

COMEX: A Cost Management Expert System

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Abstract -Understanding and using cost accounting is a key to success in any type of organization, because it helps managers to collect important data about the costs assigned to products, services and customers and use it for planning and control function. This paper discusses development and application of an expert system for reasonable decision making and continuous processes improvement. The system is called COMEX (Cost Management EXpert system) and is implemented in JavaDON, an open-source expert systems shell based on the OBOA framework for developing intelligent systems. The paper also shows how COMEX can be used for improvement of the Billing Department business processes. COMEX relies on information generated using the Activity Based Costing method, accounting method based on activities, created to improve cost management system by focusing on the driver costs of the single activity.

Keywords: Expert system, Cost Management System, ABC method

I. INTRODUCTION

A Cost Management System (CMS) consists of a set of formal methods developed for planning and controlling the organization's cost-generating activities related to its short-term objectives and long-term strategies. Business entities face two major challenges: achieving profitability in the short run, and maintaining a competitive position in the long run. An effective CMS must provide to the managers with the information needed to meet both of these challenges.

The information generated from a CMS should benefit all functional areas of the organization entity. Thus, the system should integrate the areas shown in Fig. 1 [1], and should "improve the quality, content, relevance, and timing of cost information that managers use for short-term and long-term decision making" [9].



Fig. 1. An Integrated Cost Management System

The information generated from a CMS should help managers measure and evaluate performance. The measurements may be used to evaluate human or equipment performance or to evaluate future investment opportunities.

Finally, to maintain a competitive position in an industry, a company must generate the information necessary to define and implement its organizational strategies. As the strategy represents the link between an organization's goals and objectives and the operational activities executed by the organization, companies have to be certain that such a connection exists. Information provided by the CMS enables managers to perform strategic analyses on issues such as: a) determining core competencies and organizational constraints from a cost-benefit perspective, and b) assessing the positive and negative financial and nonfinancial factors of strategic and operational plans.

Since the world of business competition is dynamic, and creative managers are constantly devising new business practices and innovative approaches to competition, a CMS must be dynamic to.

Managers in many companies were concerned about the product costing information being provided by the traditional cost accounting systems. The general consensus is that product costs currently being developed are useful in preparing financial statements, but are often of limited use for management decision making. At the same time, Activity-based costing (ABC) helps companies to work more efficiently, determine costs more accurately, and control and evaluate performance more effectively.

The rest of the paper is organized as follows. In Section 2 we describe the Activity-Based Costing (ABC) method. Section 3 is the central section in the paper. It discusses the architecture and design of COMEX in detail.

Section 4 shows some discussions. Finally, Section 5 contains some conclusion remarks and further directions.

II. ACTIVITY-BASED COSTING

In a business context, an activity is defined as a repetitive action performed in fulfillment of business functions. Management should first investigate activities that reflect the major and most significant processes conducted by the company. These activities normally overlap several functional areas and occur horizontally across the firm's departments lines. ABC is a new method of cost assignment, more compatible with the increased high technology environment in which business operates.

ABC is a powerful tool for measuring company's performances. It recognizes cause-effect relationships between assigned objects costs. Once activity costs are identified, ABC assigns costs to products/services based on the resources they consume.

ABC assigns costs to products on the basis of the types and quantities of activities that must be performed to create those

products. This costing system accumulates costs for activity centers in multiple cost groups at a variety of levels (unit, batch, product, and organizational) and then allocates these costs using multiple cost drivers. Thus, costs are assigned more accurately, and managers can focus on controlling activities that cause costs rather than trying to control the costs that result from the activities. The use of ABC should provide a more realistic picture of actual production costs than has traditionally been available. Managers have more success in understanding how organization is using its own capital by assigning costs for defined activities using the ABC system.

As a more accurate CMS than traditional cost accounting, ABC identifies opportunities to improve business process effectiveness and efficiency by determining the "true" cost of a product or a service. It is implemented in many companies around the world.

The way of applying ABC systems differs from one organization to another. Some organizations use ABC system as the main CMS, but many are selective and can be applied on subunits or separate functions of organizations.

Note, however, that although ABC typically provides better cost estimates than the traditional overhead allocation process, it is not a panacea for all managerial concerns. This is the point where an expert system can take a part.

III. COMEX

COMEX is a Cost Management Expert system developed to support the work of billing departments of utility companies. COMEX can be applied to any kind of the billing (e.g., electricity, water or waste).

Previous research has shown that good conception of the bill influences customer relationship, which is a very important part of this business branch [3].

The purpose of COMEX is to satisfy the customer's needs and stay concurrent with lower costs. For example, the customer inquiries are consuming a large percentage of the company's resources, and reducing costs for this activity brings savings and customer's satisfaction. This is applicable to all other activities. COMEX recommends how to achieve these savings.

COMEX interprets the data resulting from applying the ABC method. ABC method is the process of studying activities to classify them into activity centers, than trace costs to those activities and determine the cost drivers. The map of the activities supplied by the ABC method is essential for a knowledge engineer during the design phase of development.

COMEX is implemented using the JavaDON ES shell, developed at FON, School of Business Administration, University of Belgrade, Serbia, as an academic project. JavaDON is an open-source shell with a graphical user interface for Windows platform (see [Tomic et al., 2006] for details).

A. Knowledge Representation

COMEX is essentially a frame-based system. There are nine frames in its knowledge base:

- a) Customer
- b) Activity
- c) BillInquiry
- d) WebSite
- e) AccountVerification
- f) CustomerInquiry
- g) Correspondence
- h) Expert
- i) ExpertSolution

The frames are inter-related. The UML class diagram in Fig. 2 explains the relations among the frames.

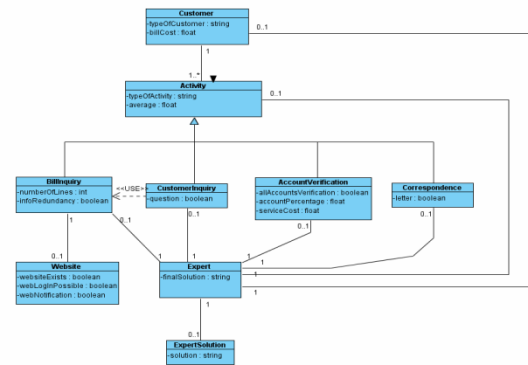


Fig. 2. – System COMEX Class Diagram

Figure 3 shows all nine frames; then the frame *Customer* is expanded and its slots are shown.

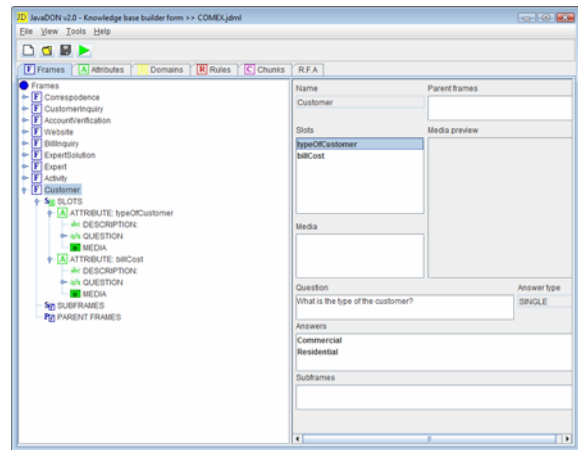


Fig. 3. –The *Customer* frame and the *typeOfCustomer* slot

Each frame can have subframes and parent frames. There are two slots in the *Customer* frame but no subframes and parent frames. SubFrames and ParentFrames have no children nodes in Fig. 3. All frames branch directly from the root of the knowledge base.

These frames have slots that represent the corresponding frame's attributes. Each slot contains the definition of the attribute it represents, a question to be presented to the end-user in dialogs with COMEX whenever the system asks the user to supply a value for the attribute, possible answers, and a description (canned text used for providing explanations in the user's consultations with COMEX).

A slot's attribute is shown in its node in the expanded tree. For example, the *typeOfCustomer* slot from the *Customer* frame, Fig. 4, is defined to ask the user "What is the type of the customer?", and the user is supposed to select between two possible types of customers: *Commercial* and *Residential*.

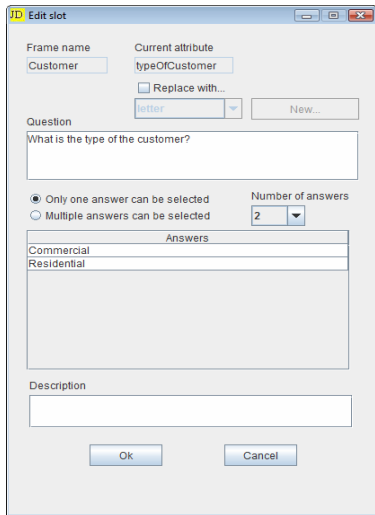


Fig. 4. – The *typeOfCustomer* slot

B. Dialogs

Another very important piece of knowledge in the COMEX knowledge base is the *typeOfActivity* slot in the *Activity* frame. The related question that COMEX will ask the user during his/her session with the system is «Which activity do you want to improve?» There are four possible answers: Bill Inquiry, Customer Inquiry, Account Verification and Correspondence (Fig. 5).

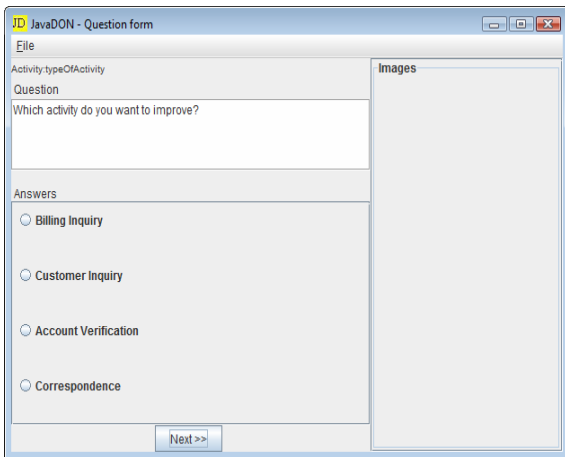


Fig. 5. Selecting an activity to improve

After the user selects an activity, COMEX will typically ask a question about the average percentage of the total cost allocated to the chosen activity. The *average* slot in the *Activity* frame stores the value of the total cost allocated in the activity of the Billing Department (BD). Depending on activity selected, the value entered is compared to the actual market average percentage. For example, the market average percentage for the Account Verification activity is 16%. Anything under this value doesn't need improvement; in case of a greater value, COMEX goes forward into improvement and asks the question Q10:

Question: Q10

What percent of the total cost is allocated for this activity?

The related rules in the knowledge base are:

Rule17:
 IF A="Commercial" AND 16 < average
 THEN Solution1
 End

Rule18:
 IF A="Commercial" AND 16 >= average
 THEN ask-question Q11.

Fig. 6 shows the activity diagram for one of the four branches, i.e. Account Verification improvement. There are five different endings that can happen, depending on the user's answers.

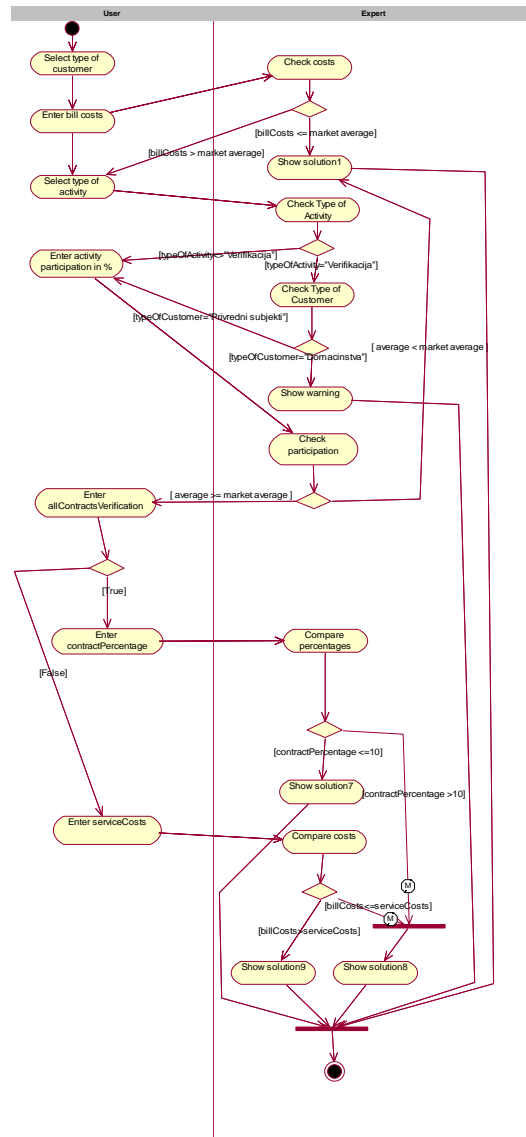


Fig. 6. – Activity diagram for Account Verification

C. User Modeling

COMEX users are knowledge engineers and end users.

A knowledge engineer is the one who creates the knowledge base and tests the system. Speaking in terms of UML, the use cases related to knowledge engineers are illustrated in Fig. 7. They include building the knowledge base, creating a new project, opening and updating the knowledge base, and the like. During the design of the COMEX system, the knowledge engineer communicated with a cost management expert, an ABC expert, and accounting and system quality experts. All the important knowledge was entered in the knowledge base through multiple iterations.

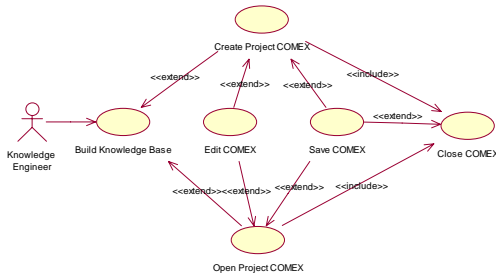


Fig. 7. Knowledge engineer's use cases with COMEX

COMEX end users are ABC experts, accountants, managers, business analysts, and students. End users do not have the permission to update knowledge base elements. He/she opens the system (Open Project COMEX), enters the session data (Enter Data) and starts the forward chaining inferencing (Forward Chaining), Fig. 8.

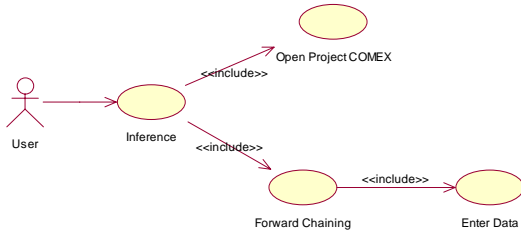


Fig. 8. – End-user use cases

D. Reasoning and Conflict Resolution

COMEX reasons using forward chaining with its rules.

Fig. 9 shows some of the COMEX' rules. IF and THEN clauses use frame slots to create logical expressions (IF clauses) and assertions (THEN clauses).

In addition to IF and THEN parts, each rule has its TYPE (which can be either AND or OR) and IMPORTANCE (the rule's priority, used to resolve conflicts when multiple rules can fire).

For example, the *BillCostComGreater* rule (Fig. 9) states that if the slot *typeOfCustomer* from the *Customers* frame has the value *Commercial* and the *billCost* slot from the same frame has a value greater than or equal to 8.5 (IF clause), then the system will ask the question (the *ask_question* action) related to the *typeOfActivity* slot of the *Activity* frame. That means if the selected customer class is *Commercial* and bill is greater than a certain limit, COMEX will proceed with the process improvement.



Fig. 9. The structure of rules in COMEX

Since COMEX is a forward-chaining system, in each cycle of its reasoning process a set of candidate rules to fire is created (the rules that have their IF clauses satisfied). Conflict resolution and selection of the rule to fire is done by selecting the highest priority rule. Each rule can be fired only once.

The reasoning process is initiated by having three rules automatically satisfied when the session starts:

- a) *INIT* (Fig. 10),
- b) *BillCostCommRes* (Fig. 12) and
- c) *ShowSolution* (Fig. 15).

The *INIT* rule's importance is set to 10 and thus it will be fired first.

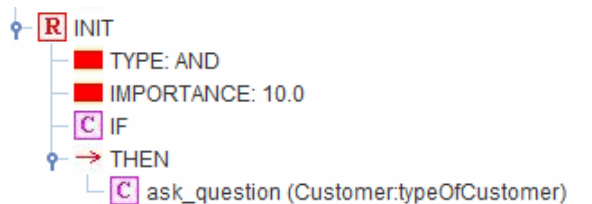


Fig. 10. The *INIT* rule

Firing the *INIT* rule means that the action *ask_question(Customer:typeOfCustomer)* will be executed. As a result, the user is presented the question about the customer type as in Fig. 11.

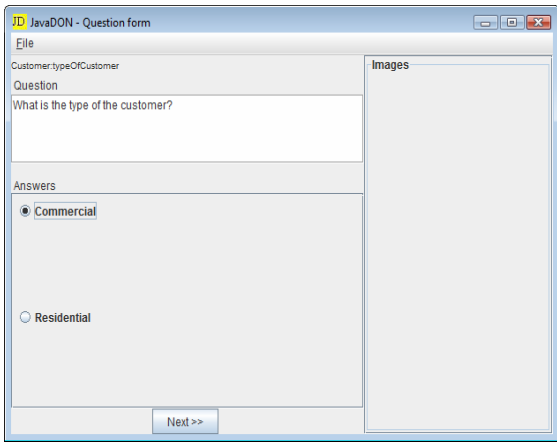


Fig. 11. The start of a session

Upon selecting the customer type and clicking Next, the next cycle of forward chaining is executed and the *BillCommRes* rule (with the IMPORTANCE set to 9.0, Fig. 12) is fired.

Its THEN clause executes the action *ask_question(Customer:billCost)* and the user is asked to enter the appropriate bill cost, Fig. 13. In this example, it is assumed that the user is a Commercial customer and that he has entered the value 6.5 that corresponds to this customer type.

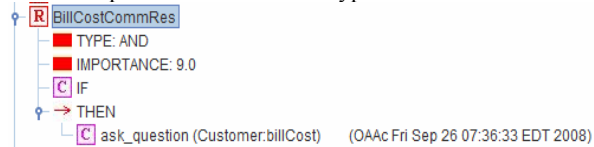


Fig. 12. The *BillCostCommRes* rule

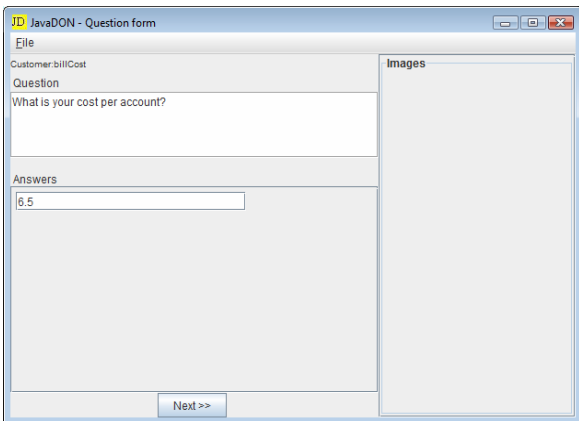


Fig. 13. The result of executing the *ask_question(Customer:billCost)* action

This result in COMEX activates the *BillCostComLess* rule (Fig. 14), because the bill cost entered is less than market average. The rule's THEN clauses are added to the working memory and the slots *Expert:finalSolution* and *ExpertSolution:solution* are assigned the appropriate values. The *ShowSolution* rule (Fig.15) will use these values when presenting the solution that COMEX displays to the user at the end of the session, Fig. 16. Note that *ShowSolution* has an empty IF clause, so it will certainly fire. However, it has the lowest IMPORTANCE (-10), hence it will fire only at the end of the session.

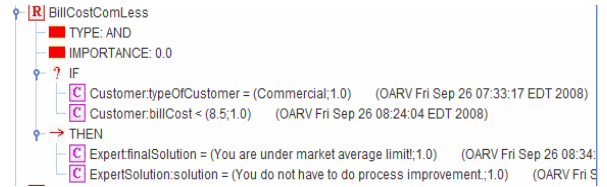


Fig. 14. The *BillCostComLess* rule

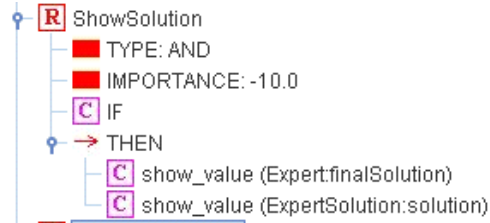


Fig. 15. The *ShowSolution* rule

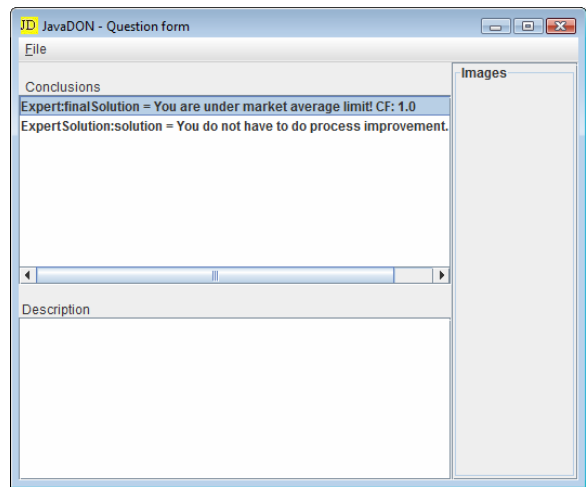


Fig. 16. – The solution presented by COMEX

This simple example demonstrates how COMEX works. In real-world examples, its reasoning takes many more steps and can get quite complex.

IV. DISCUSSION

Why expert system? Is this technology “in” or took off in 1990’s? The answers to these questions are reflecting the authors' inspiration to research the subject.

If we called COMEX a *business rule management system* (BRMS), it would certainly be “in”. And what is a BRMS? The little secret is that a BRMS was originally called "expert system" and its rule engine was called "inference engine". Then it was called "business rule engine", and today this kind of system is known as "business rule management system". Hence COMEX may change its name/categorization over time.

Expert systems didn't really go away. They went undercover [8]. This statement can be justified by, e.g., *AMEX's Authorizer's Assistant* (ES for credit cards transactions management) [2]. This magnificent ES is working perfectly since 1988.

V. CONCLUSIONS

COMEX demonstrates how business effectiveness can be improved by applying a new method for cost management and expert system technology to interpret the data resulting from applying the method. In other words, the ABC method calculates the real costs and COMEX reasons over the data to provide useful advice and recommendations. Together, they bring significant improvement to cost management.

Our current and future work is oriented towards putting the COMEX demo online and commercialization of the developed full version.

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