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A Sales Management Decision Making System based on Possibility Theory

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Abstract

One of the crucial problems for Information Technology (IT) organizations is lack of the integrity of complex systems and the so-called island view. Its goal is sharing efficient and integrated data, applications and business processes in an organizational platform. Sales department is a vital unit for any organization, thus the efficiency of performance has a significant role in the overall performance of the organization. Also integrity of data and performance in this unit is very effective to improving organization performance. In this paper, we aim to design a process of decision support system for the integration of sales unit. Here, we examine the process in two steps in which the first step surveys the flow of information for sales activities in the form of an information flow. In the second step, according to data from the previous step and due to the uncertainty in the enterprise data it is determined to implement the rules of the system by the possibility theory that is a probabilistic mathematically theory in fuzzy logic. Thereby through this, the events that have effective role in the integrity of sales department are known and organization should focus on them to achieve their goals. Also, to use actual data of organization and to be able to use the results of the work objectively, we conducted a case study for implementation purpose.

Keywords: Decision support system; Possibility theory; Sales management system; Rule base

Introduction

Frequently, an application that involves decision making in any conditions is often classified as a Decision Support System. Many advances in computer technology are dynamic and these changes are effective on information systems like DSS. It should be noted that since nature of DSS changes in parallel with the advances in the development of computer technology, therefore there is a suite of DSS applications that is dynamic and constantly changing which makes it virtually impossible to limit such changes to a static set of DSS applications. Kren [1] reported that Moore's Law (doubling of computer power every 18 months) is on track for at least the next five years. This would indicate that information systems technology will continue its advances in new and diverse directions [2].

DSS evolved in stages that are briefly discussed ahead:

In 1970, Little in his article for designing models and systems proposed some criteria. Also in 1975, Little expanded the frontiers of computer-supported modeling and called DSS as 'Brandaid' which was designed to support product, promotion, pricing and advertising decisions as explained by Osorio et al. Simon in 1977, spoke out about this subject that the process of decision-making in organization covers whole the supply chain and that the ranges of decision's are from highly unstructured to highly structured. Carlson, putting his study on the available decision support systems and classification them. In 1980, Alter published a professional book about his taxonomy of computerized DSS. Also two professors Moore and Chang, worked on the development and shaping up DSS. Bonczek et al. identified four essential "aspects" or general components that were common to all DSS; mentioned by Burstein. Keen and Morton further worked on DSS and individuals with the capabilities of the computer to improve the quality of decisions [3-10].

It was a brief overview on the process of how to create and develop the DSS.

Nowadays business environment is highly competitive and fast, correct and best decisions of managers in the shortest possible time are an absolute requirement for any organization. The notion of 'learning from mistakes' has left its place to 'one strike and you're out 'reality. In fact, in this global environment that marked by mergers, acquisitions, and ever-increasing economic instability, there is no room for the slightest mistake in the making decision. Success and survival of organization depends on that be able to quickly meeting and exceeding the actual and perceived needs and wants of the customer. To succeed in such a brutal environment, existence of an integrated intelligent decision support system that are capable of using a wide variety of models along with data and information resources available to them at various internal and external repositories, is very vital for mangers [11].

In other words, lots of managers are faced with high rate changing and highly competitive marketing environment. Marketing managers, have no way to become more competitive through better decision making because they are faced a high raised competitive marketing environment every day [12].

We can say that a decision is an output of a productive activity that is obtained from many intellectual efforts of an individual, computing hardware and software, data, etc. Developing of DSS is caused of many advances in computer technology and also in the computer based techniques in order to handling information than can be key in a business [13].

Literature and managerial studies available in relation to decision support system show that the great number of applications of DSS developed in the last decades. Usually, a DSS organizes and processes the information that managers need to make critical and effective decisions. One of the issues that in today's complex world, managers

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facing with it, is decision making under conditions of uncertainty and we know it is extremely hard. The ability of manage the uncertainty has become a very important issue in the field of DSS. In particular the design of a DSS that requires the formulation of priorities and/or knowledge of expert is often affected by uncertainty. For solve this problem namely manage of uncertainty, studies show that some techniques developed in the field of Artificial Intelligent seem to face this issue more effectively than the traditional decision analysis techniques. Among the intelligent techniques, Fuzzy Logic is one of the most promising. In order to assess the effectiveness of this technique in supporting decision-making processes and to compare it to the traditional ones, it is necessary to quantify the ability of DSS to manage uncertainty [14]. To prove this claim, one way to measurement of power the DSS is evaluating the system's robustness. In fact, robustness is a characteristic that makes the DSS work even when some of the input data or reasoning rules are missing, unreliable, inexact and when data and knowledge inherently involve uncertainty [15].

Marketing and sales are the crucial issues for any manufacturing organization. Develop the market-based product that can meet customers need in today's business world can be a powerful weapon for survival and seize the market. Discuss about decision support systems for market –based product development is very high, because in the most cases, customer needs aligned with new product success, and new product development and relationship marketing issues are inseparable. For design the some market-based decision support systems for new product development [16-20] developer consider both design and market information as the influencing factors but according to the designer view, these can be vary widely [21].

There is an obvious need for tools which can improve marketing decision making. Many efforts have been made to develop suitable software tools that can act as consultants for marketing managers. There are many opportunities for applications of information systems can assist company increase information and improve its quality. There is an increasing motivation in the use of marketing decision support systems (MDSSs) designed to be used in complicated marketing decision making problems [22].

An MDSS is defined as "a coordinated collection of data, models, analytic tools and computing power by which an organization gathers information from the environment and turns it into a basis for action" [23].

Sales department is the crucial unit for an organization, so the decisions that are taken in this unit have a great impact on the success and growth of an organization. Given the importance of the decisions that are taken in this unit, timely and accurate decisions of sales managers is very important. Also, integrity of information and being correct information between different parts of the unit is an important requirement. To achieve this goal, existence of an integrated information system that be able to creates the integrity of information and in addition in the shortest possible time provides the right information for decision makers is very important. One of the strong information system to support management decisions as previously mentioned is Decision support system (DSS). In order to, in this paper we follow the process of designed an intelligent integrated decision support system that as an information tool helps to the sales managers in the critical decisions of marketing and sales. Since the information of organization usually are vague and uncertain, it was decided that put computational core system to the Possibility theory.

Possibility theory is a mathematical theory for dealing with certain types of uncertainty and is an alternative to probability theory. Professor Lotfi Zadeh first introduced possibility theory in 1978 as an extension of his theory of fuzzy sets and fuzzy logic [24].

The paper is organized as follows. Section 2 deals with the proposed problem process and modelling. In Section 3 an implementation study is given to emphasize the applicability and effectiveness of the methodology. We conclude in Section 4.

The Proposed Process and Modelling

Here, the sales process in an assumed company is described. First, customers make contact to the sales department and the operator survey the background of his performance. If the customer has previously purchased a product then the last ID is admitted for the new process and otherwise a new ID is allocated (sales department have two forms namely A and B; form A is for customer that has customer ID and form B is for customer without an ID).

As mentioned above, if the answer is positive, Form A is selected. But in the case of a negative response, Form B is selected and in this form some information are required to be asked from the customer as given below:

1. How do the customers know this organization?
2. Clarify the type of customer (Whether retailer or wholesaler? What is the scope of business activities?)

And finally the sales operator assigns an ID to the customer.

In the next step, information about the product type, the number of product, date of delivery and the product technical plan are asked. Information records in the database of customers and order form are sent to the production unit.

Production unit admit/reject the order after reviewing the availability of materials and the technical requirements of each order form.

While the production department admits the order, the products are produced according to the process plan. Then, the customer economic behavior is checked according to the financial database and if the customer paid in time for his past transactions then a discount based on the amount of purchase is given and otherwise the base prices are used for calculations.

Finally, the products are dispatched to the customer. The proposed process for sales is diagrammed in Figure 1.

Process modeling

In this work, we use if-then model to process the decision making for the sales department according to the data we collected from the customers or deposited from the past transactions. Below are the events used in our modelling.

Events of sales department

A- If " Customer has ID" Then "Choose form A";

B- If " Customer hasn't ID " Then "Choose form B";

C- If " Production unit accepts the request" Then "Client ID is called";

D- If "Production unit does not accept the request" Then "Order will be canceled";

E- If "The Customer is creditworthy" OR

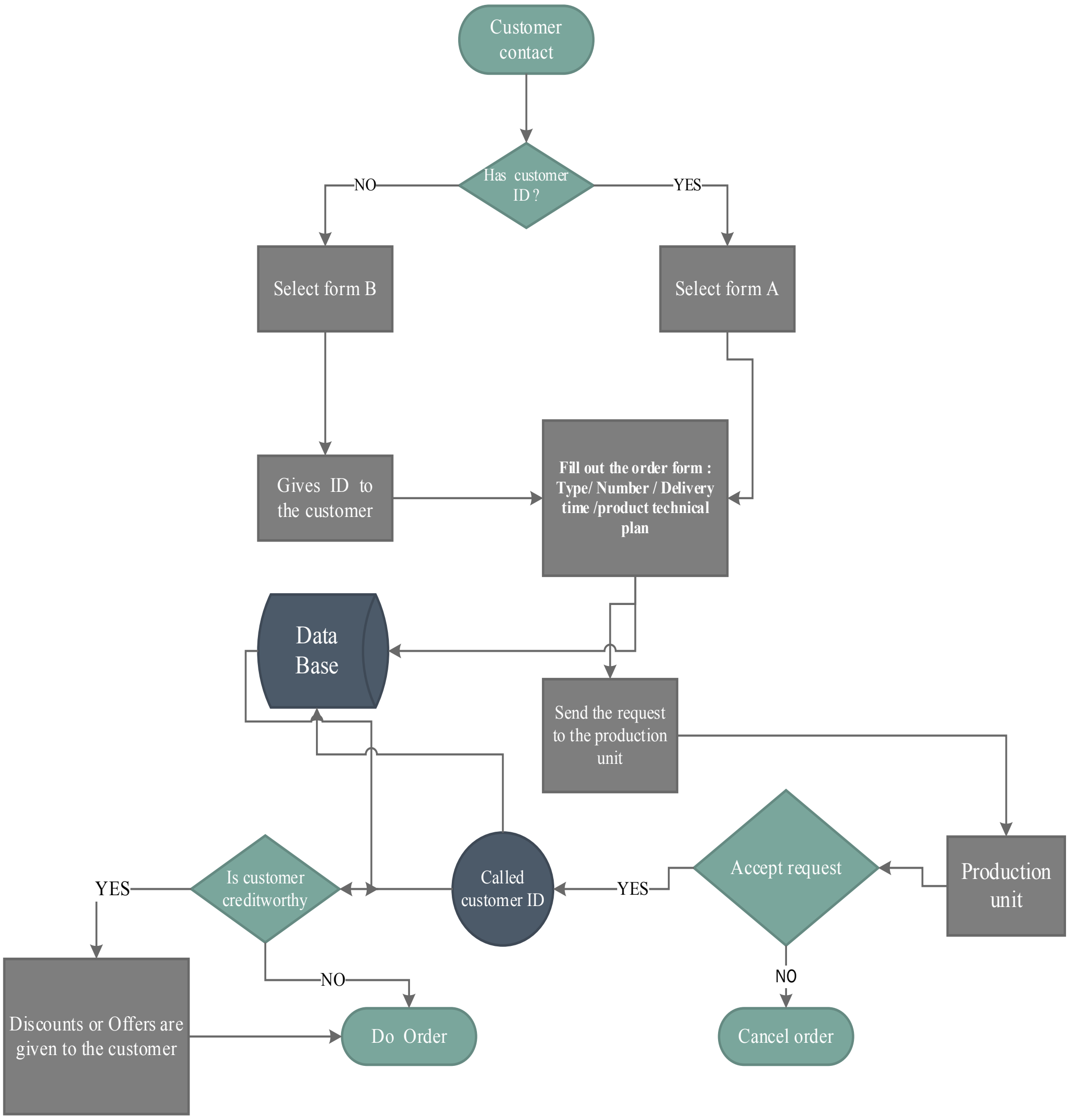

Figure 1: A proposed sales process.

F- "The Customer is permanent" Then "Give them discounts or offer";

Uncertainty of the customer behavior and process nature makes us to use an indefinite modeling approach. According to the proposed process composition given above and the key sale criteria we make use of possibility theory.

Possibility theory

Possibility theory is a mathematical theory for dealing with certain types of uncertainty and is an alternative to probability theory. Professor Lotfi Zadeh first introduced possibility theory in 1978 [24], as an extension of his theory of fuzzy sets and fuzzy logic. Dubois and Prade [25] further contributed to its development.

Formulating of possibility

For simplicity, assume that the universe of discourse Ω is a finite set, and assume that all subsets are measurable. A distribution of possibility is a function *Pos* from 2^{Ω} to [0, 1] such that:

Axiom 1: $pos(\Phi) = 0$

Axiom 2: $pos(\Omega) = 1$

Axiom 3: $pos(U \cup V) = \max\left(pos(U), pos(V)\right)$ for any disjoint subsets U and V.

It follows that, like probability, the possibility measure is determined by its behavior on singletons:

$$pos(U) = \max_{w \in U} pos(\{w\})$$

Provided that U is finite or count ably infinite.

Axiom 1: Can be interpreted as the assumption that Ω is an exhaustive description of future states of the world, because it means that no belief weight is given to elements outside Ω.

Axiom 2: Could be interpreted as the assumption that the evidence from which *Pos* was constructed is free of any contradiction. Technically, it implies that there is at least one element in Ω with possibility 1.

Axiom 3: Corresponds to the additively axiom in probabilities. However there is an important practical difference. Possibility theory is computationally more convenient because Axioms 1–3 imply that:

$pos(U \cup V) = \max(pos(U), pos(V))$ For *any* subsets U and V.

Because one can know the possibility of the union from the possibility of each component, it can be said that possibility is *compositional* with respect to the union operator. Note however that it is not compositional with respect to the intersection operator. Generally:

$pos(U \cap V) \le \min(pos(U), pos(V))$

When Ω is not finite, Axiom 3 can be replaced by:

For all index sets *I*, if the subsets $U_{i,i\in I}$ are pair wise disjoint,

$pos(\cup_{i\in I} U_i) = Sup_{i\in I}\, pos(U_i)$.

Necessity

Whereas probability theory uses a single number, the probability, to describe how likely an event is to occur, possibility theory uses two concepts, the *possibility* and the *necessity* of the event. For any set *U*, the necessity measure is defined by:

$nec(U) = 1 - pos(\overline{U})$

In the above formula, $\overline{U}$ denotes the complement of *U*, that is the elements of Ω that do not belong to *U*. It is straightforward to show that:

$nec(U) \le pos(U)$ For any *U*.

And that:

$nec(U \cap V) = \min(nec(U), nec(V))$

Note that contrary to probability theory, possibility is not self-dual. That is, for any event *U*, we only have the inequality:

$pos(U) + pos(\overline{U}) \ge 1$

However, the following duality rule holds:

For any event U, either $pos(U) = 1, or, nec(U) = 0$.

Accordingly, beliefs about an event can be represented by a number and a bit.

Interpretation

There are four cases that can be interpreted as follows:

$nec(U) = 1$ Means that *U* is necessary. *U* Is certainly true. It implies that $pos(U) = 1$.

$pos(U) = 0$ Means that *U* is impossible. *U* Is certainly false. It implies that $nec(U) = 0$.

$pos(U) = 1$ Means that *U* is possible. I would not be surprised at all if U occurs. It leaves $nec(U)$ unconstrained.

$nec(U) = 0$ Means that *U* is unnecessary. I would not be surprised at all if *U* does not occur. It leaves $pos(U)$ unconstrained.

The intersection of the last two cases is $nec(U) = 0$ and $pos(U) = 1$ meaning that I believe nothing at all about *U*. Because it allows for indeterminacy like this, possibility theory relates to the graduation of a many-valued logic, such as intuitionistic logic, rather than the classical two-valued logic.

Numerical Illustrations

The case study that we selected for this study is MAZIAR manufacturing industry. This organization begun its activity with the minimum of facilities and very small units and with ten years of initial attempt create an appropriate framework for an industrial group by name of MAZIAR INDUSTRY. Currently this factory with supply the best machines with Varity of top products every day attempt with their efforts in setting up and expansion of new units according to the standards , provide customers requirement.

Product of MAZIAR INUDSTRY:

- Concrete Beam
- Lighting Foundation
- Electrical Cabinet
- Foundation
- Masts
- Boxes Branching

Data related to the sales unit

A- If "Customer has ID" Then "Choose form A ";

Possibility measure of event A:0.6

Possibility measure of event $\overline{A}$: 0.4

B- If "Customer hasn't ID"Then"Choose form B ";

Possibility measure of event B:0.4

Possibility measure of event $\overline{B}$: 0.6

C- If "Production unit accepts the request "Then "Client ID is called ";

Possibility measure of event C: 0.8

Possibility measure of event $\overline{C}$: 0.3

D- If "Production unit does not accept the request "Then "Order will be canceled ";

Possibility measure of event D: 01

Possibility measure of event $\overline{D}$: 0.9

E- If "The Customer is creditworthy "OR

Possibility measure of event E:0.7

Possibility measure of event $\overline{E}$: 0.3

F- "The Customer is permanent " Then " Give them discounts or offer "

Possibility measure of event F:0.8

Possibility measure of event $\overline{F}$: 0.2

Computations for sales unit

A- If " Customer has ID" Then " Choose form A " ;

Possibility measure of event A: 0.6

Possibility measure of event $\overline{A}$: 0.4

$1-POS(A)=0.6$

$Nec(A)=1-POS(\overline{A})=1-0.4=0.6$

B- If " Customer hasn't ID " Then " Choose form B " ;

Possibility measure of event B: 0.4

Possibility measure of event $\overline{B}$: 0.6

$2-POS(B)=0.4$

$Nec(B)=1-POS(\overline{B})=1-0.6=0.4$

C- If "Production unit accepts the request" Then "Client ID is called";

Possibility measure of event C: 0.8

Possibility measure of event $\overline{C}$: 0.3

$3-POS(C)=0.8$

$Nec(C)=1-POS(\overline{C})=1-0.7=0.3$

D- If "Production unit does not accept the request" Then "Order will be canceled";

Possibility measure of event D: 01

Possibility measure of event $\overline{D}$: 0.9

$4-POS(D)=0.1$

$Nec(D)=1-POS(\overline{D})=1-0.9=0.1$

E- If "The Customer is creditworthy" OR

Possibility measure of event E: 0.7

Possibility measure of event $\overline{E}$: 0.3

F- "The Customer is permanent" Then "Give them discounts or offer"

Possibility measure of event F: 0.8

Possibility measure of event $\overline{F}$: 0.2

$5-POS(E\cup F)=MAX[POS(E),POS(F)]=MAX[0.8,0.7]=0.8$

$Nec(E\cup F)=MAX[Nec(E),Nec(F)]=MAX[0.7,0.8]=0.8$

$POS(E)=0.7$

$POS(F)=0.8$

$Nec(E)=1-POS(\overline{E})=1-0.3=0.7$

$Nec(F)=1-POS(\overline{F})=1-0.2=0.8$

The interpretation of the events

Here, to interpret the proposed events and their corresponding measures we assume a threshold based on the obtained values of necessity. Since possibility is the required condition and not the sufficient one and while necessity has both the required and sufficient conditions at the same time, we use necessity measure as our threshold.

The interpretations for all the proposed events are given below.

A– If " Customer has ID" Then "Choose form A";

$1-POS(A)=0.6$

$Nec(A)=1-POS(\overline{A})=1-0.4=0.6$

Interpretation

1. This event possibility degree is 0.6, this means most customers have ID. But it should be investigated the customer that hasn't customer ID is a new customer or that is a negligence of authorities that have forgotten to give him/her a customer ID.

2. This event necessity degree is 0.6, which means that your customer must have ID is necessary.

Results

Based on the threshold level that defined for necessity measure equal 0.7, the degree of necessity for this event is 0.6, so we concluded that this event not play an important role in the integrity of our system.

B- If "Customer hasn't ID" Then "Choose form B";

$2-POS(B)=0.4$

$Nec(B)=1-POS(\overline{B})=1-0.6=0.4$

Interpretation

1. This possibility degree for this event is 0.4; this means most customers are permanent customer. So range of customers is not high and can it be interpreted as a new customer refer is small and the organization should be more active in advertising and the cause of the problem must be investigated.

2. The necessity degree is 0.4. This means that a customer ID not particular need for the system and the customer can give ID here.

Results

The degree of necessity for this event is 0.4 and the threshold is not reached, then this event is not necessary for the integrity of the system.

C- If "Production unit accepts the request" Then "Client ID is called";

$3-POS(C)=0.8$

$Nec(C)=1-POS(\overline{C})=1-0.7$

Interpretation

1. Possibility degree of this event is 0.8, thus the probability that product unit accept the demand is very high and event is almost possible.

2. The necessity degree is 0.7, so this event is necessary for the organization.

Results

The degree of necessity is 0.7 and according to the threshold that we defined for necessity degree this event has effective role for integration of organization.

D- If "Production unit does not accept the request" Then "Order will be canceled";

$4-POS(D)=0.1$

$Nec(D)=1-POS(\overline{D})=1-0.9=0.1$

Interpretation

1. The degree of possibility is 0.1, this means that the probability that product unit does not accept the demand is very low and event is almost impossible.

2. The necessity degree is 0.1, so which means it is not necessary event for organization.

Results

Necessity degree is 0.1, so according to the threshold of this criterion concluded this event hasn't role in the integrity of the organization.

E- If " The Customer is creditworthy" OR

$$5 - POS(E) = 0.7$$

$$Nec(E) = 1 - POS(E) = 1 - 0.7 = 0.3$$

Interpretation

1. The degree of possibility is 0.7, means the majority of the customers are creditworthy.

2. The necessity degree is 0.7, which means it is essential for the organization that the customer is creditworthy.

Results

The degree of necessity is 0.7, according to the threshold that we defined for this criterion this event an effective event for integration of organization.

F- "The Customer is permanent" Then "Give them discounts or offer";

$$6 - POS(F) = 0.8$$

$$Nec(F) = 1 - POS(\overline{F}) = 1 - 0.2 = 0.8$$

Interpretation

1. The degree of possibility is 0.8, means the majority of the customers are permanent.

2. The necessity degree is 0.8, which means it is essential for the organization that the customer is constant and permanent.

The aggregation of events E and F

$$7 - POS(E \cup F) = MAX\left[POS(E), POS(F)\right] = MAX\left[0.8, 0.7\right] = 0.8$$

$$Nec(E \cup F) = MAX\left[Nec(E), Nec(F)\right] = MAX\left[0.7, 0.8\right] = 0.8$$

$$POS(E) = 0.7$$

$$POS(F) = 0.8$$

$$Nec(E) = 1 - POS(\overline{E}) = 1 - 0.3 = 0.7$$

$$Nec(F) = 1 - POS(\overline{F}) = 1 - 0.2 = 0.8$$

Interpretation

1. The possibility degree is 0.8, so the probability that both events happen and discounts given to the customer is high.

2. The necessity degree is 0.8, meaning that both events occurring together is essential and it is important for organization.

Results

The necessity of this event is 0.8, thus according to defined threshold, happening this two events together has effective role in integrity of organization.

Conclusions

Enterprises or small businesses are trying to meet the demands of customers and various stakeholders. The role of information sharing in the correct way in the organizational units in achieving competitive advantage something that in recent years at various levels of the company, business and supply chain is considered for many of researchers. In this study, we seek to achieve goals such as sharing the right information and data integration in the sales department; we developed a process of decision support system. Decision support systems are set of programs and data related that are designed to assist in the analysis and decision-making. In this study at first we consider how the flow of information in the form of organizational flowchart. To analyze the proposed decision making rules in uncertain environment we made use of Possibility Theory. In this regard need some information from the sales unit to be able to estimate the degree possibility and necessity of each event and we received the information tailored to the events that extracted from the previous stage. Finally, for each of events determined the measure of possibility and the degree of necessity determine the measure of urgency of each event for organization. The aim of this process was to identify the events that have effective role in the integration of organization and the organization to achieve this ideal should put its focus on these events. Therefore, to determine the events we put necessity degree serve as criteria and defined a threshold for this criteria and the analysis of the case is, the events that the degree of necessity equal to the threshold or higher than the threshold have decisive role in the integration of organization and other events don't have effective role. The analysis was carried out and at the end the effective and significant events for the integrity of organization are reported.

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