PRODUCT LIFECYCLE MANAGEMENT (PLM) AS A STRATEGY FOR PROJECT STRUCTURING AND COORDINATION

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Successful Project Management (PM) comes from the combination of skills, knowledge, tools and techniques to strategically plan, execute and control projects with a variety of requirements and constrains. In recent years, there has been an increased interest in implementation methodologies that not only allows successful PM, but integrates Product Lifecycle Management (PLM), Business Process Modelling (BPM) and Business Process Re-Engineering (BPR) in order to achieve efficient planning and execution under low margin profits and strict time constrains demanded by clients. In this paper, an integrated approach for product design and development in Small and Medium Enterprises (SME) that requires PM and information integration is presented. As a result, an implementation methodology in the Architecture Engineering and Construction (AEC) industry is proposed. This methodology is applied to support the design and construction of waste treatment plants and includes a novel PLM implementation strategy that considers mechanisms that offer high potential for developing countries.The design of the proposed approach is presented including how engineering processes were identified, analyzed and improved through BPM and PLM; the approach emphasizes in the standardization of process management guided by PLM tools through workflows. This aims to impact coordination and efficiency in the company's NPD process.

Keywords: *Project Management; Product Lifecycle Management (PLM); Business Process Modelling (BPM)*

GESTIÓN DEL CICLO DE VIDA DEL PRODUCTO (PLM) COMO ESTRATEGIA DE ESTRUCTURACIÓN Y COORDINACIÓN DE PROYECTOS.

La gestión exitosa de proyectos (PM) comprende desde la combinación de habilidades, conocimientos, herramientas y técnicas hasta la planeación, ejecución y control estratégico de proyectos con gran variedad de requisitos y restricciones. En años recientes, ha habido un interés en metodologías de implementación que no solo permitan PM, sino que integren la gestión del ciclo-de-vida del producto (PLM), la reingeniería y el modelamiento de procesos de negocios (BPM), parar lograr una planeación y ejecución eficiente bajo estrictos márgenes de rentabilidad y tiempo.Este artículo presenta una propuesta para el diseño y desarrollo de productos en pequeñas y medianas empresas que requieran PM e integración de información. Como resultado se propone una metodología de implementación para la industria de la arquitectura, ingeniería y construcción, e incluye una estrategia de implementación PLM que considera mecanismos que ofrecen alto potencial para países en desarrollo. La propuesta muestra cómo se identificaron, analizaron y mejoraron los procesos de ingeniería a través de BPM y PLM; esta enfatiza en la estandarización de la gestión de procesos asistida por herramientas PLM a través de flujos de trabajo. Con esto se pretende impactar la coordinación y eficiencia en el proceso de desarrollo de nuevos productos de la compañía.

Palabras clave: *Gestion de proyectos; Gestión del ciclo-de-vida del producto (PLM); Modelación de procesos de negocio (BPM)*

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1 Introduction

During the New Product Development (NPD) process (Merminod and Rowe, 2012), the difficulty to implement and supportive tools and methodologies for Project Management (PM), the diversity and complexity of projects, and dynamic and changing environments increase the difficulty of correct project coordination (Forcada, 2005).

Additionally, increasing market demands for reduction in time-to-market, flexibility and improvement in quality has forced companies to standardize processes and define best practices for project management (Jutras, 2010). Successful PM comes from the combination of skills, knowledge, tools and techniques to strategically plan, execute and control projects with a variety of requirements and constrains (PMI, 2009).

In recent years, there has been and increased interest in implementation methodologies that not only allow successful PM, but integrate Product Lifecycle Management (PLM), Business Process Modelling (BPM) and Business Process Re-Engineering (BPR), in order to achieve efficient planning, programming and execution under low margin profits and strict time constrains demanded by clients. The strategies towards efficient PM may facilitate and increase the company's response to changes and avoid repetition of former mistakes by providing real time information and supporting an up-front decision making process, thus increasing customer satisfaction due to effective delivery.

Strategies towards improved business performance such as PLM and BPR facilitate collaboration among distributed participants specifically in the product design process (Westkämper et al., 2001; Morris et al., 2004). They also contribute in knowledge, enhancement, project and process reuse, as well as quality improvement through standardization (Briggs, 2006). PLM aims to maximize the value of current and future products for both, customers and stakeholders (Stark, 2011). However, without a correct understanding of the PLM strategy, and its implementation, companies will fail to exploit its advantages. It is necessary to incorporate business process understanding and PM, in order to fully implement a PLM strategy.

In this paper, an integrated approach for product design and development in Small and Medium Enterprises (SME) that requires PM and information integration is presented. As a result, an implementation methodology in the Architecture Engineering and Construction (AEC) industry is proposed. This methodology is applied to support the design and construction of waste treatment plants and includes a novel PLM implementation strategy that considers mechanisms that offer high potential for developing countries.

2. Background

AEC industry relies on complex know-how, provided by multiple project participants to design and construct engineering buildings and production facilities. The main goal of these companies is to deliver projects as close to the contractual delivery date as possible, ensuring an improved profitability and achieving customer satisfaction (Jutras, 2010).

In a project base, task oriented industry such as the AEC case, efficient planning, programming and execution under low margin profits and strict time constrains are achieved through the proper use of tools, methods and techniques to capture, re-use and produce knowledge as a result of constant project analysis and feedback.

PM in AEC industry presents a significant challenge for effective collaboration across all stakeholders. The key to project profitability is delivering project on time and under budget. This requires optimal standardized best practices in project management and project management solutions (Jutras, 2010).

Engineering products developed in AEC projects are the result of a sequence of activities defined by an engineering process that includes related resources, cost, information flow and parameters. The introduction of standardize processes set accordingly to the company's characteristics and the use of IT systems to provide real time visualization ensures the traceability over project execution. Accordingly to AEC studies (Forcada et al., 2012), 67% of these industries only focus on updating or changing practices reactively after problems arise rather than proactively when new knowledge indicates potential enhancement. Moreover, studies show that one of the main drivers for poor performance in these industries is the improper management of changes introduced after project start with a 40%(Jutras, 2010).

The engineering process planning may be restructured through the use of BPR with the purpose of improving process efficiency, reducing project development cycles and include the extended enterprise into the company's perception. This is achieved through the identification and analysis of the current engineering process (known as the AS-IS model) and the creation of an improved process (known as the TO-BE model) applying BPM tools. Process based working methods demands to reshape the enterprises organizational cultures to emphasize team work, personal accountability and customer importance (Hammer, 2007). In addition, this enhancement requires integration of BPR methods with PLM strategies and tools that incorporate an understanding of business processes and facilitate knowledge transfer.

PLM is not exclusively a software tool, but also a business strategy for creating a product-centric environment (Ameri and Dutta, 2005), to manage the product lifecycle, from generating an idea, concept description, business analyzes, product design, solution architecture and technical implementation, to the market, service, maintenance and innovative product improvement, through the management of intellectual capital that is generated around it, in the extended enterprise, by integrating people, processes and resources supported by an organizational culture that can be supported on a technological platform (CIMDATA., 2002; Grieves, 2006; Pol et al., 2008; Stark, 2011) with the objective of filling the gap between enterprise business process and product development.

3. PM in AEC industry

AEC projects are unique in macro terms (e.g. context, site, client requirements, etc) but similar in associated components such as processes, team structure, tools and working methods (Kamara et al., 2003).These processes are usually divided in two macro stages: design and construction. The dynamic or linear approaches of these stages, either for managing the constant iterative developments resulting from the insights gained and propagated in to next version of the design process (Bouchlaghem et al., 2005) or the linear and mechanic approach necessary for accuracy in the construction stage (Kamara et al., 2002), requires the creation of an integrated model towards PM supported in tools such as workflow automation, document management and change management to ensure synchronous developments (Jutras, 2010).

The strategies taken to accomplish projects successfully are linked to the organizational characteristics given by some interdisciplinary factors (Carrillo and Chinowsky, 2006) such as (1) organizational culture: regarding project management planning, execution, control activities, and information management methods used across the extended enterprise, (2) Approach to learning: related with the applied methods to capture lessons and disseminate them across the organization, (3) Available systems and technology. These factors may increase the organization efficiency in developing projects or may keep the fragmented state between project teams and the inconsistent project developments.

Project managers must integrate a set of constrains in order to ensure proper planning, execution and monitoring of project stages; such activities seek to achieve client requirements successfully, within the time constrains, the expected quality, and the established budget (PMI, 2009). In addition, changing goals and requirements during project lifecycle is a common challenge in project development, thus project managers must be able to take any corrective or preventive actions proactively, and eliminate failures by constantly analyzing possible improvements (Steffens et al., 2007; Jutras, 2010). These tasks entail real time visualization, information consistency, document management, and synchronous execution of individual processes for the project such as financial processes and hiring processes (Jaafari and Manivong, 1998; PMI, 2009).

PLM systems provide the means to integrate processes, roles, information flow, metrics and the means to storage, share and transfer knowledge, thus the managerial project role changes from one of controller and supervisor to one of supporter and facilitator (Hammer, 1990). This new perspective demands to redefine roles and responsibilities so that managers oversee the processes instead of activities, develop people rather than supervise them and realign an information system so they help cross-functional processes work smoothly rather than simply support departments (Hammer, 2007). In addition, by integrating technological systems, the company is able to eliminate redundant data entry along with the inevitable errors derived from information inconsistency (Hammer, 1990).

4. Proposed approach

The proposed methodology is an alternative approach for design and development of projects that requires a strong PM and information integration in SMEs.

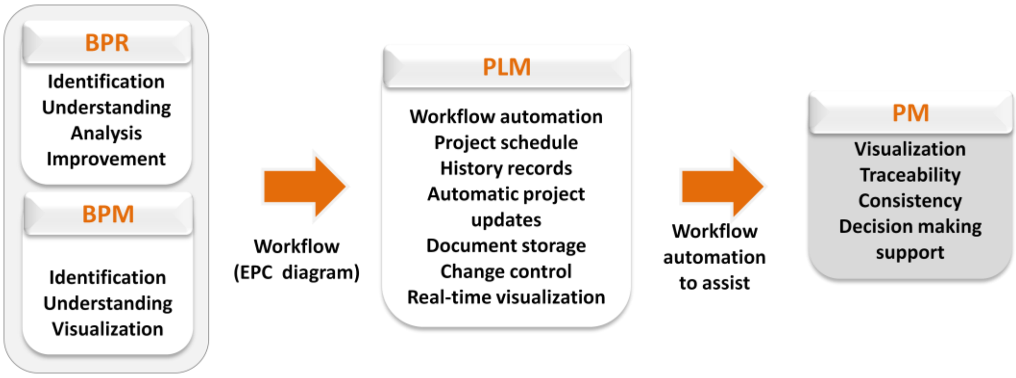
PLM implementation strategy seeks to standardize the process models through BPM automation tools (e.g. workflow engines) that associate roles, activities and project documents in one single environment set for project development and execution. This environment provides the tools to control and highlight project aspects such as time, cost, duplicated effort, and unnecessary constrains.

BPM methodology seeks to understand, visualize and standardize a company’s engineering process through the identification and representation of roles, sequences of activities, interactions, information and technologies used in the company to develop successful projects regardless of geographical location, staff and complexity and accordingly to the company guidelines and expectations. In addition, the understanding of the engineering process helps to highlight mistakes and possible improvements in current processes. New improved models may be created after a carefully analysis of current processes. Projects are extremely variable but share common elements, the created processes should be flexible enough to fit a set of projects and ensure the completion of tasks, the execution of revisions and the convenient communication of problems and solutions. The integration of BPM inside the PLM strategies provides a coherent approach for process modelling in order to be implemented in the PLM software.

With this in mind, an integration of a loosely coupled PLM environment is proposed to support the design and manufacturing processes and facilitate project coordination (see Figure 1). PLM is used in process management and project coordination integrating several elements: (1) information storage and retrieving, (2) decision-making support system, (3) organization involvements during the core business processes (4), and processes modelled through workflows and Work- Breakdown-Structures (WBS).

One important element of PLM is the use of technological tools. Information technologies help to share and distribute information and knowledge in a company and transcend to all the stakeholders. Information derived from customers, manufactures, vendors and, suppliers is easily created and accessed with the aid of user interfaces and databases.

Figure 1: Methodology integration scheme.



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5. Case study

The methodology presented has been applied within an ACE company to support the design and construction stages of waste treatment plants.

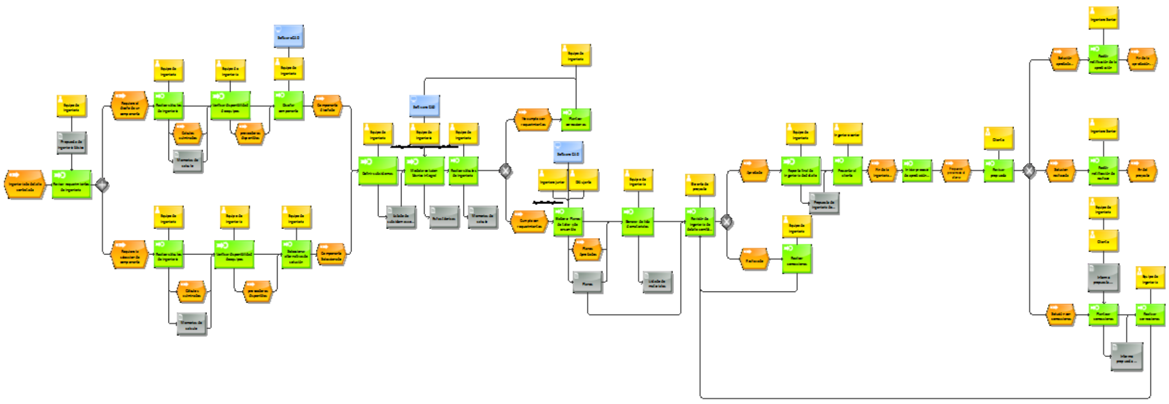
The interest of the company was tackled from identified difficulties such as: (1) low profit margins for the construction industry, (2) low reliability and control over engineering process performance resulting in constant project overruns, (3) increase delivery delays due to impaired planning, (4) lack of standardized processes and application of best practices in design and construction stages, (5) constant re-work and repetitive mistakes unsolved by the absent historical information, (6) contractual difficulties with clients and suppliers due to constant changes during project execution, (7) Lack of real time project visualization resulting in low response to project changes, (8) Lack of performance indicators to monitor project execution, (9) information inconsistency; duplication and outdated data.

Project managers are blind during project planning and execution. They experience a lack of control over the project requirements associated with quality, budget, scope, risk, schedule and resources. Moreover, the company faces new challenges in the international market which entails higher demands on project management skills.

PLM strategy integrates process and information in a common environment that enhances consistency of information in real time, thus, project managers may find this strategy the means to properly monitor projects in real-time. However, SMEs have typically a reduced investment capability, causing limitations to acquire robust licensed PLM software. Considering the company's economic constrains, the implementation team chose an Open Source alternative that provides the same applications of standard PLM software that is open for configuration according to the company's needs.

BPR methodologies deployed in the company allowed the implementation team to identify value activity sequences and the elements surrounding them such as roles, inputs, outputs, events, interactions, information and technological tools. To increase the understanding and visualization over the identified processes the implementation team chose Aris Express BPM tool (Ameri and Dutta, 2005) to create the process models. These deployments drive the organization to understand a project as a sequence of activities deployed to achieve an unique result, where knowledge transfer and project information consistency becomes fundamental to guarantee task completion. Subsequently, efficient project development enables the identification of an accurate set of activity sequences that guarantee project efficiency and may be transformed in to a standard process that ensures the future repetition of successful activity outcomes, thus the repetition of efficient projects.

Figure 2: EPC diagram.



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An AS-IS model (see Figure 2) generated with ARIS Express tool using Event-driven Process Chain (EPC) diagrams comprising the core engineering process of the organization resulted from the application of BPR methodologies. Five stages were foreseen in waste treatment plant design and construction. Each stage was detailed and analyzed in order to (1) ensure activity sequences coherency with their associated subsequent events, (2) fill the gaps with possible best practices, (3) eliminate those activities that had no value in the process, and (4) state the control points for the process. In addition, the complete operational information regarding approvals, interactions, role profiles and current documents was identified. Each identified role was associated to its corresponding activity (from which it is responsible for) and each corresponding input and output documents were detailed. The decision making events were set along with their corrective, approved and rejected possible paths.

The AS-IS process presented deficiencies in different levels of project development that decrease the project manager visualization of proper project development:

- Activity completion: the identified process was suitable for any waste treatment construction plan. However, the time constrains set for project development are so narrow that achieving delivery in the current developments required the overlook of some critical activities that may risk proper planning and adequate quality of engineering developments. Although these activities were identified as critical, no associated information was available to ensure how many times these activities were done or how many times were neglected due to the lack of historical performance indicators and real time schedule updates.
- Traceability: 92 activities resulted from the processes identification; 34 of them had records, meaning that 64% of the process occurred without keeping any associated records. The small amount of resulting records, lack of information standards and conventions. In addition, the absence of instructive documents indicating the proper execution activities increases outcome inconsistency and compromises process efficient performance. Additionally, the information regarding the environmental regulation documents, the technical regulations for waste treatment plant construction

among others was disorganized, lost or outdated. As a result project managers had no guarantee of quality engineering developments.

- Milestones and project control: Project revisions were performed, however no records were available to gather and share critical changes made towards project achievement. Duplicated effort, re-work and mistakes repetitions are usually originated from a lack of change control and history records. Identification of failure in the process was not explicit, thus deficiencies were repeated in other projects. Decisions regarding critical activities such as contractual matters, budget issues and regulation standards were absent due to the lack of participation of critical roles such as lawyers, accountants and environmental experts. In addition, regarding outsourcing weaknesses related to supplier's management, no contact information was kept and the lack of evaluation activities on the supplier performance implies constant mistakes in evaluation and selection procedures.

The TO-BE process was configured to improve the AS-IS deficiencies; particularly in the project traceability strategies, revision management and information management. Instructive manuals were suggested for every activity complex enough to require specific instructions to ensure qualified outcomes. The creation of pre-established forms to fulfill in every project activity ensures permanent up to date records and provides historical project memories, thus allowing the posterior analysis and improvement of deficient activities. The information created will remain in the company's repository and it will be available for re-use in future projects. The records of revision will be also stored; decisions taken during revisions will be available for posterior consideration. The TO-BE process sets the roles participating in every revision according to the needs of the evaluation carried out in the process timeline. These revisions will also derive in approvals, rejections or corrections of the project activities.

Process standardization creates a working discipline among project teams, ensures quality outcomes and avoids critical activity and control point overlook, the activities set in the process are the result of the consolidation of the knowledge gathered in different bodies of know how through experience and validation, therefore the created processes are convenient for this company's characteristics and strategies alone.

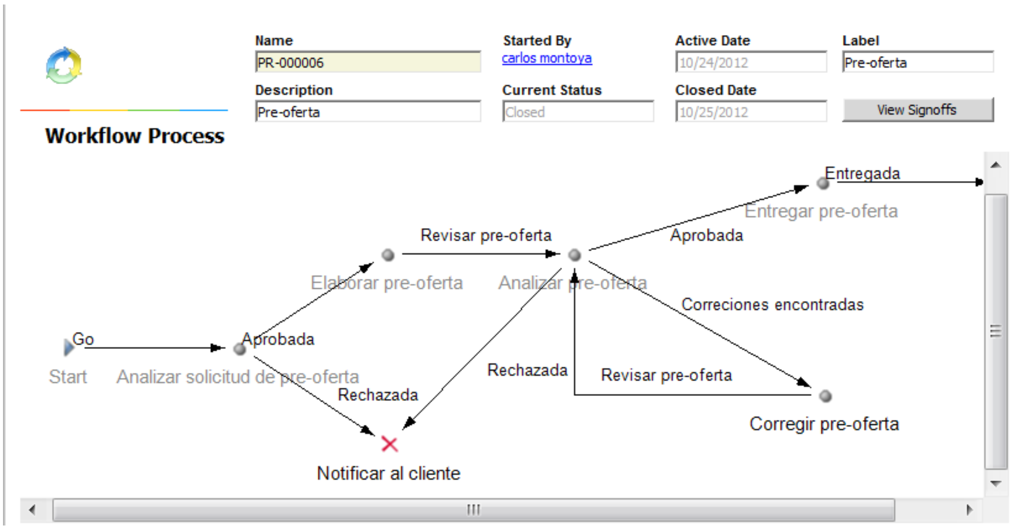
On the software matter the activities selected for the TO-BE processes were automated. The system records each step taken by the employees and give traceability of each process performance. The information regarding the performance of the supplier may be easier and faster to trace. Revisions are supported by the system, being automated in order to promote a disciplined working schedule and an efficient response for the customer. In addition, the search engines provide up to date information in an organized way, avoiding the loss of relevant project documentation.

The new process has an automated measurement method to gather performance indicators information in order to provide on-time decisions, historical efficiency records and justify activity improvements. The resulting records must remain under a standardized document control method and naming conventions.

The PLM implementation, and specifically the software tool, was applied to a specific project currently developed in the company. Aras Innovator (Arascorp, 2011, 2012) was selected due to its free availability as an open source PLM software that is based on a service-oriented architecture.

One important aspect was the standardization of process management guided by PLM tools through workflows (see Figure 3). The benefits were in project performance analysis, centralization of information and consolidation of project information. For each process identified with BPM, a workflow was modelled in Aras Innovator, including the activities, assignees and tasks. For each workflow, the lifecycle and permissions involved in the process were defined.

Figure 3: Process implementation in PLM



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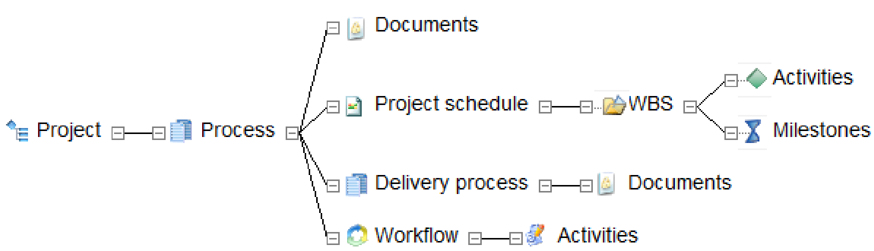
The software configuration also required the development and personalization of different modules that supply the functionalities required by the company. In so doing, different modules were used in the implementation such as project scheduling and document management. Here, different activities were defined to develop structure and organize data. The result is a data structure represented in PLM that allows users associate members with activities, components and documents. Also, a structure expressed through variety of relationships such as project structure, activity structure and data structure was created (see Figure 4). One final step was the training of the company personnel in the new methods proposed including the PLM software as well as the processes.

Figure 4: Project structure.



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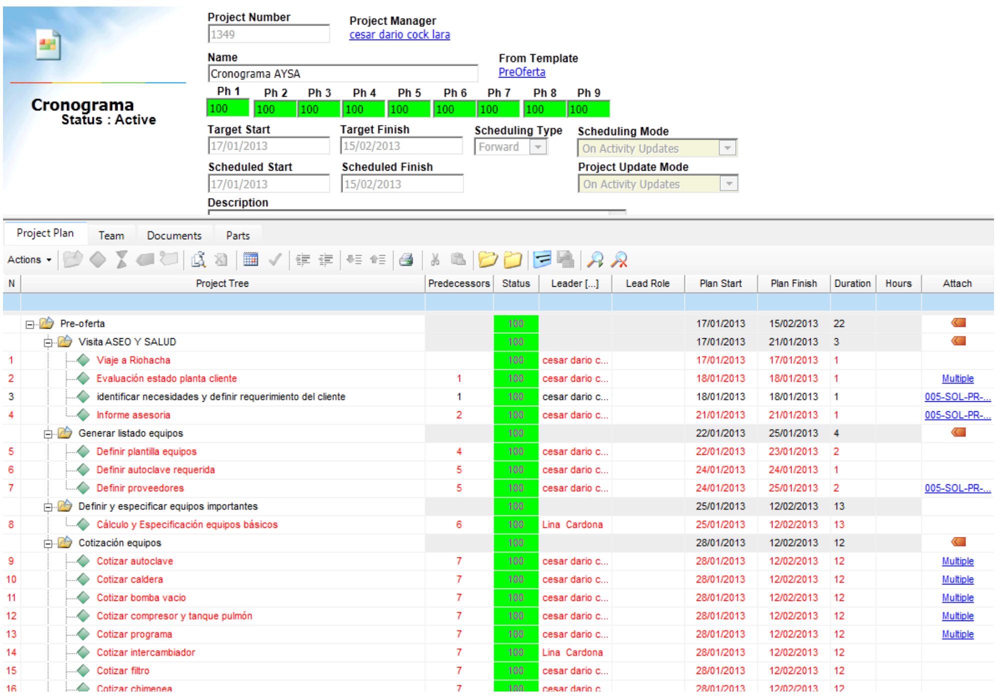
BPR methodologies suggest to tie the metrics to a clearly understood process and to have a supporting tracking mechanism. It is also crucial to implement a project level process that identifies major milestones, timings, assigned actions and ownership responsibilities (Siemens, 2009). In this particular case, both necessities are supplied by the PLM software, thus, the unit has a common framework and language that enhances the effective management of metrics. A set of Key Performance Indicators (KPI) are implemented in order to have a close follow up of the process on track, the project completion and the missing targets of the projects. Executive dashboards are created to facilitate the traceability of activities, time of execution and failures. It also offers visualization into consolidated information. By being able to review numerous reports in dashboard format, executive managers have access to all the vital product development metrics required to asses performance (Siemens, 2009), in order to find where improvements can be made. This crucial functionality enables the company to use highly favored closed loop processes to manage their product lifecycle entire set of processes (Reijers and Liman Mansar, 2005).

The business unit macro projects often need large amounts of time to reach completion; time that exceeded by far the implementation project deadline. An autoclaving project (named AYSA) was selected to apply the automated processes, starting with a *pre-offer* process. The objective of this process is to respond to a project request. This particular process included the participation of a project manager responsible of supervising a senior engineer and a junior engineer; it also involved some other roles of the company such as environmental engineer and a lawyer intervention due to the contractual responsibilities in which the customer and the company were involved. The workflow was initiated as soon as the project manager received an official request, accordingly a set of automated activities were set in motion in the explained order (1) request reception, (2) request evaluation, i.e. rejection or approval of request, (3) request development, (4) request final evaluation, (5) request delivery to customer.

The request was approved by an internal committee meeting and the project manager sent the approved decision through the software automatically enabling the activity of “request development”, the senior engineer created the project schedule with its assignments as shown in Figure 5.

Figure 5: Project schedule



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The autoclaving project began in February first 2013; and was quickly approved and automatically sent to development. The project schedule module was set with 35 activities, a notification alert was immediately sent to each project member with its corresponding assigned activity and the time range given to notify the activity completion. The completion is mandatory, if a project member fails to fulfill the activity in the system, the project will fall behind and so will the activities linked to it. Therefore, the project schedule shows a real time execution of the project activities. Soon the engineers started to focus on the deadlines of the automated activities and the visualization of the project advance, making their own initiatives to ensure the activity completion, thus participation increased. The project manager began to understand the benefits of a real time updated schedule to ensure a project satisfactory outcome, his working methods changed and by the end of the week the project manager had made space to check the project advance every morning, as a result the engineers received either some words of recognition due to the accomplished activities or some action pointers to ensure on time activity completion. All business unit members were granted with access to the PLM Software and the visibility on real time was improved 100% compared with the projects developed without PLM. The project manager revised weekly the advance of the pre-offer process and the system offered him a clear report of each change made by his team (see Figure 6).

Figure 6: Workflow history report

http://190.85.185.154/?view=tab - Report: Workflow Process History - Windows Internet Explorer

Workflow History Report

Item: PR-000005 AYSA — Pre-oferta — Current Status is: Closed
Started By: cesar dario cock lara — Started On: 01/02/2013 11:54:53 a.m. — Completed On: 20/03/2013 11:46:53 a.m.

Activity	State	Assigned To	Completed By	How Voted	When	Comments
Recibir solicitud	Closed	cesar dario cock lara	cesar dario cock lara	Analizar	01/02/2013 12:27:49 p.m.	Se programa comité para enterarlos de la visita a la empresa Aseo y Salud
Analizar solicitud	Closed	Gerentes de Proyectos	carlos montoya	Delegate	01/02/2013 12:34:00 p.m.	
Analizar solicitud	Closed	cesar dario cock lara	cesar dario cock lara	Aprobada	01/02/2013 03:29:03 p.m.	
Elaborar pre-oferta	Closed	cesar dario cock lara	cesar dario cock lara	Revisar pre-oferta	19/03/2013 02:48:52 p.m.	
Analizar pre-oferta	Closed	Gerentes de Proyectos	carlos montoya	Delegate	19/03/2013 05:17:42 p.m.	
Analizar pre-oferta	Closed	cesar dario cock lara	cesar dario cock lara	Aprobada	20/03/2013 11:46:26 a.m.	
Entregar pre-oferta	Closed	cesar dario cock lara	cesar dario cock lara	Entregada	20/03/2013 11:46:53 a.m.	

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The projects previous to the PLM implementation had an average of two effective revisions, the first one was a reactive revision; was only made if the project had a significant problem, the second was at the end of the project, and usually occurred after the project had been delivered to the client. The head managers had no tools to supervise the project and the revisions were not even planned. After the PLM implementation a complete project included six separated workflows and 14 control points, at least two for each process. The workflow control points were mandatory before delivering results to the customer; as a result contractual issues could be avoided. The revisions accelerate the approvals, thus, as soon as the request was developed the project manager received the notification of its conclusion through the PLM software, a meeting was set immediately; as the request cannot be delivered to the customer without the approval of the entire team. A record of each meeting is kept in the software with all the issues revised. Under the advice of the team the project management takes immediate decision on whether the request is satisfactory for delivery or needs changes. The decision he provides to the software enables the automated activities of correction or delivery. Once the request is delivered, the workflow ends and the records become unavailable for change.

The pre-offer was completed in 46 days; all information from the initial request to the final proposal delivered was stored. The business unit information is 100% available, and the research engine improved the document retrieval from hours to minutes. Dates, responsible members and modifications were saved in the software, a total of 33 records. Moreover, before the implementation the business unit lacked of standard documents to ensure activity developments. After the implementation 16 instructive documents, 39 forms, 5 libraries, and three check list were created improving knowledge transfer and information availability from 36% in the AS-IS process to 100% in the assisted TO-BE process for autoclaving projects.

6. Conclusions

In this paper, an implementation methodology for new product development was presented. This approach uses emerging technologies such as PLM and BPM combined with PM that help to reduce communication glitches among project members and identify best practices and processes that would enable companies to increase their control over project development and defining key project milestones and deliverables.

PM relies on information consistency to support decision making processes during project development. A PLM strategy provides the necessary working environment to develop projects within a set of regulatory activities, guidelines and milestones, avoiding duplication of effort and ensuring up to date information to support decision making processes.

PLM strategy and BPR methodology were successfully integrated inside the business unit of an AEC company to improve project coordination. The corporative knowledge was captured and the engineering processes were identified, analyzed and improved through BPR methodology and BPM tools providing an organized way to introduce the combined elements into PLM software modules.

The accesses provided by the PLM software allows monitoring real time activity reports through project schedule and associated records. The project managers can validate the quality of engineering developments, thus, increasing convenient communication of mistakes and non compliance items.

The impact of the methodology in the project management issues, whereas positive or negative, may only be measured after internalizing the process and waiting enough time to gather significant data over project efficiency and productivity.

Workflow automation creates a mandatory working schedule with distributed activities that is versatile enough to include variable project schedules according to project characteristics and also keeps the necessary control points and activities to guide the project to a successful outcome and permits to follow the right procedures if an anomaly is presented during development. It also ensures the proper recording of project records.

Before the PLM implementation, the business unit projects were not closely monitored. The Project manager only received information after a serious problem emerged or at the end of the project. The lack of project control resulted in delays, legal issues and budget overruns. The PLM software provided a real time visualization of project developments available for all engineers and managers of the business unit. Two benefits derive from this application (1) the commitment of the team members increased and each engineer had its own initiatives to keep the activities on track eliminating the need to constantly supervise their work and (2) the managers knew on a daily basis the project advance. The real time information improves the proactive decision making process.

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