-end business view of the enterprise IT governance that reflects the central role of information and technology in creating value for enterprises [13]. So, we add first a specialization of "Functional Entity" to model "IT processes" that use IT resource, this entity comes from a specialization of the entity "resource". On the other hand, we add the abstract concept "objective" which will be specialized according to the enterprise view. Indeed, the business area of the company, the business processes, the activities, the decision centers is controlled and driven according to objectives. However, Contemporary corporate performance is measured by some indicators that need to be carefully monitored to ensure that processes are being executed efficiently to achieve their intended objectives. So, we add the construct "indicator" that can be specialized as "goal indicators" or "key performance indicators" (KPI), and specific metrics for the technical and tactical evaluation of the activities achievement according to the defined goals, as shown in Figure 2 [14].

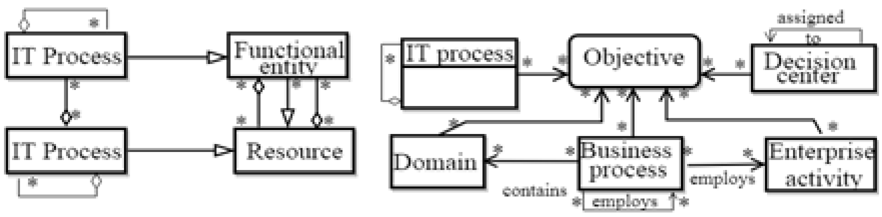

Figure 2. Use of some components of Cobit and other specific constructs

2.3. Systemic Tools integrated into the Proposed Extended Meta-Modeling

Systemic precepts define a system as an organized global unit of interacting elements, functioning and evolving according to some goals, plunged into an economic, sociotechnical, dynamic and complex environment. The genealogy of the systemic contains an important contribution of the structural paradigm (structuralism) which, under its mathematical projection, gave rise to diverse unifying structures: algebraic structures (group, monoid and dioid), order structures (lattice), and topological structures based on the notion of neighborhood. Systemic tools are generally represented by these three types of structures, or by a combination of these relevant structures. Also, in systemic best practices, the functional structure is described by processes that use some number of resources. A fundamental question emerges "how are these resources managed?" Some structural matrices have been used to give an answer to this question. The analysis of these matrices makes it possible to identify the IT resource which is deployed to achieve the business processes or activities. In the same vision, for the various facets of IS governance, including the couplings: {Organization, Activity, Process} $\times$ {Resource}; {Activity, Process, Resource} $\times$ {Information}; {Activity, Process, Organization} $\times$ {Information}, we propose to build structural matrices and, through the appropriate structures, engage specific analyzes for these structures that can give more visibility on the resource management strategy.

The structures that we suggest in this work are divided into two categories: structures that allow a unique reading of structural matrix analysis, namely Galois lattices (order structure with closure concept) and the method "Q – analysis" (structure derived from algebraic topology) [15]. The other category called "structural decomposition" makes it possible to prioritize the structural matrix (order or pre-order structure). This decomposition exploits similarities or dissimilarities, coupling indices, as well as hierarchical algorithms. In the field of IT resource management, various types of coupling can be measured: (Process / Resource), (Resources / Objective), (Resource/ Activity), etc. Other order structures can be used to address other structuralism issues such as the problem of prioritizing processes or reuse of resource. In this article, we limit ourselves to the analysis of structural matrices through Galois lattices. Other tools will be considered in other works.

2.4. Overview of the proposed systemic approach for IT resource management

Now, the proposed holistic view of the ISO 19440 Metamodel is complete by adding some components of the Cobit framework that have been linked with other specific constructs of the enterprise such as "Objective", "Indicator" and "Metric", and integrating several structures particularly systemic tools like Galois lattice which is the pillar of the proposed analysis methodology, as shown in Figure 3.

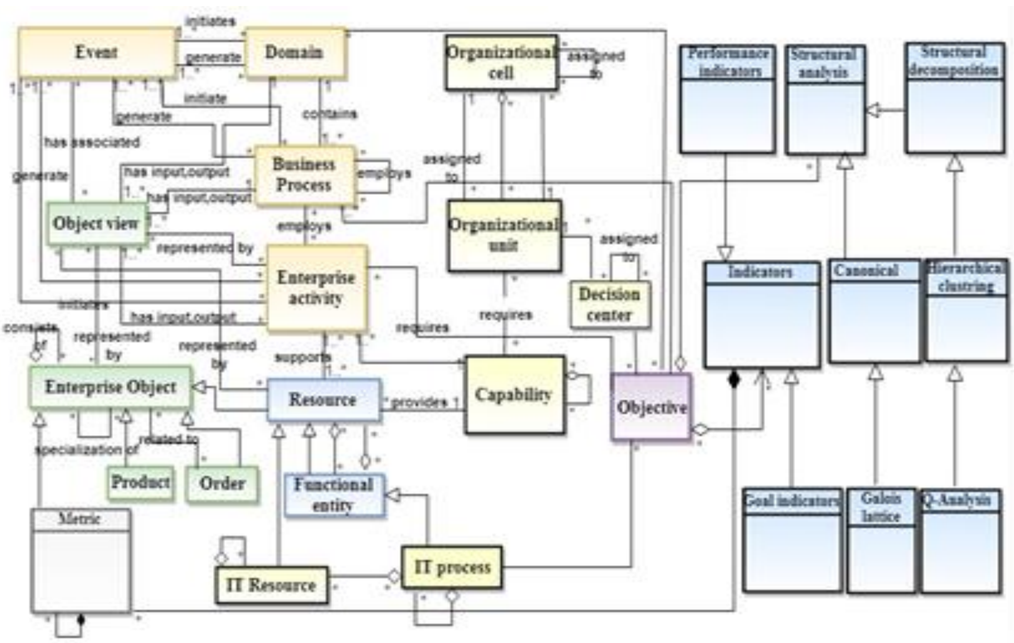

Figure 3. The proposed extended Metamodeling of the ISO 19440

2.5. Systemic analysis based on Galois lattice

The Galois lattice is a mathematical structure to represent non-disjoint classes underlying a set of described objects using a set of attributes. It is a concept of hierarchical structure induced by a binary relation and it is very suitable for data analysis and rule extraction [16]. In the following, we present an exemple highlighting this concept of Galois lattice through an appropriate matrix of resources and activities (Table 2).

Table 2. The structural matrix describing the correspondence R of the context C = (O, A, R)

	A1	A2	A3	A4	A5
R1	1	1	0	1	1
R2	0	1	1	0	1
R3	1	1	0	1	1
R4	1	1	1	0	1
R5	1	1	1	1	1
R6	0	1	1	1	0

We consider the context C which is based on the triplet (O, A, R), where O is the set of resources; A is the set of activities and R is a correspondence. This context expresses the fact that an object « Ri » is used or not by the attribute « Aj ». If yes, it is noted by 1. Else, it's 0. The set L of all concepts, provided with the order relation, has the mathematical structure of lattice and is called the Galois lattice L of the context C. A simple view of the studied matrix makes it possible to note certain obvious observations between IT resources and their attributes but remains unable to distinguishing relevant meta-data likely to provide an in-depth view of the IT resource use to execute activities in a given context. In this work, we focus especially on the structural matrix (IT Resource / Activity) which contains IT resource (objects) achieving or not some activities (attributes) and generating intersection points likely to provide formal analysis to improve IT resource management.

3. RESULTS AND DISCUSSION

A first observation of the studied matrix allows to conclude that an array of response (yes / no) to a questionnaire dichotomous "is the resource Ri used or not by the activity Aj" is giving without relevant information. To visualize the lattice representing the studied structural matrix, we use Galicia software which is developed to create, view and save the Galois lattice through several algorithms to calculate and display data and extract the association rules. The generated lattice from Galicia has a hierarchical visual representation highlighting specific concepts (Figure 4).

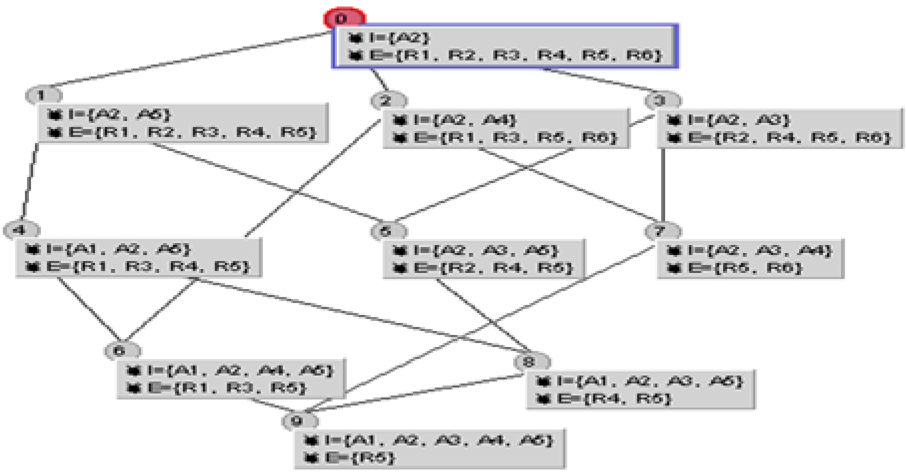

Figure 4. Lattice of the structural matrix (IT Resource / Activity)

With this simple example the laticielle representation of activities in relation to resources is canonical. In a maximal di-click or closed (E, F), E is the set of all resources used simultaneously by all activities of F (no other activity using it all). The lattice contains all maximal di-cliques to find what activities are at the same time using the same resources R0, the minimum set of resources containing R0 must be determined. The Galois lattices arcs represent the possible shifts of a maximum di-click to another when the resource set R0 is reduced or increased. On a lattice, it is possible to rearrange the elements (resources and activities) in the order given by a lattice chain. The scales of Guttman can be exploited to highlight Galoisian classifications [17]. With this same structure and with generation methods association rules from Data mining, it is possible to generate associations between activities or between resources. These associations express hidden dependencies and correlations existing between resources and activities. The intention to harmonize all the instances of the reference structures considers all the Metamodel views allowing a structural analysis integrated in a holistic vision of the company.

3.1. Analysis methodology

To concretize this approach, we propose a practical method that contributes to the IT resource management. This methodology consists of identifying non-value-added resources that contribute little to the achievement of the company's major activities, but at a very high cost of use. For this purpose, we consider the same structural matrix annotated with the deployment cost of each resource compared to the overall cost

to run an activity. The deployment cost is adopted conventionally to illustrate the contribution of the proposed methodology in the field of resource management. Other criteria can be considered like the iteration number of resources use, impact on customer satisfaction, link with IT processes, etc.
We consider some notations to execute the proposed methodology. So, we note:
R: Set of IT resource; A: Set of activities; λ: application embodying the impact force of the use of resource on activities. λ: $\Pi \times \Theta \rightarrow R$; ϖ: aggregate function, $\varpi : R+\times R+ \times \ldots \times R+ \rightarrow R+$.
For each activity Ai, we associate the aggregate measure δ, impact on the overall IT resource. $\delta(Ai) = (\varpi((\lambda(Pi,A1), \ldots, \lambda(Pi,Aj), \ldots, (\lambda(Pi,An))$.
We consider also the standard measure μ given by: $\mu(Pi) = \delta(Pi) / \Sigma(\delta(Pi))$.
The proposed analyze methodology consists of:

- Calculate $\mu(Ri)\ \forall\ Ri \in A$.
- Establish a descending sort of resource, according to μ measure.
- Δ is the list of resources achieving activities according to the Pareto rules [18].
- Let $\Lambda = A - \Delta$ resources with minor impact on activities but with a high cost.
- For each resource of Λ, follow the closed $\Phi i,j$ containing Ri according to a Guttman scale.
- For each closed, analyze expenditures related to resource/activity and Interpret the results.
- Audit responsibility entities that deploy the closed $\Phi i,j$.
- Define recommendations and propose action plans for IT resource optimization.

This technical methodology is part of the process reengineering and gives a new taxonomy of tasks in order to reduce time, resource and effort. This approach can be applied to other order structures to address other structuralism issues such as process prioritization, market analysis, performance analysis, organizational restructuring, risk analysis, etc.

4. CONCLUSION

In this article, we have proposed a systemic approach based mainly on the formal extension of the ISO 19440/2007 enterprise Meta-model, offering a better representation of the company. This meta-modeling is characterized by the integration of new components from the Cobit framework, reinforced by some specific constructs, order structures and systemic tools as Galois lattice. The analysis of the lattices's closeds generated by the coupling of some constructs of the Metamodel will aim to improve the correlation and consistency of some components for IT resource optimization. This technique could assist to the evaluation of all the pillars of the information system governance. Computationally, we have already started the implementation of an application to illustrate the added value of this approach. In other works, the proposed approach will be applied through many practical case studies analyzing other structural matrices, in several areas of the company. It can be used to evaluate IT strategic alignment, IT performance, IT resource management, IT risk management and IT added value. However, this method strikes some limitations if the number of objects and attributes of the structural matrices becomes large. However, we remain optimistic and rely on future researches focused eventually on this particular area to restore the encountered difficulties.

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