

Applications Architecture for a Medium Sized Manufacturing Firm

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Abstract— Small and Medium Enterprises require new technologies and methods of work organization that allow them to improve their productive and competitive capacities. The Enterprise Architecture is a methodology that defines architectures for the use of the information in support of the business strategy, looking for strategic alignment between information technology and business processes. The Applications Architecture is a partial architecture of the enterprise architecture, which aims to define the best kinds of applications needed for data management and support the business processes, considering the strategic use of information and technology for the competitive advantage of the company. This research project designed and implemented an application architecture in a medium-sized manufacturing company using open source software, resulting in the identification of strategic areas of opportunity for this architecture, and the development of a basic web page to start e-commerce activities, achieving 7% increase in sales of the company, thus helping to raise productivity and competitiveness.

Keywords-Application architecture; SME; Enterprise architecture; e-commerce

I. INTRODUCTION

Productivity and competitiveness of the Small and Medium Enterprises (SME's), are important, because they provide a high rate of employment, the Secretary of Economy estimates that 7 of each 10 employees work in SME's [1].

Therefore, it is necessary to create a strategic solution to improve the capabilities of these companies and respond quickly to the challenges, either business related or technological, which is today's markets demand [2].

Enterprise Architecture (EA) is a methodology to provide companies with a framework for the use of information on business processes in ways that support the business strategy [3].

The framework was created to provide a disciplined approach to managing information systems, and professional communication that would allow the improvement and integration of tools and development methodologies [4].

Recently the framework was updated by Ross, Weill, and Robertson [5], cited by Bijata and Piotrkowski, where the concept of Enterprise Architecture as Strategy (EAS), has been proposed as an enterprise framework, composed of three elements, operating model, enterprise architecture, and information technology cooperation model; established as an improvement of enterprise architecture, for an adjustment in the strategy of the organization [6].

Harrel and Sage have mentioned that the key to developing Enterprise Architecture is located in:

- Business processes.
- Data for processes.
- Technology.
- Interfaces with customers.
- Applications software.

where each factor has its own architecture and develops its own tools that support it [7].

In Singapore, a research project of strategic alignment between the business model and Information and Communication Technology (ICT) was developed, in the form of an architecture for small and medium engineering and construction enterprises, focused on four shafts, business strategy, strategy of ICT, business or organizational infrastructure, and infrastructure of ICT [8].

This project was established, looking for the transformation of the business sector aforementioned, to prepare them to face the challenges of the XXI century, supported by ICT, designed to acquiring new skills, using a framework of enterprise architecture, the results of the study were [8]:

- Some companies do not consider ICT as strategic to their business.
- The practice of using ICT is mainly in administrative functions.
- The exploitation of ICT for improving the technical areas is low.
- Insufficient professionalism.
- Shortage of professional and technical personnel.
- Insufficient use of technology.
- Methods of unproductive operation.

- Involved in domestic markets.

Ahlemann et al. [9] have proposed the EAM as a way to deal with organizational complexity and change, make it strategic for business management.

These studies have shown that results of strategic alignment between ICT and business strategy are similar in other countries.

One important activity of the pre-construction of the Applications Architecture (AA) was the analysis of business model, and the strategic planning, which discusses, among other things, the mission, vision, geography, competitive advantage, customers, suppliers, enterprise services, and other important factors that relate to the definitions of the business.

The AA is a partial architecture of the Enterprise Architecture, that aims to define the best kind of data needed to manage and support business processes applications, also known as conceptual applications model [10].

In the AA, it identifies every possible application to manage the data and support the business, considering the strategic use of ICT for competitive business advantage. As an increasing number of functions and processes within companies, it has also increased the number of computer-based information systems, which are improving the efficiency and quality of the areas and processes that support [10].

The AA is a definition of what applications will manage data, and provide information to people running business processes. Applications enable the Information Systems (IS) function to achieve its mission; this is to provide access to the necessary data in a useful format at an acceptable cost.

Using as a source of information, the definitions of data architecture, the data-matrix functions, the business model, and the applications list, to propose candidate applications.

In this case study, an applications architecture was designed, like a partial architecture of an enterprise architecture, considering key processes in manufacturing SMEs, the best practices and business modeling tools that use these companies to develop it; with the objective of supporting them in increased productivity and competitiveness. An improvement proposal was designed and implemented [11].

The methodology for the case study is shown in Figure 1, where the requirements analysis began with the description of the current applications.

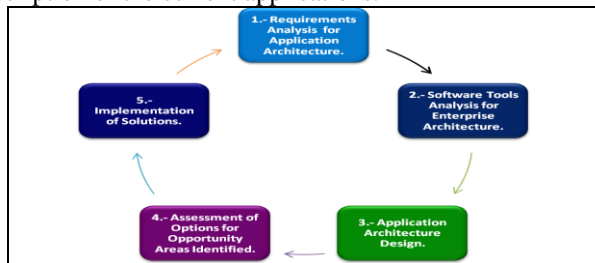


Figure 1. The methodology for AA.

The next step was a search of software tools for EA, looking for accessible tools for SME's. The selected software was Essential Architecture Manager 3.0 [12], the Figure 2 displays one view representing application capability summary, which is searching for suitable software solutions to SME's.



Figure 2. View of Essential Architecture Manager for AA.

The AA was designed (the next section describes the AA design widely), the assessment of options for opportunity areas identified, and finally the implementation of the solution.

The organization of this paper is as follows; Section 1 is mentioning the concepts, studies about applications architecture, and the methodology used in the case study; Section 2 describes the Application Portfolio Management (APM), as well as, the information required for the design of the application architecture from the company; finally, the implementation of the solution derived from the analysis is shown.

A. State of the Art

Op't et al. [13] have identified enterprise architecture as a key driver for governing the changes in companies, ensuring compliance in the implementation. Bernard [14] has defined EA as a holistic management, planning, and documentation activity, and has introduced the EA Cube Framework and implementation methodology. Where were defined lines of business as five sub-architectures, and three common thread areas.

- Strategic initiatives.
- Business services.
- Information flows.
- Systems and applications.
- Technology infrastructure.

The three threads are:

- Security.
- Standards.
- Workforce.

“Newer approaches as business services, exemplifies how EA can link strategy, business, and technology components across the enterprise within a service bus that encompasses platform independent horizontal and vertical EA components” [14].

Some frameworks were updated for including EA as a requirement, Control Objectives for Information and Related Technologies (COBIT EA), repositioned as a business framework for the governance and management of enterprise IT, defining EA such a requirement; the domains for EA in COBIT, namely business, information, data, applications, and technology [15].

EA involves key elements as, strategy, business, and technology; considering the basic Zachman’s Framework [3], and notions from Spewak [9], and the new proposals as EA Cube Framework [14].

The applications architecture proposed in this paper has considered, analysis of the current applications, identifying priority processes, developing and assessment of solutions for achievement support on strategy business and technology, which are related with the general assumptions of EA, in applications architecture level.

Figure 3 shows the proposal for applications architecture.

Agility and effectiveness in operations of the manufacturing processes, as also, data sharing across the company, were some of the advantages of using this proposal.

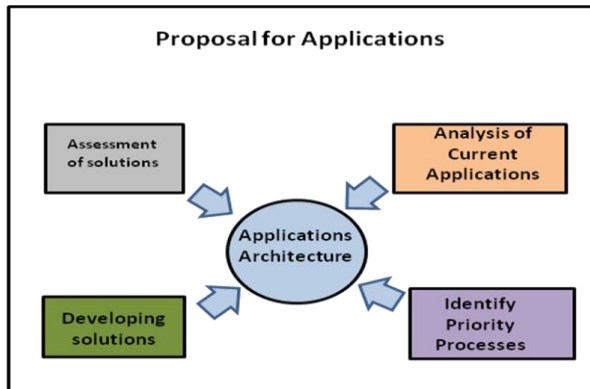


Figure 3. Proposal for Applications.

II. NOTIONS

Some researchers have identified 5 fields or categorizations related to decision making in IT [16]:

- IT Principles.
- IT Architectures.
- IT Infrastructure.
- Business needs and applications.
- IT Priorities and investments.

This set of activities have been named: The Application Portfolio Management (APM), shown in Figure 4, with the tools for each categorization [17].

Categories:

- IT Strategy: Is defined and governed by the central IT staff, who report directly to the CIO (Chief Information Office) or executive office information, considering strategic maps, strategy business, Scorecard for ICT, and Key Performance Indicators (KPI’s).
- Business application needs: These needs are analyzed according to the business requirements, using Business Processes Modeling (BPM), diagrams of the company and Use Cases.

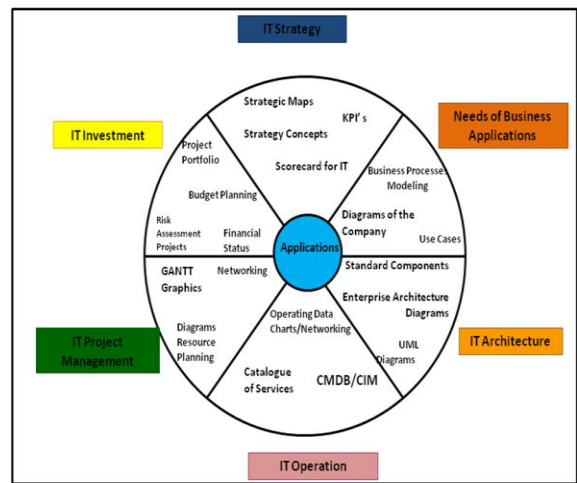


Figure 4. The Application Portfolio Management [17].

- IT Architecture: Is developed and maintained by the staff, using standard components, Enterprise Architecture diagrams, and UML diagrams.
- IT Operation: The operation is managed by the teams responsible for data centers and networks; staff also supports users in daily work, considering some tools like: Operating data charts, configuration management databases (CMDB), and catalogue of services.
- IT Project Management: Designed by staff dedicated to IT projects according to priorities, and using networking, Gantt graphics, and diagrams resource planning.
- IT Investment: Planned, negotiated and controlled by the central IT staff by cycles of annual budgets, considering project portfolio, budget planning, financial status, and risk assessment projects.

The IT staff provides support in all categories related to APM.

The AA is the conceptual model of business applications, composed of software applications to support business processes; the basics premises for construction of AA are shown in Table I, where the objective has been defined as the best kinds of applications to manage data and support the business processes, by using Essential EAM, as a repository for the instances obtained [18].

The technological domains identified by the EAM for applications were: systems implementation, environment services, integration services, business systems, business support services, and systems management. Each one has a set of capabilities executed by applications. In Figure 5 the domains and capabilities are shown.

TABLE I. OBJECTIVE, PRINCIPLES AND CAPABILITIES FOR AA.

AA	Name	Description
Objective	Define the best kinds of applications to manage data and support business processes.	Define the best applications that support the business processes.
Principle	Customizing minimum packaged applications.	Minimize app package, customization will improve the ability to ensure ongoing maintenance and maximum value obtained from the adoption of a package solution.
Capabilities	Analysis, design, programming and implementation of information systems. Search packaged solutions tailored to the needs of the SME's Provide technical support for software and hardware throughout the company.	Domain in the analysis, design, programming and implementation of information systems. Domain in search packaged solutions tailored to the needs of the SME's Domain to provide technical support for software and hardware.

This set of capabilities represents the broad domain for the applications in the companies. The IT staff must consider the capabilities required for the optimum functionality of the applications.

A. Information of the Applications Architecture

The first step was to collect the information about the current applications of the case study firm, for this purpose was applied a description format including the next data.

- System name.
- Project manager.
- User department.
- User contact.
- Description.
- Status.
- Long-range issues.
- Business processes supported.

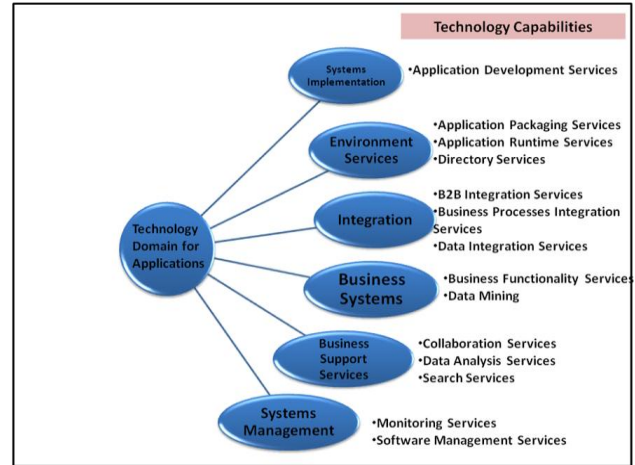


Figure 5. Technology domain for applications.

Technical aspects of the applications:

- The equipment, hardware, or physical technology platforms used.
- The networks or communication platform used.
- The software platform used.
- Preceding systems (systems that must execute before the application).
- Succeeding systems (systems that can be executed after this application has been run).

The format was applied for each application in the firm. Subsequently, the activity for to relate the applications with the business processes of the company, was developed.

Opportunity areas for application and improvement were detected.

Table II, shows some data for the matrix of business processes-applications.

Other documents that have been analyzed for AA were:

- Data diagrams [19].
- Business model [10].

B. Design of the Application Architecture

The design of the AA has included some components that describe the context for applications, which are:

- Applications information.
- Applications function.
- Applications supported by business process
- Executed by people roles
- Relation to business process.

Figure 5 displays the components of the AA.

TABLE II: INSTANCES OF APPLICATION ARCHITECTURE.

Name	Description	Domain of App	Performed by business processes
Stock Information System	Management of the inputs and outputs of the company general store.	Update catalog of items, articles inventory processing.	Registry inputs and outputs of goods and raw materials.
Quality	Spreadsheets records quality of finished products.	Data of finished products according to production plan.	Verify the manufacturing process according specifications with production.
Client IS	Manage Client Portfolio.	Update Clients Portfolio, Electronic Billing.	Client Portfolio.
Financial IS	General Financial System.	Update chart of accounts, sub and sub-sub. Update Cost-Centers.policies for debit and credit accounts. Update the information of credit banks.	Accounting Manager.

The basis for the objective, principle, and capabilities for AA were previously shown in Table I.

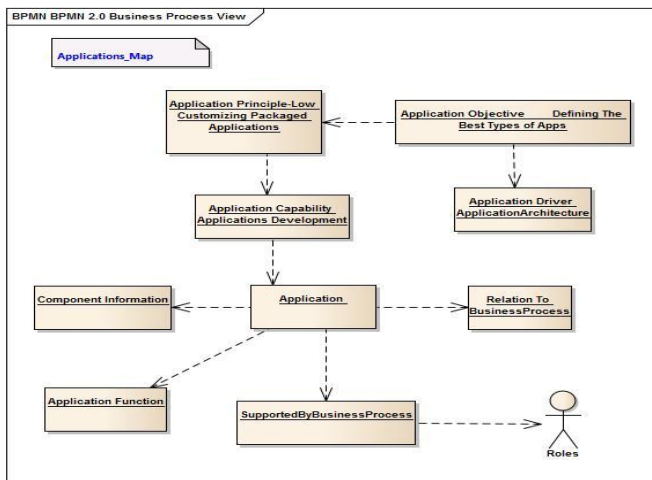


Figure 5. Application Architecture Design.

C. Needs Identified

The company has the applications support for the management processes with IS in: Distribution, Finances, Clients, Sales and Marketing, Product development, Stock and others management processes, which are shown in Table III.

The production and quality processes are supported by spreadsheets, as these processes are essential in this industry, has been programmed the acquisition, in short

term, of software to streamline processes throughout the logistics chain.

By the other hand the electronic commerce is null, then the recommendation is begin with a basic website that including information about:

- Background of the company.
- Products and services.
- Scheme of manufacture.
- Quality model.
- Clients.
- Contact.
- Important information about the company.

The website was implemented by September 2013; a rise in the sells was of 7% during the next two months.

The graphic with the access statistics website is shown in Figure 6.

We are stressing-out that the company did not have a website before, only mentioned in some industrial directories as “Infomaquila”; when entering the e-commerce in this first phase, there has been an increase of the hits and visits to the website, resulting in a rise of the customers and sales.

TABLE III: APPLICATIONS OF THE COMPANY.

Company area	Application	Activities
Distribution	Shipping Information System.	
Finance	Finances Information Systems.	
Human Resources	Personnel administration.	Detect training needs of business areas, especially productive areas for develop entrepreneurial training program.
Investment Administration	Investments of the company.	
IT	Provision of IT support for company's business processes.	
Quality	Manufacture that meets production specifications.	Testing and inspection using ultrasonic methods or industrial inspection.
Sales and Marketing	Management customers. Customer service.	Continuous communication with customers to identify needs and complaints.
Stock	Register the inputs and outputs of goods and raw materials.	Suppliers management.
Product development	Program production cycles.	Cutting, marking, machining and forming of steel plates and profiles.

The improvement proposal will be gradually implemented, starting with applications and technology that directly impacts on priority processes as quality and production; continuing with human resources processes, the Table IV shown estimated resources for opportunity areas.

TABLE IV: ESTIMATED RESOURCES FOR OPPORTUNITY AREAS.

Application	Estimated price	Delivery time	Requirements for installation
Manufacturing System	\$ 3,000.00	60 to 80 days.	Windows Server 2003 or higher, 2 Ghz or higher processor, 4Gb Ram, SQL Server Express Edition.
Information Systems for Management Training.	\$ 1,000.00	21 to 30 days.	Windows 7 or higher.
Proposal to integrate e-commerce	\$ 1,000.00	21 to 30 days.	Windows Server.

Approximate calculations to June, 2014 in USD.

The manufacturing system has been the most important need detected, since it would share information with production and quality, furthermore shipment and finances.

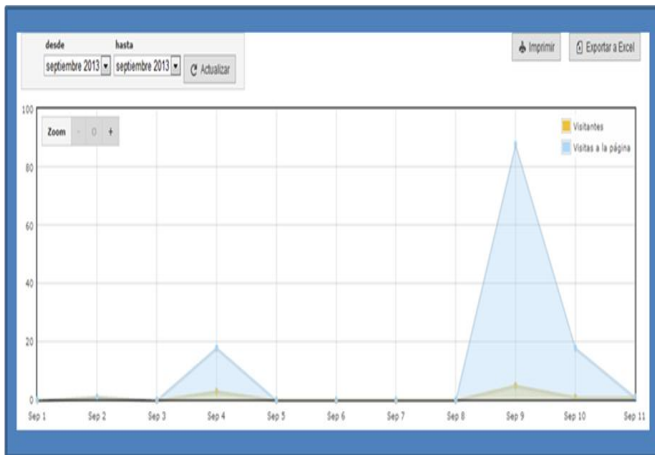


Figure 6. Access statistics website

The next stage of the website is to add popular search engines like Google, Bing, and, Yahoo; links and social networking accounts, Google maps location, bilingual website, online payments through Paypal system, and others internet characteristics.

III. CONCLUSION

The final recommendations are for using software, hardware, and next generation networks, with efforts of successful practices for manufacturing industry that would support key processes, and help incorporate them into international markets, always looking for a return on efficient investment.

This project helped to meet the needs of SME's companies to propose affordable solutions that make business management resources and technology to solve problems.

The contribution of the paper focuses on the improvement proposal for the case study firm and the development of applications solutions, detected by the analysis.

The AA takes components of the Business Architecture, and is associated with the Technology Architecture to produce the EA complete.

Other findings in terms of improvement were: SME's have demonstrated alignment with business strategy to drive a strong organizational culture and technological infrastructure.

The company has acquired new skills through ICT.

The sharing of information with customers and suppliers has improved considerably with the use of e-commerce and networking.

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