

Information System Development and Management; **Hands on Practice**

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Abstract

Nowadays, information systems are the key to organizational success if not the only chance to survival. In a world that is moving towards e-business and m-commerce being able to satisfy the customer need for a fast, social and pleasant experience leads directly back to the roots of organizational daily transactions and business processes. The optimization and automation of these routinely activities, along with more correct previsions, will allow organizations to be more competitive on a global scale in matter of products and services, as well as more advantaged in handling and using information for the organizational growth.

Keywords

Information System: System Development Lifecycle; Management

1 Introduction and Background

1.1 Description of Information Systems

An information system is a set of interrelated components that collect, process, store and distribute information to support decision making in an organization. ^[16] In a broader perspective, an information system is a sociotechnical infrastructure within an organization in which information technology and human efforts meet to produce useful output. Information systems play three fundamental roles inside an organization: automate, inform and transform. ^[23] The relation between these three roles is briefly described by Cash, J. I., Eccles, R. G., Nohria, N. and Nolan, R. L. ^[4] “when information technology substitutes human effort by automating tasks and processes, when information technology improves human effort by informing a task or a process and when information technology restructures set of task or processes”.

1.2 Importance of Information Systems

The first aim of an information system is to reach operational excellence by enhancing organizational processes that is translated into cost cutting and into profit maximization. Firms have automated many business processes facilitating employees' work and have improved their efficiency through a more thorough information processing. ^[8] Secondly, information systems informate organizational members by “translating information into action also register data about those automated activities, thus generating new streams of information. [...] For example, scanner devices in supermarkets automate the checkout process and simultaneously generate data that can be used for inventory control, warehousing, scheduling of deliveries, and market analysis”. ^[25] Information systems help spreading information throughout the firm and provide efficient information to all the levels of the organizational hierarchy flattening the organization. Moreover, information systems promote customer and supplier intimacy that lead to a better understanding of the environment, to an increased understanding of the customer attitudes and inclinations towards a product or a service and ultimately to the creation of new goods, services and business model that better contribute to the customers' welfare. Therefore, by transforming the organization, information system can produce long-term benefits. ^[3] Another important asset granted by information system is consistent decision making based on accurate, timely and relevant information that confines the possibilities hazardous judgments, which may jeopardize the

organizational stability, and that can generate a clear competitive advantage over the firm's competitors. Furthermore, information systems advocates communication between organizational members and among customer, suppliers and other firms over the Internet and within Intranets and Extranets. [5] The Internet has enabled worldwide real time free communication and has allowed knowledge storing and sharing. Business intelligence, telecommunication and networking have permitted communication dynamicity and ultimately granted the creation of multinational corporations. Ultimately, information systems may save an organization destiny by ensuring the firm's survival from obsolete business processes and backdated practices.

1.3 Types of Information Systems in the Four Level Pyramid Model

Usually an organization is divided in a four levels pyramid in which the employees as well as the technology by them exploited vary for expertise and role-responsibility.

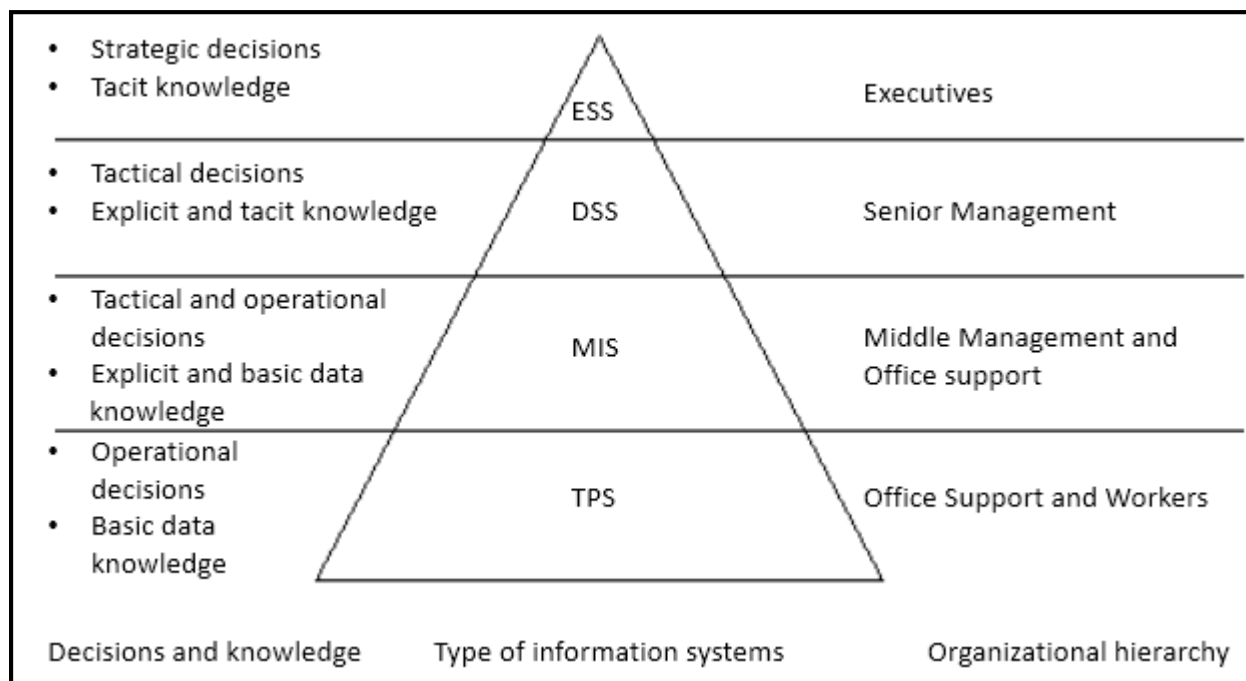


Figure 1; Personal Elaboration of the Organizational Hierarchy

In this chart are pointed out the differences in function and technology used in a four level organizational pyramid and it is possible to observe how information technology impacts and at the same time get along with the traditional organizational structure. However, as before mentioned, information systems tend to flatten the organization by eliminating superfluous passages and redundant business processes. As a consequence of this organizational development the middle management of certain firms disappeared living place to a less complex hierarchical structure that counts only executive members, senior management and office support combined with common workers. From the picture it is possible to identify four different types of information systems:

1. **TPS** → The Transaction Processing System serves the operational staff and gather current, and potentially error-free, data from daily routinely business processes. It allows a constant supervision from the operational management (office support) and eventually from middle

management. It collects data from within the company and from the external environment and provides these data to other system.

2. **MIS** → The Management Information System is used by the middle management, or by the office support, to monitor, coordinate and supervise the firm operational business. It is a system with limited analytical capacity and small flexibility, it tends to use historical and current data to analyze the company situation, to answer to routine questions and to predict the firm performance in the near future.
3. **DSS** → The Decision Support System is adopted by the senior management to create useful and usable knowledge for the organization. This system is provided with a strong set of analytical tools that also count the possibility of making forecasts through a “what if” simulation tool. The DDS uses data collected by the TPS and by the MIS. It uses internal and external data sources and help the senior management to work on tactical decisions such as the financial and logistic plans. Thanks to its high level of abstraction, the DDS can give solutions to non-routine and rapidly changing problems. It enhances the decision making and facilitates the flow of information throughout the company.
4. **ESS** → The Executive Support System is used by the top management of an organization to make long term plans based on information coming from the lower levels of the firm and also from outside sources. It is an extremely flexible system that can be designed to suit the individual taste and usually shows the real-time company’s performance through a dashboard-based display. The ESS can “drill down” specific issues and has the highest level of abstraction exploited to predict the future and make long term plans (3-5 years).

1.4 Types of Information Systems

Along with these four types of information systems, the information technology industry has provided more tailored choices for specific organizational departments to meet their needs, to improve specific areas of their business and to serve different levels of the organizational hierarchy. These additional system are recognized as enterprise applications:

- **ES** → An Enterprise System is a packaged software commonly used in big companies. It is quite difficult to implement because of its fixed structure that doesn’t allow customization. It encompasses the whole organizational activities, including Supply Chain Management System (SCMS) and Customer Relationship Management System (CRMS) and so elaborating data also from the external environment helps to streamline the entire organizational process and to adding value to the business information chain. Traditionally, SCMS, CRMS, Human Resource System (HRS), Knowledge Management System (KMS) and Financial Management System (FMS) are acquired separately by an organization, but firms such as SAP and Oracle offer Enterprise System software as a standardized package including all the software for the companies that want to adopt technology to heighten their business. ^[1] However, considering the difficulties firms faces to implement this type of system, enforcing an ES is considered a risky investment because its correct implementation usually leads to profit maximization, but its wrong integration could cost the company big losses or even the business failure.
- **ERP** → An Enterprise Resource Planning is a software-based customizable software. It is generally used in medium enterprises and helps the organization to better organize its internal processes. An ERP system uses only one database to collect and store data from different organizational units and departments and it greatly benefit a large number of firms. An ERP system integrates business processes within and across organizational confines

and share mutual data and consolidated practices “to improve decision making and performance, to maintain supply chain links, to build e-commerce premises, to reduce cycle time, to reach faster and more effective communication, to decrease stockpiles, to augment productivity, to tighten supply chain links, to reduce logistics and delivery costs and eventually to earn competitive advantage”.^[9; 17]

- **SCM** → The aim of a Supply Chain Management System is to help, secure and enforce the relationship between an organization and its suppliers and retailers. A SCM reduces inventory, manufacturing, shipment and distribution costs synchronizing all the processes in a supply chain where all the suppliers are all called to participate in the product or service R&D and, once more, succeed in cutting cost and reducing lead-times^[14; 6]. Thanks to SCM, organizations are able to streamline their production across their physical borders by maintaining a production schedule of suppliers and finally achieve a good degree of cost reduction and profit maximization.^[24] Therefore, a SCM is considered an inter-organizational system that allows companies to get in touch not only with suppliers that allow firms to outsource some of their business processes, but create also a close link with their customers in B2B and B2C activities.
- **CRM** → The aims of a Customer Relationship Management System are to identify and attract new possible customers and ultimately to retain the organization customers. Nowadays, companies customer-oriented rely on the exploitation of the Internet and of big data sources to heighten their customer relationship management efficiency. Therefore, organizations have to rely on electronic Customer Relationship Management (e-CRM) software to collect, analyze and retrieve customer information. e-CRM is an interactive, online based and content-centered customer service software that explores customers' preferences, exchanges important information with multiple systems inside the organization ensuring a better service and a steadier customer retention.^[22] Firms are increasingly taking advantage of e-CRM software to improve their market value and their competitiveness while limiting their expenses. Through e-CRM, organization come to know customers' tastes and needs and this essentially facilitates one-to-one marketing, promotional campaigns and product development.
- **KMS** → A Knowledge Management System wants to store and share within the organization, and eventually with its external links, individual soft skills and knowledge that would otherwise go lost. Typically knowledge management derive its sources from DBSM, intranet and data collected by different types of information systems while accomplishing common business processes. A KMS objective is to gather, organize and create consistent knowledge that should be available anywhere at any time.^[20] This kind of software improves flexibility and adaptability which should lead to a stronger competitive advantage and yet to survival.^[12] The real challenge for a KMS is to be able to provide ad hoc information for the current issue the organization is facing.^[10] Therefore, a particular attention should be given to data quality that has to be monitored not only when the data is recorded and store, but also when it is retrieved which means that the information browsed have to be compatible with the contextual problem.^[19]

1.5 Relation between Information System and Business Organization

Information technology encompasses three broad areas: technology, organization and management.

1. **Technology** → hardware and software facilities that enable the information system storage operations and business processes' automation.

Information systems have become a fundamental key for organizational success. However, in some cases, information systems aren't only a chance to achieve competitive advantage and profit maximization, but they are also the only possibility for a company to survive in a more and more competitive scenario. As a matter of fact, as much the Internet has provided firms with great possibilities like 24/7 instant and free communication, the opportunity to outsource production all around the globe, the chance to start e-commerce and e-business activities and finally the possibility to explore and understand the consumers' needs and attitudes, the World Wide Web has also embittered competition among organization offering substitute products and similar services. In this battle of prices, products and innovations that information systems are vital for organizations to be cutting-edge. However, every organization, considering its field of interest, has to choose which business activities need to be automated to improve the company revenue and to have a substantial ROI (Return on Investment). It is of vital importance for a company that wants to upgrade its business practices and move from manual procedures to automation to have a clear idea first about WHAT kind of information system is more needed in the organization and then about HOW this system going to implemented. The failure in identifying what is the big scope of an information system while focusing only on its implementation may lead to a big time, effort, data and money loss.

2. **Organization** → business processes, politics, hierarchical structure, employees and their culture are the factors that clearly define an organization. Implementing an information system within an organization means changing its structure and its routines. One of the main difficulties encountered by firms during such a development it's the human factor. At all organizational level employees and managers may result resistant to the change and, in the worst case, undermine the information system application within the organization. As it emerges from a case study conducted by Nauman, A. B., Aziz, R. and Ishaq, A. F. M. ^[18] "The users did not provide sufficient support and their behavior was critical. The employees did not accept the changes in business/organizational processes which were caused by the new information system. [...] The end users in the organizations were not ready to adopt the changed organizational processes necessitated by the introduction of new technology. Hence, this hostile attitude contributed to the failure of the information system implementation project"

An information system is actually a tool designed to help organizational members in the variety of their work aspects. However, some of the employees may not understand the benefit they could gain by this technological advancement and could even see the information system as a threat to their workplace. Therefore, it is duty of the management to explain the importance of this technology to their subordinates and, in a second moment, to provide them with the suitable knowledge to operate with a different instrument. As a matter of fact, sometimes, already perfectly functional information systems, for which an organization spent good money, are not well integrated in the normal business practices and for this reason are left unused resulting in a financial loss.

3. **Management** → From an economic point of view, information system technology can be seen as a productive factor as long as it automates part of the organizational business processes enabling a firm to achieve better outputs by investing less in human labor. Two theories are supporting this thesis:
 - **Transaction cost theory** → this theory affirms that usually organizations can grow in size because they are able to create a vertical integration and to produce

the same goods at a lower price than by purchasing from external suppliers. Information technology and more specifically information systems allow companies to lower their market participation cost (transaction cost) by outsourcing part of their production. Therefore, information systems can help organization rise their revenue while reducing in dimension.

- **Agency theory** → according to this theory, organizations using information technology are able to cut down agency costs, the costs of coordinating and monitoring the workers' performance, so that each manager can supervise a greater number of employees.

Therefore, researchers have concluded that information technology in organizations can promote a simpler and less structured hierarchical architecture by implementing, through information systems, information spreading among the lower levels of the firm.

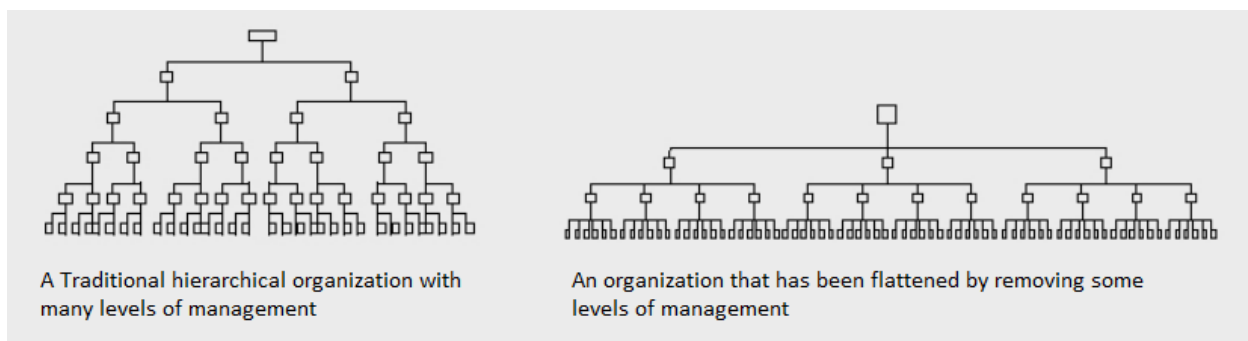


Figure 2; Hierarchical Organization Vs Flattened Organization ^[11]

In this way not only managing larger groups of employees will be easier, but also the decision-making process will be pushed down at operational levels because workers will be supplied with current and reliable data. Employees will be divided in small units and teams and incited to work together. By using the “wisdom of crowds” organizations will be provided with new and unique soft knowledge to store and eventually share with a KMS software.

2 Information System Development

2.1 System Development Life Cycle

Researches on information system development reflect the fact that information technology, as a critical mean of organizational change, has progressively infiltrated into the core functions of an organization. ^[21] Information system development, as seen by Klein H. K. and Hirscheim R. ^[13] is a technical process with social consequences as long as it impacts the organization financial and operational aspects. As a matter of fact, information system are generally implemented within an organization for two reasons:

1. To solve a specific issue obvious to the eyes of the management
2. To gain competitive advantage, reach efficiency and ultimately maximize the revenue

According to Dennis, A., Wixom, B. H., and Roth, R. M. ^[7] “the system development life cycle is the process of understanding how an information system can support business needs by designing a system, building it and delivering it to users”. Therefore, the array of activities carried out by an organization to implement an information system is called system development.



Figure 3; System Development Life Cycle ^[16]

From the above picture it is possible to highlight six phases of the system development life cycle:

1. **System Analysis** → in the first and major stage of the system development life cycle (SDLC), an organization should have clarified why and what is going to be implemented and only then how this is going to happen. This phase is considered as a brainstorming one because it calls in action all the three information system aspects: technology, management and organization (human capital).

Firstly, the organization should undergo a feasibility analysis by examining the key aspect of the project:

- Technic feasibility, analyzes whether or not the company with its set of hardware and software is able to develop a new information system
- Economic feasibility, enquiry on the possible ROI
- Organizational feasibility, investigate on the human aspect of the organization and on the employees attitudes and capabilities to deal with the new technology

Secondly, the management should appoint a project manager to supervise the project team that will carry out the work plan.

Once this initial stage is completed, the real analysis phase takes place:

- I. An analysis strategy, describing the system currently adopted (“as-is system”) by the organization and the issues that it generates, is considered to develop a draft for the new or “to-be” system
- II. A requirements gathering phase follows. Through the employees’ first hand experiences, the system analyst and his team start to develop a new system concept and to clarify how this will impact and/or work symbiotically with the current business processes from two different points of view
 - Functionally
 - Technically
- III. All the collected documents are compiled in a file called “system proposal” that will be submitted to the top management

However, the most important thing in this phase is to have clear the information requirements of a new system, such as who needs what information, where, when and how.

^[16] Failing in identifying these basic requirements, as already mentioned, could lead to waste of resources or, in the worst scenario, to organizational failure.

2. **Design** → Also this phase is divided in four sub-phases:

- I. A design strategy to understand whether the firm’s IT department is going to work on the new information system or it will be necessary to outsource or a Software as a Service (SaaS) will be purchased is developed. This step is one of the more

technical because considers what kind of hardware, software and network is going to be exploited in the implementation of the new information system

- II. The first draft and documentation will be reviewed
- III. In this stage combining documentation and concrete perspective on the company situation will be combined and the interface design will be structured and built. This is a very delicate phase because technicians and IT experts have to meet the needs of the final user by understanding their level of expertise and their eventual difficulties in using the new technology. As before mentioned, information systems are sociotechnical structures and if the technology is not calibrated for the organizational human capital the firm can expect negative implications in its ROI. In the design specifications it is possible to count:

- Input and output
- User interface
- Database design
- Processing
- Manual procedures
- Controls
- Security
- Documentation
- Conversion
- Training
- Organizational change

3. **Programming** → this step is about the development list of instructions and the code represent of the software, therefore using programming languages such as Python, C++, Java script and PHP to translate current organizational problems into programming language instructions to build a software that will be able to overcome these issues.

The program development process is divided in five main steps:

1. Defining problems → identify what is the issue (input given data) and what are the expected results (output with result)
2. Planning with solutions → designing a flowchart representing each step to reach the desired solution, so it is a process to direct the study from “what the program will do” and “how it is going to do it”
3. Coding the Program → using programming language to write instructions that the computer can understand following syntax and language specific rules
4. Testing the program → Programmers will be more precise, detailed oriented and thoughtful in analyzing their work to find the possible errors made in the previous programming steps. There are three different ways to check the program:
 - I. Desk-checking → trace or check the logic of the program to ensure it is error free and workable
 - II. Translating → Checks the syntax of the program to ensure that the programming language has been used correctly, with right syntax error message and translated into a form that the computer can elaborate
 - III. Debugging → is a cyclic activity involving execution testing and code correction.
5. Documenting the program → provides a detailed description of the programming process and specific facts about the program. Typically, the program

documentation materials include original issue, narrative description of the problem, flow chart, data records, program listing and testing results. These documents will supplement human memory and assist on program planning. Documents are critical to communicate with other programmers and with the programming team. However, nowadays company tend to purchase a system from a third party or to pay subscriptions to use Systems as a Software.

4. **Testing** → this step is very important because it will confirm whether the programmed or purchased software produces the results it was designed or purchased for. Testing an information system should follow a test plan which involves with three types of processes:
 - I. **Unit Testing** → is to pick smallest testable software in the application, isolate from the reminder code, and to determine whether it perform exactly as expected. Each unit being tested individually before integrates it into modules for testing the interfaces between modules. Unit testing has proven its value at large percentage of defects has been identified during it in use.
 - II. **System testing** → System testing is the evaluation of the behavior of entire system in accordance to the defined the scope of the project development. System testing investigates both functional and nonfunctional requirement of testing.
 - III. **Acceptance testing** → Acceptance testing is the technics performed to determine whether the software system has met the requirement specification. The purpose is to evaluate the system compliance with respective business requirements and to verify if met required criteria for delivery to end users.
5. **Conversion or Deployment** → in this phase the organization is going to start exploiting the new information system. Four different strategies can be used during this stage:
 1. **Parallel strategy** → it is the safest way to start deploying a new information system because both the old and the new system are running simultaneously so that in case of error data can be backed up from the old system. This method is very expensive because it may require additional staff and resources
 2. **Direct cutover** → contrary to the parallel strategy, the direct cutover is the riskiest, costless and more time saving strategy. The old system will be cut down and the new system will be put in use all at once on a specific date. Therefore, if some data go missing there won't be a way to restore them and also the organizational members don't have time to adapt to the new system
 3. **Pilot study** → quite safe technique that see the implementation of the new information system only in a certain area or in a department of the organization to see the impact on the employees and the effective functionality of the software
 4. **Phased approach** → another safe technique to deploy a new information system that sees involved whether the introduction of a system function or the introduction of the system by working units. It a very user-friendly approach also if it can be relatively expensive in terms of cost and time.

Also during this step documentation is fundamental as well as training. To be well used, a new information system needs to be user-friendly and in case the organizational members aren't able to properly work with it they should be provided a training. Avoiding organizational behavior clashes with the new technology is of vital importance for the good information system implementation management.

6. **Production and Maintenance** → this is the final stage of the system development process but also the starting point for its future continuous improvements. During this phase, the

system will be reviewed by programmers and organizational managers to see if the system have actually been working along with the organizational goals and objectives. Finally, once the system have been used for a while, the maintenance process starts as a stage to improve the efficiency of the information system, to change part of its features to align it with the organizational necessities and the users' requirements and finally to maximize its efficiency.

3 Examples of Information System Development and discussion on its competitive advantage

3.1 CIMB Case Study ^[2]

In 2008, CIMB Group, Malaysia second financial services provider and first Southeast Asian network banking decided to improve its technology to solve the gap and inefficiencies of its business processes. To do so it used ARIS business process management (BPM) system to identify possible areas of improvement.

One of the innovation introduced after ARIS BPM system analysis was the Account Opening Process following this steps:

1. Analysis of the possible areas of improvement and identification of the best choice in terms of ROI (cost and time saving and customer satisfaction)
2. Design of the new system by CIMB Group system-building team
3. Programming the new system in a way that allows, by scanning the Malaysian Government Multipurpose Card (MyKad), to retrieve customer data and to use them to set up a new bank account instead of filling four different forms
4. Testing the new system
5. Converting the old system with the new one, most probably CIMB Group conducted a pilot study in one of its 1.100 branches before introducing the new account opening process in all its branches. Once the process was confirmed to be effective, then the other branches experienced a direct cutover that substituted the old process with the new
6. Production and maintenance will be easier to execute because the system can be modified by CIMB Group system building team to comply with the changes in bank requirements and government norms.

3.2 Discussion on CIMB Group competitive advantage

CIMB Group benefited from the new information system in more than one way:

- Increased customer experience
- Time saving for both customers and bank, the time required to open a bank account dropped by 56 percent
- Increased productivity through business excellence
- 8-9 percent yearly lowered cost

Therefore, introducing information systems in a company can be a strategic move to rise profits while offering also a better solution for the customers. Analyzing the CIMB case study in a strategic way it is possible to recognize all the positive aspects of an information system implementation:

- Business excellence → CIMB Group is working towards business excellence and profit maximization investing with an information system on technology to improve business processes and to cutting costs. The costs of CIMB Group diminished of 8-9 percent a year
- New products, services and business models → the ARIS BPM system individualized 25 different areas of CIMB Group that can be improved. Information system can help understanding better the market and its needs to provide better services, as well as giving suggestions to increase the performance of already practiced business processes. The new account opening process is the result of the company understanding the need of change
- Better supplier and customer relationship → customers of CIMB Group experience a positive change in their banking services and also their switching cost (from CIMB Group for example to MayBank) rose
- Competitive advantage → CIMB Group acquired an advantage on competitors because to open a new account will take only few minutes and will not require to fill in many different forms. The process was reformed in such a way that now to open a bank account the time of the operation is reduced of 56 percent. Moreover, ARIS BPM system will give other useful suggestions for the Group to improve their services and be leader of the market
- Survival → CIMB Group was the first bank in Malaysia to see the possibility to link a bank account information with the Government ID card. However, in the long run, this procedure will become a trend for other financial institution that will be forced to change their business processes if they want to survive. CIMB Group was a first mover in this field and ratified the disruption of the old account opening processes.

5 Conclusion

Information systems are becoming more and more important for the survival of companies, on one hand to be competitive and on the other hand not to become backdated and to be unable to follow the market trends. Customer relationship and knowledge management are two core activities that every organization has to organize to ensure a source of income and to retain within the organization important and useful knowledge to solve problems and have a better social integration among the employees. Enterprise systems are of primary importance to ensure the overall business activities and to coordinate the supply chain flow of goods and information. Information is the determinant of success and information systems can analyze in different ways information to increase the efficiency of human decision making. Understand what kind of product/services are needed and how to deliver them to the consumer is fundamental and doing so over the Internet has become a must (and a trend as well). Information systems can interact with the World Wide Web and handle e-commerce and e-business processes cutting down the necessity of finding distributors and retailers and providing better deals for customers that can access to the same product - sometimes also personalized - at a lower price directly at home with minimum transaction costs, more detailed information about the market and a wide (technically global) choice.

Information system were initially developed to help and assist organizations in their business activity and now information systems are not only necessary for the company good management but are also determinants of success or failure.

Therefore, information systems once chosen carefully and accordingly to the organization needs are incredible tools, but they also can become an obstacle and an economic burden for that companies that didn't understand their human capital needs and basic knowledge as well as their necessities. Accurate investigations are essential before the implementation of any kind of information system.

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