A Compound Decision Support System for Corporate Planning

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ABSTRACT

Providing a plan for any corporate or firm at macro level, as an organization or enterprise resource planning has particular importance nowadays. To meet the enterprise resource planning needs applications software packages provide a set of uniform pre-prepared and pre-designed that covers all business process throughout an organization. To achieve maximum efficiency in the implementation of these packages and their synchronization with the needs, organizations face a very complex problem. In this paper, a decision support system to be used for planning in various economic firms is presented. By using this system, the managers can investigate their corporate in the past and then they can make a plan for future. We implemented the proposed decision support system for a company in Iran. This company has two production lines subject to exchange rates. In the evaluation, four alternatives to make the plan for future are applied. The experimental results show the optimizing the exchange rate allocated to production lines provides the best solution for this company.

Keywords:

Business Planning, Systems, Enterprise Resource Planning, Corporate Planning

1. Introduction

Today most companies are using, developing, or experimenting with some form of corporate planning model. This is due primarily to development of planning and modeling software packages that make it possible to develop the model without much knowledge of computer coding or programming. For the accountant and financial analyst, the attractive features of corporate modeling are the formulation of budgets, budgetary planning and control, and financial analyses that can be used to support management decision making.

A corporate planning model is an integrated business planning model in which marketing and production models are linked to the financial model 15). More specifically, a corporate model is a description, explanation, and interrelation of the functional areas of a firm (accounting, finance, marketing, production, and others) expressed in terms of a set of mathematical and logical relationships so as to produce a variety of reports including financial statements. The ultimate goals of a corporate planning model are to improve quality of planning and decision making, reduce the decision risk, and, more important, influence or even shape the future environment favorably.

Several benefits can be derived from corporate planning models. The major's benefits are**:** (a) the ability to explore more alternatives; (b) better-quality decision making; (c) more effective planning; (d) a better understanding of the business; (e) faster decision-making; (f) more timely information; and (g) more accurate forecasts and cost savings.

This paper presents a compound decision support systems in corporate planning. The structure of the remaining sections is as follows: Section 2 reviewed the latest related works. Section 3 presents the architecture and their components. In Section 4, the proposed system is used in a company and the results of several alternatives are given. Section 5 is considered for conclusion and future works.

2. Literature Review

Since 1979, most companies have used corporate models 1). Increasingly, small- and medium-sized firms are introducing some analytical tool. The advent of corporate simulation languages enables analysts with little programming experience to write modeling programs in an English-like programming language for example, IFPS, SIMPLAN, or XSIM. A corporate model can be used to simulate an alternative strategy by evaluating its impact on profits and to link the firm's goals and strategies to its master budgets [15]. It also used to measure the interactive effect on segments within the firm and helps to establish corporate and division goals. Additionally, it supports management to better understand the business with its functional relationships and help improve decision-making ability. Corporate models are the main tools to assess critically the assumptions underlying environmental constraints and preparing budgets (4), 9), 10)).

Stanoevska et al (1998) explores the applications of new coordination technologies in distributed corporate planning 2). Firstly, new technologies such as Groupware, Workflow Management Systems, Internet and WWW for supporting distributed cooperative work are investigated. Then, Group Flow, which is a Lotus Notes based workflow management solution, is selected to model and coordinate the planning processes. Qualitative planning information is exchanged in a Notes Discussion Database so that quantitative planning facts are processed by WWW-oriented Q-Calculus. Thereafter, a Lotus Notes based integrated framework for developing a distributed corporate planning system is given. Moreover, the implemented prototype is demonstrated by a corporate financial planning example in a bank. Finally, main experiences are summarized and an agent-based process management perspective is briefly discussed.

Majidi et al. (2010) reviewed the old and present styles of software architecture and presents a survey on classification of the styles 12). These styles are Layered, Client/server, Pipe & Filter, Batch, Sequential, Object-Oriented, Event-Based, Blackboard, Repository, Virtual Machine, Main program/Subroutine and Implicit invocation. In this survey, advantages and disadvantages of several kinds of classifications are analyzed, and some criterions for choosing a suitable style in different applications are also presented.

A Decision Support Systems (DSS) is a class of information systems (including but not limited to computerized systems) that support business and organizational decision-making activities. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from a combination of raw data, documents, personal knowledge, or business models to identify and solve problems and make decisions. The support given by DSS can be separated into three distinct, interrelated categories: Personal Support, Group Support, and Organizational Support. DSS components may be as: (a) Inputs: Factors, numbers, and characteristics to analyze; (b) User Knowledge and Expertise: Inputs requiring manual analysis by the user; (c) Outputs: Transformed data from which DSS "decisions" are generated; and (d) Decisions: Results generated by the DSS based on user criteria

There are several ways to classify DSS applications. Not every DSS fits neatly into one category, but a mix of two or more architecture in one. Taxonomy for DSS has been created by Daniel Power 20). Using the mode of assistance as the criterion, Power differentiates communication-driven DSS, data-driven DSS, document-driven DSS, knowledge-driven DSS, and model-driven DSS.

- A communication-driven DSS supports more than one person working on a shared task; examples include integrated tools like Microsoft's NetMeeting or Groove[7].
- A data-driven DSS or data-oriented DSS emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data.
- A document-driven DSS manages, retrieves, and manipulates unstructured information in a variety of electronic formats. A document-driven DSS relies on knowledge coding, analysis, search, and retrieval for decision support. This includes all text-based DSS and most KMS. Document-driven DSS have minimal emphasis on mathematical models.
- A knowledge-driven DSS provides specialized problem-solving expertise stored as facts, rules, procedures, or in similar structures.
- A model-driven DSS emphasizes access to and manipulation of a statistical, financial, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation; they are not necessarily data-intensive. Decodes is an example of an open source model-driven DSS generator.

Alter (1980) classifies the DSS based on the "degree of action implication of system output" of DSS. This degree shows how much of outputs can directly support the decision: Data, Data and Model, and Models 19).

The AIS SIGDSS 16)classifies DSS into : (a) Communications-driven and group DSS (GSS); (b) Data-driven DSS; (c) Document-Driven DSS; (d) Knowledge-driven DSS, Data Mining, and Management Expert Systems Applications; and (e) Model-Driven DSS; and (f) Compound DSS. A compound DSS is the most popular classification for a DSS. It is a hybrid system that includes two or more of the five basic structures described by Holsapple and Whinston.

Holsapple and Whinston (2000) classify DSS into: (a) text-oriented DSS, (b) database-oriented DSS, (c) spreadsheet-oriented DSS, (d) solver-oriented DSS, (e) rule-oriented DSS (include most knowledge-driven DSS, data mining, management, and ES applications) and the compound DSS (See 17), 18)).

Donavan and Matnick (1979) made another classification of the DSS into the institutional DSS and ad hoc DSS, based on the capabilities 25). An institutional DSS is planned and developed to handle a recurring decision. It must have the flexibility to deal with that decision in different manifestations, with different data, over time. Such DSS tend to be used at the managerial control and operational levels. An ad hoc DSS is developed to handle a one-time problem. Such problems typically appear at the strategic and management control levels. Such a DSS need not have the same degree of flexibility as an institutional DSS to deal with variations in the problem. However, problems that were not expected to recur still often do so, or it turns out that the DSS is applicable to other problems as well.

A *ready-made DSS* is a DSS software product designed to be used, with minimal modifications, by several organizations that have comparable decision making needs. Such DSS are often designed for a specific industry (e.g., hospitals) or functional area (e.g., finance).

A cooperative DSS allows the decision maker (or its advisor) to modify, complete, or refine the decision suggestions provided by the system, before sending them back to the system for validation. The system again improves, completes, and refines the suggestions of the decision maker and sends them back to her for validation. The whole process then starts again, until a consolidated solution is generated.

DSSs which perform selected cognitive decision-making functions and are based on artificial intelligence or intelligent agents' technologies are called Intelligent Decision Support Systems (IDSS).

The nascent field of Decision engineering treats the decision itself as an engineered object, and applies engineering principles such as Design and Quality assurance to an explicit representation of the elements that make up a decision. A clinical decision support system (CDSS) has been coined as an "active knowledge systems, which use two or more items of patient data to generate case-specific advice. This implies that a CDSS is simply a DSS that is focused on using knowledge management in such a way to achieve clinical advice for patient care based on some number of items of patient data. CDSSs are interactive computer programs, which are designed to assist physicians and other health professionals with decision-making tasks. The basic components of a CDSS include a dynamic (medical) knowledge base and an inference engine (usually a set of rules derived from the experts and evidence-based medicine) and implemented through medical logic modules based on a language such as Arden.

Spatial Decision Support System (SDSS) 21)is developed in parallel with the concept of decision support systems [21], which is sometimes referred to as a Policy Support System. An SDSS is an interactive, computer-based system designed to support a user or group of users in achieving a higher effectiveness of decision making while solving a semi-structured spatial problem. It is designed to assist the spatial planner with guidance in making land use decisions. An SDSS typically consists of a database management system, a standalone system for this is called a Geographical Information System, (GIS), a library of potential models that can be used to forecast the possible outcomes of decisions and an interface to aid the user's interaction with the computer system and to assist in analysis of outcomes. Although various techniques are available to simulate land use dynamics, two types are particularly suitable for SDSS. These are Cellular Automata (CA) based models and Agent Based Models (ABM).

Manos et al. (2004) present the results of a research concerning the type, category and fields of applications of Decision Support Systems (DSS) and their contribution to decision-making in agriculture 11). Their focus are in the fields of planning and management of farms, farm regions and agricultural resources11). More specifically, the research includes a taxonomy survey that has been based on an analysis of all published works on applications of DSS from 1987 to 2001, as well as a categorized presentation of these applications. The basic concepts and characteristics of DSSs along with the important role that they play in the decision-making process in agriculture, are also described at the beginning of this paper.

Suha (2007) make a design of decision support systems (DSSs) which help financial managers in evaluating proposals for strategic and long-range planning 13). With the proposed two-phased DSS, projects are first selected from a given pool according to greedy heuristics based on the project's preferences as well as the project's efficiency. Then, integer programming with an approximation algorithm is used in the second phase to re-evaluate those proposed projects which met the first phase criteria.

Using scope as the criterion, Power [9] differentiates enterprise-wide DSS and desktop DSS. An enterprise-wide DSS is linked to large data warehouses and serves many managers in the company. A desktop, single-user DSS is a small system that runs on an individual manager's PC.

3. Methodology

The Proposed System

Figure 1 shows the general components and structure of DSS 3). As we can see in the figure, there are four basic subsystems: (a) the data management subsystem; (b) the model management subsystem; (c) the user-interface (dialog) subsystem and (d) the knowledge-based management subsystem. These subsystems are described in the following subsections.

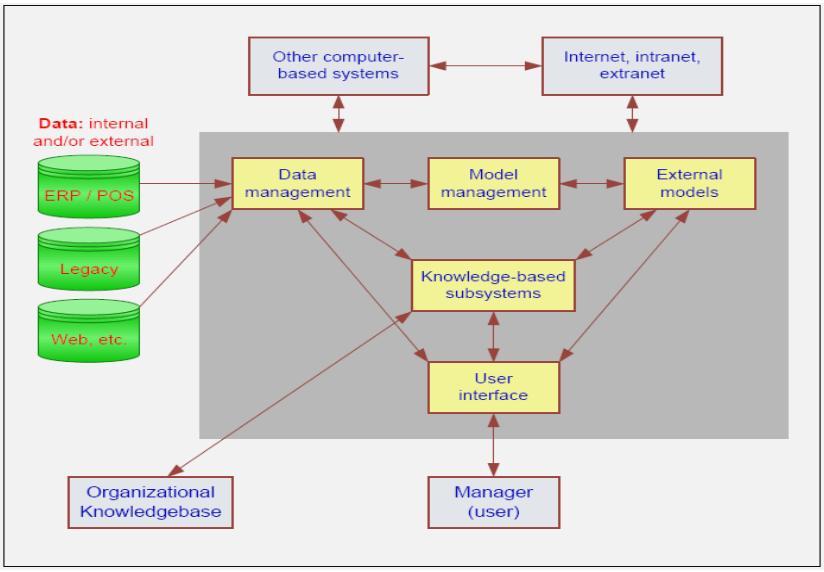

Figure 1- The components and structure of each DSS component, in general

3.1. Data Management Subsystem

Data refers to the information needed to make a decision, typically stored in a database, and to how these data are organized and managed by a DBMS. The Figure 2 shows the components of the Data management Subsystem in the DSS. These components are 'DSS database', 'DBMS', 'Data directory' and 'Query facility'.

The major functions and capabilities of DBMS are storage, retrieval, and control. The DBMS manages the database to organize, extract/access, modify, delete, and catalogue data. The role of **'E**xtraction' is the process of capturing data often from multiple sources, filtering them, summarizing, condensing and reorganizing the data to load into a DSS database such as a data warehouse. The function of a query facility in building and using DSS, it is often necessary to access, manipulate, and query data. The 'Query facility' performs these tasks. It accepts requests for data from other DSS components, determines how the request can be filled (consulting the data directory if necessary), formulates the detailed requests, and returns the results to the issuer of the request. The function of a 'Data directory' is a catalog of all data in the database. It includes data definitions and other information needed to facilitate and control access to data via the DMBS.

The Internal Data sources are categories in financial information (See Table 1- Profit and Loss Account, and Balance Sheet), Production lines information and others (See Table 2).

3.2. Model Management Subsystem

The Models refer to the models used to analyze the data and predict the results of a decision, as well as to the software used to manage the use of the models in a DSS. The Figure 3 shows the components of the model management Subsystem in the DSS. These components are Model Base, MBMS, Modeling language, Model directory, Model execution, Integration, and Command Processor.

Most of the Behavior and Logical Equations are Simulation models in which the company attempts to represent mathematically either the operations of the company or conditions in the external economic environment. By adjusting the values of controllable variables and assumed external conditions, the future implications of present decision-making can be estimated. Probabilistic simulation models incorporate probability estimates into the forecast sequence, whereas deterministic models do not. In the Optimization models the companies are intended to identify the best decision, given specific constraints.

A majority of corporate models in use are recursive and/or simultaneous models 14). In recursive models, each equation can be solved one at a time by substituting the solution values of the preceding equations into the right-hand side of the next equation.

Simultaneous models are frequently found in econometric models that require a higher level of computation methods, such as matrix inversion.

The 'Model base' has four functions: (a) Model creation, using programming languages, DSS tools and/or subroutines, and other building blocks; (b) Generation of new routines and reports; (c) Model updating and changing; (d) Model data manipulation; (e) The Model execution, integration and command.

The 'Model directory' is similar to a database directory. It is a catalog of all the models and other software in the model base. It contains model definitions and its main function is to answer questions about the availability and capability of the model.

The model building block is a repository of reusable components in the system. Examples of the software elements used to build computerized models include random-number-generator routines, a curve- or line-fitting routine, a present-value computational routine and regression analysis. Such building blocks can be used in several ways. As the figure shows, there are several Behavior and Logical Equations as well as optimization models.

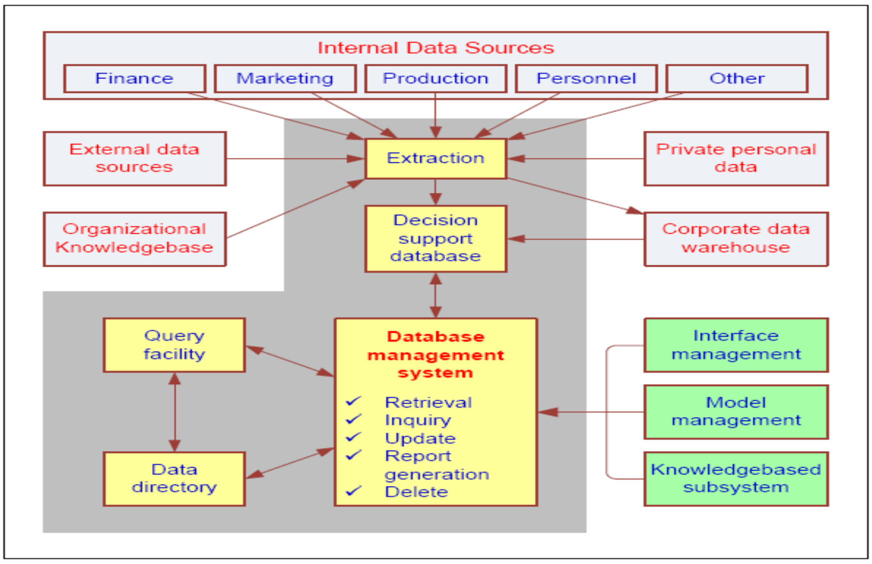

Figure 2- The components of the Data Subsystem

Table 1: Financial Information used (Profit and Loss Account-Left) and Balance Sheet (Right) in the proposed DSS

Variables	Brief Description	Variables	Brief Description
SALES	Sales Value	CASH	Cash in Firm and Banks
CGS	Cost of Goods Sold	INV	Inventory Value
MA	Material used in Production	AR	Accounts Receivable
WA	Wage Paid for production	TCA	Total Current Assets Value
OV	Over Cost of Production Lines	FA	Fixed Assets Value
GP	Gross Profit (Loss)	OA	Other Assets Value
SDE	Sales and Distribution Expenses	TA	Total Assets Value
AE	Administration Expenses	CL	Current Liabilities
OR	Other Revenue	LL	Long Term Liabilities
OC	Other Costs	TL	Total Liabilities
PBT	Profit Before Tax	OE	Owners' Equity

Table 2: Information of Production Lines (Left), Marketing, Personnel and other Information (Right)

Information of Production Lines (i=1, 2,..)		Marketing, Personnel and Other Information	
Variable	**Brief Description**	**Variable**	**Brief Description**
M_i	Material used in Production $Line_i$	YS_i	Amount of Goods Sold of Production $Line_i$
W_i	Wage Paid in Production $Line_i$	PY_i	Price of Unit Sales of Production $Line_i$
VC_i	Variable Cost of Production $Line_i$	LSDE	Number of Employee in Sales and Distribution
FC_i	Fixed Cost of Production $Line_i$	LAE	Number of Employee in Administration
C_i	Total Cost of Production $Line_i$	L	Total Number of Employees
K_i	Machinery of Production $Line_i$	TLP	Total number of Employee in Production
L_i	Number of Labors in Production $Line_i$	ARZ	Exchange Rate used in the company ($)
Y_i	Amount of Production of Production $Line_i$	T	Time Period (Year)
UE_i	Exchange Rate to produce an unit of product in line i		
PV	Present Values of Goods Produced		

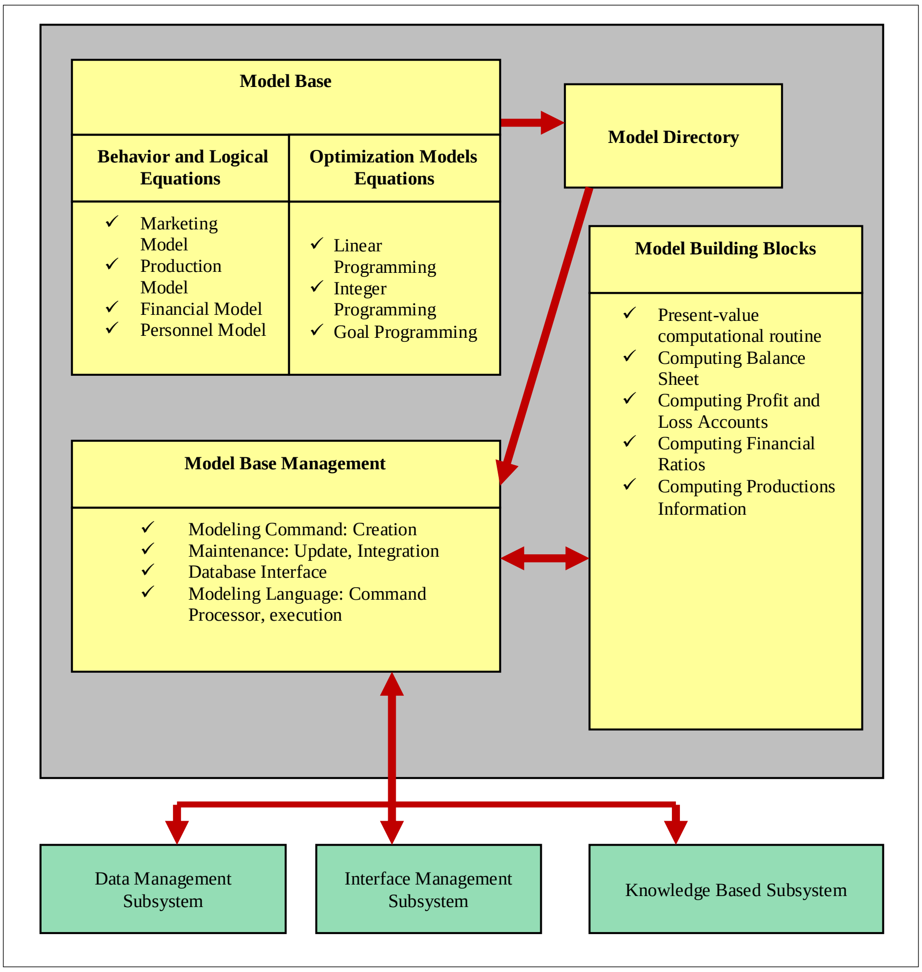

Figure 3- The components of the Model Subsystem

3.3. User Interface (Dialog) Subsystem

The User interface refers to the way a manager or decision-maker can use the system to support his or her decision making needs without having to become an expert in its technology. The Figure 3 shows the components of the User Interface Subsystem in the DSS. In fact inside the DSS, the flow of information from the user to the system and from the system to the user is handled by the User Interface Management System (UIMS)

It is the UIMS processes user commands, issued in whatever action language it requires, and passes them on to the data and model management subsystems. In the reverse direction, it presents information from those subsystems to the user. Increasingly, the action language is based on Web or operating system GUI concepts. It may also incorporate natural language processing capabilities.

The User Interface (UI) connects the user to the other system components. The knowledge-based subsystem, in addition to being connected to the user via the UI, may also connect to the database management system to obtain the data it needs, to external models, and to an organizational knowledge base. The UIMS processes user commands, issued in whatever action language it requires, and passes them on to the data and model management subsystems. In the reverse direction, it presents information from those subsystems to the user.

3.4 Knowledge Subsystem

The knowledge subsystem can either supply required expertise for solving some aspects of the decision problem or provide knowledge to enhance the operation of other DSS components. It can assist in model selection by capturing the knowledge of human experts as to the applicability of different models in different situations, making it available to people having less expertise in this area. The components in this subsystem may be expert knowledge, neural networks, intelligent agents, fuzzy logic, case-based reasoning, and so on. It is often used to better manage the other DSS components.

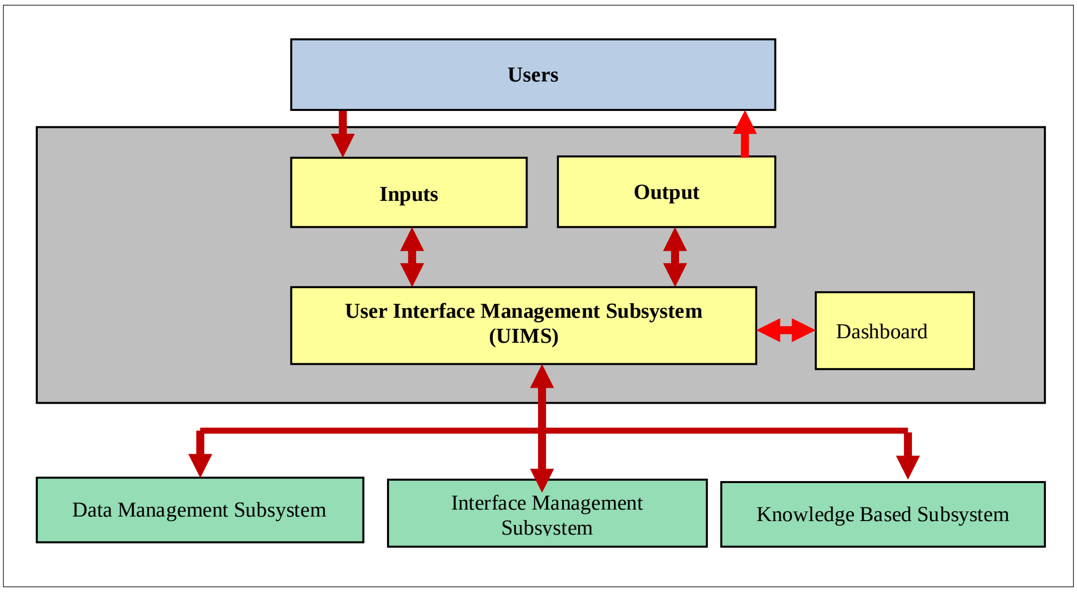

Figure 4- The components of User Interface Subsystem

4. Results

We implemented the proposed decision support system for a company using Planners Lab Software 26). Because of confidentiality of the company's financial information, the name of company is remained anonymous, but other information is provided. This company is one of the companies covered by the Industrial Development and Renovation Organization of Iran, which is working in industrial casting and rolling. So, it has two production lines.

An economic expert helped us to make the equations in the model base based on econometric methods 6)and economic theory 5). The expert used the information of the company in 15 previous years and his knowledge to estimate the equations. He used the flowchart depicted in Figure 5 for this purpose. The results of work done by this expert are presented in Tables 3-5.

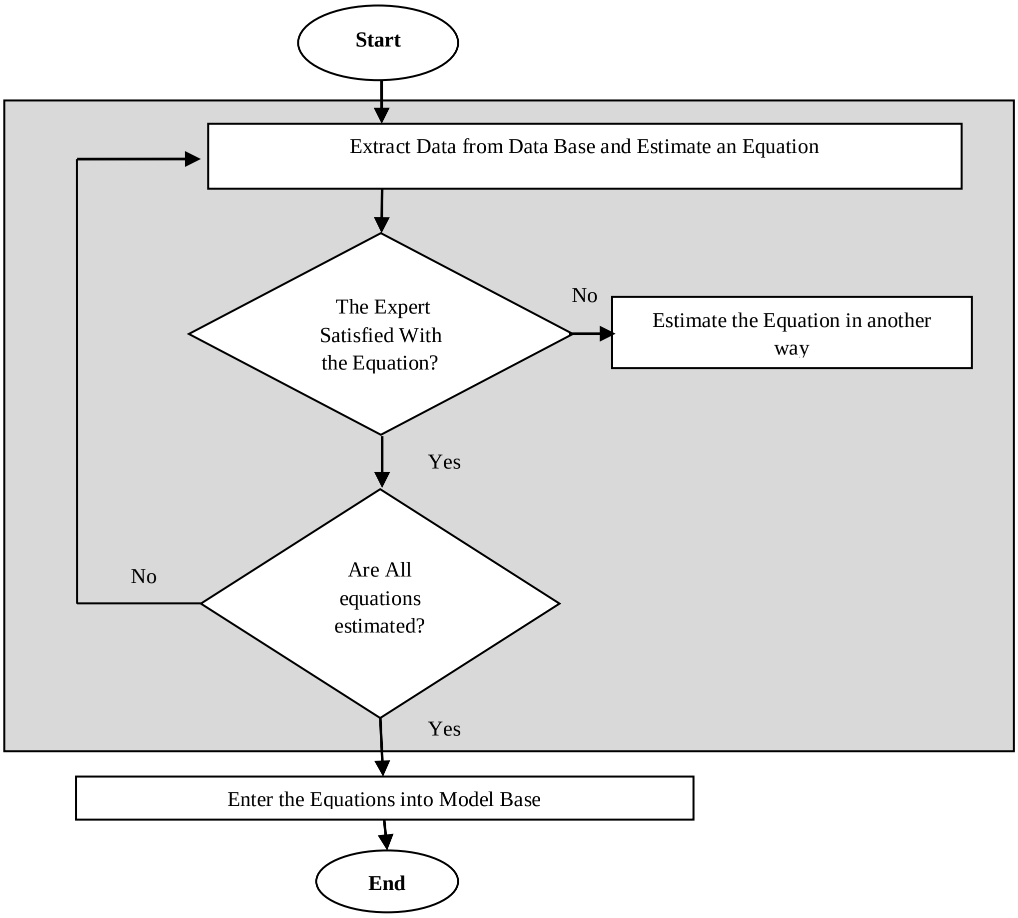

Fig. 5: Flowchart of developing models

In order to validate and make a better estimation, the expert added some dummy variables DVWAR, DUM and DUM1. These dummy variables are related to shortage in Exchange Resources and extra expenses in the administration. In the tables, R *Square is* statistic that reveals how closely the values of the estimated curve correspond to the actual data. The t-*stat* is a statistic for a null hypothesis that the coefficient is zero. The large value of t-*stat* indicates that it is of a low probability to have occurred by chance. Usually a t-*stat* greater than two is considered to indicate a coefficient is significant.

Table 3: The Financial Model (Left) and Production Model (Right) Estimated by the Expert

1	$CASH = 9592.95 + 0.29 \times SALES - 0.62 \times MA$ $t-stat$ (0.57) (3.14) (−2.45) $R^2 = 0.63$	10	$1n\,L_1 = 2.88 - 0.65 \times \ln \frac{PL_1}{PY_1} + 0.26 \times \ln Y_1$ $t-stat$ (3.1) (−6.06) (3.5) $R^2 = 0.91$
2	$AR = 37771.54 + 0.257 \times SALES$ $t-stat$ (0.609) (5.5) $R^2 = 0.7$	11	$1n\,C_1 = 3.48 + 0.93 \times \ln K_1 + 0.12 \times \ln PL_1$ $t-stat$ (12.7) (31.77) (3.1) $R^2 = 0.99$
3	$INV = -1.96(10^5) + 0.33 \times SALES + 53473.5 \times T$ $t-stat$ (−3.95) (4.64) (3.37) $R^2 = 0.97$	12	$K_1 = 0.0014 + 6.29 \times M_1$ $t-stat$ (0.84) $(5.25(10^7))$ $R^2 = 0.99$
4	$AE = 72069.14 + 1.103(10^5) \times DAWAR$ $t-stat$ (3.74) (3.45) $R^2 = 0.57$	13	$1n\,M_1 = 6.63 + 1.006 \times \ln \frac{Y_1}{PM_1}$ $t-stat$ (18.69) (17.2) $R^2 = 0.97$
5	$OR = -6164.27 + 3937.94 \times T$ $t-stat$ (−0.86) (3.75) $R^2 = 0.61$	14	$1n\,L_2 = 2.69 + 0.13 \times \ln Y_2 + 0.207 \times DUM$ $t-stat$ (16.8) (4.68) (3.69) $R^2 = 0.89$
6	$FA(T) = 1.53(10^5) + 0.68 \times FA(T-1)$ $t-stat$ (1.62) (4.87) $R^2 = 0.74$	15	$1n\,C_2 = 8.55 + 0.38 \times \ln K_2 + 0.12 \times T$ $t-stat$ (10.3) (2.06) (2.44) $R^2 = 0.91$
7	$OA = 10759.57 + 119453.7 \times DUM_1$ $t-stat$ (2.5) (8.37) $R^2 = 0.88$	16	$K_2 = 0.00042 + 54.96 \times M_2$ $t-stat$ (0.9) $(6.24(10^7))$ $R^2 = 0.99$
8	$CL = 4.68(10^5) + 0.62 \times PV$ $t-stat$ (3.88) (5.03) $R^2 = 0.73$	17	$1nM_2 = 1.13 + 0.74 \times \ln C_2 + 0.94 \times DUM_1$ $t-stat$ (0.95) (7.2) (−3.4) $R^2 = 0.87$
9	$LL = 94508 + 1.092(10^5) \times T$ $t-stat$ (1.09) (8.75) $R^2 = 0.89$	18	$PV = C_2 + C_1$

Table 4: The Marketing Model (Left) and Personnel Model (Right) Estimated by the expert

19	$YS_1 = 533.5 + 0.94 \times Y_1$ $t - stat$ (0.71) (18.9) $R^2 = 0.978$	21	$LSDE = 0.25 + 0.094 \times TLP$ $t - stat$ (0.038) (2.5) $R^2 = 0.67$
20	$YS_2 = -14.6 + 0.72 \times Y_2 - 108.76 \times DUM$ $t - stat$ (−0.53) (12.1) (−2.9) $R^2 = 0.953$	22	$LAE = 1.158 + 0.7 \times TLP$ $t - stat$ (−1.63) (4.55) $R^2 = 0.69$

The economic expert helped us to make the optimization model for the company. If we take λ_1 and λ_2 as the coefficients of sales in the production line one and two, respectively, and consider the total Exchange rate allocated to product lines one and two are ARZ_1 and ARZ_2 , respectively, then the gross profit is calculated as follows. It is the difference between the revenue of goods sold from the costs of goods sold: The result of modeling the optimization model for this company is summarized in Table 5. The constraints 2-3 are related to capacity of production lines 1 and 2 in this company.

Table 5: Components of the Optimization Model

Decision Variables	Objective Function	Constraints
Y1 Y2	$GP = PY_1 \times \lambda_1 \times Y_1 + PY_2 \times \lambda_2 \times Y_2 - CGS$ $= PY_1 \times \lambda_1 \times Y_1 + PY_2 \times \lambda_2 \times Y_2 - A(\lambda_1 \times Y_1)^{\alpha} \times (\lambda_2 \times Y_2)^{\beta}$	$ARZ_1 + ARZ_2 \leq ARZ$ $Y_1 \leq 40000$ $Y_2 \leq 2500$

Note that in the model:

$A = e^{4.82}, \lambda_1 = 0.94 \;,\; \lambda_2 = 0.72 \;,\; \alpha = 0.84 \;,\; \beta = 0.106$

(See Equations 19 and 20). Solving this optimization model leads to the following solution

$$ARZ1 = ARZ \frac{\lambda_1 \times PY_1 \times UE_1 \times \beta}{\lambda_1 \times PY_1 \times UE_1 \times \beta + \lambda_2 \times PY_2 \times UE_2 \times \alpha}$$
$$ARZ2 = ARZ \frac{\lambda_2 \times PY_2 \times UE_2 \times \alpha}{\lambda_1 \times PY_1 \times UE_1 \times \beta + \lambda_2 \times PY_2 \times UE_2 \times \alpha} \quad (23)$$

$$Y_1 = \frac{ARZ1}{UE_1} \quad , \quad Y_2 = \frac{ARZ2}{UE_2} \quad (24)$$

A manager in the company used DSS designed to investigate different alternatives to make a plan for the coming years. He used the flowchart depicted in Figure 6 for this purpose. There are typically two types of model investigations, including 'what if' question and 'goal seeking'. In 'what if' question, the DSS examines the relationship between variables of the firm and exogenous variables and then computes the result variables such as sales and profit. In the 'goal seeking', DSS requires the use of optimization model.

The exogenous variables applied to this corporate are presented in Table 4 and the manager assumed that variables DAWAR and DUM have the same values with previous years. As a sample, the results of this system for 4-year planning horizon subject to the values of exogenous variables of Table 6, are depicted in Figure 7 and Figure 8.

Figure 8 shows the important variables used in the Balance Sheet and Profit and Loss account for the decision to optimized exchange rates between

Production Lines. These variables are 'Total Assets', 'Total Liabilities', 'Owner's Equity', 'Long-Term Liabilities', 'Current Liabilities' , 'Sales' , 'Cost of Goods Sold', 'Profit Before Tax', 'Other Costs', Sales and Distribution Expenses' and 'Administration Expenses'.

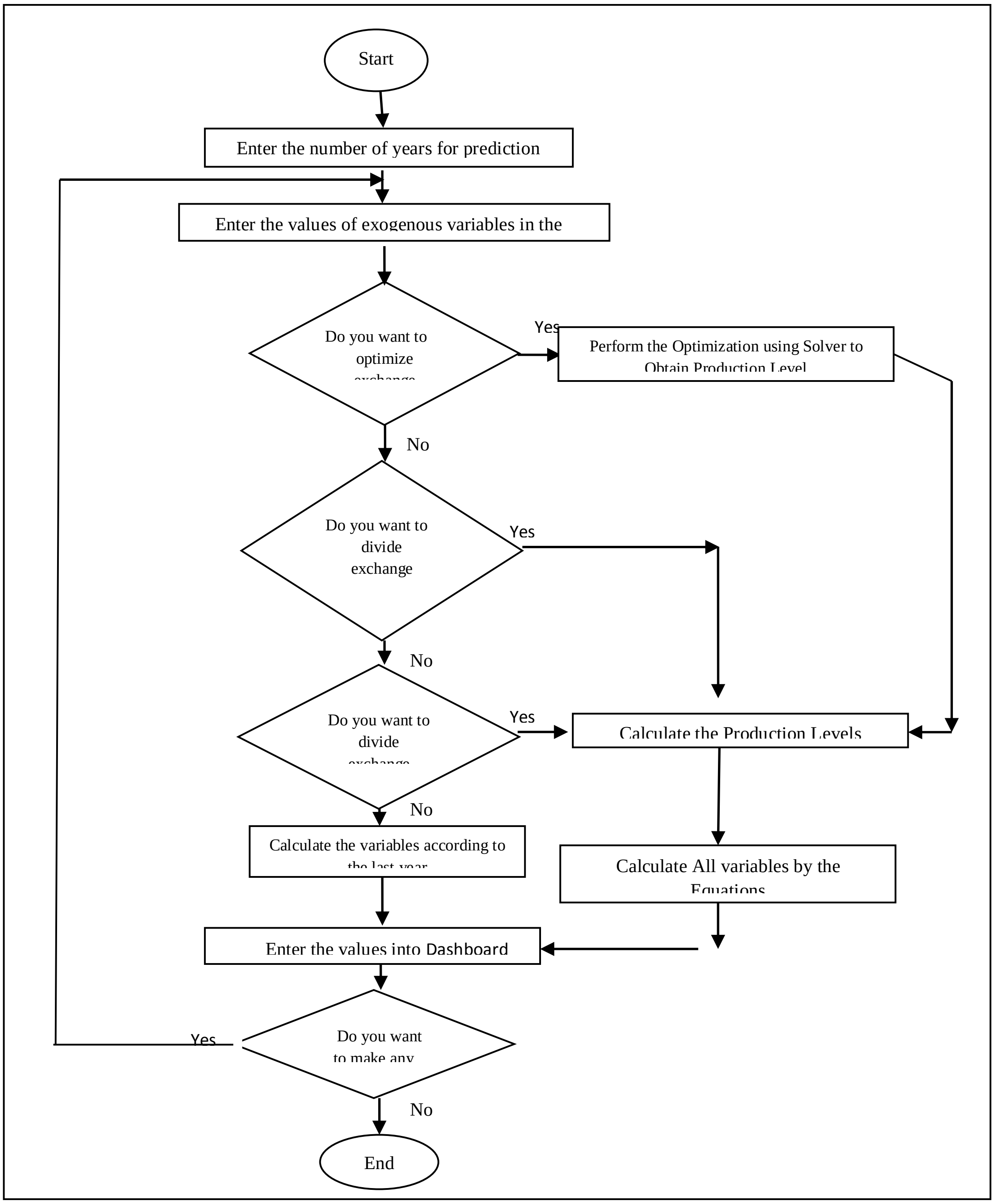

Fig. 6: Flowchart of the evaluation four alternatives

Table 6: The Exogenous variables and their Abbreviation

Variable	Brief Description
PY_1	Price Product Line 1 (Rolling)
PL_1	Rate of Wages for Production Line 1
PM_1	Price of Buying Raw Materials for Production Line 1
RD_1	Rate of Depreciation of Capital (Machinery) in Production Line 1
UE_1	Foreign Currency Required to Produce one Ton of Rolled Products
ARZ	Total Exchange Rates Allocated to Company
PY_2	Price of Product Line 2 (Casting)
PL_2	Rate of Wages for Production Line 2
PM_2	Price of Buying Raw Materials for Production Line 2
RD_2	Rate of Depreciation of Capital (Machinery) in Production Line 2
UE_2	Currency Needed to Produce a Ton of Product Line 2

Table 7: The Values of Exogenous Variables used for prediction

Variables	2015	2016	2017	2018	2019	2020
PY_1 (Thousands of Tomans/Ton)	103	104	105	106	107	108
PY_2 (Thousands of Tomans/Ton)	440	442	444	444	445	446
PM_1 (Thousands of Tomans/Ton)	29	30	32	33	35	36
PL_1 (Thousands of Tomans/Worker)	2,800	2,820	2,830	2,840	2,850	2,860
RD_1	0.41	0.40	0.41	0.41	0.42	0.42
PM_2 (Thousands of Tomans/Ton)	24	25	27	28	29	30
PL_2 (Thousands of Tomans/Worker)	1,710	1,720	1,730	1,740	1,750	1,760
RD_2	0.18	0.18	0.18	0.18	0.18	0.18
UE_1 ($)	250	250	250	250	250	250
UE_2($)	850	850	850	850	850	850
ARZ($)	4,200,000	4,210,000	5,000,000	5,100,000	5,220,000	5,230,000

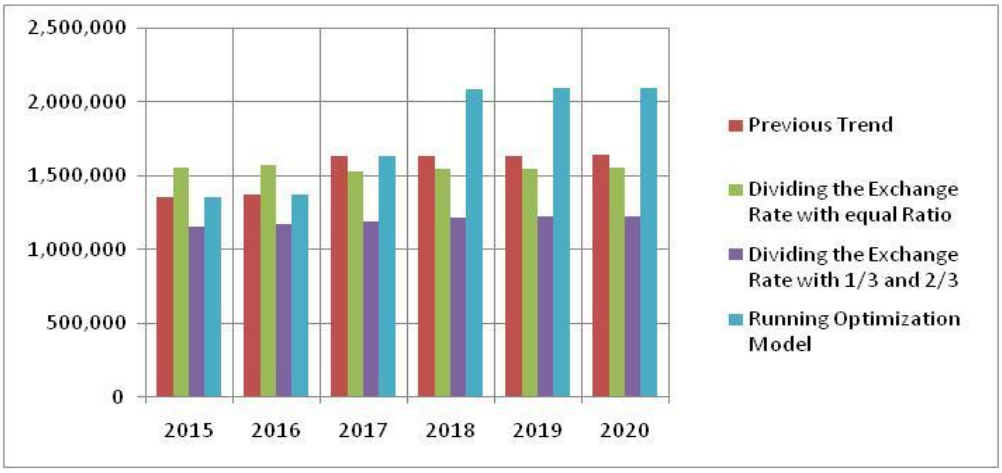

Figure 7: The Profit values in the execution scenarios

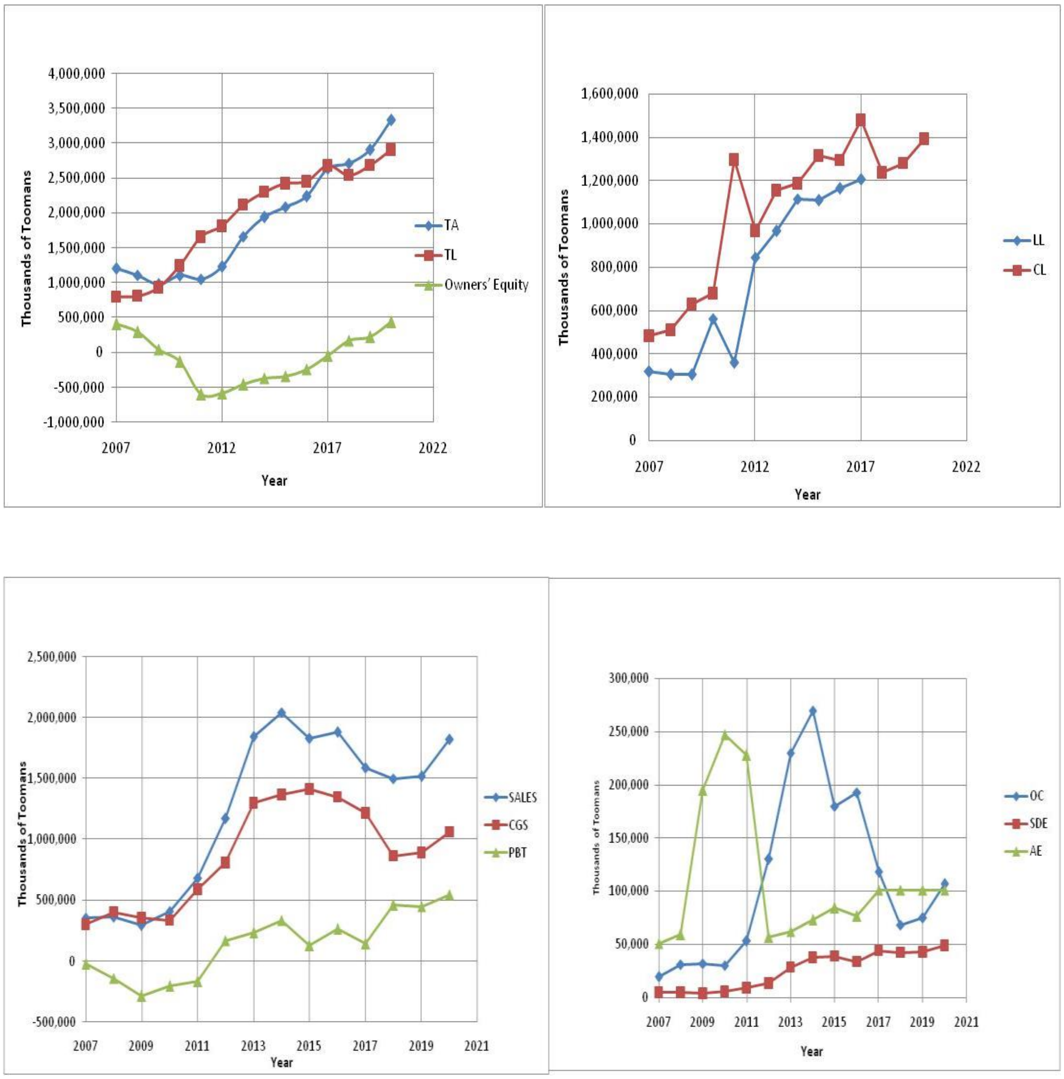

Figure 8: Total Assets, Total Liabilities and Owner's Equity (Top-Left), Long-Term Liabilities and Current Liabilities (Top-Right), Sales, Cost of Goods Soled and profit Before Tax (Bottom-Left) and Other Costs, Sales and administration Expenses and Administration Expenses (Bottom-Right) for the decision to optimized exchange rates between Production Lines

Although profit is a goal, other quantities must be investigated. In order to determine which alternative is more appropriate for this company, several indices can be used. These indices are financial and economic ratios. More details on the description of these indices and their calculations are given in 24). Figures 9 shows four financial ratios and three Turnover Ratios along with Profit per Sale ration for the decision of optimized exchange rates between Production Lines.

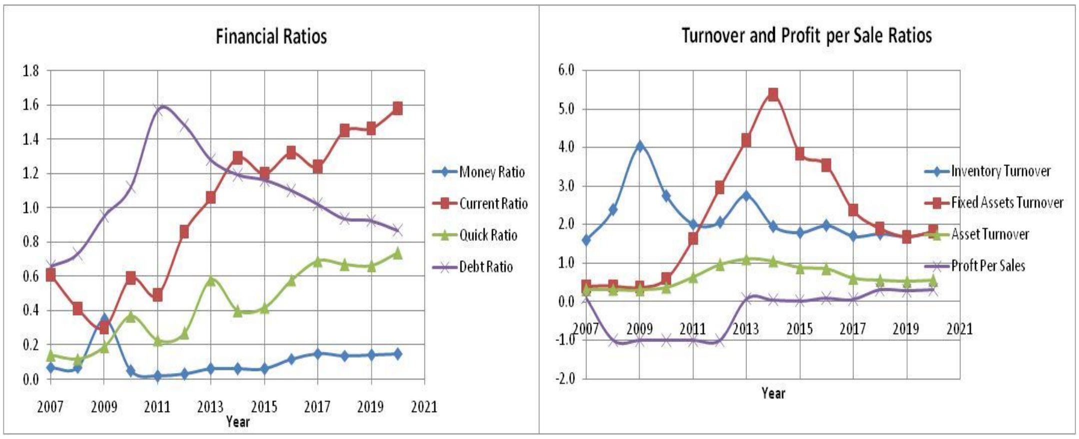

Figure 9: 4 Financial Ratios (Left) and 3 Turnover Ratios with Profit per Sale (Right) for the decision to optimized exchange rates between Production Lines

As we can see in the figures, the following observations are derived in our study in running optimization model for this firm. These observations are subject to the exonenous variables of Table 6:

- **Observation-1**: Running previous trends for this company does provide more profit rather than dividing the exchange rates with equal ratio and dividing it with 1/3 and 2/3 between the production lines as well in 2018 to 2020.
- **Observation-2**: Running optimization model to allocate exchange rates between the production lines provided more profit in 2018 to 2020
- **Observation-3**: The Profit per Sales was zero in 2007 and is negative between 2008 and 2012. Then it came up in 2013 and remains around zero until 2017. Because of increasing the exchange rates allocated and its optimization in the coming years, it grows up slightly.
- **Observation-4**: The Asset Turnover, which is the ratio of 'SALES' over 'TA', is constant from 2007 to 2010. It grows up strongly from 2010 to 2013 and then it comes down to reach 0.05 in 2017 and finally remains stable at this level until 2020.
- **Observation-5**: The Fixed Asset Turnover, which is the ratio of 'SALES' over 'FA', is constant from 2007 to 2010. It grows up strongly from 2010 to 2014 and then it comes down from 5.5 in 2014 to 2.5 in 2017 and finally reaches to less than two in 2020.
- **Observation-6**: The Inventory Turnover, which is the ratio of 'SALES' over 'INV', has a peak of 4.0 in 2009 and a smaller peak in 2013. Then it remains stable around two from 2015 to 2020.
- **Observation-7**: The Money Ratio, which is the ratio of 'CASH' over 'TCA', went down from 2007 to 2010 and then came up from zero to around 0.05 between the years 2011 and 2015. It has a growth smooth from 2015 to 2017 and finally remains almost stable around 0.18 between 2017 and 2020.
- **Observation-8**: The Current Ratio, which is the ratio of 'TCA' over 'CL', has a significant growth between 2007 and 2014. From 2014 to 2018, it has a couple of fluctuations and then it come up from 1.4 in 2018 to 1.6 in 2020.
- **Observation-9**: The Dept Ratio, which is the ratio of 'TL' over 'TA', has a significant growth from 0.6 in 2007 and 1.6 in 2011, but it came down from 2011 to 2016. This trend continues in the coming years due the 'TA' is increased according to the equations 3,6 and 7 in Table 3.
- **Observation-10**: The Quick Ratio, which is the ratio of 'TCA-INV' over 'CL', has a significant growth from 0.1 in 2007 and 0.7 in 2020 with some fluctuations.

5. Discussions and Conclusion

Decision making is a process of choosing the best alternative for reaching objectives. It is a process of selection, which aims to select the best alternative. It is aimed at achieving the objectives of the organization. In this paper, a compound decision support system was proposed for corporate planning at macro level. Then the system was used in a firm in Iran. The results of four different alternatives for the future subject to certain exogenous variables were calculated and the Optimization Scenario was the best decision for this firm. In the system, any policies can be applied and their impacts are evaluated. This system can be used then in the preparation of budgets and financial firms.

There are a few directions for this research. Firstly, we can link this model to external models such as inventory model and investment model. Secondly, we can develop a general framework for corporate planning. Thirdly, we can link this proposed system to a knowledge management system in which the previous knowledge is collected and codified.

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