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APPLICATION OF A SYSTEMIC APPROACH ON A GRADING SYSTEM OF CEREALS BASED ON FUZZY LOGIC

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Abstract:
The aim of this paper is to present, according to a system approach, a cereal grading system based on the fuzzy logic techniques proposed in Tunisia. Our motivation consists in elaborating a model describing the grading system of cereals. An information matrix associated to a systemic analysis method (Objective Oriented Project Planning) was defined and elaborated. This information matrix allows us on the one hand, to identify the produced and consumed information concerning each activity and on the other hand to determine the relations between these activities.
Keywords: System approach, Grading system of cereals, Fuzzy logic, OOPP method.

1. INTRODUCTION

The determination of cereal quality, on transaction on the organised market, is an indispensable operation to evaluate the cereal product and its aptitude in storage. But in spite its importance, this evaluation besides done with a simplest manner based on visual appreciation and on the manager good meaning, particularly at level of collection, only for the criteria relative to specific height and, in some cases, to humidity.

Besides cereals like any other biological product, change during their storage when they are bad conserved, causing degradations of quality and loss in quantity (Jlidi, 1998).

The official circuit taken by cereals locally produced begin at the level of collection and lead to transform units passing by silos and storage units.

At every step, cereals undergo a qualitative evaluation allowing to check their loyalty and to determine its commercial value (Jlidi, 1998).

This operation of quality evaluation of cereals is excised by a grading scale at the time of all operation of entrance or exit of cereals which principal points are: Basic Price; Improvement (to add to basic price if cereals have higher quality); Reduction (to reduce from basic price if cereals have a low quality).

The different steps of the cereal grading process are: taking samples, samples analysis (specific weight, humidity and impurities) and price determination (JORT, 1996).

The management of its cereal resources must be efficient and the transactions between the cereal purveyor and the clients must be excised by a coherent and objective process based on the grading system of cereals (Annabi, 1998).

In fact, the grading system determines the price of transactions at the sales and at the purchases of cereals and consequently that excited the technical and juridical relations between the different interveners (JORT, 1996).

The objective of this paper is to present on the first hand a grading system of cereals based on the fuzzy logic techniques and on the other hand to apply a systemic approach exploiting the Objectives Oriented Project Planning (OOPP) method that allows us to achieve a reliable information analysis.

2. DEFINING A GRADING SYSTEM BASED ON FUZZY LOGIC

Due to the diversity of the different categories of the bodies concerned with the assessment of the cereal quality, we adopt the TQM (Total Quality Management) methodology according to which we adopt the Customer-supplier gait. In fact, the grading system of cereals must take into account the various points of view of every intervening part according to its position in the circuit of cereals

transaction. This is how the first transformer (Miller) is called to take into account his customer's constraints (the second transformer: baker, confectioner, pastier...) through the technological parameters while considering his own constraints (flour, semolina, conservation...).

Following the dynamics of cereal parameters conditioning the grading system as well as the procedure and conditions of sampling on the one hand and the various points of view of the different bodies concerned by the transaction on the other hand, it is frequent to fall into contradictory situations (OCT, 2000) (OCT, 2001). This is why the approach that we propose enables us to contribute to the appeasing of these situations and to the establishing of a consensual and more objective support.

Hence, it is necessary to proceed to a collection of every intervening tendencies of every part expressed in a natural language and to proceed to their analyses while adopting the fuzzy logic (Lakhoua, 2002).

In order to institute a reflex of adoption of the method, we illustrate in a first time, a relative application to the grading system of cereals by using the fuzzy logic techniques (Zaddeh, 1965) (Buhler, 1994) (Fustier, 2000).

The methodology of integration of fuzzy logic techniques proposed consists in (Lakhoua, 2009):

- **Step 1:** Schematization of the transaction circuit of cereals and identification of the various operators.
- **Step 2:** Listing the parameters of quality including those not exploited at present in the grading system and classifying hierarchically these parameters.
- **Step 3:** Making an exhaustive bibliography of cereal quality assessment and constitution of a reference database representing various real situations of cereals.
- **Step 4:** Collection of the various points of view of operators of the cereal path according to a qualitative evaluation.
- **Step 5:** Organization of a workshop regrouping resources people representing the various operators in the cereals transactions.
- **Step 6:** Clarification of a consensual criterion for the determination of the price and model these criteria according to a fuzzy algorithm.
- **Step 7:** Making a simulation according to various situations exploiting the elaborated database.

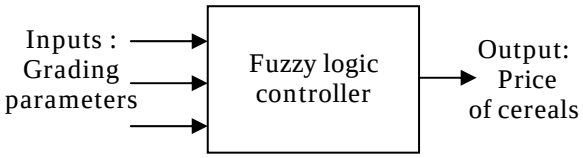

Figure 1: Fuzzy control of a grading system

According to the methodology of fuzzy logic integration presented and to the variety of cereals (durum wheat, soft wheat, barley...) and to the case of the grading process (production, sale to millers, import...), we identify many grading parameters. In fact, we exploited two techniques of fuzzy logic in order to simplify the grading system of cereals: formulation of assessment criteria based on one rule of inference and realization of fuzzy controllers based on several inference rules. Figure 1 presents an example of fuzzy control of a grading system of cereals.

3. METHODOLOGY OF THE ANALYSIS

The model of the grading system of cereals based on the fuzzy logic techniques that we propose means to describe the different activities of the process of cereals assessment and to consider it like an information system.

This model is characterised by the quality specifications (specific height, humidity, impurities...) and the management parameters (reception, analysis demand, analysis results, payment, sampling...).

The number, the complexity and the interference of information exchange taken in the study of a model need a systemic approach (Landry, 2000) defining the limits of the system (through establishing a communication between the outside environment) and identifying the principal activities and the parameters conditioning these activities.

The OOPP method (Oriented Objectives Project Planning) was used in order to identify all the activities hierarchically classified and their associated parameters: responsible, resources (infrastructure, equipment, human resources, logistic resources, information resources...), timing, place, realisation indicators (Annabi, 1998).

The OOPP analysis allows answering pertinent questions conditioning all establishing project: What (result to achieve or activity to realise)? Who (responsible and his collaborators)? How (resources)? When (time)? Where (place)?

We consider that informational resources are determining on the strategic level and on the communication one. The determination of these resources constitutes the base of all the information system. In fact, we reserve a particular importance to informational purpose and we consider all the parameters and all the functions like information that we must seize, treat and valorise. This information is evidently divided by the different activities taking into account their level.

4. PRESENTATION OF THE OOPP METHOD

The OOPP method constitutes a tool of a global systemic modelling enabling to analyse a complex situation by a hierarchically decomposition until reaching an elementary level allowing an operational planning (AGCD, 1991) (GTZ, 1991).

This method, widely used in the planning of complex projects, involves many operators and partners. In Tunisia, it 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, Organisation of the Tunis Mediterranean Games 2001...) and in restructuring private and public enterprises,...

The two determining steps for the OOPP analysis are (Ben Jouida, 2008):

- The Scheme of Planning Project (SPP) that consist in establishing a global diagnostic of a situation by elaborating a Tree of Problems using a causal logic and by transforming it to a Tree of Objectives.
- The Scheme of Planning Activity (SPA) that, according to a logic « Medium - Detailed » lead to a hierarchic analysis of the results to achieve.

In fact, these steps constitute a preliminary action for establishing a Project that requires a global Piloting and Evaluation System (PES).

5. DEFINING AN INFORMATION MATRIX

The identification and analysis of exchanged information by the activities indicate the dynamics and the communication between the elements of the system that we propose to study or to manage. So, we define an information matrix (Table 1) that establishes a correlation between activities and their information. The information concerning an activity can be classified in two categories (Annabi, 2003) (Souissi, 2002):

- An imported information by an activity is supposed to be available : it is either produced by an other activity of the system, or coming from outside,
- 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 produced information by an Activity can be considered like a transformation of imported information by this Activity.

In order to specify this information, we define an information matrix associated to the OOPP analysis permitting to:

- determine the relations between the activities or between the concerned structures,
- identify the information sources,
- determine the manner in which the information is exploited.

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 relating to Activities and the columns to information. This matrix is constituted like this (Lakhoua, 2008):

- the first line is reserved to the first activity A1,
- the first column is reserved to the first information If1 associated to this activity,
- if If1 is imported by A1, we inscribe « 0 » in the correspondent box, if it's produced by A1, we inscribe « 1 »,
- 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's produced by the same activity,
- we proceed in the same way until all the information concerning A1 are exhausted,
- we pass after that to the second line correspondent to the second activity A2,
- if If1 concern 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 concern the current activity,
- we follow the same step as far as exhausting of all activities and of all correspondent information.

Table 1: Information matrix associated to the OOPP method

N°	Code	Information						
		If1	If2	If3	If4	If5	If6	If7
1	OS1	0	0	1	1			
2	R2.3		0	0		1	0	
3	A4.2.1	1	0	0	0		0	0
4	A4.2.2		0		0			
5	A4.2.3		0		0			

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

6. RESULTS OF THE OOPP ANALYSIS

The model of the grading system of cereals based on the fuzzy logic techniques developed is complex. The OOPP method applied to this system has enabled, by its steps of analysis and planning, to understand better and better the description of this model and to facilitate after that the different expressions of relations constituting this model.

The global objective of the model: Cereal grading system assured lead to an analysis of the different steps proceeded in the evaluation system of cereals.

Figure 2 presents an Objectives Tree modelling the cereal grading system based on the fuzzy logic is presented after validation by the experts.

An analysis of imported and produced information of cereal grading system was done and an associated glossary of this analysis was established.

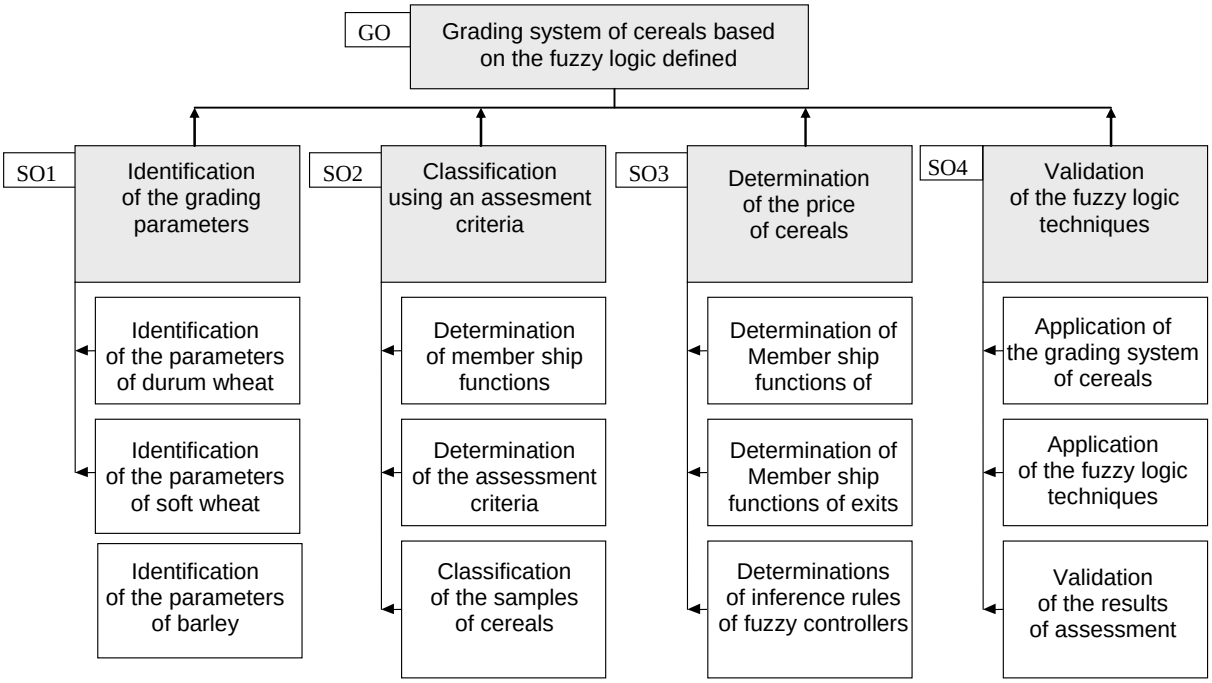

Figure 2: Tree of objectives of the cereal grading system

7. INFORMATION MATRIX OF CEREAL GRADING SYSTEM

In our approach, we consider every element of cereal grading system (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...).

By exploiting the precedent information matrix defined, we constitute an « Information Matrix of Cereal Grading System based on the fuzzy logic» where we give in the last column the different relations excising this system.

The information matrix associated to the model of cereal grading system, allows first 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 cereal acreage system released 263 activities giving 279 information. We distinguish 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...), valorisation (Improvement value, Reduction value, Net price...).

Table 2 presents, in a linear form, some parts of analysis of Specific Objective 2 (SO2) and precise the information field concerning activities and specifying the imported information (Imp.Inf) and the produced information (Prod.Inf).

Table 3 presents a part of the information matrix of the grading system of cereals based on the fuzzy logic.

Table 2: OOPP analysis of the grading system of cereals based on the fuzzy logic

N°	Code	Activité	Inf. Imp	Inf. Prod
1	SO2	Classification of the samples of cereals using an assessment criteria	N°AFL	N°MF, N°ACr, Class
2	R2.1	Determination of the member ship functions of the grading parameters of cereals		
3	A2.1.1	Determination of the member ship functions of durum wheat	AFL_1	MF_1
4	A2.1.2	Determination of the member ship functions of soft wheat	AFL_2	MF_2
5	A2.1.3	Determination of the member ship functions of barley	AFL_3	MF_3
6	R2.2	Determination of the assessment criteria of the samples of cereals		
7	A2.2.1	To determine the assessment criteria of durum wheat	AFL_1	ACr_1
8	A2.2.2	To determine the assessment criteria of soft wheat	AFL_2	ACr_2
9	A2.2.3	To determine the assessment criteria of barley	AFL_3	ACr_3
10	R2.3	Classification of the samples of cereals		
11	A2.3.1	To class the samples of durum wheat	AFL_1	$Class_1$
12	A2.3.2	To class the samples of soft wheat	AFL_2	$Class_2$
13	A2.3.3	To class the samples of barley	AFL_3	$Class_3$

Table 3: Sample of the information matrix

N°	Activity	μv1.1	...	μv1.14	μv2.1	...	μv2.14	μv3.1	...	μv3.4	ACr_1	ACr_2	ACr_3	Relation
1	A2.2.1	0	0	0							1			$ACr_1 = \gamma \min [\mu v1.1, \mu v1.2, \mu v1.3,... \mu v1.14] + (1-\gamma) [\mu v1.1 + \mu v1.2 + \mu v1.3 + ...\mu v1.14]/14$
2	A2.2.2				0	0	0					1		$ACr_2 = \gamma \min [\mu v2.1, \mu v2.2, \mu v2.3,... \mu v2.14] + (1-\gamma) [\mu v2.1 + \mu v2.2 + \mu v2.3 +... \mu v2.14]/14$
3	A2.2.3							0	0	0			1	$ACr_3 = \gamma \min [\mu v3.1, \mu v3.2, \mu v3.3, \mu v3.4] + (1-\gamma) [\mu v3.1 + \mu v3.2 + \mu v3.3 + \mu v3.4]/4$

Every imported or produced information by an activity is codified: N°AFL (N° of the algorithm of fuzzy logic), N°MFPT (N° of member ship function), Class (class of the sample of cereals)...

8. CONCLUSION

The complexity of the cereal grading system based on the fuzzy logic and the important number of the information intervening in its constitution enables to elaborate a systemic method allowing the facilitating of the system.

The OOPP method of analysis that we extended was permit to describe the information exchanges between the different elements of cereal grading system and to define the different parameters intervening in the constitution of the model. An information matrix associated to this analysis method of cereal grading model has allowed to identify the information sources and to determine the relations between the activities, permitting then a cereal evaluation and a contribution on the hand, to reduce the conflict or non objectively representatives situations and on the other hand to establish consensual and more objective support.

The application of the logic-functional rules previously indicated permit to make sure of the coherence and of the comprehensiveness of the analysis and this according to an iterative approach. This approach was applied to establish a new cereal grading system using a fuzzy logic.

This kind of analysis enables to specify the information system in order to elaborate a management and conduct tools of projects; then the development of the data processing supports will be facilitated.

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