Decision Making automation based on fuzzy event-condition-action rules.

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Abstract

This paper takes on the process of transform operational data into information and knowledge for decision making. Alongside, it concerns on the automation of Knowledge Management fashioned on a decision support system (DSS). Decision-making is implemented by (ECA-F) event-condition-action fuzzy rules: generated events, conditions to follow and actions to carry out. Herein the fuzzy logic extension of ECA rules is a novelty allowing a flexible decision making. The ECA-F rules of case study hold the decision making on managing a supply chain disruption (rupture about the regular consumption plan) of articles in a commercial store, such that minds on the urgent article supply for not interrupt the service to clients. As soon as article stock replenishment is required, the DSS automatically suggests emergent suppliers considering more adapted conditions for the store accounting the cost/benefit tradeoff.

I. Introduction

The decision making is linked to a vast amount of tasks and processes that the people make habitual in their daily tasks. There are tactic decisions and strategic ones, concerning the low level operation of the process or the high level projection, respectively. Our matter in this paper is centered on the management of supply disruption in commercial stores for stock replenishment of a product, in order to identify the best option for emergent suppliers accounting the cost - benefit tradeoff. The stock replenishment disruption of a product is due to an abnormal operation of consumption, disruptive for the usual dynamic of sell, such that the product is not more available for the costumers. Currently, the disruption attention from the store managers about how to manage the stock replenishment is not enough planned to attend nor how to overcome the emergencies.

Main difficulties that managers should deal with in order to overcome the stok disruption of a product is to find an emergent supplier for making the product replenishment such that the cost - benefit tradeoff remains in a convenient balance. A good decision must combine the efficacy for the product replenishment together with a not excesively expensive cost for that.

The parameters determining the cost - benefit equation include the availability of the supplier and the distance to the store. In turs, it carries on the specific characteristic of the product to be supplied that alongside determine the associated cost to the logistics operations involved. There are organic or inorganic products, heavy or light, fine or rude, with reduced or long caducity data, for male or female, among others diverse considerations.

In this paper the use of fuzzy logic is devoted to a formal decision making modeling on suppliers election in front of a supply chain disruption for stock replenishment. The combination of parameters about the product as well as the ones about the cost - benefit for available emergent suppliers are considered.

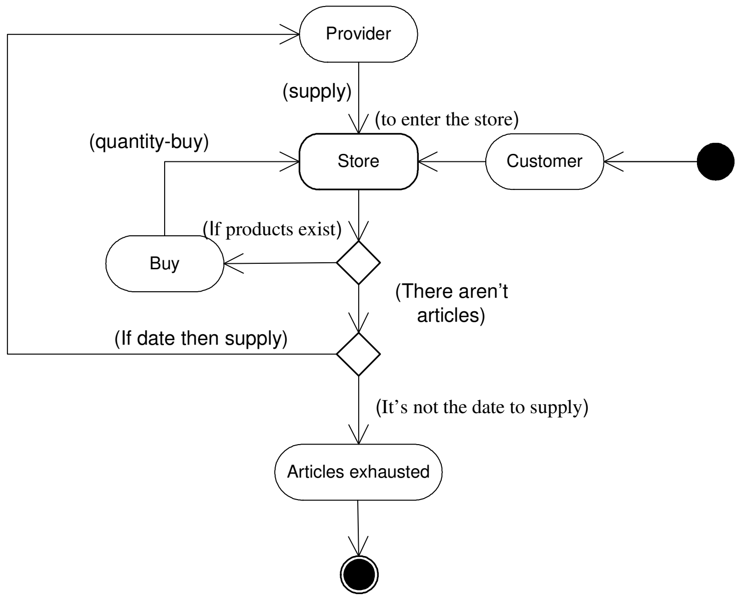

Fig. 1. Diagram "articles exhausted" in the supermarket.

A. Management of Stock Replenishment

Current situation in the control of store inventory is that each article has a fix programmed date to order replenishment that cannot be changed, even not for automated inventory control. The automation of store stock replenishment is restricted to turn on the alarm to indicate that the article is (almost) over, and it has to wait the programmed date for the stock replenishment. Thus, the stores regular dynamic of sell is interrupted when some articles are exhausted, caused by wholesale dealer that in periods, are or not of promotion, they buy almost or totally of these when its have just a short time of replenishment. (Fig. 1).

On the other hand, the suppliers present the incapacity to emergent supply to the store need once. Usually providers have strict programmed dates to supply its customers. Automation on the providers systems is restricted to indicate that supply data is close according to timetable for some customer. Usually, there is not available emergent automated plans out of the normal requisitions schedule. Mostly such kind of decisions are made by the managers based on her/his previous experience or creativity to join together the relevant parameters to make a convenient decision. Such right decision involves cost benefits, quality and pertinence tradeoff, that in turns should account different particular parameters.

To cause this problematic, a large amount of information given by a huge font number of suppliers, and in most of the cases valuing qualitative and quantitative aspects like cost, distance and readiness to overcome the disruption, need be considered. The information referred to it such displays, in addition to diversity, a high degree of uncertainty.

Due to this level of diversity and of uncertainty in the information, the linguistic model representation is tied to the concept of event generated, condition to attend and action to execute (ECA rules), as a suitable solution to deal with. The goal is that on the context of commercial product replenishment, main decision making challenges overcome the always vagueness inherent to this information so achieving a well informed and documented decision about the emergent suppliers to be contracted to overcome the disruption.

The greatest benefits involve more significant changes to the way that the organization operates [27].

B. Flexible Decision Making

Herein, proposal is that the operational but the strategic decisions can be automated by fuzzy (ECA) event-condition-action rules. So, the aim is to enable a method to provide flexible and well-rationale solutions to manage emergencies on the regular function of a supply chain. As study case the stock replenishment in a commercial store like a supermarket is analyzed and a proffs on a simulator are practiced then followed by analyzing the obtained results.

The modeling of the rules of analysis is by using fuzzy logic and the fuzzy sets representing descriptive linguistic labels of the products, providers and circumstances. The fuzzy ECA rules in the simulator are coded to support the decision making, offering plausible solutions to problems created in situations of article shortage when these are not even in list for stock replenishment requisition in the store. Stock replenishment behaviors as well as some supply policies are coded through the fuzzy ECA rules and then implemented in a decision support system (DSS).

The rules application, as fulfilling the anticipated conditions, generate actions giving solution to the triggered events. Therefore, the behavior is modeled through the fuzzy ECA rules in the (FECA-SDMS) Fuzzy ECA Strategic Decision Making System. The creation method of the fuzzy ECA rules of business on an active data warehouse (ADWH) for complenting the operational and strategic work of the analysts is given. The ADWH serves as data support for the fuzzy ECA decision making module of analysis rules for operational decision making, that is the first stage for the automation of the DWH. As validation the used parameters are compared with fictitious data generated by an ad hoc simulator.

In the next section a review of related DSS is given followed by the combination of Fuzzy Logics and Sets to support decision making described in Section III. Section IV is devoted to the review of Supply Chain for stock replenishment whereas Section V accounts the study case on the plausible recommendation on the election of a convenient emergent supplier. Results are commented in Section VI closing the paper wih conclusions.

II. Decision Support Systems

Data warehousing and data mining techniques are gaining in popularity as organizations realize the benefits of being able to perform multi-dimensional analyses of cumulated historical business data to help contemporary administrative decision-making [24], [19], [7].

The last generation of management systems are designed to provide synthesis, analysis and consolidation of relevant information for enterprises and industries accounting the context of providers and costumers. Competitive organizations are introducing or deploying computer system solutions for integral management such to automate the high level planning and decision making of their activity [30]. Information support systems are offering the software tools for developing indicators about to characterize customer relationship with the corporation, alongside to detect their customers need. Based on this information decision making on planning and enterprises projections are founded.

The DSS emerge the option to give a consistent and agile support to decision makers in front of the enormously diversified information concerning the central issues to account for the strategic planning of an organization. With a flexible enough methodology and more tools to their reach, last DSS generation overcome the difficulties to lead with imprecise, ambiguous or incomplete information for decision making. DSS overview is presented below.

A. Event-Condition-Action

An ADWH is a warehouse that by means of rules of analysis and triggers can detect necessary events to automate the decision making, that had to be anticipated by the expert users of the sequence of the data. Some of the applications of the ADWH are the monitoring of financial transactions, identification of unusual activities in the system, maintenance of derived data, opportune generation of reports, accomplishment of periodic processes, among others.

A DWH architecture for automate decision making using the concept of event, condition and action such that OLAP tools are complementing with analysis rules [15] to obtain an ADWH to automate the operational tasks [26]. It is required simple event of temporary (clock) events make up of absolute, temporary (15th of July, 2005), or periodic events (the end of each semester); as well, relative temporary events (three weeks after a certain article has been sent to the market). Excluding the other events generators it is claimed that a DWH only depends of the time as a basic characteristic.

In [6] is defined and structured a module of business rules as the main component of the analysis systems and it presents a meta-model for the rules of business. It consists of concentrating in a warehouse all the specifications to carry out an analysis based on the concept of ECA rules, extending this way to the concept of (ECAA) [10], [17] Event-Condition-Action-Active. A last action is proposed in case of not being carried out first. Thus an Active database is obtained.

The Teradata company created an ADWH that together with data mining and CRM, it looks for to also understand and to anticipate the necessities of the customer. Their application dvantage, is by taking relation of his events in a certain time to modeling behavior, then by means of reports and triggers, be able to notify it to the analyst such to support the tactical and strategic decisions making [2].

B. Fuzzy Logics

We review here works in where the fuzzy logic is an important support for flexible decision making systems.

Two stages of decision-making are the identification of non dominated new product candidates and the selection of the best new product idea to improving the quality and effectiveness of decision-making in new product introduction. These stages are composed of an integrated approach based on a fuzzy heuristic multi-attribute utility method and a hierarchical fuzzy TOPSIS method [8].

A fuzzy supplier selection algorithm (FSSA) [1] is utilized to rank the technically efficient vendors according to both predetermined performance criteria and additional product-related performance criteria. This based on calculating fuzzy suitability indices for the efficient vendor alternatives, and then, ranking the fuzzy indices to select the best supplier alternative. To solve inventory control problems an approach using information available on current demand and stock it is based on identification of nonlinear dependences using fuzzy knowledge bases [20]. This approach can further be developed by creating adaptive (neuro-fuzzy) inventory control models for enterprises and trading companies.

For identifying and analyze some critical decision criteria, including risk factors for the development of an efficient system for global supplier selection, a methodology based on fuzzy extended analytic hierarchy process (FEAHP) is discussed [3]. FEAHP is an efficient tool to handle the fuzziness of the data involved in deciding the preferences of different decision variables. Thus, to tackle the different decision criteria like cost, quality, service performance and supplier's profile including the risk factors.

In [29] a fuzzy-logic-based decision-making system for stock allocation with the objective to achieve the target DSC fill rate whilst incurring an acceptable total holding cost; as well, to achieve the target holding cost whilst with a certain level of fill rate were developed different allocation rules to aims.

The combination of fuzzy logic controllers and neural networks provides a model-free, human-like decision system. Adding triggers and assertions forms an active material requirements planning (MRP) model to replenishment of inventories on a period-by-period bases [5].

In [11] developed a fuzzy agility index (FAI) based on agility providers using fuzzy logic. To achieve a competitive edge in the rapidly changing business environment, companies must align with suppliers and customers to streamline operations, as well as working together to achieve a level of agility beyond individual companies.

In additional issues the fuzzy decision making systems can support the configuration of work teams. The TEAKS (TEAm Knowledge-based Structuring) tool, based on the fuzzy modeling of people characteristics being represented by agents, stresses on the simulatation of the deploy and performance assessment, of a whole team as well as to the each team member at work during an industrial project development [12]. Each TEAKS agent simules a person by means a set of parameters representing the human characteristics. This tool can be used to support the correct assignment of activities to each person based on her/his profile, doing that the decision making be more specific for each candidate. In [13] is presented a fuzzy-set-based approach to describe linguistic information in multicriteria decision making as well as the understandable degree and consistence degree of linguistic.

C. Multicriteria approaches

A fuzzy decision embedded genetic algorithm to partner selection is introduced [28]. The problem is described by a 0-1 integer programming with non-analytical objective function. The fuzzy rule quantification method joined to a fuzzy logic based decision making approach for the project scheduling is deployed. The solution space is reduced by identifying the inefficient candidate. Multiple objectives (or criteria) like quality, cost and duration for a task are considered. An algorithm for the task assignment using the fuzzy sets for the real-time operation in a supply chain is then proposed.

A supply chain is modeled using a multiagent framework and an architecture for the agents located at every organization in the chain. Then a real-time scheduler that can schedule new orders with soft real-time deadlines and assignment of the tasks to the suppliers, which is a multiobjective decision making problem, has to be done quickly for real-time operation [4].

Production scheduling is an essential activity in manufacturing. Scheduling is defined as a decision making problem that involves optimisation of one or more scheduling criteria. The disruptions, traditionally considered as a random event, are modeled by two parameters, the mean time between failures and the mean time for repair them. A fuzzy logic based decision support system for parallel machine scheduling/rescheduling in the presence of uncertain disruptions is applied to a real-life problem in a pottery company [18]. The uncertain disruption considered is glaze shortage, defined by two parameters: number of glaze shortage occurrences and glaze shortage duration. These parameters are modelled and combined using standard fuzzy sets and level 2 fuzzy sets, respectively. In order to deal with the glaze shortage disruption, a predictive-reactive scheduling approach is implemented, formerly defined as a two-step procedure. In the first step, a predictive schedule capable of absorbing the impact of the glaze shortage disruption is generated. In the second step, rescheduling is applied when the impact of the glaze shortage disruption is too high. Two sets of Sugeno type rules are proposed to support rescheduling decision making. One set of the rules determines when to reschedule, whilst the other one determines which rescheduling method to use. Tests carried out shown that the predictive schedules have good performance in the presence of uncertain disruptions and as well that the fuzzy inference generates appropriate rescheduling decisions. A genetic algorithm (GA) is designed and implemented to tune the weights for the real-life scheduling problem. The dispatching rules are selected and combined. These rules showed that the identified variables, including time of disruptions occurrence, durations of disruption, priority of the schedule efficiency and priority of the schedule stability are of great importance in making the rescheduling decisions.

Design and implementation of fuzzy ECA rules for the automation of the decision making strategic looks for diminish the work of the analysts, by creating an ADWH for stock replenishment of articles in a supermarket.

III. Fuzzy ECA Decision Making

In a logical systems the procedure of reasoning allows the outgrowth from the antecedents throughout an inference process [23]. A logic reasoning is based on syllogisms such that the antecedents are the conditional proposals as the present observations conforming the premises of each rule [31]. A fuzzy set can represent any object's property so graded level to belong to. The fuzzy logic being used to formalize graded statement is flexible enough to describe human behaviors so that to reason and to make conclusions from observed facts. The fuzzy rules in knowledge-based systems allow graded inference according to the fuzzy sets supporting them.

Part of the specification of the reactive/proactive behavior is by defining fuzzy ECA rules on the knowledge base, such to provide the DSS mechanisms of reaction or preaction. In the figure **??** a conceptual model of the SDMS_FECA is outlined. As well, the knowledge base contains the application dominion knowledge together with the control objectives. The fuzzy ECA rules of the control system likewise *IF* ($X_1$is A_1) AND (X_2 is A_2) *THEN* (Y is B), with X_i the variables of the states, Y a control variable, A_i and B linguistic labels with a function of membership giving values to their variables. The fuzzification gets the input variables values to the fuzzy controller; then conversion of the input real data (crisp) into fuzzy sets allowing to be treated like such. The inference system is the nucleus of the fuzzy controller so the control actions simulates the human process of decision based on the fuzzy logic rules of inference. It

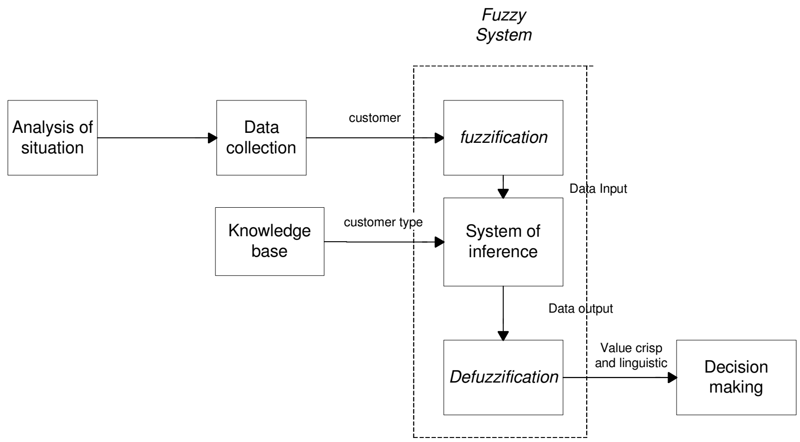

Fig. 2. Modelo conceptual del FECA_SDMS.

uses the techniques of the rules based systems for the inference of the request. Complementary, the during the defuzziffication step the fuzzy values of the output variables are converted in crisp values within the universe of corresponding speech.

Fuzzy logic is applied to model ECA rules so giving answer to the ongoing corporations' challenges. Main goal is the achievement of automated strategic decisions on supporting the disruptions management. Thus, helping the analyst's decision making, the event, condition and action rules deserves like analysis work to appoint a rationale enough decision making. The rules are modeled from the analyst's perspective, who specifies the right time for triggers into the analysis rules.

An ADWH must offer a model of knowledge and a model of execution in the handling of the active rules.

A. Recursion Rules

Three basic functions sustain the nested rules automation by a recursive procedure. Each function fulfills a basic role in the implementation of ECA rules. The proposed algorithm being exemplify it in the figure 3 sets the sequence of the functions based on the principle of an ECA rule.

The three basic components of an ECA rule is the modeled and specified event into the trigger; simultaneously, it makes reference to the funcion_trigger that encapsulates, and it makes call to another function containing the cursors: its realize the loading of the results of the conditions thus to give action to this request.

B. The active datawarehouse

By creating the automation based on the fuzzy ECA rules will provide the action capacities in the DWH. By its event, condition and action structure, by using cursors for the development of functions in the warehouse in the procedural language PL/pgsql more robust support us to make complex functions and calculations within the DWH is achived. In the figure 4 is drwan the scheme of the Active DWH, made up of the next modules:

The container of Fuzzy ECA rules, containted within the administrator of PostgreSQL.

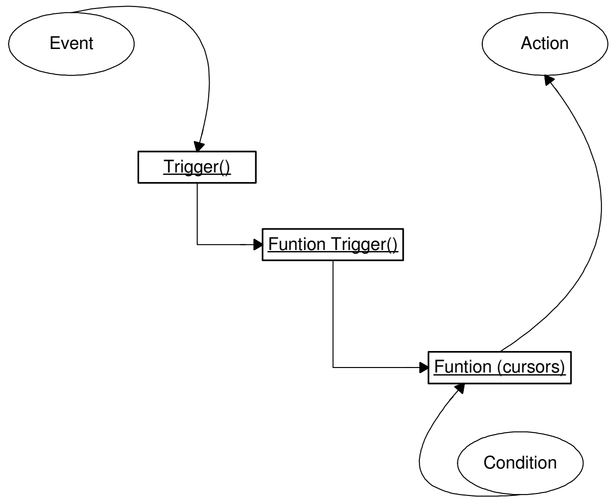

Fig. 3. Diagram of behaviour of analysis' rules into the interface.

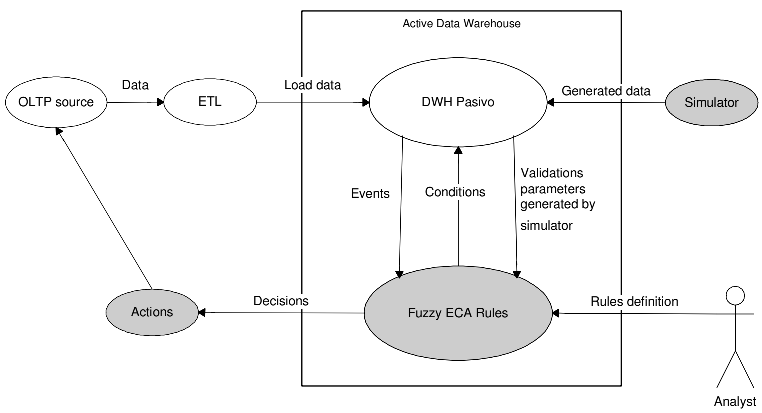

Fig. 4. Diagram of decision support system based in Fuzzy ECA rules.

The passive DWH composed of the metadata and the structure of the dimension-based model.

The ETL (Extraction - Transform - Load) Process interface in which the data are introduced to the DWH.

The module of Actions, being metadata in which the decisions are carried out, by the condition of the DWH, being single of reading; so in this table the results are introduced.

In the figure **??** the analyst declares the fuzzy ECA rules of analysis through the (PL) procedure language, making the connection with the DWH metadata to detect the need events to make up the DWH (OLTP) external actions. Then, to make the tasks of operational routines for decision. Next step is the implementation of the fuzzy ECA rules for the strategic decision making, in particular by including the problem of the exhaust articles in a supermarket, being declared in a module within the PostgreSQL DBMS.

IV. Supply Chains for Stock Replenishment

A supply chain, in nature and in human societies incorporates a set of interdependent supply entities, such that the produced for one is consumed by other ones, that in turn they supply the consumption of thirds, and so on [21].

Decision making is clever to an effective supply chain management (SCM), like the supply chain decision models demonstrate for integrating the decisions across the supply chain [16]. These models illustrate the diversity of analytical approaches and their usefulness in managing global supply chain issues. For improvements stock replenishment doing use of the techniques of decision making like support [9], has designed systems it is complement with other modalities.

In [14] is suggested that a supply chain can be viewed from four perspectives: the upstream as purchaser, the downstream as supplier, the static network as an auditor of position within its supply network, typically comprising several supply chains, providing a static and comparative view; and the dynamic network as the strategist, seeking opportunities to improve the firm's position in an existing network or creating a new network, providing a strategic, dynamic and long-term view.

The general objective its give support to decision making for management of disruption of exhausted articles, so determined to best supplier that adjust, for the stock replenishment the articles, to considered costs the supply, the location the supplier, time delivery and others characteristic necessary for the strategic assignation.

A. Management of Disruptions

Each set classifies articles in common relations among them, thus to be able to define linguistic labels to him, according to the degree of membership $\mu_a(x)$ which it represents his numerical values. Different parameters exist to model in the definition of labels, one of them is the frequency of sale of each article acquired by the clients.

It is necessary to obtain an average of daily sales of each article, in where we assumed that the article tomato, has a frequency of high sale since is within joint the basic packings and is an article of much affluence by the consumers.

The frequency arises to make comparative of daily sales in relation to its own set fuzzy and thus have considering of the sales. We assumed that all the basic articles that belong to the set of perishables have greater frequency of sale, but in the reality all the basic articles do not have the same frequency of sale.

Another factor important to define is the degree of membership, parameter percentage of article existence in the store, with this assigns to a qualification or linguistic value to him necessary to know the necessity to supply to the warehouse its quick sale and to give a better service to the client, so can go with a wholesale supplier or retailer.

The threshold is an indispensable requirement to be able to assign to him to a property degree (to see table 5.1), example if the existence is in a 0,2 factor the linguistic value indicates that the stock replenishment requisition is very urgent.

Table 5.1. Degree of membership parameter "percentage of existence".

Stock	**membership values**	**linguistic label**
100%	1	totally complete
80%	0.8	semi complete
60%	0.6	moderate
40%	0.4	semi exhausted
20%	0.2	exhausted

Another important factor is the time and example is due to also assign to a property degree (to see table 5.2), if the tunas display "very urgent" a linguistic value of parameter existence, but displays "null" its linguistic value in out days to stock replenishment, then it indicates that a stock replenishment with a retail supplier is not necessary, but with the wholesale supplier, since indicates that it was a normal sale.

Table 5.2. Degree of membership parameter "out days" to resurtir shelf.

Percentage out days	**membership values**	**linguistic label**
100%	1	very urgent
80%	0.8	urgent
60%	0.6	moderate
40%	0.4	semi null
20%	0.2	null

V. Case Study: Emergent Supplier Election

In a supermarket store in having a big amount of information of his articles that offer to their clients, it is possible to implement in his DWH these rules. All this according to the processes, restrictions, movements and decisions that automatic can be executed, according to certain parameters required for the strategic decision making that they exist in the DWH. The conceptual entity-relationship model(E-R) is used. The logical design this based on the theory of the dimensional modeled one for this case of study.

A. Fact tables and fuzzy sets

In the design of the DWH is necessary to create 3 tables of facts as concentration of data minimal:

- Fact table_orders (product, supplier, store, sold date of order, units, cost of the article, amount of the sale, status of the order, hour in which the order became). It concentrates in a table all the orders that were made and that they were stored in its respective tables, provided concretely single information related to the made orders.
- Fact table_complaint (number of complaint, employee, product, supplier, date of the complaint, reason for the complaint, estatus of the complaint). Together the data necessary to create and to conform in a single table the data necessary to take a better analysis of the made complaints.
- Fact table_sales (date of the sales, period of the sale, article, sold store, promotion, units, sold amount of the sales, amount sold by article). In this table one concentrates the sales made in the supermarket. Together the necessary elements of each table respectively, to be able to take the automation of the inventory. In this table of facts the data necessary are obtained to make a good analysis of the data sales, herein the tables are created summarize in which operations and calculations are made to be able to create the operational automation within the DWH.

The following tables arise as result of the tables of facts, to be able to make the definition of Fuzzy ECA rules and thus to obtain automation in the DWH.

- Summary tables_sold (season,sold units, total amount sold, amount sold by article). It arises from the relations between several tables to update articles of the inventory of the store. The statistics of sales of articles can here be made to obtain their values of property according to the sale frequency that presents/displays each article.
- Summary tables_article (article, category to which belong, department, supplier, frequency of sale, date of stock replenishment). Of summary tables_sold to

the values of property of the article and the sets can be assigned fuzzy according to the category of articles.

• Summary tables_supplier (supplier, frequency of delivery, location, cost). The summary is turned out to collect the necessary data of the summary tables_supplier table of arise the values here from property to be able to assign the linguistic values.

• Summary tables_existence (article, existence, supply, price of the article). Here they calculate and one updates of the inventory the real existence of articles, occur the values of membership of the existence to assign its linguistic value to him.

From the dimension tables_article obtains the sets fuzzy to assign to him to its values of property and their linguistic values, and thus to be able to define Fuzzy ECA rules of the following way:

Perishables foods = {basic foodstuffs, process foodstuff, milkies, meats and fish}

Non perishables foods = {disposable, organic chemist, wines and liqueur, toy shop, fashion, plastic, glass}

(A) Perishables foods:

(A_1) basic foodstuffs, (A_2) process foodstuff, (A_3) milkies, (A_4) meats and fish.

(B) Non perishables foods:

(B_1) disposable, (B_2) organic chemist, (B_3) wines and liqueur, (B_4) toy shop, (B_5) fashion, (B_6) plastic, (B_7) glass.

A_1={*tomato*, *onion*, *potato*, *red tomato*, *et al.*}

A_2={*tuna*, *chilis* tinned, *mayonnaise*, *sardine*, *et al*}

A_3={*milk*, *manchego_cheese*, *mexican_cheese*, *butter*, *et al.*}

A_4={*chicken*, *breast*, *bistec*, *mince_meats*, *et al.*}

B_1={*toilet paper*, *serviette*, *dish*, *glass*, *fork*, *spoon*, *et al.*}

B_2={*chlorine*, *soap for frets*, *corporal soap*, *environmental deodorants*, *et al.*}

B_3={*tequilas*, *wisky*, *coñage*, *red wine*, *white wine*, *et al.*}

B_4={*dolls*, *cars*, *cuddly toy*, *balls*, *bicycles*, *board game*, *et al.*}

B_5={*clothes for lady*, *clothes for horseman*, *children*, *babies*, *footwear*, *et al.*}

B_6={*glasses*, *boats for sweepings*, *boats for water*, *dish*, *spoons*, *accessories for kitchen*, *et al.*}

B_7={*dish*, *glass*, *tin*, *jars*, *vase*, *et al.*}

B. Fuzzy ECA Rules

When the articles were classified within their respective sets and values of membership were already assigned to him, they defined following Fuzzy ECA rules. These rules are executed automatically whenever an event is shot within the DWH and thus active this. The rules that were defined within the DWH are the following:

The first rules correspond to the allocation of the frequency of sale of articles by day (sold units per day), according to a the set that belong, assigning their corresponding linguistic value to him.

IF A_1 Is perishable, THEN frecuency is HIGH

IF A_2 Is perishable, THEN frecuency is HIGH

IF A_1 Is perishable, THEN frecuency is MIDDLE

IF A_4 Is perishable, THEN frecuency is HIGH

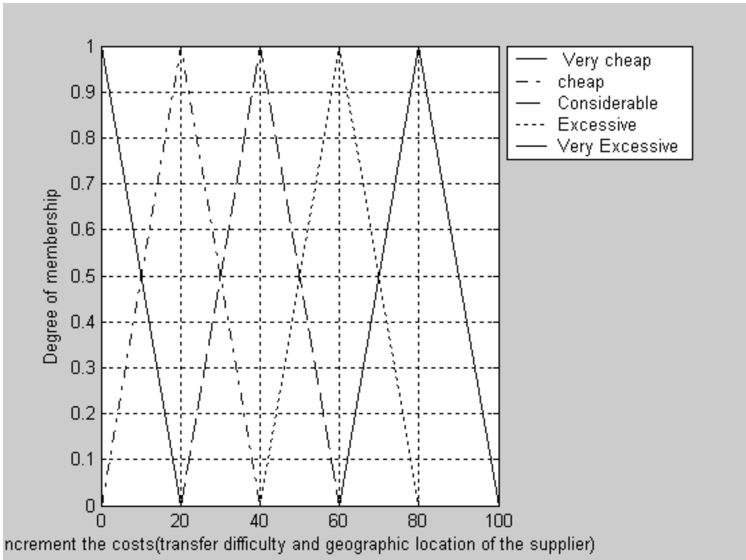

Fig. 5. Degree of membership of the increment the costs to based in percentage(%) parameter "transfer difficulty" and "geographic location of the supplier".

These linguistic values are determined according to the consumption of the customers per day, where we can see that the perishable foods have more consumption per day than the non perishable foods ones.

IF B_1 is non_perishable, THEN frecuency is MIDDLE
IF B_2 is non_perishable, THEN frecuency is MIDDLE
IF B_3 is non_perishable, THEN frecuency is MIDDLE
IF B_4 is non_perishable, THEN frecuency is LOW
IF B_5 is non_perishable, THEN frecuency is LOW
IF B_6 is non_perishable, THEN frecuency is LOW
IF B_7 is non_perishable, THEN frecuency is LOW

The second rules correspond to the allocation of the linguistic value of the costs of the suppliers taking into account several indispensable factors to classify the costs by assortment. In where the transfer difficulty it is important as determining factor for the collection of the services as well as the location of the supplier to valore the distance in kilometre and to include it in the factor of costs (Fig. 5).

IF transfer difficulty is Very Complex AND location_supplier IS further
THEN cost_supplier IS Very Excessive
IF transfer difficulty is Very Complex AND
location_supplier IS aloof
THEN cost_supplier IS Very Excessive
IF transfer difficulty is Very Complex AND location_supplier IS middle
THEN cost_supplier IS Excessive
IF transfer difficulty is Very Complex AND location_supplier IS near
THEN cost_supplier IS Excessive
IF transfer difficulty is Very Complex AND location_supplier IS Very near
THEN cost_supplier IS Considerable
IF stock is Out of stock AND time Very Urgent AND costs Very inexpensive
THEN retail supplier.

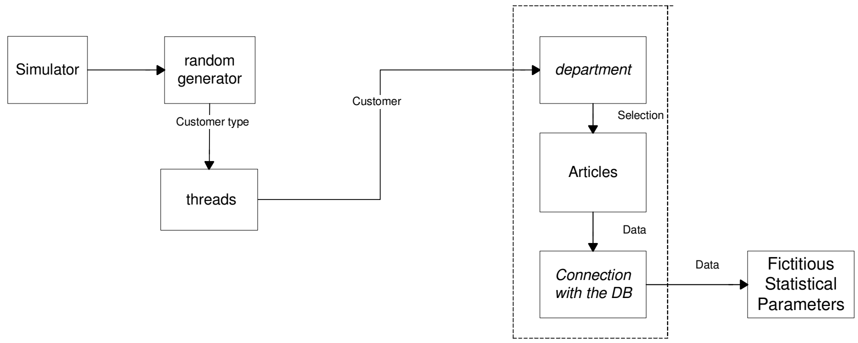

Fig. 6. Conceptual model of the simulator.

In this section the data used for our data modeling are justified, that was used within our DWH like parameters to generate the Fuzzy ECA rules.

VI. Simulations and proofs

The technical viability evaluates beforehand a certain requirement in order to determine if it is possible to carry out it in conditions of security within the available technology. It is by verifying diverse factors like durability, power operativity, implications, control mechanisms, according to the field. In the commerce field the store (supermarket) sales data are required for decision making. The simulator viability for the treatment of sales data should come from real data of sales already made. Otherwise, an statistical analysis is needed. In this case study data could not be taken from the real store sales data due to the politics of nonviolation of information. On such reason, data generation is randomly by means of a simulator. Data are considering the daily sales, and then sent to a table of the DWH for their manipulation. A Java application in the platform to randomly generate inputs to the supermarket departments is implemented. In first instance threads for each type of client are deployed. Five type of customers' profiles are modeled: housewife, father of family, professional, worker and student. Up to the profile persons tend to frequent certain departments of the store.

The store departments being modeled are basic foodstuff, process foodstuff, milkies, meats and fish, wines and liqueur, disposable, organic chemist, toy shop, fashion, glass.

Once the customers are generated, the second instance is by randomly generate the frequency of purchase for each department that another generator of random form will assign to them. The third instance is to collect the data of the frequency generated by each customer in each department and introduced in some table of the DWH for its manipulation.

In 6 is the model that follows the simulator, happening through each one of the instances before mentioned, until arriving at the connection with the DB so could be define by means of statistics the parameters that will be like model in the ECA rules its validate.

Several executions of the simulator were made to obtain the parameters and to validate them with the parameters given to the Fuzzy ECA rules. One day in the supermarket was modeled with 450 transactions in the simulator, representing the same number of customers. For verify that they followed the same behavior one week of sales in the store imagined, which caused 3150 registries into table of articles within the DWH.

VII. Results

The registries that were turned out to simulate the behavior of a supermarket in 7 days are in a table "articles" within the DWH. The affluence was simulated several bullfights of the system to obtain the value of one day obtaining 450 registries, representing that presents each department by the clients in the store. This table contains the fields that represent each section of the store. The obtained results of 7 days simulation shows that the department of basic articles is the most visited by the clients, followed by department of food process; the third position is occupied by the department of meats and fish. The wines and liqueur, the tois department and the milky one appears like less visited. The other departments have frequency of regular sale.

Department	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Average**
basic foodstuff	208	199	181	227	232	211	217	**210.7**
process foodstuff	136	150	149	139	177	150	166	**152.4**
milkies	61	76	75	66	75	70	69	**70.2**
meats and fish	161	150	145	149	142	155	152	**150.5**
disposable	62	88	85	71	71	62	60	**71.2**
wines and liqueur	79	69	75	69	72	55	52	**67.2**
organic chemist	79	89	76	78	66	62	70	**74.2**
toy shop	85	53	62	67	72	61	60	**65.7**
fashion	87	78	79	72	75	73	65	**75.5**
plastic	68	77	78	83	66	62	70	**72**

This simulator is just a form to validate our data when comparing them with the values that empirically defined for the deploy of the fuzzy ECA rules. We did not assume these values like definitive for validation, followed our common and empirical sense to assign frequencies of sales of the articles in the DWH.

VIII. Related works

A principal objective is conform a repository to get access to history vision and alongside handle the data to obtain management indicators and information to get for improving the marketing process, the feasibility and risks control, to cause correct decision make.

A. The Active Data Warehouse

The ADWH graphical interface has an ample variety of bookstores for graphs and functionalities as well as portability to be executed in different platforms (as deployed in Java programming language.) The DB's systems of management of data bases are used through the calls (SGBD), in which making use of PostgreSQL, functions in several languages can be developed. In the PL/pgSQL language the functions were implemented, due to the support that offers to develop complex functions.

The ADWH can migrate to other DB's that implements the use triggers for example Oracle or Firebird also they offer the Procedural language and they implement the use of triggers, it is necessary to remember that the syntaxes of these vary from one to another one and the ADWH even can be implemented in other platforms of operating systems as UNIX and Mac.

IX. Conclusion

For model analysis'rules with fuzzy declared parameters to the labels linguistic, in where these were implemented certain behaviors necessary to develop politics in the rules. These parameters were compared with fictitious data generated by a simulator that was developed for such case. These rules were modeled for support of the decision making, offering possible solutions to problems created in situations of article shortage when these are not even in list for stock replenisment requisition in this store.

The implement of rules generated actions satisfactorily to give solution to certain events triggers, fulfilling the conditions anticipated in the rules, obtaining therefore behavior ECA that combined with the fuzzy logic gave rise to Fuzzy ECA rules thus being generated to FECA_SDMS.

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