OpenMRS FRAMEWORK : HEALTH INFORMATION SYSTEM SOLUTION TO DEVELOP IN SABHA, LIBYA

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Abstract

The health care system in Libya in recent years does not change significantly, less developed and modernized. This problem is further exacerbated by the revolution that occurred in Libya. The revolution that occurred in 2011 has caused the health care system into collapse. In this study conducted a review for the development of health information systems in Libya by using OpenMRS Framework.

At the stage of gathering information using questionnaires concluded that the majority of respondents (about 95.35%) wanted the development of a new system that can resolve the main problems that occurred in Libya, the health information system ineffective and inefficient in which this system has led to wastage of time and increased operating costs. Based on analysis of system vulnerabilities using PIECES method could also be concluded that the current system is not used effectively and efficiently. In this study is also presented on how to implement OpenMRS.

Based on the results of the discussion it can be concluded that OpenMRS is a solution that can be taken for the development of a health information system that is fast, low cost, and is an open source application that only requires a little setting in the system of patient management and care. OpenMRS can be implemented to support the health services of a small clinic to the health services with enterprise scale. Therefore, OpenMRS could be the answer to the development of health information systems in various countries around the world, including Libya.

Introduction

The health care system in Libya in recent years does not change significantly, less developed and modernized. This problem is further exacerbated by the revolution that occurred in Libya. The revolution that occurred in 2011 has caused the health care system into collapse.

The Ministry of Health (MoH), in an attempt to establish a modern health care system in Libya, sponsored the National Health Systems Conference (NHSC) that was held in Tripoli, Libya, in August 2012. The NHSC aimed at reviewing the current health systems status, assimilating its problems, and, where there is a consensus, producing recommendation(s) for health system strengthening [1].

The scientific program of the NHSC adopted the World Health Organization (WHO) health care systems framework and used its six building blocks (Health Governance, Health Care Finance, Health Service Delivery, Human Resources for Health, Pharmaceuticals and Health Technology (PHT), and Health Information Service) to structure the debate (Figure 1).

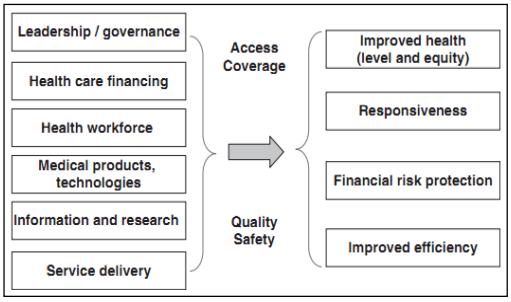

Figure 1. World Health Organisation health system framework [7]

The 500 Libyan health experts believe that despite the time constraints, the most urgent and essential difficulties facing the Libyan health systems have been identified. Potential solutions and direct recommendations have also been suggested, with alternative options on occasion. These experts recommend the establishment of a National Health System Task Force to carry forward these recommendations.

It is essential that the General National Congress and the future Libyan parliament as well as current and future governments grant the necessary legislative powers to the National Health System Task Force and the MoH to introduce the necessary administrative changes and help implement the recommendations on a short, medium and long-term basis.

Related to the health care system in hospitals that utilize computer-based information systems, today most hospitals in Libya still manually run a paper-based business. Every time a patient comes to a hospital, the main problem faced is how to find the patient's medical record. With the manual system is still paper-based, patient when treated at another hospital must still register. This is certainly very waste of time, effort and cost. That is why the development of computer-based information systems that can integrate the data can be accessed and shared by the hospitals became an urgent need.

In terms of the development of health care information systems in a hospital or Hospital Information System (HIS), at present there are several frameworks that can be implemented. One such framework is OpenMRS Framework. OpenMRS is a Java-based, web-based electronic medical record. OpenMRS started from a simple (at least it used to be simple) data model, wrapped that into an API, and then built a web-based application that uses the API [2]. The OpenMRS API works like a "black box," hiding the complexities of the data model beneath it and ensuring that applications and modules using the API work with a similar set of business rules for managing the electronic medical record system data.

OpenMRS was designed to be a generic medical record system that can support the care of patients, gathering observations, encounters, notes, and other data from the healthcare system and rendering those in summaries, reports, and data views that would improve the effectiveness of the people using the system [2].

At the heart of OpenMRS is a concept dictionary. This dictionary, much like a typical dictionary, defines all of the unique concepts (both questions and answers) used throughout the system. Using combinations of questions and answers, it can define observations (observable data) as well as forms that gather multiple observations within a single encounter. The first systems were built by taking very carefully considered paper forms and turning them into electronic forms by cataloging all of the concepts on the forms (questions and answers) and then organizing these into an electronic schema (hierarchy) that represented all the data on the paper forms. By doing this, it could easily capture all of the data from the paper forms into the computer system as discrete, coded data that the computer could understand and then begin using those data to improve patient care [2].

Based on the facts described above, this study will be a review of the development of the hospital information system using the OpenMRS Framework to be implemented in Libya.

Literature Review

Hospital Information System is a subsystem of the hospital that processes and stores information [3]. Much of the information stored and processed is an element of medical documentation that becomes, in turn, an integrated component of the hospital information system. Even if computer systems and networks (the hardware) and the application systems installed on them (the software) are of particular importance, there is more at stake than that: the processing of data, information, and medical knowledge in the hospital as a whole.

The information system of a hospital is a quality factor. Virtually all groups of people working in a hospital need enormous amounts of information for their activities. The better these needs can be met, the higher the quality of care as well as of the hospital's management. For example, for a newly admitted patient, the first thing a physician needs to know is the reason for admission and the most recent medical history. Later, the results of diagnostic tests are supplemented. Eventually, he or she might also need pieces of the most current medical knowledge, concerning differential diagnostics or therapeutic methods for the diseases in question. If this information arrives too late, or is obsolete, or even wrong, this will affect the quality of care. A time-consuming search for information as well as redundant examinations may become necessary, which will increase the costs of patient care.

The need for a strategic information management plan of a hospital's information system arises from the mere fact that almost all groups of persons and all areas in a hospital are affected and may profit from a high-quality information system.

Integrated information processing is advantageous not only to the patients and the staff of a hospital, but also to health insurance companies and to the owners of a hospital. All information barriers put up between professional groups or departments will generate redundancies, inconsistencies, unnecessary costs, and inferior patient care.

Associated with the development of the hospital information system in Libya, there are some previous studies. In 2011, T. M. Abuzeid [4] conducted a study about Bed Spaces Management System for the Libyan Public Hospital Al-Jumhouriya in Benghazi. This study was initialed for the current issues in determining the bed availability in the Libyan public hospital Al- Jumhouriya in Benghazi for pregnant. Thus, this study successful designed and developed the system based on the System Research Process Methodology. The system was developed based on JSP and MySQL tools and tested on local server. The result of the evolution found that the proposed Bed Reservation System (BRS) was easy to use, useful and achieve the uses intention in using it.

On 2013 M. Abdellgoad et al [5] conducted a study titled "A Grey box Hospital Information System in the Medical Center Tobruk Libya based on 3LGM". The study is set out to consider the different suggested models for hospital information system and then to look at their advantages and disadvantages in comparison with other model the selected information system model. This is where this project comes in to study the current information system architecture and the quality of information system to propose a comprehensive hospital information system model to support information system managers.

They are supposed to make the right information and knowledge available to the right people, in the right place, at the right time and in the right form. To improve a HIS, its current state needs to be known. Three-layer Graph-based model (3LGM) is a structured already validated approach for modeling and analyzing HIS.

On the same year, A. Awami conducted a study titled "A Conceptual Framework for Education in Health Informatics: guidance for the Libyan context" [2]. This study attempts to synthesize a conceptual framework for education in HI and draw some guidelines for developing a HI educational program in a Libyan University.

The study concluded that gaining skills and competencies in health informatics is becoming essential to enhance and achieve better healthcare outcomes. This is due to many reasons including: the break through achievements in ICT and potential applications in healthcare, recommendations of governing bodies and associations in the healthcare, expectation that healthcare professionals are competent users of HIS to manage vast amounts of medical data and information, and to be able to mitigate the risks associated with the implementation of what is considered to be technically sound HIS.

Education in HI, particularly degrees at the undergraduate level, has not been widely offered by universities around the world. We believe that the reason behind that is attributed to the characteristics of HI discipline (immatureness, multidisciplinary, and diversity of infancy subspecialties). The conceptual framework presented in this the study conducted characterizes HI discipline and illustrate aspects of education in HI including: constituent knowledge, levels of education and aims of the educational program.

The difference between the previous studies with the ongoing study is that this will be tell about what is OpenMRS and how it used in the development of Hospital Information System in Libya.

Research Method

1. Analysis

a) Information Gathering

Information gathering refers to gathering information about the issue we're facing and the ways other organizations and communities have addressed it. The more information we have about the issue itself and the ways it has been approached, the more likely we are to be able to devise an effective program or intervention of our own.

In this study, the information gathering is very important to do in order to know the real condition of the health care information systems that run today. The method used in gathering information was a questionnaire method. Questionnaire will be distributed to the respondents in the four hospitals in the city of Sabha. Sabha is a city in southwestern Libya and is the capital of Mantiqa Janubiya region. Sahba city has four hospitals as centers for public health services. Just like other cities in Libya, many public facilities such as hospitals which suffered considerable damage as a result of the war that took place during the Libyan revolution after the fall of the regime of Muammar Gaddafi.

Characteristic of Respondents

The characteristics of respondents profiled in some detail, particularly characteristics such as sex, educational

background, year of experiences, and level of job. From total 54 respondents as presented by Table 1, based on the gender, the percentages of respondent were men are 38.89% and women are 61.11%. Based on the educational background, we can divide respondents into four categories, namely undergraduate with percentages are 42.50%, bachelor with percentages are 31.48%, master with percentages are 18.52% and the rest is doctoral with percentages 7.40%.

Table 1 Characteristics of the Respondents

Number of Respondents = 54		
	N	**%**
Gender		
Male	21	38.89
Women	33	61.11
Educational Background		
Undergraduate	23	42.60
Bachelor	17	31.48
Master	10	18.52
Doctoral	4	7.40
Year of Experiences		
<1 Year	9	16.67
1-3 Years	24	44.44
>3 Years	21	38.89
Level of Job		
Operator	20	37.04
Lower Management	17	31.48
Middle Management	13	24.07
Top Management	4	7.41

Based on the respondents' year of experiences, we can divided respondent into three categories, namely respondents with work experiences less than 1 year with percentages 16.67%, between 1 to 3 years with percentages 44.44%, and more than 3 years work experiences with percentages 38.89%. Based on the level of job, we can divide respondent into four level, namely operator with percentages 37.04%, lower management with percentages 31.48%, middle management with percentages 20.07% and top management with percentages 7.41%. If observed by educational background and level of job, it can be said that the educational background is proportional to the level of job.

b) Information Gathering Result Analysis

To analyze the results of the questionnaire, consider Table A in Appendix presents a summary of the number of respondent answers to the questions given. In Table A it can be seen the percentage for each answer given by the respondent. The questions on the questionnaire can be classified into four themes. The first theme is performed to determine whether the tools used by respondents in completing the work. This theme is represented by question number 1, which would classify respondents into three categories, namely respondents who works using paper, respondents who work using computer facilities and respondents who work using both.

Based on the results of the questionnaire are shown in Table A it can be seen that of the 54 respondents, there is a 20.37% of respondents who are still working with paper, 29.63% of

respondents who work using computer facilities, and there are 50% of respondents who work using paper and computer.

From these results above will then be investigated further in the next theme, which aims to determine, of the total respondents who use computers to complete their work, the application is used, if the data processing application/ Spreadsheet software (e.g. Microsoft Excel) or Computer Based Information System (CBIS). Based on Table 2 can be calculated that the number of respondents who use the computer facilities is 79.63% or 43 respondents. Of this amount then it is known that respondents were still using spreadsheet software is 70.07% and the remaining 29.03% had used Computer Based Information System. It can be concluded that most of the business activities carried on not using computer-based information systems, despite the use of computer facilities with a spreadsheet application. It is understandable that the post-revolution Libya in the past few years has suffered severe damage and destruction of public service facilities. Despite efforts to rebuild and repair public facilities have been made, but will still require considerable time to run optimally.

Next theme of the questionnaire is to find out how the experience of the respondents in completing the work with the applications they use today. This theme is represented by question number 3, 4, 5, 6, 7 and 8. Question number 3 aims to determine whether the application that respondents use this time is enough to help them in completing their routine work easily and quickly or not. 72% of respondents said that the application that respondents use this time is not enough to help them in completing their routine work easily and quickly. Just as the answer to question number 3, from the answer to question number 4,5,6, 7 and 8 it can be concluded that the majority of respondents said that the application or system being used today are not effective and efficient in helping them finish the job.

Question number 9 and 10 on the questionnaire aims to find out the opinion of respondents, whether at this point required the development of a new system or not, and whether the development of the new system was something that is urgent or not. Based on respondents' answers to the question number 9 can be concluded that the majority of respondents (95.35%) wanted the development of a new system, and 88.37% of the respondents said that the development of this new system is something that is urgent.

Overall based on the information gathering through a questionnaire of 54 respondents were spread across four hospitals in the city of Sabha can be concluded that most hospitals still run a variety of business activities using computer and paper based systems. Although it has yet to use the computer facilities used applications is still limited to a spreadsheet application and a few that have been utilizing computer based information system (CBIS). With the system currently employed respondents considered that the system currently used have not been effective and efficient in helping to complete the job. Therefore, it is expected that the development of the new system and this is an urgent financing needs.

c) Weakness Analysis of Current System

Analysis of weaknesses in the system is important thing to do in order to evaluate a running system. One model that can be used to analyze the system was PIECES framework. PIECE is a framework introduced by James Wheterbe [6]. PIECES framework consists of

Performance, Information / Data, Economic, Control / Security, Efficiency, Service. This framework can be used to analyze both the manual system and computer-based systems.

Table B in Appendix presents the results of the analysis of system vulnerabilities using PIECES framework. Analysis results for each aspect is based on the answers given by the respondents are also based on the author's observation.

OpenMRS Implementation

OpenMRS is designed to manage patient data longitudinally, linking multiple interactions over time into a single patient chart. Having this complete patient history available empowers clinicians to make more informed decisions about care, while also enabling a deeper analysis of patient health in order to draw more meaningful conclusions on improving outcomes. If you only care about individual patient visits, and not about linking those together into a longitudinal chart, then OpenMRS may not be the right tool for us.

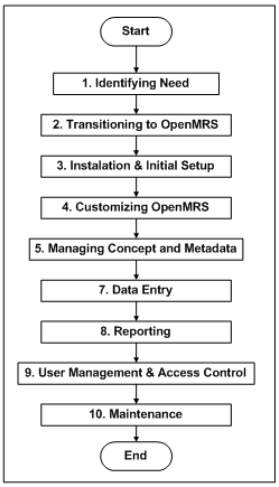

Figure 2 OpenMRS implementation flowchart

Figure 2 shows the flowchart for OpenMRS implementation phase. Below is an explanation for each step taken in implementing the OpenMRS:

1) Identifying need

OpenMRS has been designed to be flexible and adaptable, based on input from many different partners, but it may not be an exact fit for the ways that the organization currently works. Doing things the "OpenMRS way" could mean adapting our workflow and adopting best practices in medical informatics.

2) Transitioning to OpenMRS

Once the need has been identified, the next will be prepared project management. Project management is useful for determining the project team, the business purpose of the use of OpenMRS, the approach to be used in the initial setup, ongoing support is needed, the costs associated with information and communication technology infrastructure, training and documentation.

3) Installation & initial setup

OpenMRS offers two solutions in the implementation of health information systems, which is a stand-alone and enterprise. OpenMRS stand alone offer a simplified solution which is suitable for use a small clinic. The recommended solution is OpenMRS enterprise, which can be implemented on a network-based system of local and large integrated systems through the Internet. Figure 2 shows the technical architecture of the openMRS. The core OpenMRS application comprises a web application, programmed in Java and JavaScript and a number of open source component applications, maintained by other open source communities, including:

1) MySQL Relational Database Management System
2) Apache Tomcat – servlet application
3) Mozzila Firefox – web browser application

4) Hibernate - object to relational mapping and persistence application.

A number of modules can be loaded into the core application to provide additional functionality. Almost all OpenMRS installations use the FormEntry module that allows forms to be developed for data capture and entry to the system.

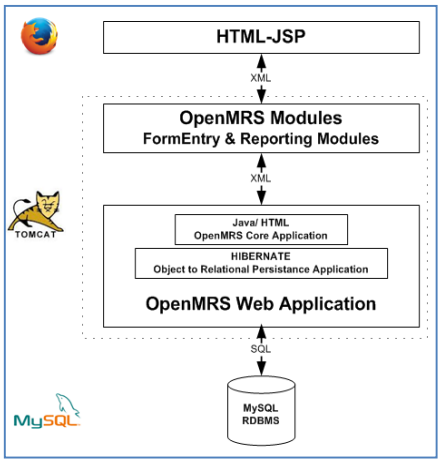

Figure 2 OpenMRS technical architecture

5) Customizing OpenMRS

OpenMRS has a modular architecture which allows special functionality to be easily added or removed from the system. Modules have full access to the system and can modify or enhance the behavior of the system. For example, the Sync module adds the ability for an OpenMRS server to synchronize its data with other OpenMRS servers; the HTML Form Entry module provides a way to create web-based forms for collecting data; and the Flowsheet module adds a new way for viewing information. Modules also provide a mechanism for adapting OpenMRS to local needs.

6) Managing concepts and metadata

The actual information we want to record in OpenMRS is called Data. Examples of Data in OpenMRS are Patients, Encounters, and Observations. To support this data, and describe its meaning, you need additional Metadata.

The fundamental expectation of OpenMRS's design is that we will customize it for our clinical program's use case. T he system has no built-in idea of the patient's weight or seeing the patient in an outpatient visit. Instead, you can configure these things yourself, to match our project's workflow. Generally speaking, the things that you need to configure in order to describe the real patient information you will be capturing are referred to as Metadata. An example of a piece of metadata is a Location that represents a hospital.

The most important part of the system's metadata is the Concept Dictionary, which is a list of all the medical and program-related terms that we will use as questions and answers in Observations. This dictionary does not need to be complete when we begin using OpenMRS.

We should expect new terms to be added and old terms to be retired as our use of the system evolves. It is better to start with a pre-populated Concept Dictionary, rather than starting from scratch yourself. See the chapter "Sharing Concepts and Metadata" for more details.

Every question you ask about a patient needs to be defined by a Concept. For example, to record a patient's weight you need a Concept like Weight in kilograms.

7) Data Entry

An electronic medical records system has many advantages compared to a traditional paper-based system. Data is collected using electronic forms, and a standard template means that each user sees the same structure, simplifying the representation of the underlying information structure and complexity. Electronic forms also allow for basic data validation.

8) Reporting

The Cohort Builder is a tool in the Reporting Compatibility module (included with most OpenMRS installations) that lets you perform ad-hoc queries for patients with defined characteristics, and combines multiple queries into more complex ones.

A cohort query returns a list of patients matching the specified criteria. It is not possible to create lists of data elements other than patients. For example, you can use the cohort builder to search for all patients with any weight observation > 7 0, but it is not possible to create a list of all observations of weight > 7 0.

9) User management & access control

Roles and Privileges are controlled through the Administration page, under the Manage Users section.

OpenMRS uses privileges and roles to control access to data within the system. Privileges define what can or cannot be done in the system (e.g., Edit Patients or Add Users) while roles are used to group privileges into more manageable groupings. T o make the system easier to manage, roles can contain other roles as well as privileges. Roles inherit all the privileges of their parent roles.

We will use this example: you are working with several privileges related to patient data—e.g., View Patients, Edit Patients, and Add Patients. T he View Patients privilege lets users look at patients in the system, the Edit Patients privilege lets users edit information about existing patients, and the Add Patients privilege allows users to create a completely new patient record within the system.

10) Maintenance

Once we have installed and configured OpenMRS and it is being used to support day-to-day clinical operations, there is still work to be done. To ensure the system runs smoothly and error-free, use the following tips as a starting point to create a maintenance plan for our OpenMRS installation.

Discussion

In the analysis made clear that the problems faced by Libya in the current health care system is still not used effectively and efficiently in supporting various business activities. From the results of the questionnaire can be seen that only 20.93% of respondents who had used a computer-based information systems in running activities and work routine. While the rest despite the use of computer facilities used, but the application is a spreadsheet application and the activity of combining the use of paper and the computer to complete the job. The system is not effective and efficient this would then cause the service to the patient to be not optimal. In addition it will also eventually result in operational cost overruns. If the case is allowed to continue the case would be very detrimental.

In this study, based on the results of the analysis it was concluded that most of the respondents who are the people who are involved in the development of health services want a new system that can cope with the problems that are currently facing. And they assume that the need for a new system is something very urgent.

However, it should be considered that the development of a new system is certainly not an easy thing to do. It Required careful planning and the right strategy. Because of errors in planning and development strategies can lead to the development of the new system will take a very long time, perhaps even fail. Development of a system that delayed and not completed the

planned schedule will cause the loss of time, effort and cost.

Based on the review we reccomended to address these issues is to implement OpenMRS for the development of health care information systems. OpenMRS is fulfill its potential as a low cost, rapid development, open source application for developing patient and treatment management systems in resource-poor settings. The generality of the core application design-based on the clinical encounter with flexible addition of observations linked to concepts will likely support extension to information management in a number of primary healthcare settings in developing countries.

With the rapid growth in OpenMRS functionality, the OpenMRS Implementers Network fills a very necessary requirement to support the use of OpenMRS by implementers without which it would be difficult to advocate using the application or to make it sustainable. Importantly, the OpenMRS Implementers Network also provides a vehicle for including developing country perspectives and information to guide the development of OpenMRS.

Conclusion

OpenMRS is a solution that can be taken for the development of a health information system that is fast, low cost, and is an open source application that only requires a little setting in the system of patient management and care. OpenMRS can be implemented to support the health services of a small clinic to the health services with enterprise scale.

Supported by the development is done continuously to address various problems in terms of health care, OpenMRS to support the development of adaptive systems and friendly to change. Therefore, OpenMRS could be the answer to the development of health information systems in various countries around the world, including Libya.

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Appendix

Table A Questionnaire's result

NO	Question	N	Answer					
1	What tools do you use to carry out your work on a regular basis?	54	Paper based		Computer based		Paper and Computer based	
			N	**%**	**N**	**%**	**N**	**%**
			11	20.37	16	29.63	27	50
2	If your work using computer tools, what kind of applications do you use?	43	Spreadsheet software (e.g. Microsoft Excel)		Computer Based Information System			
			N	**%**	**N**	**%**		
			34	79.07	9	20.93		
3	Is the application that you use this time is enough to help you in completing your routine work easily and quickly?	43	Yes		No			
			N	**%**	**N**	**%**		
			12	27.91	31	72.09		
4	Is the current application you are running allows you to get information quickly and accurately?	43	Yes		No			
			N	**%**	**N**	**%**		
			11	25.59	32	74.41		
5	Do the applications that you use current is enough to assist you in making a report to your boss?	43	Yes		No			
			N	**%**	**N**	**%**		
			14	32.56%	29	63.46%		
6	Is the current application you are running allows you to control your work quickly and easily?	43	Yes		No			
			N	**%**	**N**	**%**		
			12	27.91	31	72.09		
7	Is the current application you are running equipped with a safety feature that prevents unauthorized people to access the data that you have?		Yes		No			
			N	**%**	**N**	**%**		
			9	20.93	34	79.07		
8	In general, do you consider that the current system can be used to help you to get the job done effectively and efficiently?		Yes		No			
			N	**%**	**N**	**%**		
			10	23.26	33	76.74		
9	Do you think the development of a new system is needed to improve the system that is currently used?		Yes		No			
			N	**%**	**N**	**%**		
			41	95.35	2	4.65		
10	According to your need for the development of a new system to improve the system that is currently used is urgent to be done?		Yes		Don't know		No	
			N	**%**	**N**	**%**	**N**	**%**
			38	88.37	3	6.98	2	4.65

Table B Weakness analysis result of the current system using PIECES framework

Category	Problems
Performance	Takes a long time to complete one phase of work, this is because the data processing is done separately and not integrated.
Information/ Data • Outputs	• Report to be made by collecting the files and process them using Spreadsheet Software, and very risky to human error. • Information that is not timely to its subsequent use . • Information difficult to produce. • Information not accurate. • Information not in useful format.
• Inputs	• Data is not captured in time to be useful

• Stored data	• Data is difficult to capture. • Data captured redundantly (same data captured more than once) • Too much data captured. • Data is not well organized. • Data is not secure from accident. • There is no data backup system. • Data is not flexible – not easy to meet new information needs from stored data
Economics • Costs	• Costs are unknown. • Costs are untraceable. • Costs are too high.
Control	• Too little security or control • Storage of data in spreadsheet software format has the potential to lose data and easily accessed by unauthorized parties. • There is no data privacy regulation. • Redundantly data is stored inconsistently in different files.
Efficiency	• Data is redundantly input or copied • Data is redundantly processed • Information is redundantly generated. • Effort required for tasks is excessive • Materials required for tasks is excessive
Services	• The system produces inaccurate results • The system produces inconsistent results • The system produces unreliable results • The system is inflexible to new or exceptional situations • The system is inflexible to change • The system is incompatible with other systems • The system is not coordinated with other systems