Linking project management to an EAM through workflow*

Marisa Padovani
University of São Paulo
marisa.padovani@poli.usp.br

Monica Rottmann de Biazzi
University of São Paulo
monica.rottmann@poli.usp.br

Marly Monteiro de Carvalho
University of São Paulo
marlymc@usp.br

Abstract: The present work discusses the importance of merging enterprise asset management systems (EAM), workflow systems and project management methodologies in order to achieve success in project activities. It also presents existing gaps between theory and practice found in the research developed in a large size Brazilian chemical and petrochemical company. It was adopted in this paper the action research method performed in a large size Brazilian chemical and petrochemical company. This paper attempts to contribute to increase the performance of management of projects eliminating existing gaps through the application of the project management model developed. As results of this work we have found that the model developed allows for a better utilization of material and human resources, as well as automation of implementation activities, in order to assure information reliability and obtain the project status in real time to enable decision making.
Keywords: EAM, ("enterprise asset management system"), project management, workflow.

1. Introduction

Since the decade of 1990, with the advent of globalization, Brazilian organizations were forced to face an unknown competition environment. This new scenario stimulated the organizations to review their strategies and processes in order to raise productivity through cost reduction, fulfilling deadlines, margin increases, reliability and flexibility. In this new competitive scenario, firms had to adjust themselves to new rules in order to survive.

In this turbulent context, organizations are being led to dedicate more time to projects implementation, either to adjust their installed capacity or to build new plants, so that demand of new markets and new businesses can be faced, either to incorporate technological innovations that provide process flexibility, cost reduction, warranty of product quality and facilities safety.

To meet this demand, especially in capital intensive organizations, the function of projects implementation management became of outstanding importance to businesses. It is during the project that equipment, spares and materials specifications are defined. These kinds of equipment, spare parts and materials will directly influence asset useful life after operations start in a new plant. Project definitions also interfere on parts and spare parts inventory. It has to be noted that the objective of a project consists of meeting clients' needs in terms of products and services at low cost and short term. Thus, planning and controlling projects' execution stages is a point of crucial importance. To obtain an effective control of project progress it is necessary to have a reliable information base.

The present work discusses the importance of enterprise asset management systems (EAM), of workflow systems and the existing methodologies of project implementation. It also presents gaps between theory and practical results found in a case study developed in a large size Brazilian chemical and petrochemical company, whose annual project portfolio reaches approximately US$ 30,000 thousands in current investments.

The objective of this work consists of presenting the project implementation model developed in the studied organization. The model permits the online monitoring of physic and financial progress of the organizations' projects, planning and controlling activities, internal and outsourced staff and materials. This automation of implementation activities permits to assure information reliability and obtain the status of the project in real time, so that it is possible to take decision at the right moment and avoid problems with material delivery, staff contracts, differences of balance in inventories and other factors that impact on project duration. The model also permits the improvement of material and human resources involved.

---

*Enhanced version of an article previously published in the proceedings of EurOMA - Intr. Conf. on Oper. and Glob. Manag.

The literature about project management is vast, including theoretical models, studies on critical success factors, treatment on uncertainty of human factors involved in projects, such as stakeholders interests, conflicts between areas and power relationships. The existing literature also presents project management tools. However, these tools do not have all the necessary resources to project management when used alone. The proposal of this work is to contribute to reduce the existing gap in the area of project planning and control.

This paper is organized as follows. The literature review section presents a synthesis of project management and enterprise asset management system theoretical framework while the next one discusses the methodological approach in the field research. Finally, the next sections present the case study analysis, results and conclusions.

2. Literature review

As discussed previously, this paper's aim is to merge the concepts of project management, enterprise asset management system and work flow in a theoretical framework that support the field research. The main issues are presented below.

2.1. Project Management

The concept of project has evolved in the last years, having reached a standard definition. A project can be defined as "a temporary endeavor undertaken to create a unique product, service or result" (PMI, 2004). This definition presents characteristics relative to temporality, as a project has well defined beginning and end, and relative to singularity, since each project is, in some way, different from similar projects.

However, it is also important to highlight the uncertainty and complexity characteristics of project activities. Furthermore, (DVIR et al., 2003) warns that the degree of uncertainty and complexity differs from project to another and one size does not fit all. The greater the unknowns, the greater the uncertainty and risk involved. Projects are characterized by progressive elaboration that makes the initial scope more explicit and detailed, during project development, generating a better understanding of its objectives, especially in a complex project. Because of these characteristics, projects are different of routine activities, demanding specific typologies and managerial techniques, tools and competences (CARVALHO & RABECHINI Jr, 2005).

The current literature on the evaluation of project success commonly reports efficiency measures in terms of time, cost and scope. Thus, project result is the development of a new solution, considering time and resources limitations, which can be verified by analyzing if its objectives have been reached (HELDMAN, 2006; MAXIMIANO, 1997).

In the project context, it is important to measure performance and project progress during the whole life cycle in both efficiency and effectiveness way. The efficiency key performance indicators (KPI) regards cost, time and quality/scope frames. CARVALHO & RABECHINI Jr. (2005) suggest that Earned Value Analysis (EVA) and Critical Chain can help project manager to control and manage schedule and resource issues during the project life cycle. Nevertheless, measures concerning to stakeholders requirements satisfaction, returns over investments, competences build and lesson learned must be considered.

The concept of project management includes "the application of knowledge, skills, tools and techniques to project activities to meet project requirements" (PMI, 2004). Furthermore, the application of a specific methodology in project management is a critical issue in order to achieve top stakeholders needs and expectations. Managing projects involve administrate resource and time constraints. The balance of these aspects influences project success. CARVALHO & LAURINDO (2003) argue that there is significant resistance of project teams to the adoption of project tools. Beside this, evaluation of efficiency is controversial in project environment, since the uncertainty and complexity inherent to a project difficult the evaluation.

The process of project management has also been object of improvement. The project management success value could also be measured as a function of processes they create, since, in many cases, processes are born from successful projects (IBBS & REGINATO, 2002). For PMI (2004), project management body of knowledge (PMBoK) third edition, project management is accomplished through the application and integration of processes and knowledge areas. The five PM process are initiating, planning, executing, monitoring and controlling, and closing. The project management best practices are presented considering nine areas: integration, scope, time, cost, human resources, procurement, quality, risk and communication. This model provides and promotes a common vocabulary to discuss, review and apply project management.

2.2. Integrated systems

Organizations generally have diverse information systems to support the different functions, organizational levels and processes. Many of these systems, developed along time to attend different functions, business units or processes, do not communicate well with each other, making it difficult to obtain information. This fragmentation made evident the need of development of information systems integrating the various organization functions. The first integrated systems came up in the decade of 1960, and its main scope was inventory control (NIKOLOPOULOS et al., 2003). These systems evolved to the logic of MRP (materials requirements planning). In the decade of 1980, appeared the MRP II (manufacturing resources planning) system integrating other manufacture resources. In the 90's, MRP II evolved to ERP (enterprise resource planning), consisting of a business management software, integrating all its functions: planning, manufacture, sales, marketing. The main modules in any ERP application are: finance and accounting, customer order management, MRP, materials management, decision support, data warehousing, logistics and inventory control. Besides, some ERPs include modules with the function of asset management, related to activities of acquisition and maintenance.

HOCHHEIM et al (2003) presented EAM systems as MES (manufacturing execution systems), systems that work in an intermediate strip, integrated to shop floor platforms and to ERP. Its function consists of collecting critic equipment data in productive plants, allowing precise analysis of operational and maintenance costs. It is possible, therefore, to characterize direct maintenance costs, indirect costs of production stops, failure costs, equipments life cycle costs and annual average costs, in order to find the activities mix between preventive and corrective maintenance of least cost.

EAM systems are composed of modules of work order management, preventive maintenance, equipment database, operational positions, specification and failure diagrams, inventory, material and services purchase, suppliers database, labor (proper and outsourced), work plans and security, service scheduling and labor management. Besides, there are other modules, with administrative function (system parameterization and creation of customized applications) and security functions, report generation, or optional modules of workflow or electronic commerce.

A case analysis of EAM implementation in capital intensive organizations in Brazil (BERSSANETI et al., 2005) concluded that, in the point of view of process integration, for all analyzed firms, the configuration of EAM integrated to ERP was more appropriate than the maintenance module of the ERP, since the use of specialist systems of asset management proved to be advantageous in that kind of organizations. Figure 1 shows in a resumed way the asset management system structure recommended to be used in maintenance areas of capital intensive organizations.

Workflows are document management software that automatizes processes as documents move between sectors, approvals, planning and reports generation (LAUDON & LAUDON, 2002). Workflow systems were developed to streamline paperwork and are used to register in an electronic form process documents. This kind of application allows organizations to redesign workflows in a way that documents can be simultaneously accessed and can move

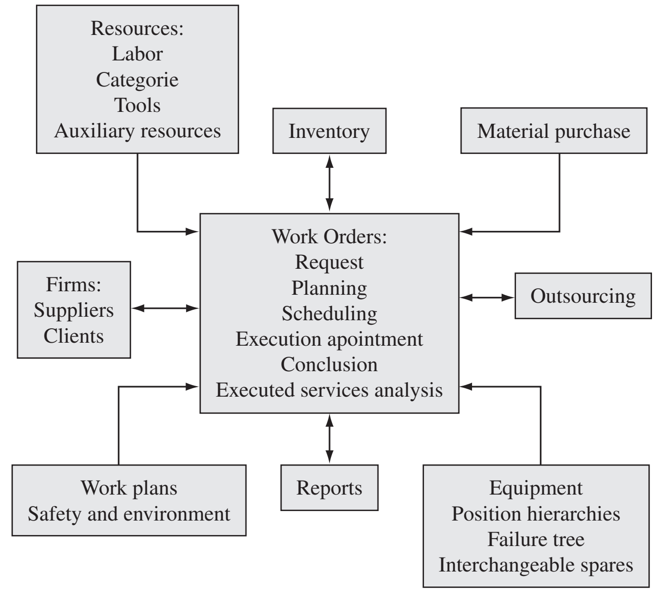


Figure 1. Asset management system structure (source: authors).

in an easy and efficient way from a sector to another. SHIH & TSENG (1996) noted that workflow applications could be used to monitor, control and coordinate projects and processes, with additional benefits of facilitating communication, documentation and data reutilization.

2.3. Project Management Systems

The particular characteristics of projects led to development of integrated systems specific to project management. A module of project management of an integrated system must be connected with: Engineering (to redesign new processes, including facilities and equipment), Purchasing (to send requisitions and expedite purchasing orders), Maintenance (to install equipments), Accounting (for budgeting) and Planning (for availability of new equipments to production). Figure 2 shows a scheme of a Project Management Module (LANGENWALTER, 2000):

There are many project management tools available in the market, such as MS-Project, Primavera or others. It was observed in practice, however, that these tools do not dispose of all necessary resources to project management when used alone. It is necessary to use complementary tools. HWEE & TIONG (2002) developed a computer based model to support project cash flow forecasting and risk analysis. The need for complementary tools was observed by other authors (GELBARD et al., 2001), that proposed a model integrating computer-aided tools for system analysis with project management tools. Perceiving this gap, the proposal of this work is to contribute to the area of project planning

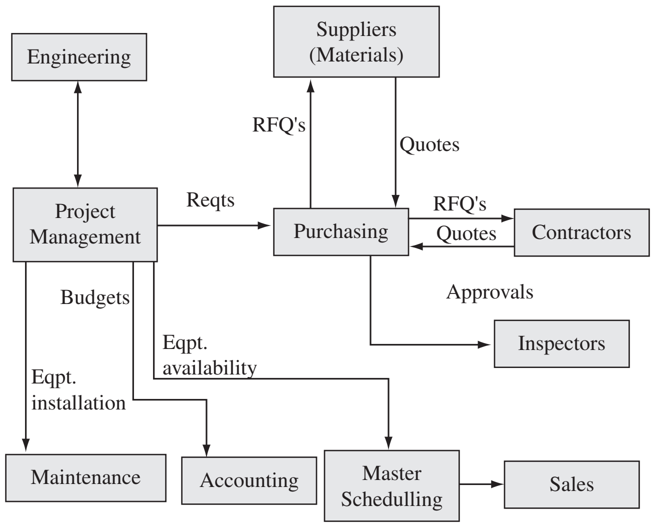


Figure 2. Project management integration (LANGENWALTER, 2000).

and control through a description of a model developed in a real case.

3. Methodology

This paper aims to understand and develop a model to support project management activities merged to EAM and workflow system. Based on the theoretical framework presented in the previous sections a model has been developed, to be tested in the field research through an action research approach, since this approach has been chosen as the best way to develop theory on a new approach in the company practice, according to COUGHLAN & COGHLAN (2002).

The company selection criteria were the following: the importance of project management to the organization, the existence of EAM and workflow systems implemented and the commitment with the research goals. Following these criteria a large size Brazilian chemical and petrochemical company was selected.

This company is of one of the biggest chemical and petrochemical company in the country, with a prominent place in the national and international market, with four industrial units in Brazil and two abroad, which have EAM and workflow systems implemented. The project management area is characterized by multidisciplinary teams in a matrix organization, with high degree of heterogeneity and complexity. The main projects involved growing its production capacity, which are linked with EAM and workflow systems.

The research process carried out in 2005 through a series of workshops and evaluation meetings, where the studied company presented the current implemented systems and the project management requirements, the researchers provided the theoretical background and one of them was selected to coordinate the project and to conceive and develop the integrated model. The studied company provides also his own sponsor of the project in order to achieving the involvement of other functions. Thus, people from the various firm's departments worked as experts with direct knowledge of specific issues to provide the new assignments demanded by the new model implementation. These people were outside the project team, and generally did not attend workshops.

The work has been planned and documented in order to capture all the possible contributions from the field research. The researchers also supported and monitored the process between the workshops using specific tools for each step following a guide framework. This step by step guide presents the actors' roles and action plan during the whole action research process and a milestone was fixed to evaluate the model, leading to its refinement.

4. Studied company

The company analyzed in this study is a Brazilian firm from the chemical and petrochemical industry, with annual revenues of 500 million dollars, 2% from it invested in research and development. The organization operates in over 40 countries in over 30 segments, for example: cosmetics, detergents, paints and varnish, leather, food, functional fluids, plastics, textile, and others.

The firm has 900 employees in its 4 plants in Brazil and headquarters, and 12% of these employees correspond to the work force dedicated to research and development projects and engineering.

To meet the market demand and maintain operational continuity with process security and desired performance, the firm invests nearly 30 million dollars/year in substitution of equipment in end of useful life, the adequacy of quality of products to clients needs, industrial safety systems, capacity growth, modernization, development of new products and new facilities, environment and related projects and other ones related to infra-structure and information technology.

Currently, the studied organization runs nearly 150 projects to be implemented in 4 sites. These projects are performed in phases, with different specialists and variable duration and cost, according to their complexity.

4.1. Project phases

Figure 3 shows the different project phases in the studied firm. A complex project from a new plant, with new products and processes, generally has to undergo all phases represented in Figure 3. First, R&D area develops the new product, process and analytic procedure in laboratory. Next, new synthesis processes are developed in pilot scale or by mathematics modeling or simulation. After this phase ends, if the project is viable, the investment to construction of the new productive unit is approved. In this stage, phase II, engineering develops the basic project and the main documents are made: process flowcharts, equipment data sheets, instruments lists, pipeline lists, etc. These documents are detailed in the next stage in order to obtain quantities and kinds of materials, equipments and instruments that have to be purchased and the local to be installed. With the material list, the supply team makes the purchase requisitions and, once the material is received, the implementation team starts the assembly phase. Assembly follows a logic order where, earth moving, filling in, leveling and civil work come first. After that, installation of big equipment and pipelines is made; and in sequence, electric and instrumentation installation. Finally, pre-operational tests take place and the new plant is started. Generally, assembly is made by specialized firms and contractors, specially outsourced to the project. After plant starts, operation of the assets become responsibility of the maintenance area that implements facilities improvement projects and substitute systems in end of useful life, if is necessary. As these projects are smaller, phases I and/or II are not necessary. Regarding previous risk analysis, projects phases can be jumped.

Despite the different phases of a project being related the R&D works isolated in the studied enterprise, with follow up tools and very simple control, usually electronic spread sheet in Excel and reports in Word, totally apart the existing corporative systems like EAM, ERP or Planning and Follow up Budget System.

That isolation caused, in many cases, development of products and processes that wouldn't consider existing constrains in stages that followed: plants engineering and operation. The engineering itself had several follow up and projects control tools: special-tools such as AUTOCAD (to design), ASPEN (still simulator), EAM (purchase module) and MS_Project to elaborate the implantation chronogram. The expenditure follow up was done through consultation with an ERP financial module utilized by the corporation and another ERP of the enterprise. The survey for information was fulfilled in another system internally developed so that the forecasted, compromised expenditure carried out in the period could be seen. This situation, besides loading with re-digitalizing, allowed the knowledge of physical and financial improvement on the project just by the end of the month, on the issue of the monthly report, which could be in some cases too late to change routes or to take actions

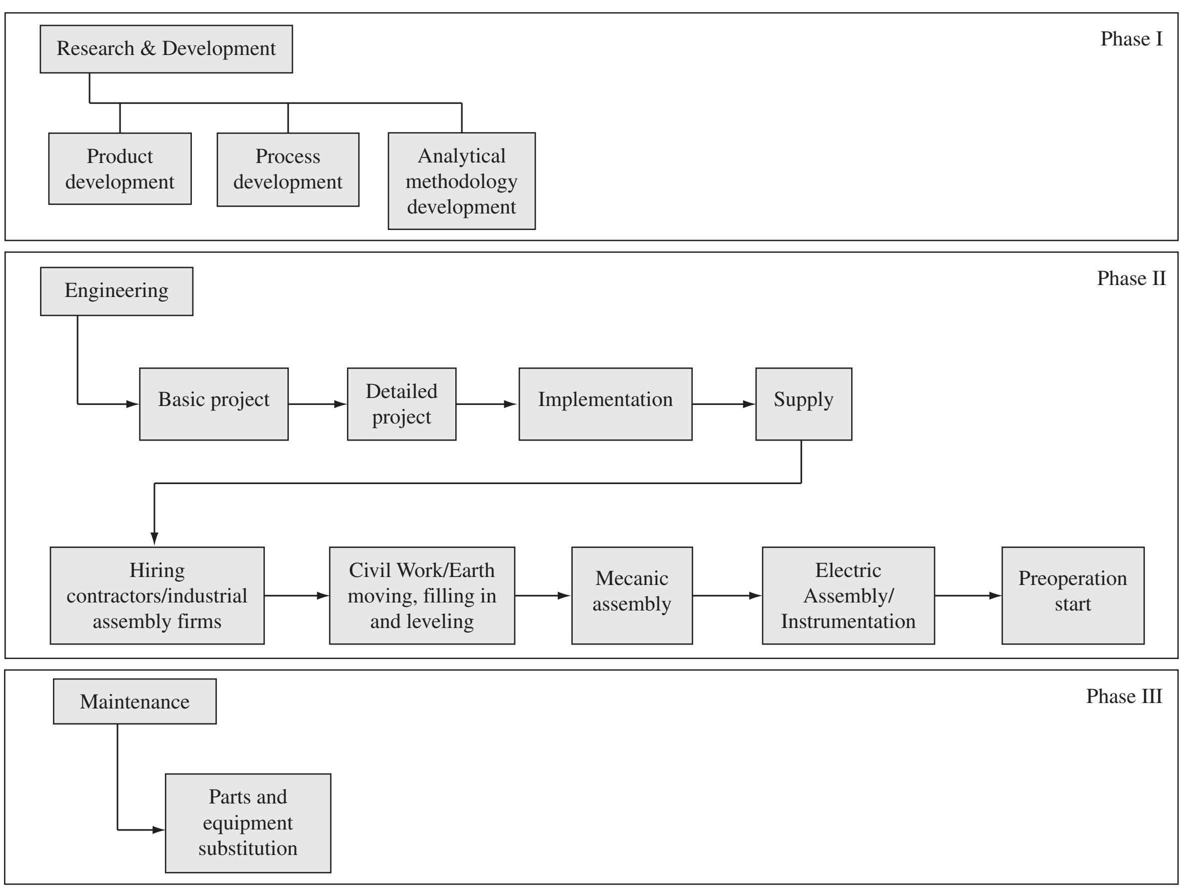


Figure 3. Project development phases in the studied company (source: authors).

in order to avoid delays and overrun the budget. In the implantation phases the most common complaint coming from the project coordinators was the lack of material at the assembly time, which delayed the work and increased costs on stopping the contractors who had to wait for the material to arrive.

This lack of material was caused either by theft or "loans" taken by the maintenance area to meet their emergencies and never given back.

Thus, it was verified that to manage projects properly according to the recommended PMBoK and considering the nine areas of knowledge: integration, scope, datelines, costs, human resources, acquisitions (procurement), quality, risks and communication of the undertaking, the integration of the different kinds of information generated by the several stages of the project was required. To meet such a demand, it was proposed in this study a model of project management which takes into account its different phases and valid regardless of its complexity and scope. Such a model utilizes as tools EAM, workflow, ERP and MS_Project integrated, allowing the managers to have information on line on the project physical and financial improvement. This model is introduced as it follows.

4.2. Developed model

The proposed model is based on the EAM work order module. It is a requirement of this model that every project has work orders opened to their different phases. Thus, considering a more complex project, which has all phases, a study work order in phases R&D should be open, where the different stages of development will be planned, the starting and ending date foreseen as well as labor, material and necessary resources. There may be created child work order for the study products, process and method of analysis, in case of individual and global control of the project is required. Figure 4 presents the project study workflow.

Once the phases of the study are concluded and the investment is approved, one mother work order of the project is opened, which in the system is placed in hierarchical order as child of the major work order of the study. This work order should contain the macro planning of the project with the global starting and ending date, macro stages of the project and type of labor required by each stage, informing ability and quantity. There should be created child work order of the project mother work order for the phases of basic project, for the details project and assembly. The assembly work orders should be created according to the craft (civil, mechanics, pipeline, instrumentation, electric), subordinated to the work order (WO) of the details project. In all hierarchical levels, the WOs should have the craft (mechanic, electrician, builder, etc) planned and which tasks should be performed by WOs, as well as the starting and ending date of each stage. The material planning is made automatically, through integration between the EAM purchasing and the work order modules. One of the products of these phases of the project is the creation of the TAG number and process specifications of the equipment, instruments and lines, which should be recorded in the equipment module with specified data indicating documents of origin and the GL account. Such TAGs are classified with the status "in_project". At the end of the assembly, the status is altered to "in operation" and the GL account changes from the project account to the depreciation account.

To avoid re-digitalizations, it was a premise that once the specification of the items of the project is made, they should be registered in the EAM, in the inventory module in the application asset catalogue, which allows the standardization of the register through the use of datasheets standard models, regarding the type of the material or equipment. Only items previously registered can be bought. Once the register of the items is made, next step is the creation of the purchase requisitions (PR), using the EAM purchasing module. There, the items previously registered are selected by code, avoiding to digitalize their descriptions every time they are bought. Every item with purchase requisition (PR) for a certain project are imported to the project assembly work order, informed in the purchase requisition lines, to the material planning application, having as key the GL account of the project (one project has a sole GL account in WO and PR, or any other module of the system), avoiding this way the re-digitalization of the material in the work order planning and in the purchase requisition. All the items bought for a project are sent to the project virtual warehouse, codified with the same number of the project and having the same GL account. When the items start to arrive at the plant where the assembly will occur, the receipt is done at the ERP, using an interface with the EAM to transfer the receipts data to the EAM receiving module, informing the project warehouse which and how many items are delivered and which purchase orders (POs) are still total or partially undelivered. Along with the phase when the material starts to come, the coordinator of the project does the biddings and hires the contractors and specialized assembly firms to carry out the assembly step. All the bidding and hiring phases are fulfilled inside the EAM, in the service purchase module. This module is integrated to the EAM receipt module so that the payments of the accomplished jobs can be approved in the EAM and received and paid through the ERP. The service scheduling is done through the exportation of the project work orders of the EAM work order module to the MS_Project, where the daily service scheduling is done with the related precedence. At that point, the Gantt chart of the project is generated and the baseline saved. This schedule is returned to the EAM so that the accomplished services can be noted down in the work order module, in the accomplished services screen. The consumption

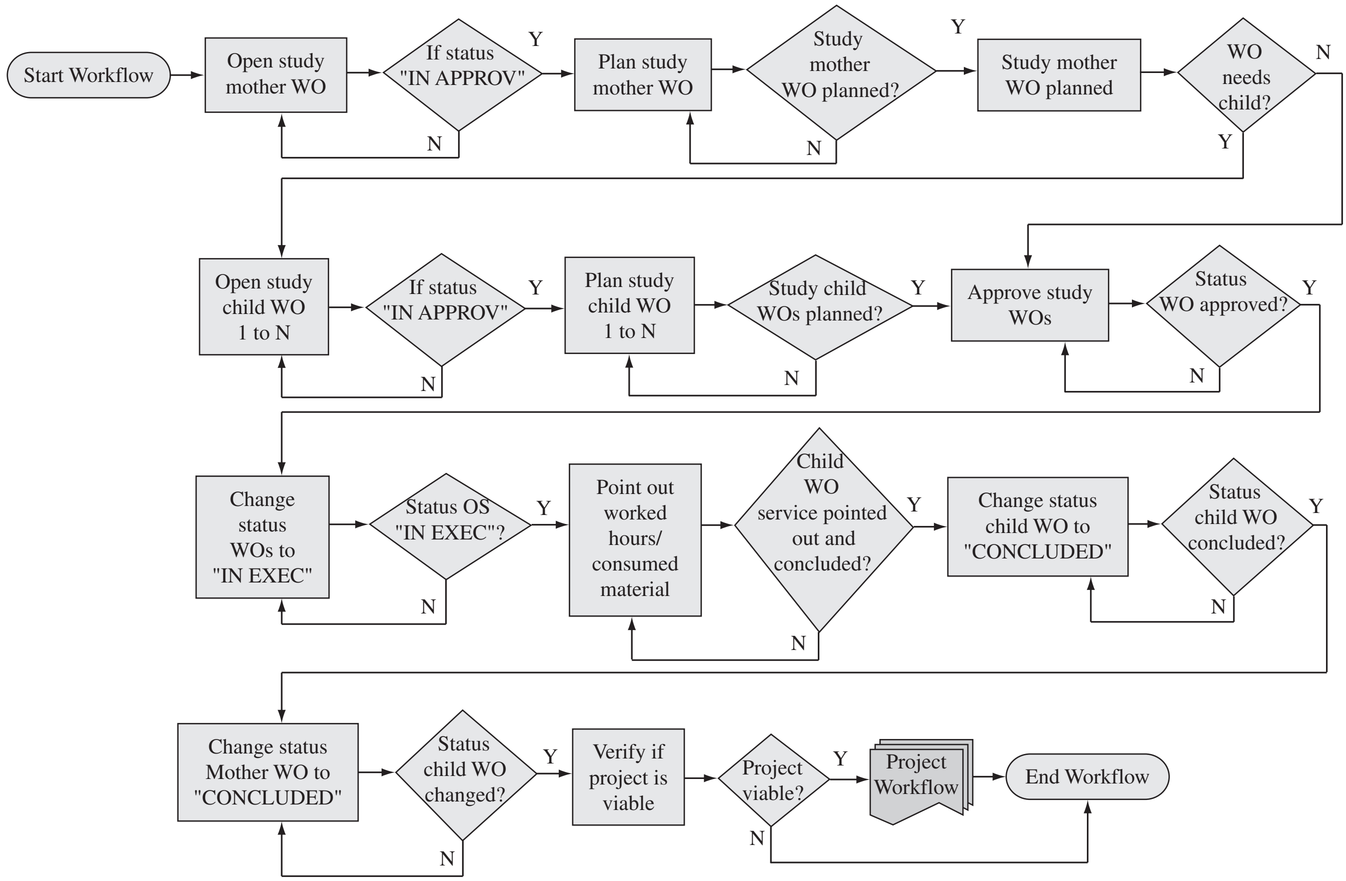
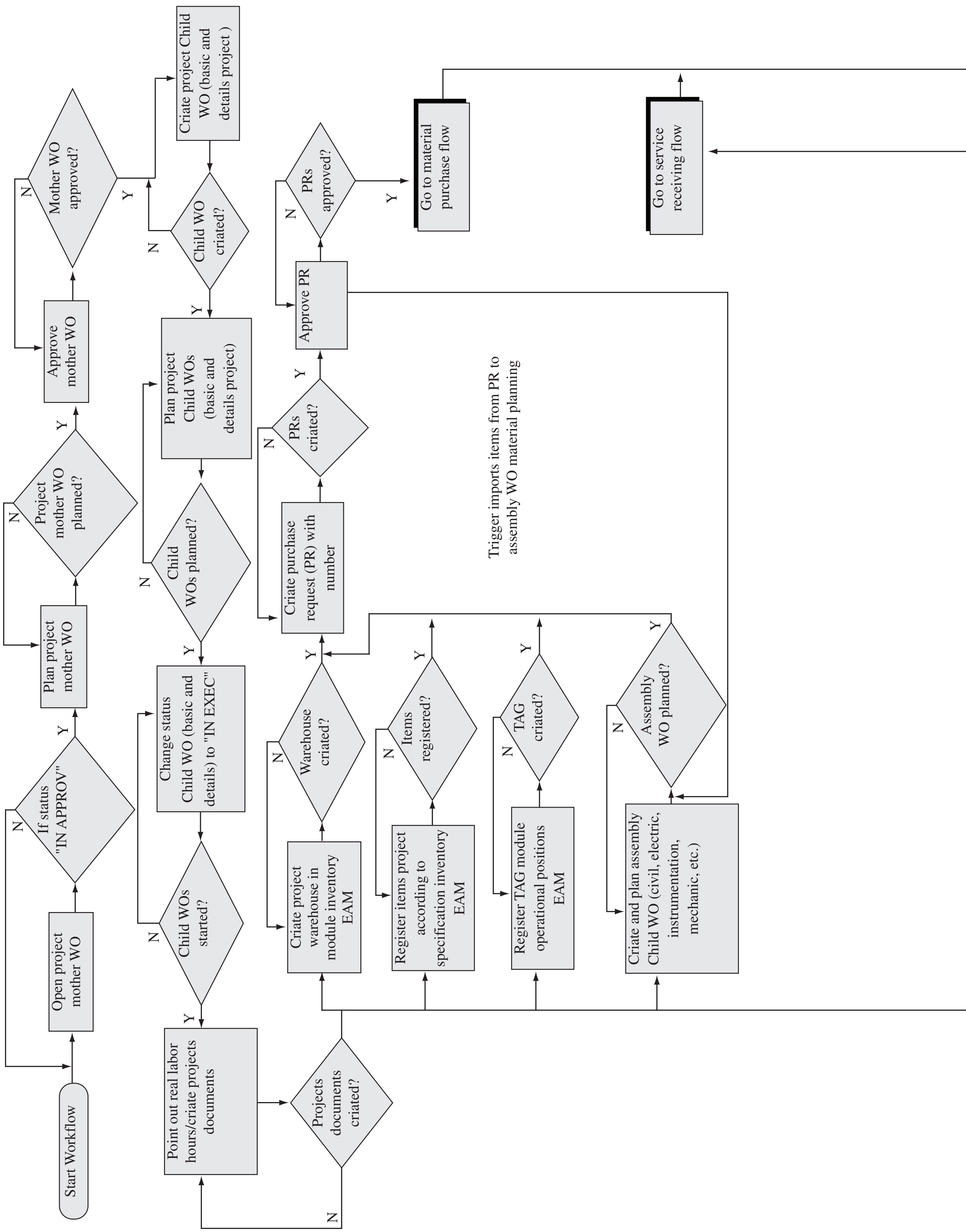


Figure 4. Project study phase workflow in the studied company (source: authors).

of the material during the work is done in the inventory module by the project warehouse. This download is done by presenting the work order that the maintenance worker will do on that date. The chief of each warehouse check the material reserved for the presented work order, hand out the material physically and download in the system informing which material, quantity and to whom it has been handed out on that date for each work order. The system reserves the material for the project automatically, at the moment when the planning is made. During the fulfillment of the project the assigned people to carry out the job should note down the accomplished services in the EAM. Through the process so far hire explained, the coordinator of the project has on line information about which job has been accomplished, which purchased material has already been delivered and which and where has been consumed. The financial follow up is also a product automatically generated by the system, which information can be obtained from the outsourced contracts or from the registration of labor, which has information about man/hour cost per craft. The medium and real material cost are obtained from the purchase and inventory modules. Hour load and material expenses come from the accomplished services and utilized material screens. At the end of the project, the child work orders and ultimately the mother work order are concluded through the change of the status of the work orders. In the project inventory it is verified if there are project remains, being those transferred to the project remains warehouse, making them available for the future projects. Finally, the operation, after the start of the operation plant, closes the project work order through the change of the status in the system and also through the issue of a report of agreement, which certifies that the project works as specified. When the WOs of the project are closed, the TAG status and the GL account are altered as previously explained.

The workflow integrated to the EAM has a function to automate some of the flow stages of the project accomplishment, as well as to track and to insert locks so that compulsory tasks are not forgotten. The workflow also automates the flow of the approval of the project work orders.

Thus, once a project work order is opened, it is sent to the person in charge of making the planning. Some compulsory fields were defined so that no critical stage is missed. In the next phases, the work order goes to the approval. The stage of planning the material through the


Start Workflow
Open project mother WO
If status "IN APPROV"
N
Y
Plan project mother WO
Project mother WO planned?
N
Y
Approve mother WO
Mother WO approved?
N
Y
Criate project Child WO (basic and details project)
Child WO criated?
N
Y
Plan project Child WOs (basic and details project)
Child WOs planned?
N
Y
Change status Child WO (basic and details) to "IN EXEC"
Child WOs started?
N
Y
Point out real labor hours/criate projects documents
Projects documents criated?
N
Criate project warehouse in module inventory EAM
Warehouse criated?
N
Y
Criate purchase request (PR) with number
PRs criated?
N
Y
Approve PR
PRs approved?
N
Y
Go to material purchase flow
Go to service receiving flow
Trigger imports items from PR to assembly WO material planning
Register items project according to specification inventory EAM
Items registered?
N
Y
Register TAG module operational positions EAM
TAG criated?
N
Y
Criate and plan assembly Child WO (civil, electric, instrumentation, mechanic, etc.)
Assembly WO planned?
N
Y

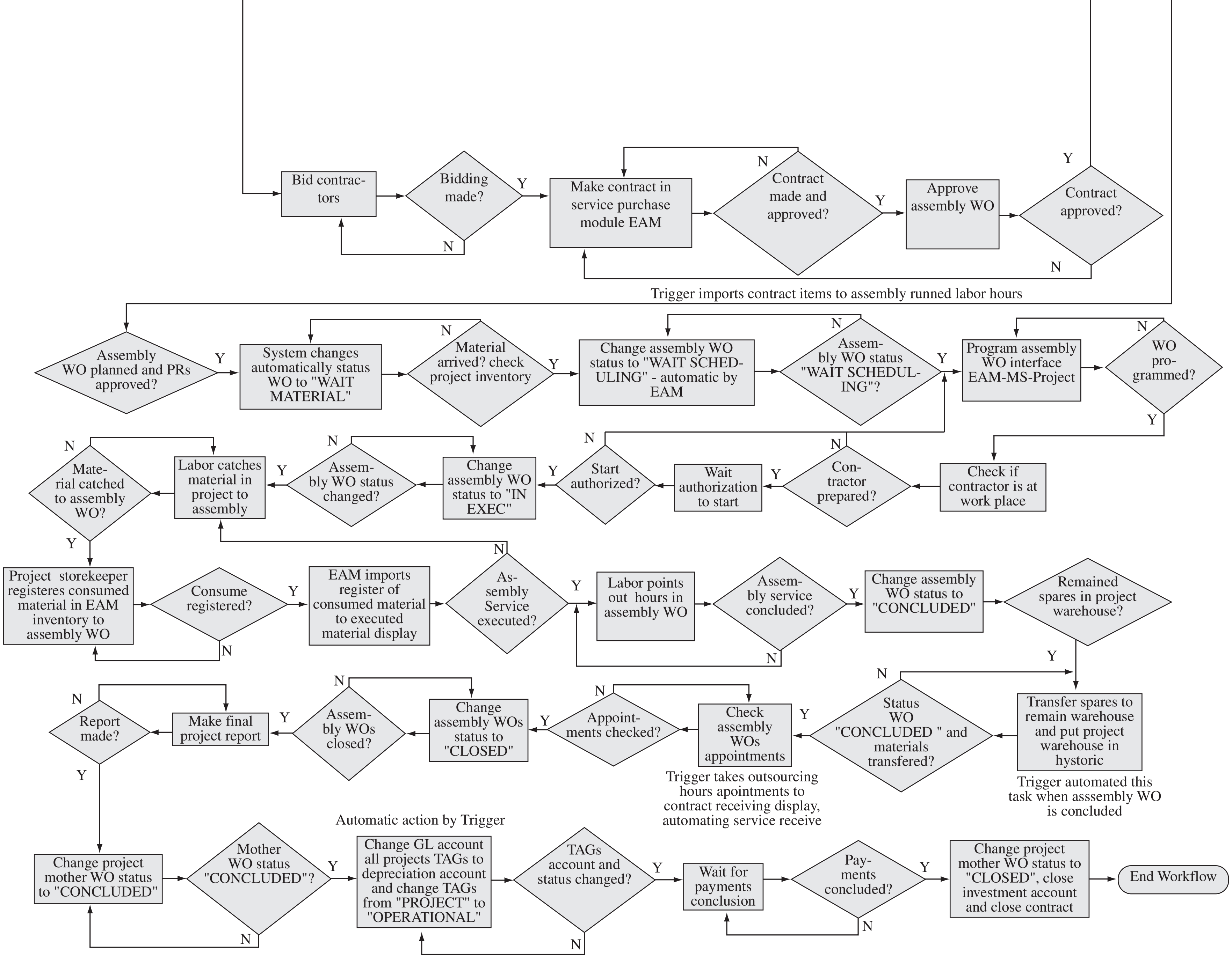


Figure 5. Project phase workflow in the studied company (source: authors).

importation of information about items and number of purchase requisitions is also an automation allowed by the workflow. After the planning and the approval, the person in charge of the accomplishments of the phases of the study or project can alter the status to " in execution", when effectively starts the job. The phase of assembly has as basic constraints the fact that compulsorily a mother work order has been approved, the material planned for that order has already arrived and is in the project warehouse and that there is at least one agreement in the system with the project GL account. At the end of the flow, to transfer the project remains to the remains warehouse, to alter the TAG GL account and items status from "project" to "in operation" the workflow is also responsible for this automatic action at the moment of the change of the status by the people in charge of this activity.

During the project, revisions in the scheduling can be done, repeating the process of exporting the work orders to MS_Project, revising datelines and resources and importing again the work orders to the EAM. The resume of the case can be seen in Figure 5 as it follows.

5. Conclusions

The proposed model has been recently introduced in the studied organization, being still in the experimental implementation phase. However, improvement in the project organization and discipline in the fulfillment of tasks have been verified. It is also possible to see that the objectives of elimination of re-digitalizations and errors due to this kind of re-work have been reached. There has been a great reduction in errors on purchasing the items, thanks to the standardization of the material specification and reduction in the lead time of the purchasing, thanks of the reduction in time of issuing a purchase requisition and discussions to eliminate doubts and complementation of data.

The control of the received and consumed material through the system, with a person responsible for the input of information, has increased the possibility to track and eliminate the material shortage problem during the assembly.

The automation of the transfer of the material remains to one place in particular and the possibility of on-line consultation eliminated losses due to the obsolescence of the items that changed into scrap. This loss in 2001 was of 500 thousand dollars.

Actually, on-line systems integrate all the stages of the project with available follow-up to all engaged people. Thus, the communication and the controls in terms of deadlines and expenditures were improved. However, to make the use of the system effective, it's essential to provide the new employees a periodic training and to the senior a recycling and the labor awareness. Otherwise, the users may refuse it.

The obtained results in this research study showed that the developed model is applicable in a capital intensive organization, and that it covers the integration gaps observed in the literature (HWEE & TIONG, 2002; GELBARD et al., 2001).

To enable the introduced model to be generalized, new studies in different organizations are required, so that characteristics can be identified by industrial segment, by geographic region, by type of project and available infrastructure.

As CARVALHO & LAURINDO (2003) described, it was observed resistance of project teams to the adoption of the developed model, especially by the oldest employees, probably because of difficulty to use information technology (IT) tools. These employees misunderstand the application objective, thinking it will control their activities. To avoid these problems, it is important to emphasize the project divulgation and training. Other point that must be noted is the necessity to have an IT team with knowledge of all softwares and interfaces used to enable a good integration and support its running.

6. References

BERSSANETI, F. T.; PADOVANI, M.; MUSCAT, A. N. R. Implantação de Sistema Integrado de Gestão de Manutenção: Análise de Casos Múltiplos. In: **XI SEMINÁRIO LATINO** - Iberoamericano de Gestión Tecnológica - Innovación Tecnológica, Cooperación y Desarrollo – ALTEC, 2005, Salvador. Salvador: Tec ART Editora Ltda, out/2005, p. 1-17.

CARVALHO, M. M.; RABECHINI Jr., R. **Construindo Competências para Gerenciar Projetos**, São Paulo: Atlas, 2005. p. 317.

CARVALHO, M. M; LAURINDO, F. J. B. **Estratégias para Competitividade**. São Paulo: Futura, 2003. p. 254.

COUGHLAN, P.; COGHLAN, D. Action research for operations management. **International Journal of Operations & Production Management**, Bradford, v. 22, n. 2, p. 230-240, 2002.

DVIR, D., RAZ, T., SHENHAR, A. An empirical analysis of the relationship between project planning and project success. **International Journal of Project Management**. 21, p. 89-95, 2003.

GELBARD, R.; PLISKIN, N.; SPIEGLER, I. Integrating system analysis and project management tools. **International Journal of Project Management**, Guildford, v. 20, n. 6, p. 461-468, 2001.

HELDMAN, K. **Gerência de Projetos**. 3. ed. Rio de Janeiro: Campus, 2006. p. 529.

HOCHHEIM, R; Santos, A .; Lima, G.; Bibancos, D. Gerenciamento de Manutenção Integrado às Plataformas de Chão de Fábrica". In: **MES -** Manufacturing Execution Systems, mai, 2003. Palestra Rockwell Automation, Evento MRO WORLD BRASIL, São Paulo, 2003.

HWEE, N. G.; TIONG, R. L. K. Model on cash flow forecasting and risk analysis for contracting firms. **International Journal of Project Management**, Guildford, v. 20, n. 5, p. 351-363, 2002.

IBBS, W.; REGINATO, J. **Quantifying the Value of Project Management**. Newtown Square: Project Management Institute Inc., 2002. p. 64.

LANGENWALTER, G. A. **Enterprise Resources Planning and Beyond**. Boca Raton: St Lucie Press, 2000. p. 390.

LAUDON, K. C.; LAUDON, J. P. **Management Information Systems**. 7. ed. New Jersey: Prentice Hall, 2002. v. 1 (various pagings).

MAXIMIANO, A. C. A. **Administração de Projetos**, São Paulo: Atlas, 1997. p. 196.

NIKOLOPOULOS, K.; METAXIOTIS, K.; LEKATIS, N.; ASSIMAKOPOULOS, V. Integrating Industrial Maintenance Strategy into ERP. **Industrial Management & Data Systems**, Shreveport, v. 103, n. 3, p. 184-191, 2003.

PMI - Project Management Institute. **A Guide to the Project Management Body of Knowledge (PMBoK)**. 3. ed. Newtown Square: Project Management Institute Inc., 2004. p. 390.

SHIH, H. M.; TSENG, M. M. Workflow Technology-based monitoring and control for business process and project management, **International Journal of Project Management**, Guildford, v. 14, n. 6, p. 373-378, 1996.