Database Application to Facilitate Equipment Cost in Agricultural Engineering Station

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Abstract

A user-friendly computer program, called "DbMIS", was designed to aid managers in storing, manipulating, retrieving, and reporting all necessary costs of farm equipment in the Agricultural Engineering Stations (AES). The program was mainly based on the relational database model, accomplished via Microsoft Access, in order to replace the core paper-based system employed in recording and keeping tractor-implement data at one of AES in Sharkia governorate as a case study. Furthermore, structured five principal queries to extract specific information from the numerous data stored in the database, eight printable reports to present the queried data, and finally graphical user interfaces to smoothly and effectively connect and control all the preceding objects. After implementing "DbMIS", the proposed system was capable of calculation the repair and maintenance costs, operating hours, executed area, fuel costs, and oil & lubricants costs per a machine in a certain period, as well as allowed to input, update, delete, navigate, and search the reserved records. It can be concluded that decision makers of AES may utilize this demonstrated software to get answers concerning the mechanization costs over any definite period in a sub-second, supporting both decision-making process and research purposes.

Kew Words: *AES, DB, DbMIS, MIS*

Introduction

In Egypt, Agricultural Engineering Stations (AES), approximately 160 stations, have been designed as a public sector to provide various mechanization services such as plowing, laser leveling, planting, and harvesting for farmers and agricultural investors (Economic Affairs Sector, 2013). Unfortunately, farm machines at AES have been in service with an apparent lack of facilitating most management decisions (Soliman, 2007). For example, there is presently no dedicated computerized database (DB) system for the purpose of record-keeping of machines" information even though people now are living in the era of advanced information technology. As a result, all records are kept manually in a paper-based system; this, of course, might affect the decision in question due to the undesirable errors of the paper documentation (Hunt, 2001), as well as (Thakur et al., 2011) point out that a well documentation system in a digital format guarantees timely required data to official authorities for inspection intentions.

Hunt (2001) and Soliman (2007) emphasize that the most essential responsibility of farm machinery mangers is that storing the indispensable information of equipment costs in a secure procedure, and such data achieve their extreme benefit when they are employed in supporting the decision-making process. Certainly, this reflects that how the security and quality of recorded cost data at AES can significantly affect the final decision.

The logical solution for how the organization can deal with the issue of data management is to design and implement digital information systems having the ability to strengthen different area, e.g. research needs or making decisions (Batte, 2005; Alvarez and Nuthall, 2006). For instance, Liu et al. (2013) develop an interactive website to help investigators to overcome the problem of enormous amount of Chinese oil plants data by storing and sharing the data among researchers. By this on-line tool, end-users can browse, retrieve, and update a huge amount of experimental data according to their need.

In general, management information systems (MIS) can be defined as electronic tools to gather, handle, and manage data that may have a potential value in making management decisions (Boehlje and Eidman, 1984; Verstegen and Huirne, 2001). Additionally, Verstegen and Huirne (2001) demonstrate that how the improved management level at sow farmers are positively dependent on MIS value; they indicate that clear relationships are between farm size and MIS value. Correlating this result with what it is going on the ground at AMS, it can be concluded that the sustainability of management at AMS is in doubt due to the missing of real MIS.

There are many publications that have effectively applied MIS in agribusiness with different aims, but the current study presents the most recent literatures. In particular, studies mainly utilize the concept of relational database modelling because this model was used in this investigation. In Brief, the relational database model is initially proposed by Coddin 1970. He mathematically designs a relational structure of data for large shared data banks.

Sallabi et al. (2011) design a poultry production documentation system that basically depends on relational data structure. The implemented system has a capacity to process the activities in the poultry building per day whereby the manager and other stakeholders can easily make the suitable decisions during crises. They also notice that user efficiency has a major role in increasing the success of this documentation system. Another paper by Peets et al. (2012) presents some procedures for managing data in the precision agricultural farm. The notion of relational database as a medium between sensors and user-friendly interfaces is executed to store heterogeneous data for soil and fertilization.

The goal of this study was to develop a computerized program to primarily substitute the paper-based procedures applied for registering and holding farm machinery costs, to assess equipment costs during any period of time, and to support decision-making process at AMS by maximizing the ability to retrieve meaningful timely information effectively. First, all farm machinery cost records were examined. Subsequently, data, required to build relational database tables, were assigned and assembled. Afterward, end-users interfaces were designed and linked to database tables by programming mean to explore and control the reserved records. Then, a set of objective queries and reports was structured and generated as a consequence of operating the developed software within an AMS in East Egypt.

Methodology

1. Data collection

To attain the goal of the present study, AES at Mashtol Elsok in Sharkia governorate was determined to collect the data needed in 2013. The study selected this station because there are no significant differences among all AES in Egypt. It was revealed that all AES have the same administrating, managerial and information systems for managing different fleets of farm machines, and they are centrally administered by a head office in the Ministry of Agriculture. This means that gathering the data needed for constructing the "DbMIS" model can be achieved via exploring and examining any AES in the country.

Then, two facilities were used to assemble the required data: (A) Interviews were made with the manger of AES, heads of departments and technical employees to get a clear image of the general system applied to record and estimate mechanization costs; and (B) Machinery documents and records were utilized to deeply understand the paper-based system used in registering and assessing farm machinery costs.

2. Program design

Before describing the steps, followed to accomplish the aimed application, it is vital to demonstrate what the database application may do at AMS. (Fig 1) gives a summarized and concise image about the potential outcomes of applying the "DbMIS" application. The major three steps, employed for structuring the "DbMIS" program, are as follows:

2.1 Database tables

The database tables of the "DbMIS" program, storing machinery data at AES, were constructed based on the relational database model and by using Microsoft Office© Access 2003. Accordingly, seven relational tables (Table 1) were established in an Access file named "MData.mdb", and this file was linked to "DbMIS" via Microsoft Visual Basic© (VB) programming. Moreover, (Fig 2) depicts how the designed tables are linked. The links between tables allow the database to combine meaningful data from different tables, and also gives the program the capability to enforce referential integrity.

2.2 End-user interfaces and connection

Mainly seven screens/end-user interfaces were designed, by using Microsoft VB programming language version (6.0), as a data entry screen for the seven database tables. Each screen was connected by VB code to only one, two, or three tables in the database file (Fig 3) and had a number of buttons (or objects) to execute a particular function, drop-down lists to store specified data, textboxes which were parallel to most fields in the connected table(s) to read data from the table or write data into the table, and labels to distinguish each textbox or drop-down list on the screen. Furthermore, five screens were structured to manage all generated reports, as well as auto-screens for error and help messages.

The connection between the screens and different database tables was realized via two intermediate components, which were the Data Access Object model (DAO 3.6) and the jet database engine. The Data Access Object model is a computer programming model developed by Microsoft Corporation© to connect a VB application to a database engine, passing information back and forth between the two; it can be applied through the VB code (Microsoft, 2015). The jet database engine is computer software embodied into Microsoft Office Access to connect the VB application to Microsoft Office Access (Microsoft, 2006).

In order to control what gets into the database tables through the data entry screens, the data integrity concept was considered during this step. Briefly, data integrity means that only valid data are stored in the database.

2.3 Queries and reports

Queries were structured to handle and process data stored in various database tables in order to provide certain information. The structured queries were built in VB codes and by using the Structured Query Language© (SQL) version (ANSI-SQL 92). The principal types of queries in "DbMIS" application perform the following calculations between two definite calendar dates: (1) Repair and maintenance (R&M) costs for any machine (EGP[1]/period); (2) The number of operating hours for any machine (h/period); (3) The total executed area for any machine (Fed[2]/period); (4) Fuel costs for self-propelled (SP) equipment (EGP/period); and (5) Oil and lubricants costs for self-propelled equipment (EGP/period).

The issue of how to present the queried information to the end user is addressed by designing reports. Hence, report layouts were structured using Crystal Report© program version (4.6.1.0) and also employed under the environment of VB. There are two major types of reports: (1) reports related to the self-propelled machines; and (2) reports related to attached machines. The first type has five reports: the R&M costs report, operating hours and executed area report, fuel costs report, oil & lubricants report, and collective report. The second type has three reports: the R&M costs report, operating hours and executed area report, and collective report.

3. Testing the model

The designed "DbMIS" model was tested at Mashtol Elsok station in order to prove its capability to get field machinery data and generate different reports. Therefore, the tests considered were composed of: (1) testing the ability of the model to receive, update, delete, navigate, and search data stored in the database; and (2) testing the ability of the model to be queried about certain information and produce the appropriate report. The input data were gathered from machinery records in the investigated station and between 4/5/2008 and 28/3/2009.

4. Model Justifications

Although all functions and outcomes expected from the "DbMIS" model as a database management system could also be attained via only designing an entire Microsoft Office Access application, this study was concerned with linking the structured Access database tables with the VB environment for the justifications outlined below:

Employees at AES require no knowledge concerning the database and how it works in order to interact with the "DbMIS" model. Contrary, in the case of using only a developed Microsoft Access database application, it is supposed that employees should have sufficient knowledge of Microsoft Office Access; With the "DbMIS" model, what the employees will do with data within the database is limited and controlled, but Access applications provide no such limit; and The "DbMIS" model provides more security for data stored in the database tables than the Microsoft Access application.

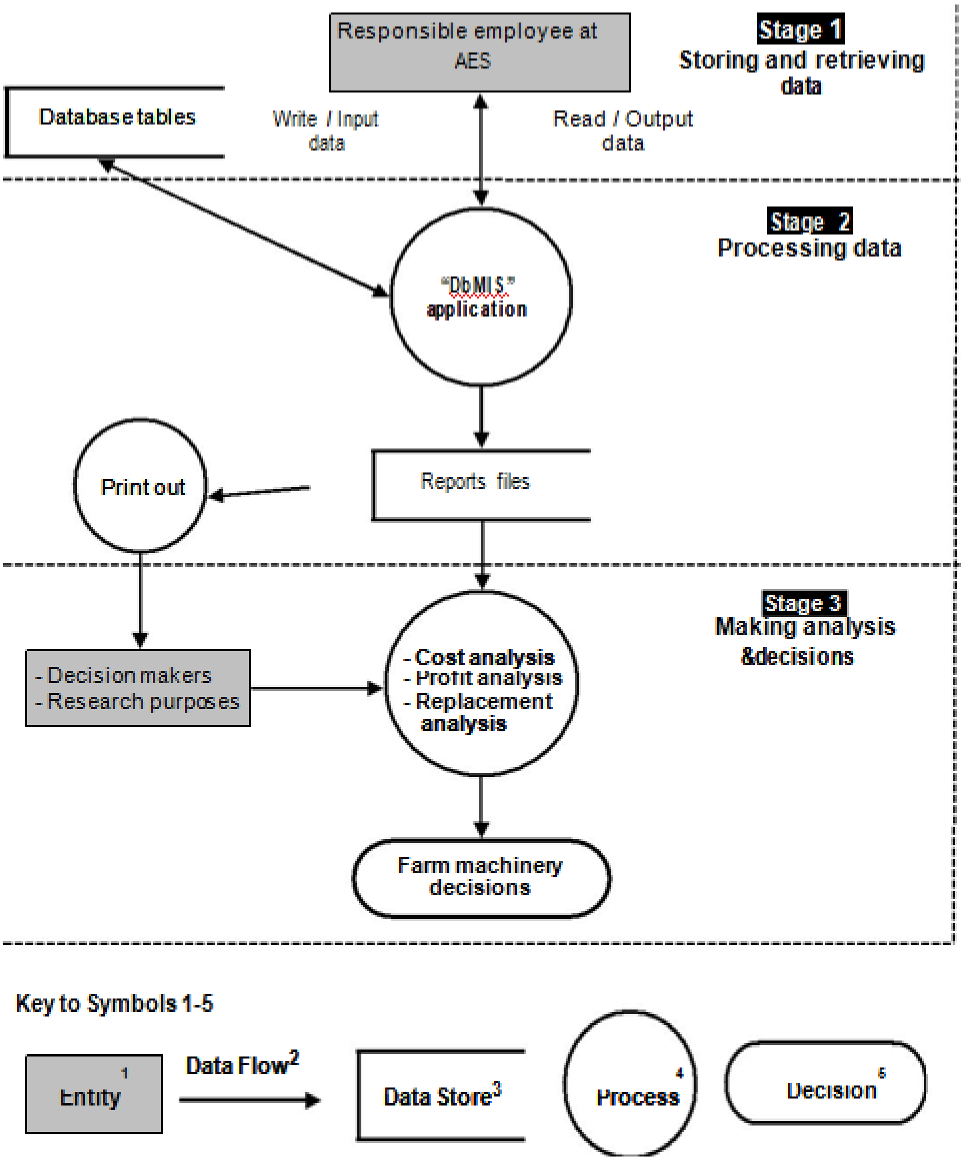
Results

The computer model "DbMIS" is started with displaying its main menu (Fig 4). This menu contains two columns of eight options, and each one shows a data entry screen except the last one on the left. First -time users should start by entering the elementary data pertaining to new farm machines, generally classified for SP machines and attached machines, in order to establish a reference for other DB tables. That is, users should start by selecting screen 1 or screen 2; in the case of choosing any option other than those, the model produces an auto-help message guiding the user as to what he/she should do.

Figs (5 and 6) depict two samples of the data entry screens, screens No. 1 and 5, developed in the program; the others have the same features except for the kind of data fields and the connected DB tables. The end-user can add, update, find, or delete a record in the database, as well as he/she is able to navigate the stored records through the right menu in the similar screens.

In Fig. 6, for example, the field operation was plowing two paths and needed a Kubota tractor with a chisel plow to achieve it. Hence, the initial step applied on this screen was specifying the self-propelled machine, the Kubota tractor, by selecting its code from the drop-down list labeled „SP machine code‟, with the result that the informational data related to it were also automatically displayed on the textboxes at the right side of this drop-down list on the screen. A similar process was also applied for specifying the attached machine, the chisel plow, from the drop-down list labeled „Attached machine code‟ on the screen. Then, the input data of the present screen chiefly consisted of the SP machine code with/without the attached machine code operating order number, agricultural operation type, and total operating hours (h), automatically calculated via subtracting the value of the started hour meter reading from the finished hour meter reading, total executed area (fed), and registered data.

Figs (7 and 8) show the most two main distinguished format of the eight designed reports. The rest of reports format is identical to whether fig 7 or 8. For instance, fig 7 displayed the report for 7 tested machines at the investigated station, and it included the machine code and type, model name and number, mechanical horse power (hp), and total R&M costs (EGP). In constant, fig 8 showed the all chief data for one machine only.



[1]Entity symbol stands for sending or receiving data.
[2]Data Flow symbol stands for the movement of data throughout the system.
[3] Data Store symbol stands for a unit used to store data. It may be a file or database table.
[4]Process symbol stands for transforming data, or performing computations. [5]Decision symbol stands for the end step.

Fig 1:*A Simple Data Flow Diagram For The "Dbmis" Application.*

Table (1): Description of the database tables designed in the program.

Table name	Table functions
"BIDSP"	(1) To store the elementary data for tractors and SP machines. These data include the SP machine code (PK[1]), machine type, model name, model number, motor number, chassis number, local number, mechanical horse power (hp), purchase price (EGP), purchased date, age when purchased, and any other notes related to new equipment; and (2) Used as a reference to "RMDSP", "OMD", "FUD", and "LUD" DB tables.
"BIDA"	(1) To store the basic data for attached machines. These data contain the attached machine code (PK), machine type, model name, model number, purchase price (EGP), purchased date, age when purchased, and any other notes related to new machinery; and (2) Used as a reference to "RMDA", and "OMD" tables in the database.
"RMDSP"	(1) To store the data of R&M costs for any machine previously recorded in the "BIDSP" table. These data mainly compose of SP machine code (FK), spare parts data, miscellaneous materials data, and total costs data, in addition to a sequence auto-number (PK). Spare parts data consist of the spare part number, name and description, and total price (EGP) which was automatically computed through multiplying the quantity of parts by their unit price (EGP/part). Miscellaneous materials data include material type and description, and their total costs (EGP). Finally, total costs data comprise of registered date, any other notes related to this record, and R&M costs (EGP), which are computed automatically through adding the value of maintenance costs, total costs of miscellaneous materials, and total costs of spare parts; and (2) Utilized to estimate the total R&M costs (EGP) of a SP machine during a certain period.
"RMDA"	(1) To store the R&M expenditures for a machine previously recorded in the "BIDA" table. The input data for this database table are identical to those in "RMDSP" table except that the attached machine code is (FK); and (2) Utilized to calculate the total R&M costs (EGP) of an attached machine during any definite period.
"OMD"	(1) To store To store operating orders data for both SP and attached machines. The data are the operating order number (PK), SP machine code (FK), attached machine code (FK), agricultural operation type, and total operating hours (h), automatically calculated via subtracting the value of the started hour meter reading from the finished hour meter reading, total executed area (Fed), registered date, and other notes; and (2) Used as a reference to "FUD" table, and also to estimate the total operating hours (h) and total executed area (Fed) of a machine during any certain period.
"FUD"	(1) To record the SP machine fuel data of an operating order stored in the "OMD" table. The main data compose of operating order number (PK and FK), SP machine code (FK), fuel type, total fuel consumption (Liter) which is automatically calculated by subtracting the quantity of fuel in the tank after operating from the total quantity of fuel resulting from adding the quantity of fuel in the tank before operating to the quantity of fuel purchased during the field operation, total fuel costs (EGP) which is also automatically computed via multiplying the total fuel consumption by its unit price, other notes, and finally the registered date that is identical to the date in the "OMD" table. (2) Used to estimate the total fuel costs (EGP) of a self-propelled machine during a limited period.

[1]For example, the relationship between "BIDSP" and "RMDSP" tables is one-to-many relationship, respectively. This means that each self-propelled machine in the "BIDSP" table, parent table, can have more than one record in the "RMDSP" table, child table. That is, one machine in the parent table can have much different expenditures data throughout its life in the child table. Thus, the machine code field, primary key (PK), in the "BIDSP" table is used to link between the two tables via putting this field, here called foreign key (FK), in the child table.

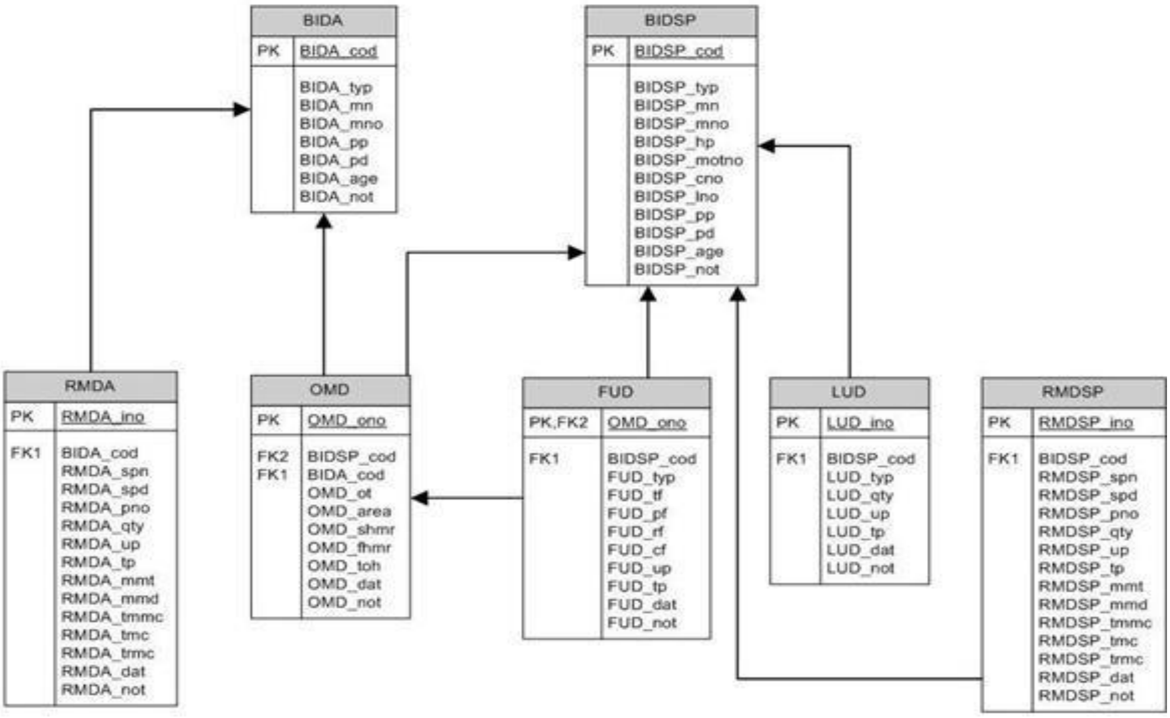
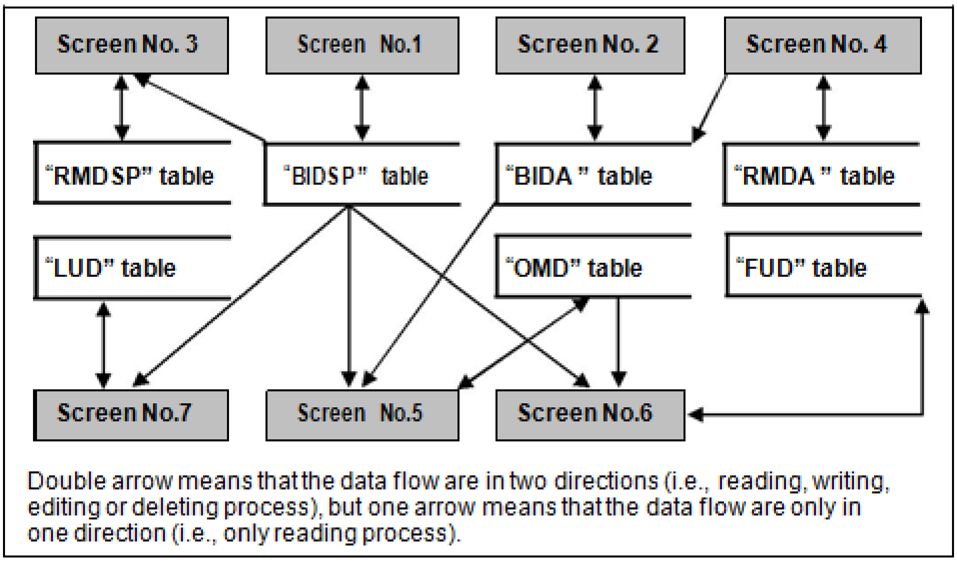


Fig 2: A physical layout for the relationship among DB tables.



Double arrow means that the data flow are in two directions (i.e., reading, writing, editing or deleting process), but one arrow means that the data flow are only in one direction (i.e., only reading process).

Fig 3: *An illustration diagram for the connection between DB table and data entry screens.*

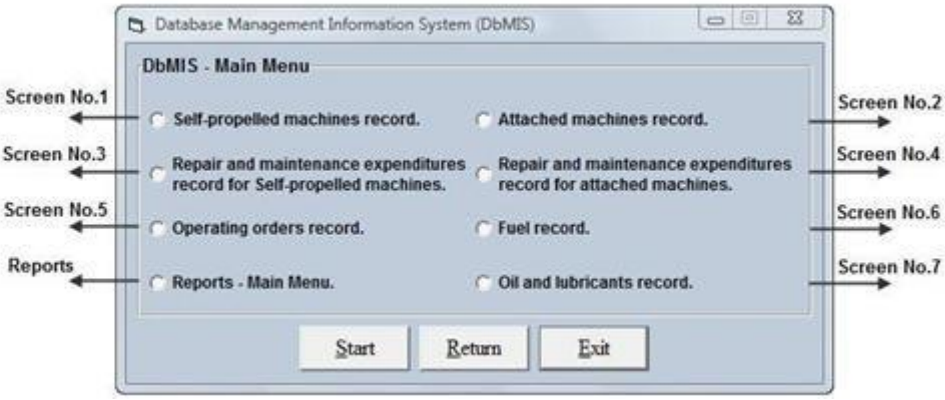


Fig 4: *The main menu of "DbMIS" program.*

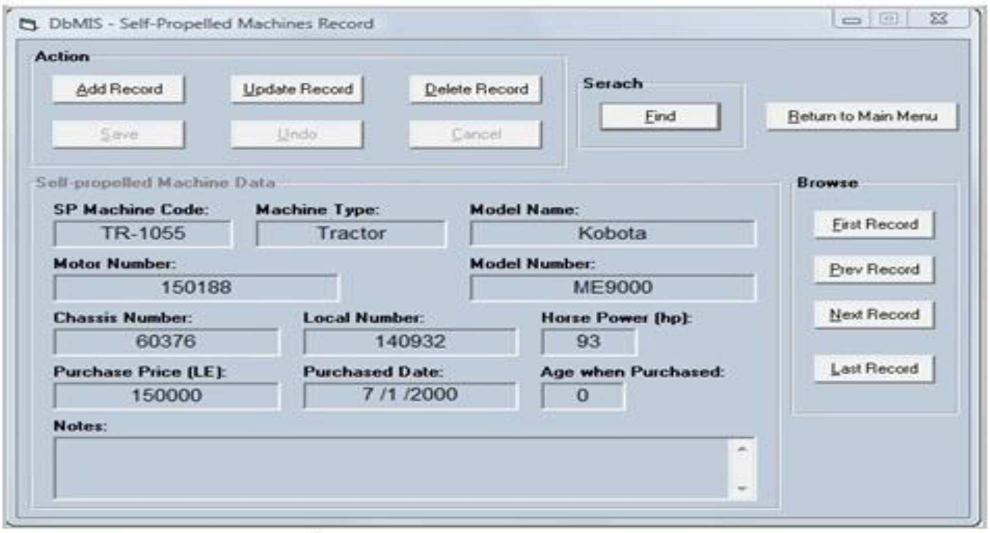


Fig 5: *An example of the 1st data entry screen.*

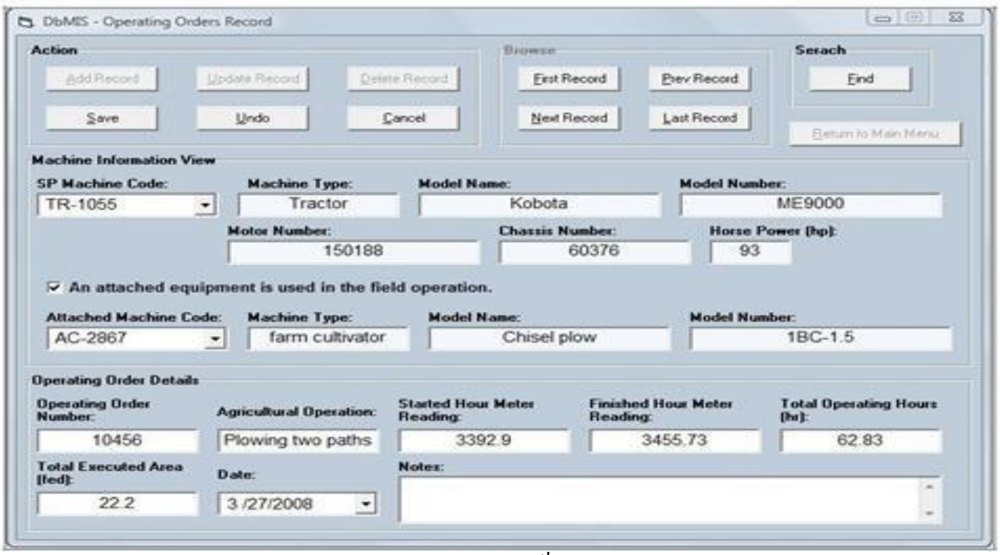
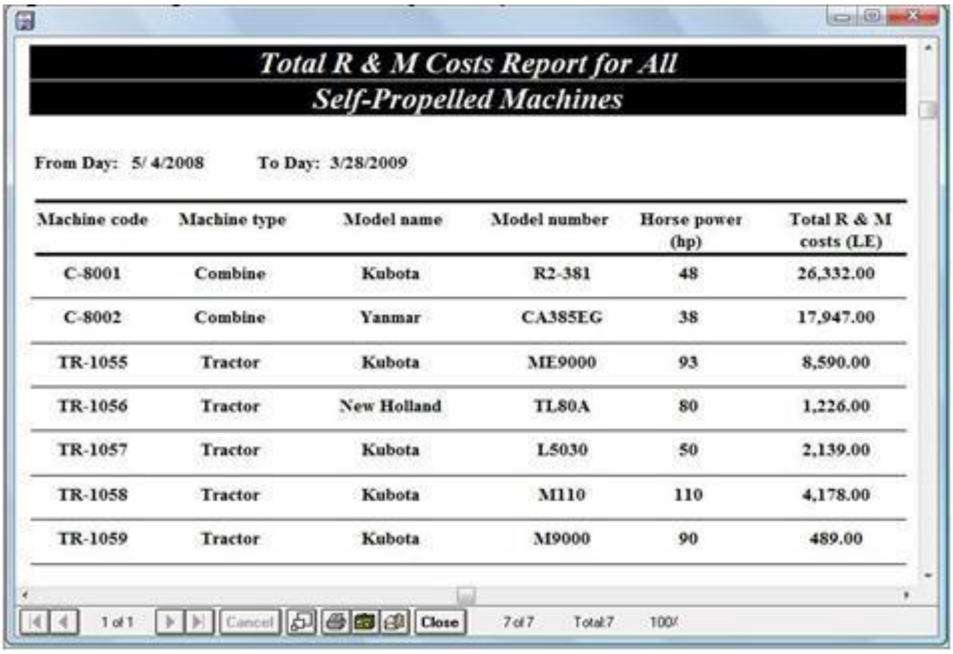


Fig 6: *An example of the 5th data entry screen.*

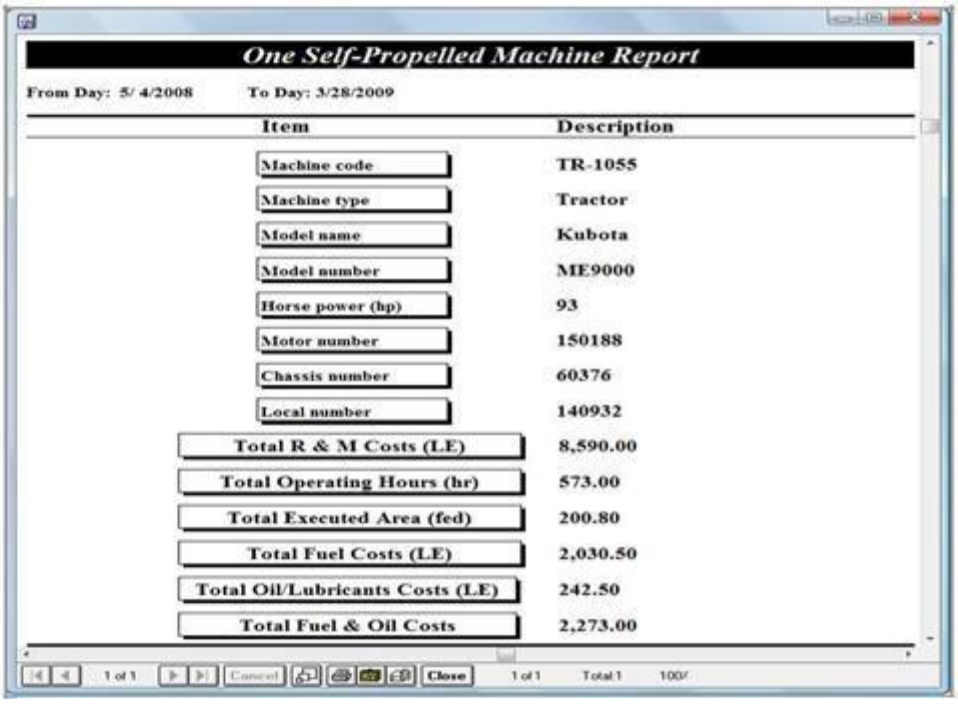


Total R & M Costs Report for All
Self-Propelled Machines

From Day: 5/ 4/2008 To Day: 3/28/2009

Machine code	Machine type	Model name	Model number	Horse power (hp)	Total R & M costs (LE)
C-8001	Combine	Kubota	R2-381	48	26,332.00
C-8002	Combine	Yanmar	CA385EG	38	17,947.00
TR-1055	Tractor	Kubota	ME9000	93	8,590.00
TR-1056	Tractor	New Holland	TL80A	80	1,226.00
TR-1057	Tractor	Kubota	L5030	50	2,139.00
TR-1058	Tractor	Kubota	M110	110	4,178.00
TR-1059	Tractor	Kubota	M9000	90	489.00

Fig 7: *An example of the total R&M costs report for all SP machines*



One Self-Propelled Machine Report

From Day: 5/ 4/2008 To Day: 3/28/2009

Item	Description
Machine code	TR-1055
Machine type	Tractor
Model name	Kubota
Model number	ME9000
Horse power (hp)	93
Motor number	150188
Chassis number	60376
Local number	140932
Total R & M Costs (LE)	8,590.00
Total Operating Hours (hr)	573.00
Total Executed Area (fed)	200.80
Total Fuel Costs (LE)	2,030.50
Total Oil/Lubricants Costs (LE)	242.50
Total Fuel & Oil Costs	2,273.00

Fig 8: An example of collective report for a SP machine report.

Conclusions

The study was done with the aim of providing a database application, "DbMIS", for the AES in Egypt. The major weakness of the existing paper-based system at AES is inefficiency in the retrieval and analysis of data. Furthermore, the main advantage of using a computer-based system rather than a paper-based system is in the capacity for retrieving information effectively. Via the presented one, the user at AES can input, update, delete, navigate, and search all machine data in the database and then query and ask the computer a question. The chances of getting an answer back are at sub-second speed. On the other hand, in the old paper-based system, the task might take several minutes, several hours, or perhaps even several days. More specifically, the central objective in the design of this

database model for the AES was not only the unification of information processing into one coherent system, but also supplying replacement decisions.
Several conclusions can be drawn from the investigated farm machines and from designing and implementing the whole “DbMIS” model, as follows:

1. The “DbMIS” model might be applicable for all AMS in Egypt because all stations have the same information system, which is currently a paper-based system, for managing and controlling various fleets of farm machinery.
2. The “DbMIS” model provides timely and up-to-date information concerning repair and maintenance costs, total operating hours, executed area, fuel costs, and oil and lubricants costs over any certain period. Certainly, this will identify the remunerative aspects of farm machines.
3. The proposed model could aid many researchers and technicians who work in the field of farm machinery management, for example, in the prediction of farm machinery costs such as fuel costs, and repair and maintenance costs.
4. When the database model was implemented at AMS, labor requirements might be decreased significantly because the new application, in particular, will enable the farm manager to minimize book-keeping practices.
5. In order to install this new system, low capital cost should be assigned involving only purchase of the microcomputer, including the operating system and printer. Accordingly, the system could be operational for approximately 5,000 EGP per computer.

References

[1]. Alvarez, J. and Nuthall, P. (2006): Adoption of computer based information systems the case of dairy farmers in Canterbury, NZ, and Florida, Uruguay. Computer and Electronics in Agriculture, 50: 48 - 60.

[2]. Batte, M.T. (2005): Changing computer use in agriculture: evidence from Ohio. Computer and Electronics in Agriculture, 47: 1 -13.

[3]. Boehlje, M.D. and Eidman V.R. (1984): Farm management. John Wiley & Sons, New York.

[4]. Codd, E.F. (1970): A relational model of data for large shared data banks. Communications of the Association of Computing Machinery, 13 (6): 377 – 387.

[5]. Economic Affairs Sector (2013): Statistics of Farm Machinery in Egypt. (in Arabic), Ministry of Agriculture & Land Reclamation Press.

[6]. Hunt, D. (2001): Farm power and machinery management. 10th edition, Iowa State University Press, Ames, Iowa. Liu, Q., Jiang, L, Han, J., Liu, Q., Yin, X. and Li, P. (2013): Chinese Oil Plants Information System (COPIS): An on-line information store, query and management system for three Chinese industrial oil plants. Computer and Electronics in Agriculture, 90: 86 – 92.

[7]. MacKenzie, J. (1996): Regional Australia and the Information Superhighway: rural and regional online services pilot (project). In: Proc. OUTLOOK96 Conference, Canberra, ACT, January. Microsoft, (2006): Jet database engine. (accessed February, 2015).

[8]. Microsoft, (2015): Microsoft data access objects (DAO) 3.6 object library. (accessed February, 2015).

[9]. Peets, S., Mouazen. A. M., Blackburn, K., Kuang, B. andWiebensohn, J. (2012): Methods and procedures for automatic collection and management of data acquired from on-the-go sensors with application to on-the-go soil sensors. Computer and Electronics in Agriculture, 81: 104 – 112.

[10]. Sallabi, F., Fadelb M., Hussein, A., Jaffar, A. and El Khatib, H. (2011): Design and implementation of an electronic mobile poultry production documentation system. Computer and Electronics in Agriculture, 76: 28 – 37.

[11]. Soliman, I. (2007): Agricultural mechanization systems management. 1st edition, Dar ElfikrElarabi Press, Egypt. Thakur, M., Martens, B.J. and Hurburgh, C.R. (2011): Data modeling to facilitate internal traceability at a grainelevator. Computer and Electronics in Agriculture, 75: 327–336.

[12]. Verstegen, J.A.A.M., and Huirne, R.B. M. (2001): The impact of farm management on value of management information systems. Computer and Electronics in Agriculture, 30: 51 - 69.