Proceedings of ICAD2009
The Fifth International Conference on Axiomatic Design
Campus de Caparica – March 25-27, 2009
ICAD-2009-16

BUSINESS PROCESS ANALYSIS AND REENGINEERING OF ADMINISTRATIVE PROCESSES USING AXIOMATIC DESIGN: THEORY AND CASE STUDY FROM THE UNIVERSITY OF FIRENZE

Gianni Campatelli
gianni.campatelli@unifi.it
DMTI,
Department of Mechanical Engineering and Industrial Technologies,
University of Firenze
Via di S.Marta, 3 – 50139 – Firenze, ITALY

Paolo Citti
paolo.citti@unifi.it
DMTI,
Department of Mechanical Engineering and Industrial Technologies,
University of Firenze
Via di S.Marta, 3 – 50139 – Firenze, ITALY

ABSTRACT

The business process analysis is the first step for the improvement of the overall performances of every organization. In this paper will be presented the case study of the University of Firenze. Our group has developed a model for the evaluation of the coupling for the administrative processes to identify the most critical activities and to evaluate alternative solutions to reduce the coupling and increase the efficiency. This model has been used as basis for the ABC evaluation of the process. This model has been applied to some administrative processes of the University of Firenze in order to prove how the administrative process coupling, in a AD sense, brings to a high level of inefficiency of the processes with the results of long processing time and high cost for the organization.

Keywords: Business Process Analysis, Business Process Reengineering, Activity Based Costing, Axiomatic Design.

1 INTRODUCTION

The primary goal of Axiomatic Design (AD) is to establish a systematic foundation for the design process by means of two fundamental axioms and a set of implementation methods [11]. The axioms are:

- Axiom 1: The Independence Axiom: maintain the independence of functional requirements (FRs).
- Axiom 2: The Information Axiom: minimise the information content in design.

Guided by the design axioms, AD maps the functional requirements FRi to the Design Parameters DPi. This approach has been usually applied to the field of mechanical and system design because this application is the easier to be implemented due to a clear definition of the FRs and the related performance measure of the product or system (i.e. performance of a packaging system).

The authors propose as a new field of research for the AD theory the transactional process analysis and the related evaluation of efficiency and strategy. The approach that has been developed has the aim to create an AD framework for the analysis of these processes and create a series of guidelines for the process improvements [5]. This approach has contributed also to the development of tools for the application of Activity Based Cost (ABC), usually performed for transactional processes.

The ABC, proposed by R. Cooper and R. S. Kaplan in 1987 [2, 9], has the aim to give the input to the organization to auto evaluate its performances in order to measure the cost of the activities and establish if all of them are value adding or there is some activity that is not useful. Cooper and Kaplan described ABC as an approach to solve the problems of traditional cost management systems. These traditional costing systems are often unable to determine accurately the actual costs of production and of the costs of related services. Consequently managers were making decisions based on inaccurate data especially where there are multiple products/services [1]. The ABC could be carried out using five steps [8]:

1. Analysis of the activities: focused on the activities that an organization performs in order to produce a service or a product; the activities performed has to be considered, not the product or service itself.
2. Economic data collection: the organization has to collect cost data related to its existence and production of services and products, such as organizational and research investments, office furniture, continuous education, salaries.
3. Linking the cost to the activities: in this step the measured costs have to be related to the specific activities that the organization carries out, this represents how much the organization "pay" in order to produce a product or a service, the general aim is not to evaluate exactly the cost but the cost sources for each product/service.
4. Output calculation: in this step the output of the organization is measured in order to quantify the product/service produced, this information is used for the exact calculation of the total cost of each output. This is obtained as the ratio among the input cost and the output.
5. Analysis of the costs: the analysis of the cost roadmap has two main objectives: to evaluate the most cost-consuming activities in the organization, that will eventually be reengineered in order to improve their efficiency, and if there are activities with relevant cost that are secondary or with very low added value that so could be reduced or eliminated without a sensible quality loss of the product/service.

The general idea of ABC is that a product/service needs some activities to be carried out in order to exist and that each activity uses a certain amount of resources. This approach allow both the quantification of the needed activities for the whole organization (so helping the reorganization process) and the cost (in term of resources) needed by the organization.

The general idea of this paper is to link the results of the ABC to the process analysis of the AD in order to find how the organization setup could be improved thanks to the decoupling of the structure [4]. To apply this concept a new definition of the AD domains is however necessary.

The processes of the University of Florence have been divided in three main areas: didactic, research and administrative. These processes are related to the activity of the whole University that includes Departments, Faculties and Central Administrative Offices (CAO). In particular will be presented the process to make a payment for a research activity. The actual interrelation of all the processes is presented schematically in figure 1, where the area of the form is the entity of the processes and the overlap represents the degree of interrelation.

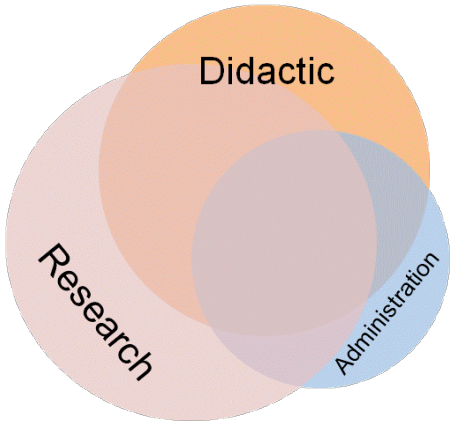

Figure 1. Schematic representation of the processes.

2 PROPOSED APPROACH

The proposed approach is based on the redefinition of the classical AD domains, a different definition of information needed for each domain is provided, and the creation of a new one, useful for the process optimization.

The 4 classical domain of the AD are so definite:

- Customer Domain: in this domain are collected all the needs of the society (student, government, …) and of the staff (teachers, researchers, technicians, …) respect to the University; these needs are expressed with the "Voice of the Customers" and are often to be reported in a practical language for the definition of the service that the University must provide.
- Functional Domain: in this domain are reported all the services that the University must provide to the users and staff, derived directly from the CNs.
- Physical Domain: the physical domain will contain all the activities needed for the production of the service defined in the FRs, the interrelation of the activities with multiple FRs will provide a measure of the coupling of the process that will be discussed further later.
- Process Domain: in the process domain will be reported the responsibility for each activity, the coupling of this matrix with the previous is useful to evaluate the efficiency of the organizational model adopted by the University.

While the new one is:

- Resource Domain: resources needed for the existence of the activity, the coupling of the matrix that link the Resource Domain to the Physical Domain is not relevant, the usefulness of this domain is the simplification and rationalization in the evaluation of the resources needed by the whole organization (Resource Needs or RNs).

A scheme of the 5 domains is presented in figure 2.

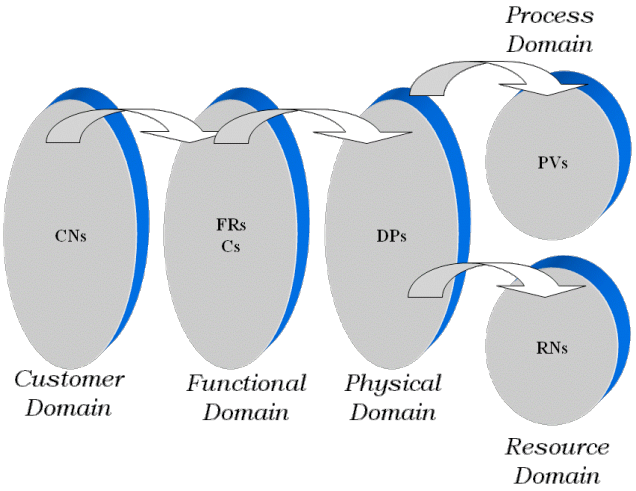

Figure 2. Five Domains of the approach

The steps of the proposed approach are the following:

1. Analysis of the Customer Needs and definition of the Customer Domain; this analysis could be carried out also using interview, benchmarking with similar organization and so on.
2. Definition of the services that the organization must provide in order to satisfy the customers, these are to be reported as FRs in the Functional Domain. The analysis of the design matrix between Customer and Functional Domains is crucial to evaluate if all the CNs are really satisfied and eventually if the not satisfied CNs are crucial or trivial. Moreover a check could be carried out to find if some service is provide in spite of no request from the customers. This analysis is to be carried out periodically because the needs of the customer of an organization are always changing and the services provided are to be updated periodically in order not to waste resources for unwanted or little requested services. In this case the terms of the matrix could be the number of service required by the customers. This information will be used later as Output for the ABC cost evaluation of the service. An example of this analysis is reported in figure 3.

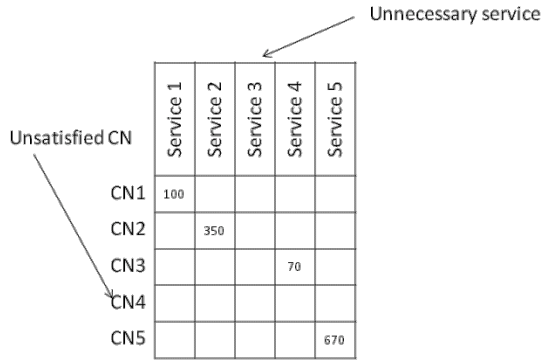

Figure 3. Example of the first matrix (CNs-FRs)

3. Analysis of the activities and definition of the DPs. In this step the process must be studied in detail in order to evaluate the activities needed to produce a specific service. This analysis needs to consider the process "as is" in order to find out if some not value added activities are carried out. The research of not added value activity is one of the most relevant action to improve the efficiency of the organization, especially in the public sector where the "inertia" to change is very high and the organizational structure is static. The matrix that link FRs and DPS in this case will report the information of how much the activity is working for the satisfying of each specific task. This information will be reported in percentage, so the sum of the values on each column must be 1. This data will be used later for the estimation of the cost of each service based on ABC. This step include the second step of the ABC. An example of application is reported in figure 4.

	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7
Service 1	70%		20%				15%
Service 2		70%			35%		
Service 3			80%			40%	
Service 4		30%		100%	65%		
Service 5	30%					60%	85%
Sum	100%	100%	100%	100%	100%	100%	100%

Figure 4. Example of the matrix FRs-DPs

4. In this step is necessary the mapping among the DPs and the PVs, so the task is to find the relation among the activities and its chief. This analysis is very useful during the reengineering of the process for the allocation of the responsibility and the realization of a responsibility matrix. The rearranging of this matrix is fundamental for the evaluation of the optimal responsibility allocation and the definition of the offices layout. Moreover the responsibility matrix has been used to seek a balance for the responsibility of all the middle manager.
5. This step consists of the definition of the resources consumed by the various activities that have to be included in the Resource Domain. This new domain has been proposed in order to find the cost of each activity and of the related service provided by the organization. The matrix used for the mapping among the DPs (activities) and the resources (RNs – Resources Needed) is usually a rectangular matrix because the number of activities is usually larger than the different types of resources that . an organization could use during its processing (i.e. – electrical power, human resources, etc.). The form of the matrix (later called Resource Matrix - RM) is not an issue because the decoupling of such architecture could not bring to any advantages. The RM could however be used to store the resources consumption of all the activities in a synthetic form. An example of the application of the RM is presented in figure 5.

	Resource 1	Resource 2	Resource 3
Activity1	2	1	0.5
Activity 2		3	1
Activity 3			2
Activity 4		1.5	
Activity 5	0.3	0.7	
Activity 6	2		
Activity 7		2	

Figure 5. Example of Resource Matrix

6. The following step consists of the analysis of the resource consumption of each service provided by the organization. In order to find the exact resource consumption is possible to compute this value using the design matrix. In the first matrix (CNs-FRs) is collected the output of the process in terms of number of services provided, in the second (FRs-DPs) the relation among services and activities while in the third (DPs-RNs) the consumption of resources for each activity. This value could be so computed with the following formula, where RC is a vector with the cost of each resource unit:

$$\{\text{Service cost}\} = [DM_1] \cdot [DM_2] \cdot ([RM] \cdot \{RC\})^{-1} \qquad [1]$$

7. The last step is the improvement of the process that could be carried out considering three guidelines: evaluate if there are unnecessary service offered by the organization thanks to the analysis of the first design matrix [3]; evaluate if there are no added value activity that could be easily removed from the process thanks to the study of the process value stream; improve the efficiency of the most critical and resource consuming activities that are highlighted by the analysis of the Resource Matrix [6, 7].

3 CASE STUDY

The proposed approach has been applied to a relevant number of administrative processes of the University of Firenze with very encouraging results. The general result has been the decoupling of all the function inside the University with the adoption of a different interaction model. As schematically presented in figure 6 the new organization of the administrative processes has separated the role of didactic and research staff from the administrative ones: the processes are simply started by the first and carried out autonomously by the administrative. The starting condition presented a far larger mixture of responsibility and tasks.

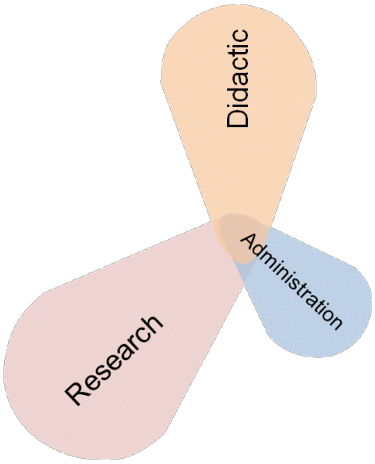

Figure 6. New scheme of the processes

As case study the analysis of the payment for research expenses is presented.

The first step is the study of the Customer Needs that are mainly produced by the research staff and the Central Administrative Office. The first matrix show us that the services provided by the administrative offices are fit to the request. The matrix has been compiled for the whole administrative office. A part of the matrix is presented in figure 7. In the case of the specific process the FRs are:

FR1: Provide payment to the supplier
- FR11: Check the research staff request
- FR12: Provide an economic order to the research staff
- FR13: Check the invoice
- FR14: Check the supplier status in accordance to government laws
- FR15: Transfer the request to the bank
- FR16: Check the bank payment

FR2: Assign the payment to the funds of the research staff
- FR21: Check the fund availability
- FR22: Update the fund availability
- FR23: Communicate the fund availability

In the representation of the whole administrative activities have been used 42 first level FRs and 83 first level DPs (activities), only part of the DPs involved in the process is presented in figure 7.

	Order invoice emission	Buyer management	Staff contracts	Internal Shipment	Fund management	Material management	Bank information management	Mailing service	Product Check
FR1	50%	10%		5%			15%	5%	
FR2		70%			35%			20%	
FR3			80%			40%			
FR4		30%		15%	65%				
FR5	30%					60%	85%		

Figure 7. Second matrix for the activities evaluation

The second step has been the creation of a process map "as is" in order to create a matrix among FRs and DPs. The map is also used for the evaluation of no added value phases in the process. It is usual to find such activities in administrative processes that have not been recently reengineered because the process has not been adapted to the new approach that could be adopted thanks to ICT. The preliminary analysis of the no added value activities for only this process is presented in figure 8, signed with a cross.

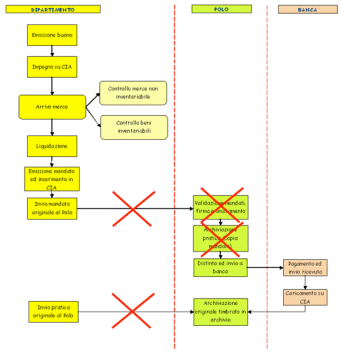

Figure 8. No added value activities

Moreover the administrative process proven to be highly interrelated with the research processes, with the FRs-DPs matrix highly coupled. The analysis of the coupling has allowed the redefinition of the involvement of the research staff in the process. The effort has been to remove as much as possible the need for contact, authorization or signature of the research staff for this process. With the reengineering the process is only started by the research staff and then is carried out nearly autonomously by the administrative staff. This has been obtained improving the use of ICT and web services and promoting the process simplification. In order to simplify the process has been fundamental the responsibility matrix; this has been obtained mapping the DPs-PVs. In this case the matrix was highly interrelated and presented a very high fragmentation of the responsibility of the process. The defragmentation and the unification of some activities and responsibility has been the driver of simplification.

The resource matrix have been create thanks to the information of the University Human Resource Office. For this process only two resources have been considered: human resources and shipment cost, the other resource consumption have been considered not relevant for this specific process. The Resource Matrix has been used to link the resource

consumed by activities. The HR Office provided the personnel cost for each office, for the office that carry out more than one activity the HR dedicated to each activities has been evaluated thanks to interview and questionnaires that our group have extensively applied to the administrative structure of the University of Firenze.

The resource matrix has been useful in order to quantify the cost of the service provided. The costs have been quantified before and after the optimization approach and are reported in table 1.

Table 1. Cost of the services

FRs	Cost before (€)	Cost after (€)	Delta
FR1	50.2	22.4	- 55.4%
FR2	5.7	2.1	- 63.2%

4 CONCLUSION

The processes of the University of Firenze have been divided in three main areas: didactic, research and administrative. These processes are related to the activity of the whole University that includes Departments, Faculties and Central Administrative Offices. The AD representation allowed to identify the coupling among these three classes and to reengineer the processes phases in order to decouple them. The result of this optimization has been the reduction of the cost of most of the processes -i.e. the cost of a payment to a supplier has been reduced of about 55%-, the improvement of the quality and efficiency of the services provided by the University and consequently the improvement of the capability to attract external resources by the research teams.

The advantages of the use of AD instead of a more traditional approaches are:

- the easy and fast identification of the coupling of the processes;
- the evaluation of the best alternative to improve the processes;
- the easy implementation of an ABC approach to evaluate the process cost thanks to the rock solid base provided by the AD representation;
- the simplified definition of a matrix of responsibility for each process, so allowing a smoother flow of information and a clearer definition of the role of each office (Department, Faculty, Central Administrative Offices).

Moreover this work has proven that the improvement of administrative process must rely on two different pillars: the innovation in terms of technologies and the ABC and BPR (Business Process Reengineering), this assumption is reported in figure 9.

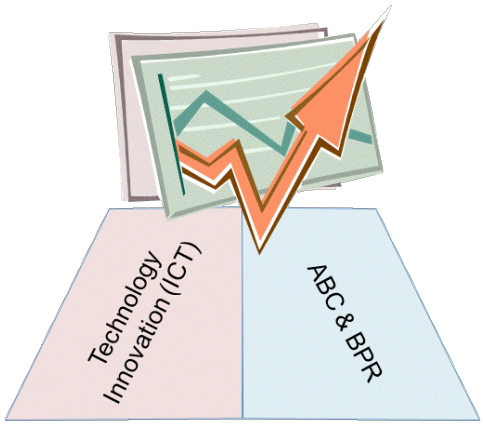

Figure 9. Pillars of the administrative process improvement

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