Decision Support System for Technical Management of Food Processing Industries

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Abstract . A computer-based decision support system called a Production Economical Reporting and Control System (PERCS) has been developed to help people work in food processing industries: decisions making, choosing between alternatives, solving problems and planning for the future. The system was divided into five parts: (a) the data management, (b) the model management system, (c) the knowledge engine, (d) the user interface, and (e) the user(s). This system was capable to report on the following functions: First, materials traceability which includes: sources, quantities, dates, names, prices, packages types and numbers, etc. Second was for machines and product lines report. Third, part was concerning about labor reports which includes: jobs, productivity, shift number, breakdown causes. Fourth, storing status, and the final part was for the quality report which includes: quantities, types, dates, .. etc. Onion dehydration industry was taken as a case study to apply the computer-based system for helping in technical management for this factory.

Keywords: Decision Support System, Food Industries, Database, Computer Model.

I. INTRODUCTION

Decision Support Systems (DSS) are tools that an organization uses to support and enhance decision- making activities (**Alter, [1]**). Early use of decision support analysis was marketing. Decision Support System (DSS) was defined by **Power** [2] as a coordinated collection of data, system, tools and technology, with supporting software and hardware by which an organization gathers and interprets information from business and environment and turns it into a basis for marketing action.

Because there are many approaches to decision-making and because of the wide range of domains in which decisions are made, the concept of decision support system (DSS) is very broad. A DSS can take many different forms. In general, we can say that a DSS is a computerized system to help making decisions. A decision is a choice between alternatives based on estimates of the values of those alternatives. Supporting a decision means helping people working alone or in a group gathers intelligence, generate alternatives and make choices. Supporting the choice making process involves supporting the estimation, the evaluation and/or the comparison of alternatives. In practice, references to DSS are usually references to computer applications that perform such a supporting role **(Alter,** [1]**).**

The term decision support system has been used in many different ways **(Alter, (**[1] and **Power,** [2]**))** and has been defined in various ways depending upon the author's point of view **(Druzdzel and Flynn,** [3]**). Finlay** [4] defines a DSS rather broadly as "a computer-based system that aids the process of decision making". **Turban** [5] defines it more specifically as "an interactive, flexible, and adaptable computer-based information system, especially developed for supporting the solution of a non-structured management problem for improved decision making. It utilizes data, provides an easy-to-use interface, and allows for the decision maker's own insights." Other definitions fall between these two extremes. **Little [6]** defined the DSS as a "model-based set of procedures for processing data and judgments to assist a manager in his decision-making." For **Keen [7]**., a DSS couples the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions ("DSS are computer-based support for management decision makers who are dealing with semi-structured problems"). **Moore and Chang [8]** define DSS as extendible systems capable of supporting ad hoc data analysis and decision modeling, oriented toward future planning, and used at irregular, unplanned intervals. For **Sprague and Carlson [9]**, DSS are "interactive computer-based systems that help decision makers utilize data and models to solve unstructured problems." In contrast, **Keen [10]** claims that it is impossible to give a precise definition including all the facets of the DSS ("there can be no definition of decision support systems, only of decision support"). Nevertheless, according to **Power [11]**, the term decision support system remains a useful and inclusive term for many types of information systems that support decision making. He humorously adds that every time a computerized system is not an on-line transaction processing system (OLTP), someone will be tempted to call it a DSS. As you can see, there is no universally accepted definition of DSS.

Awady *et al.* [12] developed an expert system for farm machinery selection under Egyptian conditions (FARMEC). They concluded that system provides a basic model for section machinery through four files: plowing, seeding, spraying and harvesting. Extension workers and agricultural engineers should cooperate in the field of machinery by using computers ES for appropriately selecting farm machinery and computing operating costs.

Lababidi, and Baker [13] proposed an integrated web-based fuzzy expert system for food dryer selection. A modular approach to designing the system was employed. It consists of a number of knowledge sources controlled by a scheduler, which communicate through a common blackboard. The system has been fully implemented to run on the web and provides an excellent example of how a number of heterogeneous tools and applications can be integrated on the www. Java was used

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as the main programming language, and a new server-side technology, Java servlets, was utilized and found to be very effective in integrating different applications on the web. Rule-based knowledge sources and the inference mechanisms were implemented using ReSolver. The system, which also includes ‘foreign’ programs coded in Fortran, clearly demonstrated the integration of the various tools in a seamless user-friendly environment. **Butler *et al.*** [14] discussed how a geographic information system (GIS) based DSS allows a scheduler interact with optimization algorithms to plan milk collection routes. They added that the DSS can be integrated with automatic data capture devices and database management systems to provide effective management of milk collection operations. **Cano and Liern [15]** have developed a flexible decision support system to help managers in their decision-making functions. This DSS simulates experts’ evaluations using ordered weighted average (OWA) aggregation operators, which assign different weights to different selection criteria. Moreover, they show an aggregation model based on efficiency analysis to put the candidates into an order. **Lautenbach *et al.* [16]** developed a decision support system (DSS) for sustainable river basin management in the German. The system integrates geo-referenced simulation models and related data sets with a user friendly interface and includes a library function. Design and content of the DSS have been developed in close cooperation with end users and stakeholders. The user can evaluate effectiveness of management actions like reforestation, improvement of treatment plant technology or the application of buffer strips under the influence of external constraints on climate, demographic and agro-economic changes to meet water management objectives such as water quality standards and discharge control. The geo- referenced approach allows the identification of local inputs in sub-catchments and their impact on the overall water quality, which helps the user to prioritize his management actions in terms of spatial distribution and effectiveness.

Management of food industries is very tedious and complicated job that in order to get better and sound technical management for factories. A decision support system (DSS) should be used to overcome the management problems, increase the production rate and quality, in addition to controlling and improving the production lines performance. The specific objectives of this work are: (a) constructing a general data base for the industry, (b) developing an appropriate daily data for industry, (c) reporting and controlling industry, and (d) remarking of applying the "DSS" to a case study of an existing factory (El-Neana'ia for Drying) for validation of the system results, and coming up with pertinent recommendations.

II. PROCEDURES

a. System Development: Decision support system (DSS) requires the use of expert knowledge, judgment and experience. The major steps and components that are involved in the complex process for developing a DS system were defined as: identification, conceptualization, formulization, implementation and testing or validation.

- Identification: During this stage, the participants, resources, problems, characteristics and objectives were identified.

- Conceptualization: The relationships and connections between the main modules and their subdivisions of the system are shown in Fig. 1. As it can be seen, raw materials are connected to companies filed, work shift, production line and final products, where IDC, refers to the identification of company, CNAMEA and CNAMEE are the company name in Arabic and English. IDR refers to the identification of the raw materials. RMNAMEA and RMNAMEE are the raw materials name in Arabic and English. IDS refers to the identification of the shift of work. ShiftNAMEA and shiftNAME are the shift name in Arabic and English. In case of production (IDP), it needs to deal with the IDC, IDR, IDS, unitcode, raw materials prices to get the final products.

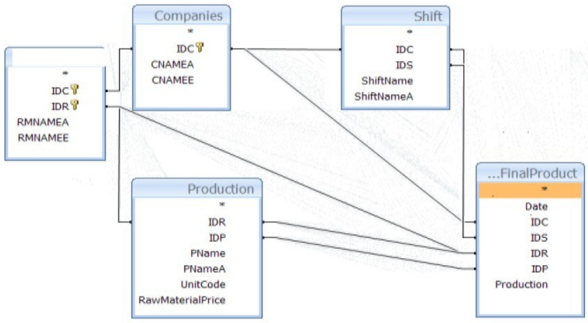

Figure (1) Relationships and connections between the main modules and their subdivisions.

Daily inputs:

Figure 2 shows the relations between the daily inputs data and their effects on each other, where, it includes IDC, IDR, IDS, IDP, IDSP (sub- products), and their codes.

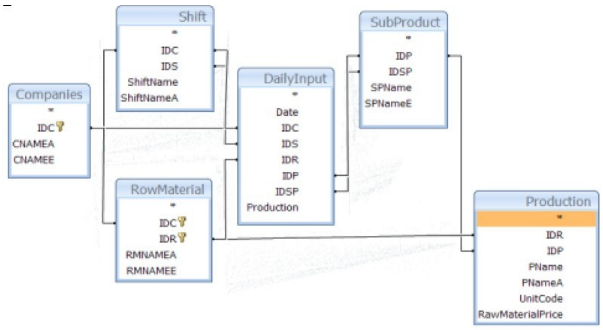

Figure (2) Relations between the daily inputs data and their effects on each other.

- Formulization: All statements and calculations were coded using visual basic language. For example, the following is a part of the program code of cost calculation which includes all the statements of determining the fixed and variable costs.

-Implementation: The problem parameters were translated into a group of rules, demos, and methods which explain the management procedures. These information appear as a group of message boxes, display and conclusion display.

-Testing and validation: To test the completeness, accuracy and the functionality of the DSS, a sequence of verification, validation and evaluation processes was used throughout the development process. In the verification process, information, relationship and logic of the DSS were verified by the domain expert to be sufficient in details and accurate in terminologies. Validation was carried out using a real data of a real case study of an onion dehydration industry (El-Neana'ia For Drying). Figure 3 shows the flowchart of the production stages, which include: raw materials receiving, preparation, processing, packaging and shipping stages.

III. RESULTS AND DISCUSSIONS

To show the utility and operational functions of the DSS, an example of its inputs and outputs is presented using the data of an onion dehydration industry at EL-Nena'ia, Monofia Govern., Egypt, which was taken as a case study. When the user starts the DSS, the main menu of the system contains three main parts, basic data, daily data and reports as shown in Fig. 4.

b. Basic Data:

The basic data include: (a) the general information such as company name, raw materials type and sources, final products and secondary products, (b) production stages, processes, packages and machines, (c) troubleshooting data, types, reasons and repairing, and (d) basic information about workers, activities, customers, employees, wages. The system could be used for more than one activity or company; also, it gives updated information for the technical and management issues in the industry.

c. Daily Data:

Daily data include daily production, daily storage from raw materials, processed materials and final product, also daily information about exportation, maintenance and spare parts status as shown in Fig 5.

c. Reporting:

Reports, by clicking on reports button, you can have reports about (a) final products and raw materials, (b) costs (machines costs, ,,,,), (c) Daily production in details, and (d) Storage status (final products, spare parts, raw materials and exportation), as shown in Figure 6, each interface has an exit button to end the process.

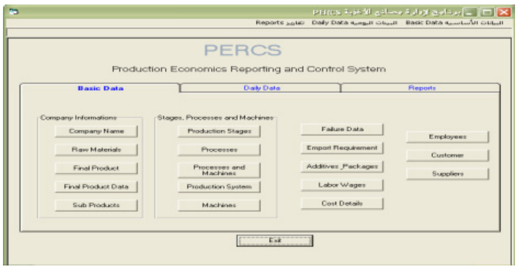

Figure 4 : Main menu and basic data.

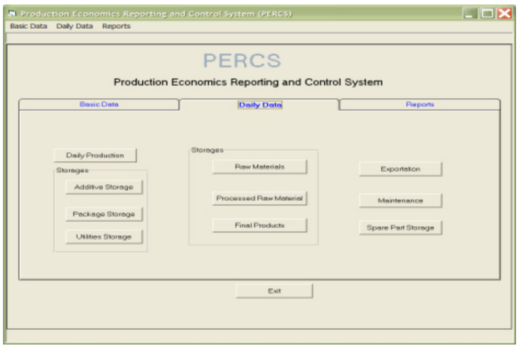

Fig. 5. The daily data.

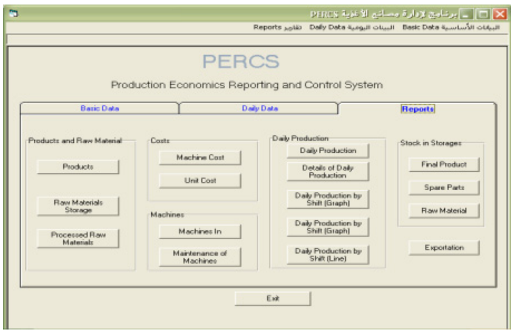

Figure 6: The DSS reports.

The main parts of the system are connected to each other, where, If the user wants to input the raw materials, which can be applied by starting the basic data and selecting the required raw materials and then exit and consequently, all processes connecting to those materials will be changed. Also, the user can have information by reporting about these raw materials, sources, quantities, places, prices and varieties.

d. System validity and capability

- Breakdowns case:

To test the capability of the system to help the decision maker, for example, if there is a breakdown in a machine (sieving machine as shown in figures 7, a and b), and the action was taken to change the machine gear, the system will show the date, company name, shift number, worker, machine name, failed part, spare part, how many, cost and breakdown time. This will be connected to both breakdowns data field and spare parts storage status, where, at the breakdowns data, the failure part will be recorded and at the spare parts storage, the part will be recorded, with date, quantity and unit price. In the final report, by clicking on search button, you can have report about the machine, worker, which indicates how many times this breakdown was happened during a certain period, worker in charge, machine, spare parts , costs and breakdown time. This will help the manger, in case, machine should be replaced for breakdown repeating or worker should be changed…etc.

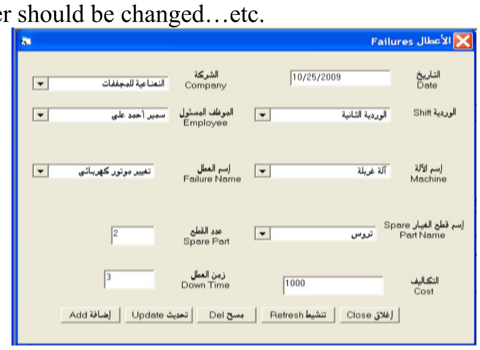

Figure 7 a. Daily report about breakdowns.

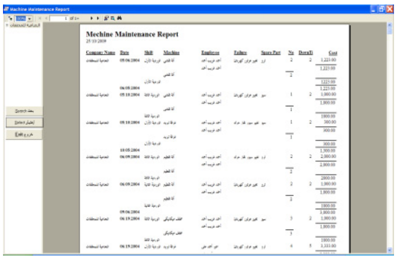

Figure 7b. Final report about breakdowns.

-Raw materials follow up operation selection:

Also, this system could help the manger to follow up raw materials, since entering, by having information about its type, variety, date, source, quantity, prices, even car number and supplier. This could be done by opening the basic data section. The second part (Daily data) will have information about these raw materials in term of entering date and losses. If the user wants to select an operation such as mechanical peeling or manual peeling, he will open the processes form and chooses the process (mechanical peeling) and adding it and exit. Third part will give daily production in details numerically and graphically, where it shows company name, date, raw materials, shift, final product and sub-product categories; and its quantities. So if the manger wants to follow up certain raw materials and its final products, he will click on search button and have a detailed report about it, also he can have the same for workers, machines ….. etc. In the first two parts (Basic and Daily data), user can search, edit, refresh, update, save and close, while the reporting part, user can have only reports and he has only select, search and exit buttons.

- Effect of peeling method on the production, losses and costs:

The system is able to study the effect of peeling method on the production, losses and costs. According the pervious cases, user can obtained final report about the categories of final report as affected by the peeling method. Raw material losses and final cost were also studied. Table (1) shows the effect of peeling method on the production, losses and costs. It could be seen that the onion losses due to manual peeling (20.89%) were almost 2 times of those of the mechanical peeling. The final product after drying (6595 kg) of the mechanical peeling was higher than that of the manual peeling (5862 kg) with an increasing per cent of 11.11%. The cost per one kg final product using mechanical peeling (47 L.E/ton) was lower than that of using manual peeling (52 LE/ton). It could be concluded that the DSS system shows the importance of using the mechanical peeling in increasing the final product and decreasing the production costs, on the other hand, using the mechanical peeling decreases time and microbial loads. Table (1) shows the effect of peeling method on the production, losses and costs.

	Manual Peeling	Mechanical Peeling
Fresh Product, kg	55419	55419
Product after peeling, kg	43839	49323
Losses after peeling, %	20.89	10.99
Final product after drying	5862	6595
Cost, L.E/ton	52	47

IV. CONCLUSIONS

DSS for the technical management of food industries was developed, implemented and validated to an onion dehydration industry. The system called PERCS, production economical and controlling system. System was constructed by building a data base for the industry which includes general data such as company name and activities, daily data, which has all the daily activities such as raw materials status, workers, machines, failures, processing stages, and final production data. Secondly, each data base was built using the "Visual Basic Language" statements. These data base modules were connected to each other using the query fields. All fields were turned into simple windows as user interfaces. This system was finally capable to do the following functions: Raw materials traceability. Following up all the production stages and shifts. Giving a true image about the daily activities regarding production, storage status, raw materials, final product, and exportation. Having information about machine performances and breakdown cases. Following the maintenance and spare parts status. Making decisions through the daily working problems. Discovering the failure causes, results and losses. Having an accurate data about final product and components. Sub-products quality information. Giving the production costs. Exportation and sales status. Easy management and decision making. Opening an understanding window for the future needs by continual reporting and controlling of the system. It could be used for more than one activity or company at the same time. Finally, further studies are recommended in this area to deal with the production problems, recent technologies and take into consideration, more processing operations and product quality.

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