Effective and Secure DSS for E-Government

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Abstract—Effective Decision Support Systems (DSS) have become very essential for electronic-government (e-government). This is because DSS will make government decision-makers access useful information and support decision making to solve its semi-structured and/or unstructured problems. This paper presents a proposed DSS framework in an integrated e-government platform. The integrated e-government platform called Service Oriented E-government (SOE) that will use Service Oriented Architecture (SOA) methodology in order to integrate e-services and orchestrate between them. SOE will contain three layers. They are access layer, e-government layer and e-business layer. The e-business layer composes from application and data layers and business intelligence (BI). It also can include the proposed DSS framework. The proposed DSS framework contains four components: (data component subsystem, model component subsystem, knowledge component subsystem, and model management module [3, 4]. The security of the whole system is considered by using biometrics and fast intrusion detection techniques. The proposed DSS framework applied to Egyptian e-health waste fund reduction decision service.

Keywords- DSS, E-government platform, SOE, SOA, DSS Framework, BI, e-services

I. INTRODUCTION

Decision Support Systems (DSS) are computer-mediated tools that assist managerial decision making by presenting information and interpretations for various alternatives [1,2]. Such systems can help the decision makers to make more effective and efficient decisions. Nowadays, the major components of DSS framework are: user interface module; knowledge management module; data management module and model management module [3, 4].

E-government [5] is expected to improve governmental services and increases public participation in government. Moreover, E-government allows the public access to government information and services 24 hours a day, 7 days a week, and provides the potential for government to fundamentally restructure its operations [6]. There are enormous e-government platforms [7] for different countries. Every country was constructed its e-government platform according to its technology and its information and communication technologies (ICT) capabilities.

Most E-government platforms are moved towards applying Service Oriented Architecture (SOA) methodology in order to integrate between different services and other client applications. The main advantages of SOA are business centric, high-degree distributed, loose coupling of service, service reusability, and rapid flexibility. SOA (Service Oriented Architecture) is a new method of degree distributed computing environment. SOA integrates heterogeneous systems by the means of services that represents different system functionality, independent from underlying platforms or programming languages and interact via message exchange. As it is shown in fig. 1 There is SOA service model based on three roles. The first role is Service Provider that is used to publish its services and response to the application of using the service. The second is Service Registry that is used in registering the services published by the service provider, having catalogue and providing search functions. The third is Service Requester that is used to search required services with service registry, bind service provider and run the services. Three respectively operations between the three roles above are i) Publish ii) Find iii) Bind [8].

Questions have been raised about the way that government managers will take their decisions into updatable electronic society. These rapid changes are having a serious effect on taking decision. There is no clear and explicit DSS Framework inside e-government except our paper [9,21]. We are the first researchers that handle this problem. It is necessary to include DSS inside e-government framework as an essential part which is the aim of this paper.

Academic researchers from many disciplines have been studying computerized DSS for approximately 50 years. DSS frameworks [3, 4, 7, 9, and 10] can be divided into five categories including:

1. Model-driven DSS,
2. Data-driven DSS,
3. Communications-driven DSS,
4. Document-driven DSS and
5. Knowledge-driven DSS

Model-driven DSS emphasize access to and manipulation of financial, optimization, and/or simulation models. Model-
driven DSS use limited data and parameters provided by decision makers to aid decision makers in analyzing a situation. Early versions of model-driven DSS were called model-oriented DSS. Researchers focused on model management and on enhancing more diverse types of models for use in DSS such as multi-criteria, optimization, and simulation models [12, 13].

In general, data-driven DSS emphasize access to and manipulation of a time series of internal company data and sometimes external and real-time data. Simple file systems accessed by query and retrieval tools provide the most elementary level of functionality. Data warehouse systems that allow the manipulation of data by computerized tools tailored to a specific task and setting or by more general tools and operators provide additional functionality [3, 14].

Communications-driven DSS use network and communications technologies to facilitate decision-relevant collaboration and communication. In these systems, communication technologies are the dominant architectural component. Tools used include groupware, video conferencing and computer-based bulletin boards. In general, groupware, bulletin boards, audio and videoconferencing are the primary technologies for communications-driven decision support [3].

A document-driven DSS uses computer storage and processing technologies to provide document retrieval and analysis. Large document databases may include scanned documents, hypertext documents, images, sounds, and video. Examples of documents that might be accessed by a document-driven DSS are policies and procedures, product specifications, catalogs, and corporate historical documents, including minutes of meetings and correspondence. A search engine is a primary decision-aiding tool associated with a document-driven DSS [4].

Knowledge-driven DSS can suggest or recommend actions to managers. These DSS are person-computer systems with specialized problem-solving expertise. The expertise consists of knowledge about a particular domain, understanding of problems within that domain. These systems have been called suggestion DSS and knowledge-based DSS [11, 12].

The integrated platform (SOA) with DSS will satisfy the managers’ requirements to support their decisions. E-government will be able to orchestrate their systems levels in order to increase the flexibility, reliability and availability of e-government decision making.

The rest of paper is organized as follows: The major components of the proposed framework including SOA are presented in section II. A road map for supporting Egyptian e-service (e-health waste fund reduction) is presents in Section III. Finally, section IV contains conclusion.

II. E-GOVERNMENT FRAMEWORK

Any E-government framework contains three layers; access layer, e-government layer and e-business layer as it is shown in Fig. 2. Access layer contains data and communication devices but e-government layer composites different web sites and integrated into single sign-on Portal. All networked-enabled data processing applications and government data sources across agencies are the contents of e-business layer. E-business layer contains all e-government applications. The e-business layer composes from application and data layers and business intelligence (BI) tools such as reporting, mining and analyzing techniques. E-business layer can accept DSS and its subcomponents. The pervious layers are integrated to build SOA for e-government platform (SOE) with DSS.

The proposed DSS framework is composed from four major components as it is shown in fig.3. The first component is data component subsystem which establishes a uniform method and mechanism to collect the problem data moreover integrate them in data integration format. Global Data warehouse [15] is extracted from operational databases for specific domain, in a public and integrated data such as extensible markup language (XML) or resource description format (RDF). Global data warehouse are not only the accumulation of the data resources, but also the recombination, composition of data from other local stand alone data warehouses.

Therefore, summarizations of the important data management subsystem functions are [4] as the following:

- Collecting different governmental data
- Processing different governmental Data (storing/ analyzing/querying)
- Integrating different governmental data
- Establishing standard information sharing platform
- Managing metadata about different governmental databases

Metadata is data about other data or objects, used to describe digitized and non-digitized resources in e-government applications. It may be used, amongst other for the discovery and retrieval of government information, by identifying resources, bringing similar resources together, distinguishing similar resources, and giving specific information which enable users to search and locate electronic and non-electronic government information without needing details of government structure [8, 9].

The second component is model component subsystem which gives decision makers access to a variety of models so that they can explore different scenarios and see their effects in order to assist them in decision making. Model management software is often used to coordinate the use of models in a DSS, including financial, statistical analysis, and graphical models. DSS software typically contains built in analytical
modeling routines and also enables you to build your own models [13, 14].

The model base component may need decision models that relate to operational, tactical and strategic decisions. Each model can be supplied also with the files (in the same format as input ones) containing default, minimum and maximum values for its input parameters. These files compose the contents of the Reference Data Base (RefDB) used to validate user’s input and to help inexperienced users with the default values for the unknown parameters. Discussion of its important subcomponents [14, 16-20] as it follows:

- **Model base** is a set of computer decision models. Its functions are similar to those of database; the only difference is that its stored objects are models. The models in the model base can be divided, in accordance with their type, into several categories such as: strategic, tactical, operational and analytical.

- **Model base management system** (MBMS) is a software package providing an access to a model base and its connections with other components. It often includes model development environment (MDE) and also model runtimes (MR) for model processing in a model base.

- The function of the model directory (MD) equals to that of a data base directory. It is a catalogue of all models and other software in the model base. It has definitions of the models and their main functions to answer the questions of availability and compatibility of the models.

- **Model development environment** (MDE) supports the process of building a model in order to achieve the highest level of usability. It should contain the model definition language (MDL), so that the models have been properly represented and stored in the model base for execution. It also provides the platform where models can be created, stored, integrated, selected and maintained when necessary.

- **Model runtime** (MR) includes the model manipulation language (MML), which starts the execution of the existing models to get the best possible solution. It also contains the user’s interface for managing the models that have been selected, and the links to solvers and data management modules [16, 17].

- **Solvers or solver-systems** are program tools that help users manage the models and find the solution (including the optimal one) for the problem [17].

- **Model Agents and Solver Agents** are used as a proposed approach for model management by using web services for model-to-server integration. Model agent and solver agent work closely together to provide necessary support [18].

Capabilities of the model component subsystem [4, 13] are summarized as the following:

1) Creates models easily and quickly, either from scratch or from existing models or from the building blocks.
2) Allows users to manipulate the models so they can conduct experiments and sensitivity analyses ranging from “what-if” to goal seeking.
3) Stores, retrieves, and manages a wide variety of different types of models in a logical and integrated manner.
4) Accesses and integrates the model building blocks.
5) Catalogs and displays the directory of models for use by several individuals in the organization.
6) Tracks models data and application use.
7) Interrelates models with appropriate linkages with the database and integrates them within the DSS.
8) Manages and maintains the model base with management functions analogous to database management: store, access, run, update, link, catalog, and query.

DSS framework for e-government should include Knowledge component subsystem. It is the third component of the proposed framework. It contains knowledge library and its management system that are systematically organize, manage, store, insert or delete and query knowledge as well as check the consistency and integrity of knowledge by using knowledge representation and reasoning subcomponent. They are used to represent knowledge such as production rules, semantic networks and logic statements with traces of responsibilities for conclusions [12].

The discussion of each subcomponent [4, 11, and 12] for knowledge component is described as follow:

**A. Knowledge development runtime**

It includes inference engine for creating and maintaining the government's Knowledge base.

**B. Collaboration facility/ acquisition**

It is the extraction and formulation of knowledge derived from various sources or from experts. Moreover is used to collect the desired government data or model(s) from their repositories or from government knowledge base itself.

**C. Government Knowledge Base**

It is a collection of organized facts, rules and procedures for all government's departments. This knowledge base has a
description of the elements in the process along with their characteristics, functions, relationships. It also combines rules about the action to implement as a result of certain events. It can also obtain its information from external program/databases.

D. Inference Engine

It is the software that actually performs the reasoning function that uses the knowledge represented in the knowledge base to draw its conclusion. It reasons with a set of rules created by knowledge engineer/miner. Knowledge base plus inference engine construct knowledge DSS.

E. Agent Knowledge

It extracts knowledge from different sources by using a data mining and knowledge discovery tools. The knowledge agent is a self-contained program that runs in the e-government background either on a client or server and performs useful functions such as (decision history, domain knowledge, strategic knowledge, and most common vocabulary) for a specific owner.

F. Knowledge Query Processing Facilities

It is a software module that allows the e-government stockholders or decision makers making a query on the accumulative (feedback learned) e-government knowledge base furthermore storing and retrieving the new or old knowledge.

E. Knowledge directory log Management

It likes database log file. It is a catalogue of all e-government knowledge. It has definitions of the knowledge and their main representation and its extraction that related government events or situation. It answers the questions of availability of certain or desired knowledge.

The dialogue subsystem is the fourth important component which aims to develop screen layout and interfaces that are easy to use and that are visually attractive. A user interface is what managers see and use when they interact with a DSS. A dialogue subsystem is a set of menus, icons, commands, graphically display formats and/or other representations by any software program. The Dialogue subsystem of DSS inside E-government should contains operation aids part, Control aids part to place users in control, and memory aids parts to reduce the user's memory loads.

There are important issues related to the building a User DSS interface [4, 9]:

1) User interface style (style or combination of styles)
2) Screen design and layout (easy to understand, attractive, symmetric)

3) The human-software interaction sequence that makes people responding predictably to the sequence of interaction.
4) Uses of colors, lines and graphics.
5) Uses of icons and symbols.
6) Choice of input and output devices.

In order to construct the desired framework you will need four specialist managers plus a general DSS framework manager. Table (1) introduces a summary of all framework users that we need them to build DSS framework in e-government successfully. Each one of them has assign tasks and his responsibilities.

Table 1: Framework Users and its responsibilities

<table>
<thead>
<tr>
<th>No.</th>
<th>Framework Components</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data subsystem</td>
<td>Data manager</td>
</tr>
<tr>
<td>2</td>
<td>Model Subsystem</td>
<td>Model developer</td>
</tr>
<tr>
<td>3</td>
<td>Knowledge subsystem</td>
<td>Knowledge Miner/Engineer</td>
</tr>
<tr>
<td>4</td>
<td>Interface subsystem</td>
<td>Interface Designer</td>
</tr>
<tr>
<td>5</td>
<td>Framework itself</td>
<td>Framework manager</td>
</tr>
</tbody>
</table>

Fig. 3 presents a proposed framework of DSS in E-government as a result of integration of DSS Components in e-government those are discussed previously. The security of the whole system has been achieved by using biometrics and fast intrusion detection techniques [21-128].

III. DECISION SUPPORT FOR E-HEALTH WASTE FUND REDUCTION

Table Type Styles Managers in the Egyptian Ministry of Health and Population [19] need to reduce the waste money of Governmental Treatment Fund (GTF) institute. They need to achieve a true redistribution of governmental fund for poor patients. Every month, Egypt lost millions of pound to treatment persons who are rich or have personal health care assurance. So, after making preliminary analysis for this problem we found that we need different data sources such as patient data, his hospital database, his surgery data, and must integrate them into single source. Data warehouse is used here to solve this problem. Fig.4 shows the data warehouse architecture for e-health fund reduction service with different sources.

Decision makers in the Ministry of health [19] assign tasks to solve this problem. Fig.4 shows the detailed use case for decision maker/s and the cooperation between proposed framework users to implement e-health fund reduction service. This figure illustrates the scenario of DSS e-service working and the duties of its users as a translation of the framework that is shown in fig.3.

The implementation steps for e-health waste fund reduction decision are summarized as follow:
• Load different Database tables about all patients, their hospital, cost of their medicine and their surgical operation for each case.
• Integrate them into standard format such as (XML, RDF, XLSheet)
• Create a Data Warehouse (DW) using Extract, Transform and Loading (ETL) processes.
• Minimize DW into specific health data mart which contains a subset of the data warehouse that contains most of the information used routinely for business intelligence.
• Apply different suitable mathematical models such as (summation of cost, maximum cost, total of high urgent cases, etc) in order to support ad-hoc queries, reporting, analysis and mining capabilities.

The most common data warehouse dimensional data model is star schema because it is more flexible, efficiently and high usability than snowflake. Star schema can be used to speed up query performance by denormalize reference information into a single dimension table. There are advantages from using star schema; it reduces the number of tables in the database, number of relationships between them and also number of joins that is required in user queries.

Snowflake schema is a variant of star schema with all hierarchies explicitly shown and dimension tables don’t contain denormalized data [16]. Table (2) summarizes the data mart design phases those required for construct the fact table for e-health waste fund reduction [20].

Fig.6 presents the fact table for e-health fund reduction decision using star schema while Fig.7, presents the BI visualization to support Ministry’s manager to make a decision about health fund reduction. It composes from four parts. Part (a) of fig.7 presents ad-hoc query for any patient case. But part (b) contains the selected case with its associated cost and its type of surgical item. Part (c) shows the Total numbers of similarity cases with their hospital. Part (d) shows the empowerment of information of the selected case with the deadline time for his surgical operation.

BI becomes an integration technique for decision making environment. Finally, decision makers in the ministry will be able to decide who may take the fund effectively without any waste money.

IV. Conclusion

Establishing an effective DSS for e-government is a key to a government’s success in decision making procedures/ processes and managing government resources many e-governments will complete its leadership with offering DSS framework. In this paper; a proposed DSS framework with its components in details are described to support decisions in e-government. The considered DSS is an important component inside any e-government platform and plays a key role in supporting decision making. DSS Framework is an essential part of e-government platform. It bases of major four subcomponents (Data, Model, Knowledge, and interface) components. Furthermore, A road map for proposed DSS framework is presented with its user responsibilities. SOE platform have a great advantages for integration and interoperability between different e-services. Moreover, the security of the whole system has been achieved by using biometrics and fast intrusion detection techniques.

Table 2: Data Mart Design Phases for construct Fact Table for E-health waste fund reduction [20]

<table>
<thead>
<tr>
<th>NO.</th>
<th>Data Mart Phases</th>
<th>In details Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design the schema</td>
<td>1. Gathering the business and technical requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Identifying data sources</td>
</tr>
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<td></td>
<td></td>
<td>3. Selecting the appropriate subset of data</td>
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<tr>
<td></td>
<td></td>
<td>4. Designing the logical and physical structure of the data mart</td>
</tr>
<tr>
<td>2</td>
<td>Construct the physical storage</td>
<td>1. Creating the physical database and storage structures associated with the data mart</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Creating the schema objects, such as tables and indexes defined in the design step</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Determining how best to set up the tables and the access structures</td>
</tr>
<tr>
<td>3</td>
<td>Populate the data mart with data from source systems</td>
<td>1. Mapping data sources to target data structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Extracting data</td>
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<td></td>
<td></td>
<td>3. Cleansing and transforming the data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Loading data into the data mart</td>
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<tr>
<td></td>
<td></td>
<td>5. Creating and storing metadata</td>
</tr>
<tr>
<td>4</td>
<td>Access it to make informed decisions</td>
<td>1. Set up an intermediate layer for the front-end tool to use. This layer, the meta-layer, translates database structures and object names into business terms, so that the end user can interact with the data mart using terms that relate to the business function.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Maintain and manage these business interfaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Set up and manage database structures, like summarized tables that help queries submitted through the front-end tool execute quickly and efficiently.</td>
</tr>
<tr>
<td>5</td>
<td>Manage it over time</td>
<td>1. Providing secure access to the data</td>
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<tr>
<td></td>
<td></td>
<td>2. Managing the growth of the data</td>
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<tr>
<td></td>
<td></td>
<td>3. Optimizing the system for better performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Ensuring the availability of data even with system failures</td>
</tr>
</tbody>
</table>

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Figure 1. The SOA service Model based on three roles.
Figure 2. SOA for E-government (SOE)
Figure 3. The Proposed DSS Framework in E-government
Figure 4. The Detailed Use Case for DSS e-service’s Users

Figure 5. Data Warehouse Architecture for E-Health Waste Fund Reduction
Figure 6. Dimensional Fact Table for E-health Fund Reduction Service.

Figure 7. BI Visualization to support leadership's in decision making.

- **Fig. 7.a**
  - Total numbers of similarity cases with their hospital

- **Fig. 7.b**
  - Selected cases with its associated cost and its type of surgical item

- **Fig. 7.c**
  - Total numbers of similarity cases with their hospital

- **Fig. 7.d**
  - The empowerment information of the selected patients with its deadline time