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Research paper

Extended Enterprise Metamodeling for Strategic Information System Alignment: Case Study

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Abstract

The enterprise meta-modeling is an important process for studying and managing organizations in order to improve their performance; it allows representing all views of the company for better governance. In this paper, we propose an extension of the ISO/DIS 19940 Meta-model by adding strategic constructs and specific tools from the Cobit framework. This extended meta-modeling allows a systemic and holistic analysis based on Galois lattices to intelligently drive the alignment of several components of the company. We also present a case study in a Moroccan transport company. We analyze a particular structural matrix to identify any relevant information that may contribute to process reengineering for Information System governance.

Keywords: *Systemic; Meta-modeling; Strategic Alignment; Galois lattices; ISO/DIS 19440.*

1. Introduction

The Information System (IS) is a package of 4 essential elements: information technologies (IT), information, processes and actors [1]. The (IS) ensures communication between the operating system and the decision-making system as well as the exchange with the environment. Business executives and IT professionals are constantly confronted with the problem of strategic alignment of Information System. The resolution of this problem is an essential factor for predicting and organizing the IT/Business synergies according tothe strategic orientationof the company [2]. In this work, we propose an original systemic meta-modeling that we deploy through a case study in a Moroccan transport company to detect synchronization gaps between some business processes and the company's strategy. We study in particular the structural matrix (Process / Strategic Axis)where we develop Galois lattices generating closed and bringing a better visibility of the strategic IS alignment. The closed are studied particularly by Pareto rules. Results are used for process reengineering as a contribution to Information System governance.

2. Materials and methods

2.1. State of the Art

2.1.1. Strategic alignment of Information System

Strategic alignment is considered as a key element for improving the organization's performance in order to increase its efficiency and effectiveness for more competitive in their business areas [3]. The alignment process refers to an organizational process where the mission, goals, objectives, and activities of the IS function [4]. There are four main objectives to engage in the formulation of the strategic alignment of Information System:
Alignment and impact of computer applications that could help the enterprise achieve its business goals; development of a flexible and cost-effective technology infrastructure; development of resources and skills required to deploy the information system successfully throughout the organization [5].
One of the first steps towards strategic alignment is to have tools to measure it. Current approaches of evaluation although primarily focused at the strategic level provide little finesse at the tactical and operational levels, which are identified as important areas for achieving strategic alignment. Moreover, most existing approaches are tested in big organizations and there is little research to evaluate the effectiveness of these approaches in small and medium enterprises[6]. This work offers systemic approach, based on structural analysis that provides an opportunity to measure strategic alignment at the tactical and operational levels.

2.2. Enterprise Modeling

Enterprise modeling is a technique that gives the company multi-views representation for boosting all processes according its strategic and business goals. Since the 90s, several models have been developed for a business model that fully or partially covers the functional, informational, organizational and human aspect of the company as: IDEF languages; GRAI and GIM-GRAI approach; CIMOSA model; AICOSCOP; ARIS model; GERAM method; ABC/ABM technics [7]. However, the majority of frameworks related to modeling a particular area of the company offers relevant concepts of modeling and integration, as well as their relationships. So, the determination of the positioning and potentialities of any approach is important, given its strong participation in bringing together existing methods for better integration. This diversity of techniques imposes a unique

framework of corporate representativeness to correct the flaws of each of these approaches considered individually.
The research efforts of enterprise modeling lead to a standardized framework to meet the needs of a systemic approach of the company; it’s the ISO 19440 Metamodel whish is oriented “process”. It offers four views on these models: the organizational view, the informational view, the functional view and the view of resources [8]. A teleological anchoring of the ISO 19440 Meta-model is given in (Figure 1), according the four points of view mentioned above.

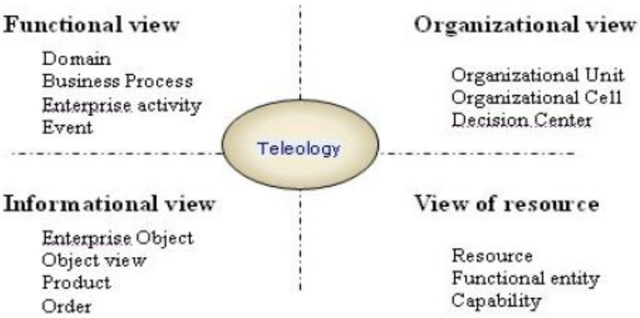

Fig. 1: ISO 19440 views with teleological anchoring.

The analysis of the different methods of enterprise modeling according to their coverage of these four views leads to draw up the following matrix. For each model or technic “X” means that the associated vision is covered by this model. Else, it is represented by 0 (Table 1).

Table 1 : Modeling Techniques versus Company Perspectives

Model		View				
		Functional	Informational	Organizational	Resource	Systemic
IDEF Suite	IDEF0	X	0	0	0	0
	IDEF1	0	X	0	0	0
	IDEF2	X	X	0	X	0
GRAI		0	X	0	0	0
GIM GRAI		0	X	0	X	0
CIMOSA		X	X	X	X	X
AICOSCOP		X	0	X	0	0
PERA		X	X	0	X	0
ARIS		X	X	X	0	0
GERAM		X	X	X	X	0
ABC/ABM		X	0	0	0	0
ISO 19440		X	X	X	X	X

According to the table above, there is no modeling approach that covers the five representative aspects of the company: functional, informational, organizational, systemic views and view of resource. Only the CIMOSA method offers coverage of all these views. However, the CIMOSA model has deficiencies related to the decision management mode in the organizational view. On the other hand, the ISO 19440 offers a more comprehensive representativeness of the company, covering all these views for a better IT / Business consistency. This explains the use of the ISO 19940 Meta-model able to support the proposed structural analysis through specific systemic tools.

2.3. The Cobit Referential

The Cobit (Control Objectives for Information and Technology) referential was created by ISACA (Information Systems Audit and Control Association). It provides a reference framework and a set of tools for controlling and monitoring the IT governance [9]. Cobit proposes to establish a process oriented “IT steering” in order to contribute to the alignment of IT on business strategy [10]. COBIT components are all interconnected and aimed at meeting the needs of governance, management, control and assurance of different actors (Figure 2).

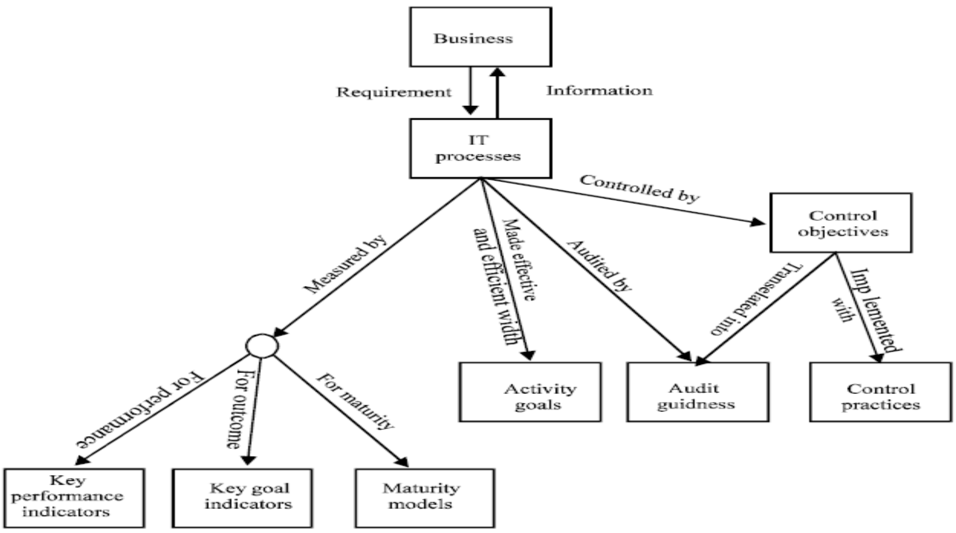

Fig. 2 : Interconnection of COBIT components

In this work, we borrow from Cobit the construct "IT Process" as control and measurement elements. These elements are used for the extension of some aspects of the ISO 19440 Meta-model that are extremely useful for the strategic IS alignment.

2.4. Galois Lattices

The concept lattice (or Galois lattice) is a mathematical structure to represent non-disjoint classes underlying a set of described objects using a set of attributes [11]. The value of concept lattices (Galois) can be summarized as follows:

- Each concept corresponds to a grouping of objects based on their descriptions and offering a full description of each object: a file system analogy between concept and Directory;
- Groupings based on these concepts are dynamic: they change whenever objects are added/deleted or that the descriptions of objects change;
- Direct correspondence between description of concepts and interrogation request;
- Can be used for navigation;
- Every object is accessible from the root of the lattice;
- Unlike a hierarchical organization in general each object can be reached in several ways.

Example:

Consider the context C represented by the triplet (A, B, R) where A, B are sets and R is a relation. The binary matrix describing the relation R of the context C is given by Table 2, where A = (A1, A2, A3, A4, A5) and B = (B1, B2, B3, B4, B5, B6). This context reflects that if an element Ai of the set A is in relation with another element Bj of B, we put 1 as intersection, else, it's 0 (Table 2).

Table 2 : Matrix describing the relation R of the context C

	B1	B2	B3	B4	B5	B6
A1	1	0	1	0	1	0
A2	0	1	0	1	0	1
A3	0	0	0	0	0	0
A4	1	0	1	0	0	1
A5	0	1	0	1	0	1

2.5. Proposed Extended Metamodeling Approach

In this paragraph, we propose to build an extension of the ISO 19440 meta-model, to explicitly bring the issue of alignment of various aspects.

2.5.1. Extended Meta-modeling

We first develop the analysis of the original meta-modelstructure. The basic borders of alignment are at interactions and couplings between the different views of the meta-model. The interaction between enterprise business and resource shows the alignment <process, activity | resource>; the coupling business process, enterprise activity and object view relate the alignment <process, activity | information>; the interdependence of resource entities and enterprise objects gives information of the alignment <resource | information> etc. The structure of the basic meta-model allows the expression of the IS alignment in the manner described above. However, the formulation of the strategic alignment within the meaning of decision-making is not explicit in the modeling of the four views.

First, we propose to use the Cobit best practices for driving the IT processes. So, we add a specialization of Functional Entity to model (IT process) that use (IT resource), the entity "IT resource" is modeled by a specialization of the entity "resource" (Figure 3).

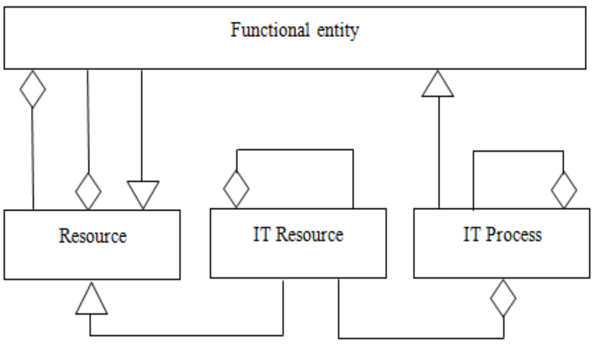

Fig. 3: Integration of "IT resource" and "IT process".

Then, we add the abstract concept "objective" which will be specialized according the view. Enterprise activity, business processes, activities, decision-making centers are controlled and driven by objectives. We remember that the built "objective" has been proposed in ISO19440 under his functional aspects; however, links with decision-making centers and metric measurement are not explicit (Figure 4).

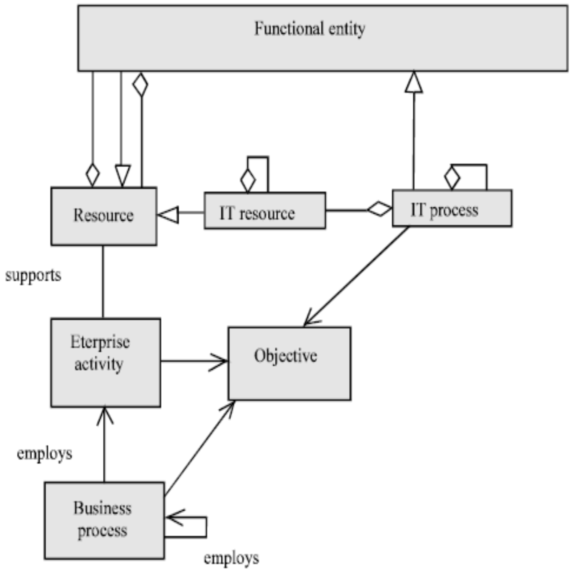

Fig.4: Integration of Objective entity

2.5.2. Structural paradigm and systemic tools

The systemic precepts define a system as an organized unit of elements in interaction, operating and evolving according to an objective, immersed in an environment that acts on it and on which it acts.
Symbolic rewriting of the definition of a system takes the following form: (S) = (E, Ri, O, Re), where E: set of all the components, Ri: set of internal relations, O: set of objectives and Re: set of external relations. This symbolic rewriting refers to structure concept. The genealogy of the systemic has an important input from the structural paradigm (structuralism), which in its mathematical projection gives rise to several unifying structures: algebraic structures (group, monoid, dioides), structures of order (lattice), and topological structures based on the concept of neighbor-hood. The systemic tools that are the basis of structuralism draw their representation strengths in these three types of structures, or combination of these reference structures (such as algebraic topology).
In the best practices of the systemic, the functional structure is described by processes, a fundamental question emerges "how do processes fit together"? The structural matrixes were used to give an answer to this question. The analysis of these matrices relates to networks of processes and allows study of the tree of processes, linear chains, feedback, etc. In the same vision for the various problems of IS alignment: {Organization, activity, process} x {resource}; {Activity, Process, Resource} x {information}; {Activity, Process, organization} x {Information} etc. We propose the construction of the structural matrices and initiate analysis permitted by appropriate structures. The structures evoked in this work are divided into two categories: structures that allow a single reading of the matrix structural analysis, namely the Galois lattice (order structure with closure concept) and the method Q-analysis (structure from algebraic topology). The other category called "structural decomposition" allows prioritizing the structural matrix (order or pre-order structure). Various types of coupling can be measured: process/process coupling through resources, activity/resource link and dependency of the processes by entropic measures, information/resource link, process/objective link etc. [12]. This structural package can be used formally in the Meta-model. Thus, we graft into the proposed extended meta-modeling this panoply of structural analysis that shares the same objectives as the other constructs of the Metamodel (Figure 5).

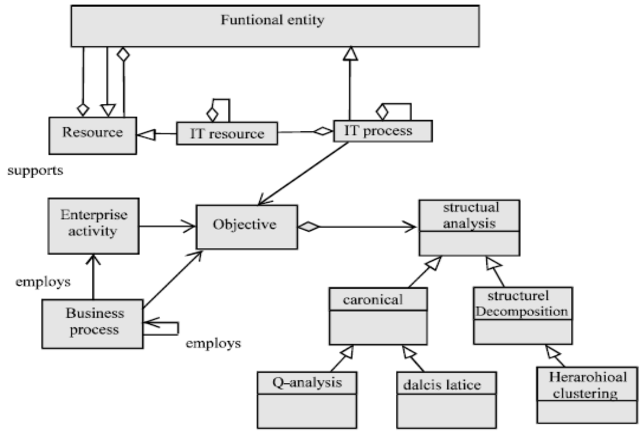

Fig. 5 : Integration of structural analysis

3. Results and Discussion

3.1. Case Study

In this section, we deploy the proposed holistic approach in a Moroccan transport company, to optimizing its processes according to the strategic axis. In this study, we selected a sample of 17 processes, mainly business processes (Table 3).

Table 3 : List of some processes running the company studied

Process Id	Process Name
P1	Logistics Watch Process
P2	Customer Watch Process
P3	Strategic Watch Process
P4	Simulation of offers characteristics
P5	history
P6	Partner portal (e-partners)
P7	Follow-up of the means according needs
P8	Customer tracking management (e-client)
P9	travelers Customer Relationship Management
P10	Messaging Customer Relationship Management
P11	Logistic Customer Relationship Management
P12	E-logistique
P13	E-messagerie
P14	Integration of E-client, E-logistics and E-mail with traffic
P15	E-voyage
P16	Electronic exchanges of EDI compliant documents
P17	IS Integration with Partner IS

These processes contribute or not to the achievement of 14 strategic axis in a given context (Table 4).

Table 4 : List of studied strategic axis

Axe Id	Strategic Axe Name
Axe1	Reference carrier for customer service
Axe2	Successful and growing company
Axe3	Model in Human Resources Management
Axe4	Business at the service of the community
Axe5	Reference partner for its suppliers
Axe6	Integrated Services with added value to customers
Axe7	Planning Optimization and Circulation of transport means
Axe8	Hardware and Infrastructure Optimization
Axe9	Modernization of management processes
Axe10	Modernization of monitoring
Axe11	improved openness and interoperability of the IS
Axe12	Enhance the IS scalability, agility and security
Axe13	Strengthening the IS urbanization (best practices)
Axe14	Strengthening the IS transversality

3.2. Choice of the Structural Matrix

In this study, we are particularly interested to the structural matrix (Process / strategic Axe) which is essentially composed by some processes Pi that contribute or not to the achievement of some strategic axis Aj. If yes, we represent it by 1. Else, it's 0 (Table 5).

Table 5 : « Process/ strategic Axis » structural matrix of studied company

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15
p1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
P2	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0
P3	1	1	0	0	0	1	1	1	0	0	1	0	0	0	0
P4	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P5	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0
P6	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
P7	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P8	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P9	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
P10	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P11	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P12	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P13	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P14	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0
P15	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
P16	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0
P17	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0

3.3. Concept Analysis: Galois Lattice

We integrate this studied matrix into the Galicia solution which is a free platform for lattice generation and we obtain the following Galois lattice (Figure 6). Closed analysis contributes in particular to process reengineering. Its challenges are to boost the quality of service to improve the performance of the company.

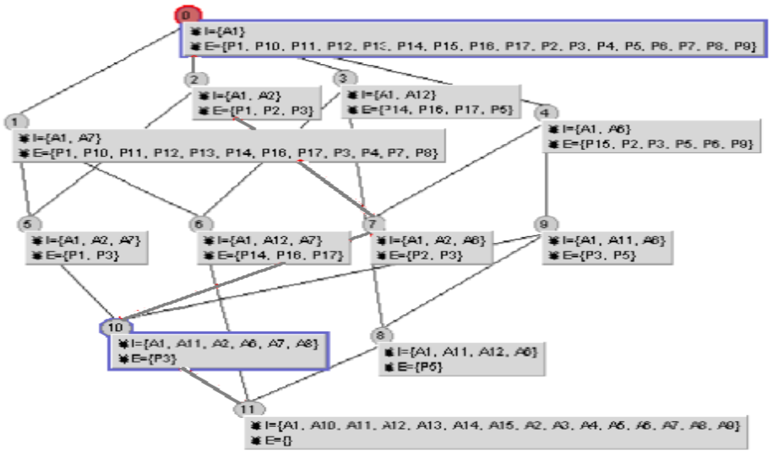

Fig. 6 : Detailed visualization of the generated Galois lattice

3.4. Processes Reengineering based on closed

In this section we describe an analysis method contributing to the Process reengineering. It consists of identifying non-value-added processes that contribute little to the achievement of the company's major strategic axis, but at a very high cost of implementation. We take again the structural matrix annotated of the deployment costs of each process compared to the overall cost of all the processes (Table 6).

Table 6 : Matrix representing the cost of deploying processes against the overall cost

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15
P1	3%	2%	0	0	0	0	1%	0	0	0	0	0	0	0	0
P2	1%	3%	0	0	0	3%	0	0	0	0	0	0	0	0	0
P3	2%	5%	0	0	0	1%	1%	3%	0	0	2%	0	0	0	0
P4	5%	0	0	0	0	0	2%	0	0	0	0	0	0	0	0
P5	1%	0	0	0	0	2%	0	0	0	0	3%	5%	0	0	0
P6	5%	0	0	0	0	1%	0	0	0	0	0	0	0	0	0
P7	1%	0	0	0	0	0	2%	0	0	0	0	0	0	0	0
P8	2%	0	0	0	0	0	3%	0	0	0	0	0	0	0	0
P9	1%	0	0	0	0	1%	0	0	0	0	0	0	0	0	0
P10	2%	0	0	0	0	0	2%	0	0	0	0	0	0	0	0
P11	3%	0	0	0	0	0	1%	0	0	0	0	0	0	0	0
P12	2%	0	0	0	0	0	1%	0	0	0	0	0	0	0	0
P13	2%	0	0	0	0	0	2%	0	0	0	0	0	0	0	0
P14	1%	0	0	0	0	0	2%	0	0	0	0	2%	0	0	0
P15	5%	0	0	0	0	1%	0	0	0	0	0	0	0	0	0
P16	1%	0	0	0	0	0	1%	0	0	0	0	5%	0	0	0
P17	1%	0	0	0	0	0	2%	0	0	0	0	3%	0	0	0

<u>Notation</u>

Π : Set of processes, Θ : Set of strategic axis, λ application embodying the impact force of a process on a target, $\lambda : \Pi\times\Theta\rightarrow R+$, ϖ aggregate function, $\varpi : R+\times R+ \times \ldots\times R+\rightarrow R+$. For each process Pi we associate the δ aggregate measure, impact on the overall axis.

$\delta(Pi) = (\varpi((\lambda(Pi,A1), \ldots, \lambda(Pi,Aj), \ldots, (\lambda(Pi,An))$.

The standard measure μ is given by: $\mu(Pi) = \delta(Pi) / \Sigma(\delta(Pi))$.

<u>Analysis methodology</u>

- Calculate $\mu(Pi)\ \forall\ Pi \in\Pi$.
- Establish a descending sort of process, as the μ measure.
- Δ is the list of processes impacting the strategic axis according to the Pareto rules.
- $\Lambda = \Pi - \Delta$ processes impacting low strategic axis.
- For each process Pi of Λ follow the closed $\Phi i,j$ containing Pi according to a Guttman scale [13].
- For each closed $\Phi i,j$ analyze expenditures related processes strategic axis.
- Audit responsibility centers that deploy $\Phi i,j$ processes.

<u>Application</u>

Calculation of μ (Pi) $\forall$Pi $\in\Pi$.

$\delta (P1) = \varpi ((\lambda(P1, A1), \lambda(P1, A2), \lambda(P1, A7))$

We consider that the aggregation function $\varpi$is the average value of $\lambda(Pi)$.

So, we have: $\delta(P1) = \varpi$ (3%, 2%, 1%) = 2%; Similarly, we calculate $\delta(P2)$, $\delta(P3)$, ...,$\delta(P17)$. Moreover, we know that $\mu(Pi) = \delta(Pi) / \Sigma(\delta(Pi))\ \forall$ i.

Hence: $\mu(P1) = \delta(P1) / \Sigma (\delta(Pi)) = 2/49$. $\mu(P1)$ = 4%. And we do the same to calculate all μ measures. The (Table 7) summarizes all the results obtained.

Table 7 : Value of δ and $\mu$of each process "Pi"

Pi	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
δ(Pi) (%)	2	3,5	7	3,5	5,5	3	1,5	2,5	1	2	2	1,5	2	2,5	3	3,5	3
μ(Pi) (%)	4%	7%	14%	7%	11%	6%	3%	5%	2%	4%	4%	3%	4%	5%	6%	7%	6%

We classify processes according to μ measure. The measure μmakes it possible to establish a descending sorting of theprocesses whose order is as follows:

P3>P5> P2≈P4≈P16> P6≈P15≈P17> P8≈P14> P1≈P10≈P11≈P13> P7≈P12> P9

<u>Pareto rule</u>

Vilfredo Pareto is an Italian economist who estimated that 80% of the world's wealth was held by only 20% of the population. The Pareto principle expresses the fact that 80% of turnover from commercial activities is achieved by only 20% of customer category [14].

Δ is the list of processes with costs classified according to the Pareto rule. This set is made up by the majority of the processes using a minimum of cost for the achievement of the assigned strategic axis, in accordance with the 80/20 rule of Pareto.

P3 : 14% ;

P5 : 14% + 11% = 26% ;

P2 ≈ P4 ≈ P16 : 14% + 11% + 7% = 33%

P6 ≈ P15 ≈ P17 : 14% + 11% + 7% + 6% = 39%

P8 ≈ P14 : 14% + 11% + 7% + 6% + 5% = 44%

P1≈P10≈P11≈P13 : 14% + 11% + 7% + 6% + 5% + 4% = 48%

P7≈P12 : 14% + 11% + 7% + 6% + 5% + 4% + 3% = 51%

P9 : 14% + 11% + 7% + 6% + 5% + 4% + 3% + 2% = 53%

Δ= {P5, P2, P4, P16, P6, P15, P17, P8, P14, P1, P10, P11, P13, P7, P12, P9}: set of processes achieving strategic axis with moderate costs. Let Λ = Π-Δ: all the expensive processes that con-tribute little to the achievement of the strategic axis. We have in this case Λ = {P3}.

3.5. Discussion

In the case of the studied company, the closed analysis leads us to conquer the organizational entities deploying the Process P3 "Strategic watch"; it is the Marketing Department. For this purpose it is proposed to ask the high authorities of the organization to:

- List the headings of the functional and investment budget of this department;
- Define the budget policy;
- Identify the annual budget rate allocated to the P3 process;
- Study the possibility of merging the "strategic watch" process with other processes, without compromising the achievement of other goals;
- Revise organizational structures;
- Streamline costs and optimize expenses.

This approach is likely to bring a new vision of Process Reengineering. The objective of the structural analysis of the closed will aim to review the Company's Meta-model in its functional form in order to review the structuring of entities likely to affect the overall performance of the company. The proposed methodology was implemented on a grid of Process × strategic axis. The approach is original and remains to be validated by the organization's steering and dashboard stakeholders. Other structural matrices may be explored in future work to enhance the library of meta-knowledge useful to organizations seeking decision support and better vision for strategic Information System alignment.

4. Conclusion

This work is part of the IS Governance. It is based on an original holistic meta-modeling for IT/Business alignment. We have already started the implementation of an application to illustrate the added value of this approach including study of several structural matrixes in order to evaluate the contribution of this approach to IS strategic alignment. In other future works, we will use this methodology in the classification field, to apply an analysis of generated Galois lattices resulting from the structural matrices. However, structural analysis has been applied in this work on a small matrix taken as a sample. This technique can run into some difficulties for the processing of a larger matrix with even more processes: more complex computation, unreliable budget data, etc. But it is a good way to dig deeper into this discipline and find other alternatives likely to solve this problem.

Acknowledgement

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