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Utilizing the OOPP strategy to investigate complex mechanical frameworks

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Abstract

The aim of this paper is to propose a methodology for the analysis and modeling of complex industrial systems and to validate it through a case study. In fact, an effective management of a complex industrial system can be only in systems whose activities are synchronized and enabling a good traceability. The development of a reliable information system (IS) is primordial. The methodology is divided into five steps and it is based on the use of OOPP (objectives oriented project planning) method. In this research, a case study of a grain silo in Tunisia is presented.

Keywords: Analysis and modeling, information system, planning, OOPP method, grain silo.

INTRODUCTION

As a result of the evolution of the socio-economic context of the country after the process of globalization and of the partnership particularly with the European Union, the managers have inscribed in their priorities the upgrading of grain silo in Tunisia. The model developed was a general one; in order to validate this model, it was applied to a situation of a grain silo located in Tunis, considered like a pilot application. This choice was taken in consideration of the importance of this unit (the most big storage capacity in Tunisia: 54000 tonnes) (Annabi, 2004) because of its strategic position and the diversity of its activities. We respected also the culture and the historic of the enterprise.

In order to establish a model for upgrading a grain silo, we proceeded at first to the instruction of the situation close to the managers according to a brain-storming approach; secondly, we exploited an analysis of the existing one done by the supporting comity constituted. This analysis was achieved according to a participate approach associating the diverse structures of the office of cereals directly concerned by the activities of a grain silo and adopting an environment of quality comity.

After a proposition to adopt a systemic approach, exploiting notably the OOPP (objectives oriented project planning) method in analysing the activities of a grain silo according to the Office of Cereals Policy, a Total Quality Comity was constituted. Its purpose was to upgrade according to a total quality management (TQM) approach that was confided. A series of production workshops are organised. These workshops are either collectively organised, implicating all that are concerned by the diverse assigned functions of the grain silo or are dedicated to a specific function.

This paper can be loosely divided into five parts. First, we present participative methods literature. Second, we present the design methodology of the OOPP method. The next section presents a methodology of analysis of complex industrial systems. Next, the results of the application of the OOPP method are presented. The last section concludes this article giving some advantages of the method used.

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PARTICIPATIVE METHODS LITERATURE

There are many methods that have been used to enhance participation in Information System (IS) planning and requirements analysis (Cavelery, 1994; Jackson, 1995; Lakhoua, 2006) . We review some methods here because we think them to be fairly representative of the general kinds of methods in use. The methods include Delphi, focus groups, SADT (Structured Analysis Design Technique), OOPP method, multiple criteria decision-making (MCDM), and total quality management (TQM).

The objective of the Delphi method is to acquire and aggregate knowledge from multiple experts so that participants can find a

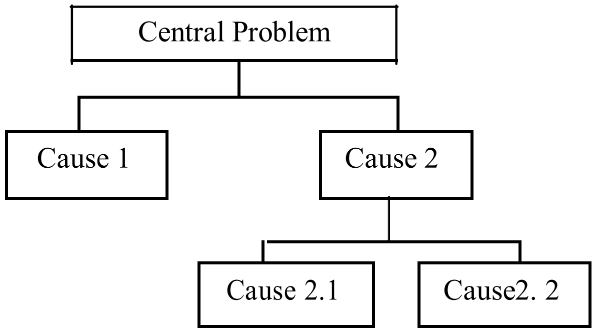

Figure 1. Problem tree.

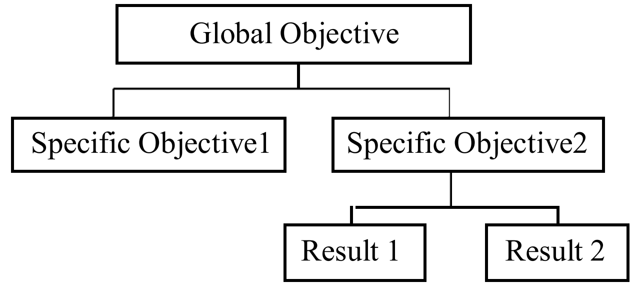

Figure 2. Objective tree.

consensus solution to a problem (Roth, 1990).

A second distinct method is focus groups (or focused group interviews). This method relies on team or group dynamics to generate as many ideas as possible. Focus groups have been used for decades by marketing researchers to understand customer product preferences (Parent, 2000).

MCDM views requirements of gathering and analysis as a problem requiring individual interviews (Jain, 1991). Analysts using MCDM focus primarily on analysis of the collected data to reveal users' requirements, rather than on resolving or negotiating ambiguities. The objective is to find an optimal solution for the problem of conflicting values and objectives, where the problem is modelled as a set of quantitative values requiring optimization.

TQM is a way to include the customer in development process, to improve product quality. In a TQM project, data gathering for customers needs, that is requirements elicitation may be done with QFD (Stylianou, 1997).

The SADT method represents attempts to apply the concept of focus groups specifically to information systems planning, eliciting data from groups of stakeholders or organizational teams (Marca, 1988; Jaulent 1989, 1992). They are characterized by their use of predetermined roles for group/team members and the use of graphically structured diagrams. SADT enables capturing of a proposed system's functions and data flow among the functions.

The OOPP method (AGCD, 1991; Killich, 2002), also referred to as Logical Framework Approach (LFA), is a structured meeting process. This approach seeks to identify the major current problems using cause-effect analysis and search for the best strategy to alleviate those identified problems. OOPP method has become the standard for the International Development Project Design. Team Technologies have continued to refine the approach into TeamUP.

DESIGN METHODOLOGY OF THE OOPP METHOD

The design methodology of the OOPP method (Annabi, 2003) is a rigorous process, which if used as intended by the creators, will impose a logical discipline on the project design team. If the process is used with integrity the result will be a high quality project design. The method is not without its limitations, but most of these can be avoided with careful use of ancillary techniques. Many things can go wrong in the implementation phase of a project, but if the design is flawed, implementation starts with a severe handicap.

The first few steps of the LFA are: situation analysis; stakeholder analysis; problems analysis (Walter, 1998; McLean, 1988).

The document of "Situation Analysis" describes the situation surrounding the problem. The source could be a feasibility study, a pre-appraisal report, or be a compilation done specifically for the project design workshop. Typically, the document describes the problem situation in detail, identifies the stakeholders and describes the effects of the problems on them.

The stage of "Stakeholder or Participation Analysis" is an analysis of the people, groups, or organizations that may influence or be influenced by the problem or a potential solution to the problem. This is the first step to understanding the problem. We might say, without people or interest groups there would be no problem. So to understand the problem, we must first understand the stakeholders. The objectives of this step are to reveal and discuss the interest and expectations of persons and groups that are important to the success of the project.

If there is no agreement between participants on the statement of the problem, it is unlikely there will be agreement on the solution. This stage of "Problem Analysis" therefore seeks to get consensus on the detailed aspects of the problem. The first procedure in problem analysis is brainstorming. All participants are invited to write their problem ideas on small cards. The participants may write as many cards as they wish. The participants group the cards or look for cause-effect relationship between the themes on the cards by arranging the cards to form a problem tree (Figure 1).

In the step of "Objectives Analysis" the problem statements are converted into objective statements and if possible into an objective tree (Figure 2). Just as the problem tree shows cause-effect relationships, the objective tree shows means-end relationships. The means-end relationships show the means by which the project can achieve the desired ends or future desirable conditions. Frequently, there are many possible areas that could be the focus of an "intervention" or development project. The next step addresses those choices.

The objective tree usually shows the large number of possible strategies or means-end links that could contribute to a solution to the problem. Since there will be a limit to the resources that can be applied to the project, it is necessary for the participants to examine these alternatives and select the most promising strategy. This step is called "Alternatives Analysis". After selection of the decision criteria, these are applied in order to select one or more means-end chains to become the set of objectives that will form the project strategy.

After defining the objectives and specifying how they will be measured (OVIs) and where and how that information will be found (MOVs), we get to the detailed planning phase: "Activities Planning". We determine what activities are required to achieve each objective. It is tempting to say: ''always start at the situation analysis stage and from there determine who the stakeholders are''.

We present some studies of the OOPP method in IS planning that has been presented in various researches.

Gu et al. (1994) presented an object-oriented approach to the development of a generative process planning system. The system consists of three functional modules: object-oriented product model, object-oriented manufacturing facility model module, and object-oriented process planner.

Peter (2000) questioned the appropriateness of highly structured strategic planning approaches in situations of complexity and change, using the Cambodian-German Health Project as a case study. He has demonstrated the limitations of these planning processes in complex situations of high uncertainty, with little reliable information and a rapidly changing environment.

Peffers et al. (2005) used information theory to justify the use of a method to help managers better understand why and what new IT (Information Technology) applications and features will be most valued by users, and how to apply this method in a case study involving the development of financial service applications for mobile devices.

METHODOLOGY OF ANALYSIS OF COMPLEX INDUSTRIAL SYSTEMS

After proposition to adopt a systemic approach, exploiting notably the OOPP method to analysis the activities of a grain silo (Lakhoua, 2008), we organised a series of production workshops. These workshops are either collectively organised, implicating all that are concerned by the diverse assigned functions of the grain silo or are dedicated to a specific function.

In fact, the technique of work group through the organization of workshops proved to be very efficient since through the stake in common of the appraisals of people resources, a synergy of group creates it and an adherence to the project of upgrading operates itself.

A various workshops have been organized to make the diagnosis and to identify the various functions of a grain silo. In fact, in addition to classic functions (exploitation, maintenance, management of stock, quality produces, common services), the function "Insurance Quality and System of information" has been instituted.

The first workshop identified began the basic functions, defined participants of the dedicated workshops and established a first planning. Then, during these workshops diverse validations and adjustments are done. This is because of the synergy phenomenon of the group and of the complement of the functions. The dedicated workshops caused the exploit of the expertise of the resource persons for the description with logic and in a hierarchy manner the diverse activities of functions.

The different steps of the methodology of the upgrading of a grain silo and their chronological events are:

Step 1: initialisation of the process of the upgrading of the grain silo by conversion of the results of the supporting comities according to OOPP formalism.

Step 2: preliminary definition of different functions of the grain silo and constitution of the commissions according to the defined functions. The participants at a commission are been chosen by speciality. The results of works of each commission are presented in a workshop and preliminary validation was done.

Step 3: coherence of the works of the dedicated workshops by a Total Quality Cell.

Step 4: presentation of the dedicated functions and global validation of the activities of each function.

Step 5: determination of the operational parameters of the analysis, particularly the delimitation of the responsibilities of the diverse activities.

The OOPP method constitutes a tool of a global systemic modelling enabling the analysis of a complex situation by a hierarchically decomposition until it reaches an elementary level that allows an operational planning. This method, widely used in the planning of complex projects, involves many operators and partners.

In Tunisia, this method was used in Development projects financed by bilateral or multilateral co-operation mechanism (with Germany, Belgium, Canada, World bank), in upgrading different structures (Training and Employment through MANFORME project, Organization of the Tunis Mediterranean Games 2001…) and in restructuring private and public enterprises.

An effort has been provided in order to bring improvements to this method (Annabi, 2003). The OOPP method has been spread and a new MISDIP denomination (Method of Specification, Development and Implementation of Project) was adopted. The MISDIP method adopts the OOPP analysis which is meant to complete it, to specify the system of organization, to specify the system of information, and to contribute to its development and implementation.

Analysis of the information

The identification and the analysis of the information exchanged by the activities indicate the dynamics and the communication between the elements of the system that we propose to study or to manage (Annabi, 2003).

So, an information matrix was defined. This matrix establishes a correlation between activities and their information. The information concerning an activity can be classified in two categories: (1) Imported information by an activity is supposed to be available: it is either produced by other activity of the system, or it comes from outside; (2) The produced information by an activity reflects the state of this activity. This last information may be exploited by other activities of the project.

In fact, the information produced by an activity can be considered like a transformation of imported information by this activity.

Information matrix

In order to specify this information, we define an information matrix (Table 2) that is associated with OOPP analysis which determines the relations between the activities or the concerned structures, and also identifies the information sources, determines the manner in which the information is exploited (Annabi, 2003).

To make sure of the quality of information system, we define some logic-functional rules reflecting the coherence, the reliability and the comprehensiveness of the analysis by an information matrix in which the lines are related to activities and the columns, to information. This matrix is constituted like this: (1) The first line is reserved to the first activity A1; (2) The first column is reserved to the first information If1 linked to this activity; (3) If If1 is imported by A1, we inscribe « 0 » in the correspondent box; if it is produced by A1, we inscribe « 1 » ; (4) We pass after that to the second information If2 and we associate the correspondent binary character « 0 » if the information is imported by the activity A1 and « 1 » if it is produced by the same activity; (5) We proceed in the same way until all the information concerning A1 is exhausted; (6) We pass after that to the second line that is correspondent to the second activity A2; (7) If If1 concerns A2, we inscribe the correspondent binary number (0 or 1 according to this information is imported or produced), otherwise, we leave a blank in the correspondent box, then we add the new information that concerns the current activity and (8) We follow the same step as far as exhausting of all activities and of all correspondent information.

We finally construct progressively a matrix of big dimension if the system is complex; it is constituted of « 0 », « 1 » and « blank ».

The information matrix defined enables us to establish a correlation between the activities and their information. This matrix was used in order to specify the information exchanged between the different elements of a system.

RESULTS OF THE OOPP ANALYSIS OF A GRAIN SILO

The production of the enterprise is often based on a technical process that cannot be taken as good knowledge

Table 1. Information matrix associated to the OOPP analysis.

N^{O}	Code	Activity	If_1	If_2	If_3	if_4	If_5	If_6	If_7	If_8	If_9
1		A_1	0	0	1	1					
2		A_2		0	0		1	0			
3		A_3	1	0	0	0		0	0	1	
4		A_n									

Table 2. Analysis of the different functions of a grain silo using the OOPP method.

N°	Code	Designation
1	GO	Functions of the grain silo defined
2	SO1	Exploitation of the grain silo assured
3	*R1.1*	Planning of the exploitation of the grain silo assured
4	R1.2	Realisation of the operations assured
5	SO2	Maintenance of the grain silo assured
6	R2.1	Planning of the maintenance of the grain silo assured
7	R2.2	Intervention assured
8	R2.3	Management of the material resources assured
9	SO3	Management of the stock assured
10	R3.1	Programme of the movement of the cereals established
11	R3.2	Movement of the cereals recorded
12	R3.3	Reporting elaborated
13	SO4	Function of cereals quality management assured
14	R4.1	Evaluation of cereal quality assured
15	R4.2	Preservation of cereal quality assured
16	R4.3	Amelioration of cereal quality assured
17	SO5	Function of common services management assured
18	R5.1	Administrative management of the personnel assured
19	R5.2	Formation management assured
20	R5.3	Financial and book-keeping management assured
21	SO6	Function of assurance quality and Information System defined
22	R6.1	Function of assurance quality defined
23	R6.2	Information system efficient

knowledge only if other functions of support are led as well. So the enterprise, in addition to the technical functions of basis, is called to assure various functions of different natures: Human resource management, accountant, financial, communication, management of stock, maintenance, formation etc.

The achievement of every function requires the realization of various activities. Because functions bound some to others, and that activities are interdependent, there is a place to assure a function of co-ordination, allowing the enterprise to evolve previously of a coherent manner according to its definite objectives. The function “Assurance quality and Information System” is determinant to assure a system of communication and co-ordination of activities of an enterprise.

After the OOPP analysis, six specific objectives are identified corresponding to the basic functions of a grain silo (exploitation, maintenance, quality product management, management of the common services, TQM and Information System) . The analysis of the Specific Objectives (SO) enables us to identify 14 Results (R) and more than 1700 activities. The Table 1 presents results of the OOPP analysis of a grain silo.

In order to design the responsibility of each activity, we adopt the structured analysis elaborated using the two methods SADT and OOPP after a validation and we proceed to identify the responsibility of the activities and their collaborators for the diverse functions of a grain silo.

The final production of the application of the OOPP method enabled us to answer clearly the questions: ‘’what?’’ and ‘’who?’’ and allowed the establishment of the record post and the elaboration of the chart of a grain silo notably the specification of the responsible of the activities and their collaborators. The answer to the question ‘’how?’’ led to the elaboration of the work procedures, but the answer to the question ‘’when?’’ made

Table 3. Sample of the OOPP analysis of a grading system of cereals.

N°	Code of activity	Activity	Imp.Inf	Prod.Inf
179	SO4	Evaluation of cereals assured	N°AT	N°PT
180	R4.1	Identification of the grading scale assured	NatCer, N°LtCer, VPA, BPQI	
184	R4.2	Improvements and reductions determined		
185	A4.1.1	Identify the improvements to add to basic price		
186	S4.1.1.1	Identify the codes of improvements		CdImp
190	S4.1.1.2	Identify the improvements values		VImp
194	A4.1.2	Identify the reductions to reduce from price base		
195	S4.1.2.1	Identify the codes of reductions		CdRed
199	S4.1.2.2	Identify the reductions values		VRed
203	R4.3	Payment ticket established		
204	A4.3.1	Cereal price determined		
205	S4.1.3.1	Determine the total of improvements		TotImp
209	S4.1.3.2	Determine the total of reductions		TolRed
213	S4.1.3.3	Determine the gross price		GP
217	S4.1.3.4	Determine the deduction		Ded
221	S4.1.3.5	Determine the net price		NP

made for the establishing of the planning of the actions. And finally by answering to the question ‘’ where?’’ we were able to determine the frontiers post. The most important function that exists in the new structure, compared to that in the application, is the TQM function and Information System.

In order to present a sample, an information matrix connected to the OOPP analysis, we present the case study of the grading system of cereals that allows us to determine the price of transactions of cereals (Durum wheat, Soft wheat, Barley, etc).

In fact, we consider every element of the grading system of cereals (Grading Parameters, Cereal variety, Reception ticket, demand of analysis, Analysis ticket, Payment ticket, Cereal sampling ticket,...) like an information that can be expressed according to other information (Number of order, date, quantity, etc).

By exploiting the information matrix defined, we constitute an ‘’information matrix of cereal grading system’’ (IMGSC) where we give in the last column the different relations excising this system.

The information matrix connected to the grading system of cereals allows firstly to determine the relations between the activities defined in the descriptive table of tree of objectives, and secondly to identify and to exploit the information sources that constitute the different parameters of the model.

The complete OOPP analysis of grading system of cereals released 263 activities, giving 279 information. We can identify various types of information source: declarative (name, N° Lot…), measure (specific weight, percentage of impurities, time…), data base (Grading scale, sample protocol, homogenisation protocol, basic price, etc), valorisation (improvement value, reduction value, net price, etc).

Table 3 presents, in a linear form, some parts of the analysis and precise the information field concerning activities and specifying the imported information (Imp.Inf) and the produced information (Prod.Inf). We present in Table 4 a part of the IMGSC.

Every imported or produced information by an activity is codified: N°AT (number of analysis ticket), N°PT (N° of the payment ticket), NatCer (nature of the cereals), N°LtCer (number of lot of cereals), VAP (value of a grading parameter), BPQI (basic price per quintal)…

Conclusion

In most situations, an industrial system such as a grain silo already existing, conditioned by its history, its culture and its context are in difficulty facing the necessity to restructure itself in an organizational and technological environment in perpetual evolution. This is how all operation of upgrading first of all requires a diagnosis based on a various function analysis.

The global analysis exploits the various available documents (legal texts, balances, reports…) on the one hand and takes on the other hand in consideration of various testimonies through investigations, the interviews or the collective workshops; otherwise, it also takes observations through visits as a basis and even of the specific operations. The exploitation of this diagnosis enables for the elaboration of the project, restructuring thereafter.

In this paper, a methodology of analysis and modelling for the upgrading of industrial systems has been presented. A participative method (OOPP) has been used and a practical case of a grain silo has been used to verify the model developed. This analysis enables to identify the different activities in a grain silo. It enables then to implant a process of the tractability of flux movements

Table 4. Part of the IMGSC associated to the OOPP analysis.

N°	Code \Inf	223	224	225	227	228	229	235	236	237	239	240	241	Relation
1	T4.1.3.1.1	1												$TotImp_1 = VImp_{1.1} + VImp_{1.2} + \ldots + VImp_{1.14}$
2	T4.1.3.1.2		1											$TotImp_2 = VImp_{2.1} + VImp_{2.2} + \ldots + VImp_{2.12}$
3	T4.1.3.1.3			1										$TotImp_3 = VImp_{3.1} + VImp_{3.2} + VImp_{3.3} + VImp_{3.4}$
4	T4.1.3.2.1				1									$TolRed_1 = VRed_{1.1} + VRed_{1.2} + \ldots + VRed_{1.14}$
5	T4.1.3.2.2					1								$TolRed_2 = VRed_{2.1} + VRed_{2.2} + \ldots + VRed_{2.12}$
6	T4.1.3.2.3						1							$TolRed_3 = VRed_{3.1} + VRed_{3.2} + VRed_{3.3} + VRed_{3.4}$
7	T4.1.3.5.1	0			0			0			1			$NP_1 = GP_1 + TotImp_1 - TolRed_1 - Ded_1$
8	T4.1.3.5.2		0			0			0			1		$NP_2 = GP_2 + TotImp_2 - TolRed_2 - Ded_2$
9	T4.1.3.5.3			0			0			0			1	$NP_3 = GP_3 + TotImp_3 - TolRed_3 - Ded_3$

movements with the knowledge of the handling circuits and the actions of the maintenance of the equipment.

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