Cód. 154

Expanding the Limits of IT Governance to the Factory Floor

8.6 Las tecnologías de información y comunicación como soporte a la innovación

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RESUMEN

The search for transparence in executing activities is presently one of the principal concerns of organizations. The adoption of good practices of governance confers market confidence on company management. although usually, there is a fragmented vision of production inside the companies, which often leads to a lack of availability and lack of integrity of information. This can negatively affect the IT objectives in terms of the level of information service provided. The objective of this article is to shape a model that makes it possible to translate company strategy into terms of business requirements for the MES layer, and thus allow the utilization of COBIT as a governance mechanism. The first step is to understand the company through its strategies and processes. The second consists in classifying the information requirements in relation to performance goals and the support needs of the operation. A third step validates the classification of the requirements taking into consideration the strategy adopted, the desired behaviors defined by corporate governance and the viability of meeting the criteria proposed by COBIT for each of the business requirements.

Key words: Corporate Governance, Production, Enterprise Resource Planning, Manufacturing Execution System, COBIT

1. Introduction

The search for transparency in the execution of activities, especially those that affect the generation of financial reports, is presently one of the main concerns of organizations, given the requirements of the regulatory agencies of the capital markets. Companies that adopt good governance practices enjoy the confidence of the market in their management ability, which, in turn, translates into a premium on share value.

These companies seek to establish mechanisms to govern the utilization of their principal assets. Among these assets is IT – information technology -one of the principal assets of the organizations managed, in their majority, by practices proposed in the *COBIT – Control Objectives for Information and related Technology* (Fernandes & Abreu, 2006).

The production information available inside the companies is split, divided between the corporative systems and factory floor computerization systems, as pointed out by the regulation ANSI/ISA-95.00.01 (ISA, 2000). This division puts the financial, accounting and HR areas, for example, on one side and the factory information on the other. This translates into a fragmented vision, often leading to a lack of availability of information and to gaps in its integrity, which negatively affects the IT objectives in terms of the level of service.

A new class of systems called the MES – Manufacturing Execution System by the ISA – the Instrumentation Systems and Automation Society is arising as a response to this problem of fragmentation. These systems consist of applications positioned between automation and management systems, covering some of the gaps in the functionality of the ERP – Enterprise Resources Planning and of the automation systems. Adopting the MES allows all the company departments to collaborate with a focus on production, thus closing the net new between planning and executing the process.

The potential for benefits from using this type of system is broad and contributes positively to the transparency of events that generate financial results. Meanwhile, like the other IT resources, these should be subjected to adequate governance, which depends on a clear alignment with the production strategy adopted by the company. The objective of this article is to trace one path that makes it possible to translate the company strategy in terms of business requirement to the MES layer, thus permitting the utilization of the COBIT as a governance mechanism. To do so, the work is organized into three parts: the introduction was presented in the first section; the relevance of the MES layer as an agglutinator of information in production will be presented second; the third part will identify the components present in this scenario; the fourth will discuss the relation among the components in such a way as to establish a possible path an lastly, the final considerations will be presented.

2. Establishing a path for the utilization of COBIT in the governance of the MES layer

2.1 Importance of the MES layer as an agglutinator of production information

The MES systems are shaping up as outstanding components for manufacturing, due to their innovative nature and their potential to generate a new cycle of production in the industry. This can be perceived by the attention that the MES systems have gotten, for example, from the suppliers of software and computerization, professional associations and consulting firms. Taking this scenario as a base, it can be inferred that the utilization of MES as an agglutinator of information for production might become a trend in various companies.

As a first step in confirming this view, field research was carried out with the 50 of the companies listed in *Exame* magazine's 2005 "Guide to the 500 Biggest and Best." The study attempted to find evidence of whether the attention being given to this layer of systems in Brazil is similar to what is has happened in the United States. The sample was chosen because the companies selected were very important to the Brazilian GDP, their earnings representing around 150 billion dollars or approximately 15 % of GDP. The study used questionnaires sent by e-mail to Engineering and IT area executives who were involved in the implantation of support systems for production.

It was important to carry out this research with Brazilian companies, because the information available about cases of companies in other countries doesn't necessarily reflect our reality.

Thus, the central objective of the study was to discover whether companies in Brazil have made significant investments in MES and thus learn the importance of MES relative to other technologies, such as the *ERP (Enterprise Resources Plan), EMI (Enterprise Manufacturing Intelligence), PLM (Product Lifecycle Management), APS (Advanced Planning Schedule), LIMS (Laboratorial Information Management System), PIMS (Plant Information Management System)* and AI (*Automação Industrial-Industrial Automation*). We can also learn the principle motive for investment in MES among the performance objectives for cost reduction and increased quality, flexibility, velocity, reliability and innovation (Slack, 1991, Paiva, et al, 2004), and whether the MES is a natural evolution in the technology used in manufacturing. These questions are developed based on the perspective that after a broad implantation of ERP and Industrial Automation, as well as stability in these technologies it is natural that the next step be to interconnect these layers of software and hardware.

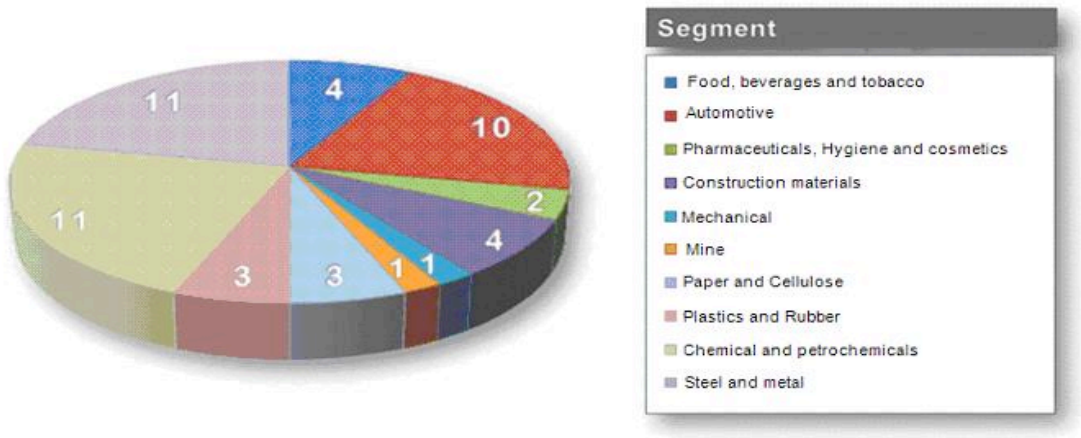
Gil (1988) points to three types of studies: exploratory, descriptive and explanatory. The classes can further be organized into a second level in function of the process of data collection. In the first group are document and bibliographic research. In the second group are experimental research, ex post facto research, surveys and case studies. In this survey questions were asked directly of the people whose behavior it

wanted to learn about. The survey method was chosen because out goal was to demonstrate in practice the hypothesis that a trend toward investing in MES also exists in Brazil.

Data collection was done through questionnaires sent and returned via e-mail. In addition, a follow up technique was used and respondents were contacted by phone to try to guarantee the return of the questionnaires.

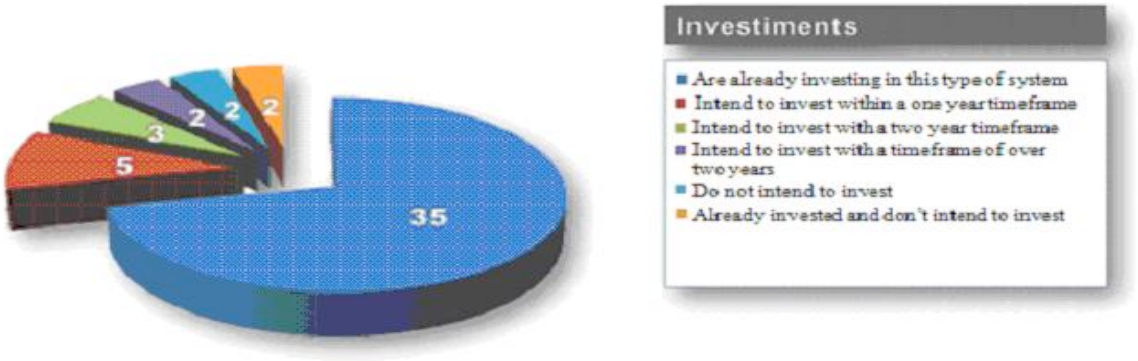
The questionnaire contained 11 multiple choice or classificatory questions. The questions also had the purposed of describing the companies, their processes the level and age of automation of their management systems and the positioning of the companies in relation to the utilization of MES systems. The responses were tabulated and are presented in the graphs below.

The first graph shows the distribution of the companies studied in terms of activity segments, according to the classifications from the 2005 edition of The Biggest and Best, published by *Exame* magazine. In this distribution, there is a greater concentration of companies in the segments: steel and metals, chemical and petrochemicals and automotive.



Graph 1 – Distribution of respondents by segment
Source: authors

In the following graph, companies are distributed in terms of their intention to invest in MES, considering different time lines.



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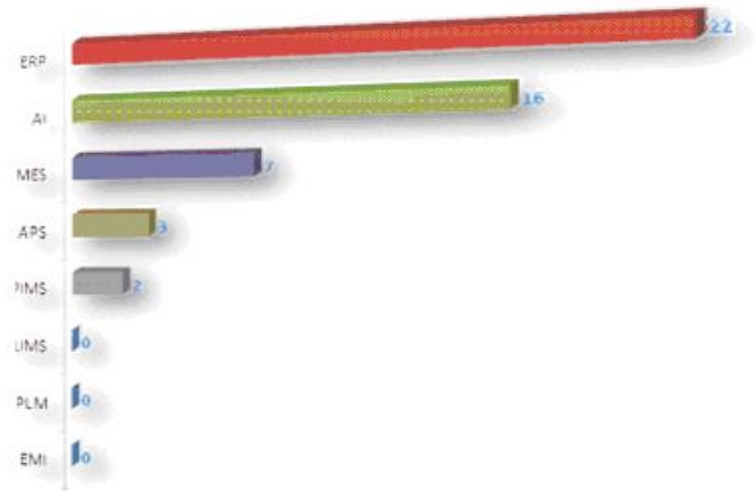
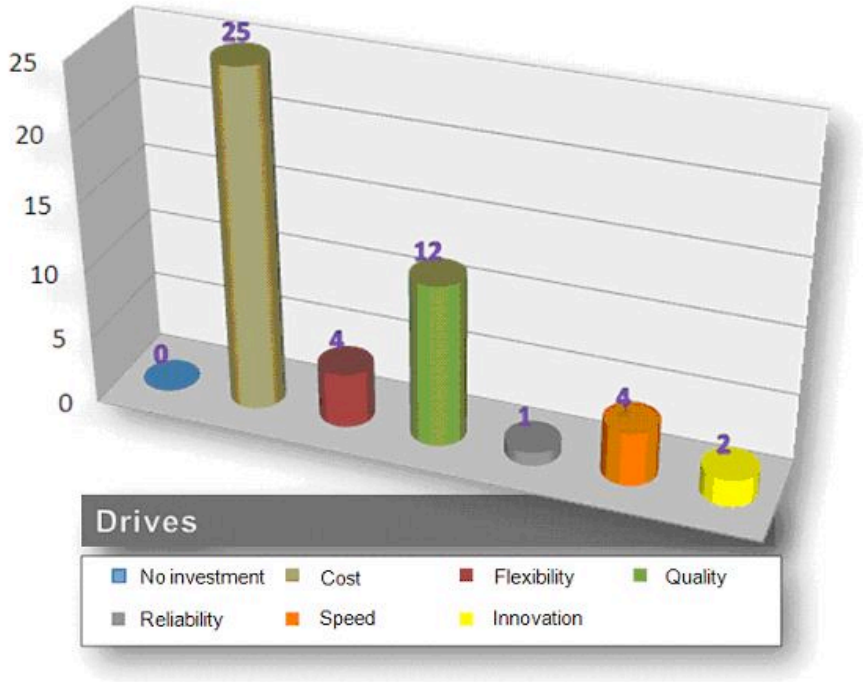
aph 2 – Respondents Intention to Invest in MES by respondents
Source: authors

In the third graph the different technologies used as support for production are identified. *ERP (Enterprise Resource Planning), AI (Industrial Automation), MES (Manufacturing Execution System), APS (Advanced Planning System), PIMS (Plant Information Management System), LIMS (Laboratory Information Management System), PLM (Product Lifecycle Management) e EMI (Enterprise Manufacturing Intelligence)* and the number of companies that are considering using an MES system as a priority in relation to others that support production is shown.



Graph 3 –Relative importance of MES in relation to other technologies
Source: Authors

The fourth graph classifies cost performance objectives: flexibility, quality, reliability, speed and innovation in terms of their importance as motives for investing in MES systems.



Graph 4 – Principal motivators for implanting MES
Source: authors

Also analyzed was whether the adoption of MES systems was dependent on a broad implementation of ERP and Industrial Automation as well as the stability of these technologies. For this analysis, the statistical techniques Homals and Discriminant Analysis and the SPSS statistical software package were used. Considering both analyses, it was concluded that companies who prioritized investment in MES are those that have a high level of automation.

2.2 Components of the Map for the utilization of COBIT in the governance of MES systems.

There is evidence from the sample that the outstanding companies in the Brazilian economy are making investments in this area, especially those with a high level of automation. We believe that a study of the mechanism that provides the impulse to effectiveness and efficiency in the use of this type of system would be important.. In the proposal presented in this article, represented in Figure 3, the path between the Production Strategy and Governance of the MES layer begins with an understanding of the concepts of IT governance. This is followed by a comprehension of COBIT (1) understanding production as one of the primary functions of the value chain (2) its singularity due to the division into layers of the dominion over information (3), holding the MES layer as responsible for re-establishing integration among the divided information (4). The MES layer is a production asset and therefore has become the focus of adequate governance (5). The COBIT is a possible model. Nevertheless its utilization in production requires the definition of requirements as an entry point (6).

The definition of these processes, of an adequate alignment and a validation of the adherence of the requirements to the COBIT criteria (7), which then permit these requirements be governed through COBIT (8).

Figure-3: Map of the components of IT governance in production
Source: Authors

In the flow chart above, it is possible to visualize the following components:
0 – IT Governance. In the view of Weill & Ross (2004), corporate governance is made up of the interactions between shareholders and stakeholders, the board of directors and executives under the influence of the monitoring goals and confidentiality. Governance becomes concrete in terms of corporate strategy and the policies that lead to desirable behavior in the organization. Corporate strategy and the desirable behaviors are governed by mechanisms applied to the main assets of the organization, among them the IT stakeholders.

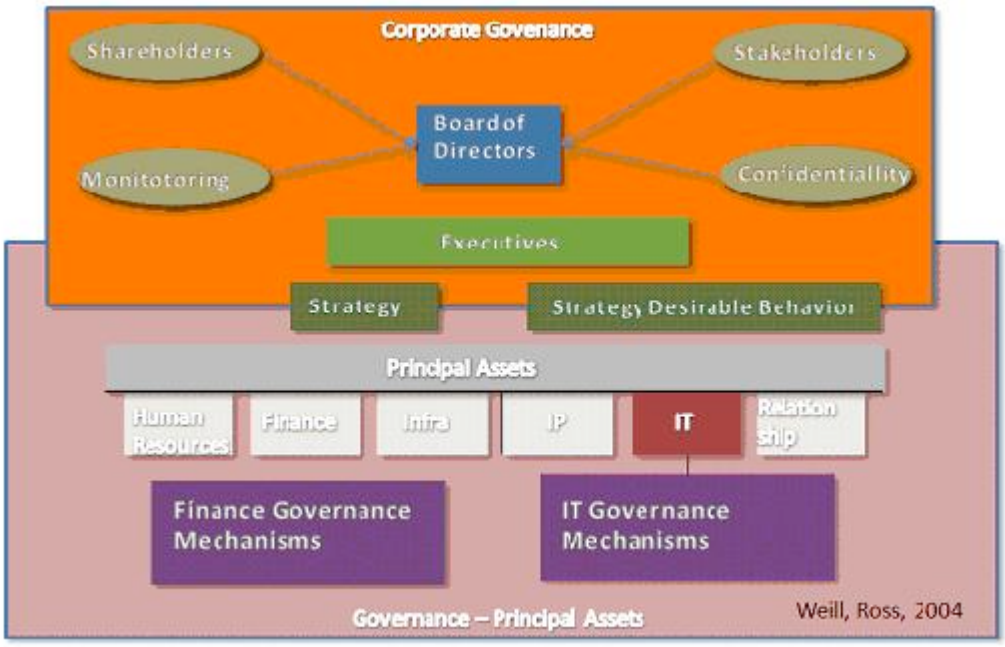


Figure 3 – Governance of Principal Assets
Source: Weill & Ross, 2004

1 - The COBIT was created by the ISACF (Information System Audit and Control Foundation) in 1994 to contribute to the delivery of IT products and services, based on business needs. It is currently accepted as the best practice in terms of IT governance mechanisms. COBIT can be represented on the macro level by a Cube (Figure 4) where resources are managed by processes, in order to reach goals which in turn are strictly linked to business requirements.

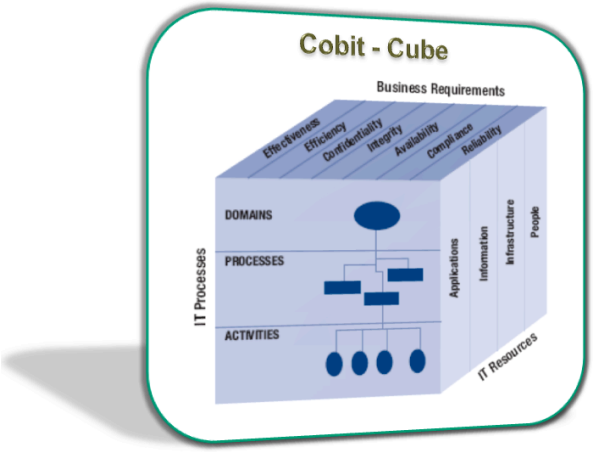


Figure 4 – COBIT
Source: IT Governance Institute, 2004

In the COBIT view, defining the IT Business Objectives is the result of a process of alignment, where business requirements derived from the company strategy combined with the influence of the requirements of governance define the information services to be delivered for the IT area, which result in criteria to be met in such a way as to establish adequate IT governance (*IT Governance Institute, 2004*). The prerequisite for utilizing the COBIT consists therefore in defining the business requirements, as mentioned earlier.

2 – The Value Chain: The value chain (Figure 5) expresses the form by which the company adds value in the market, where it is active in offering its products and services. According to Porter & Miller (1985) a company's "value activities" can be established in nine generic categories divided into two general categories. Production is represented in this model as a company's primary activity, i.e., subservient to corporate governance and therefore, influences it to adopt governance mechanisms for its assets, among them the IT Value Chain.

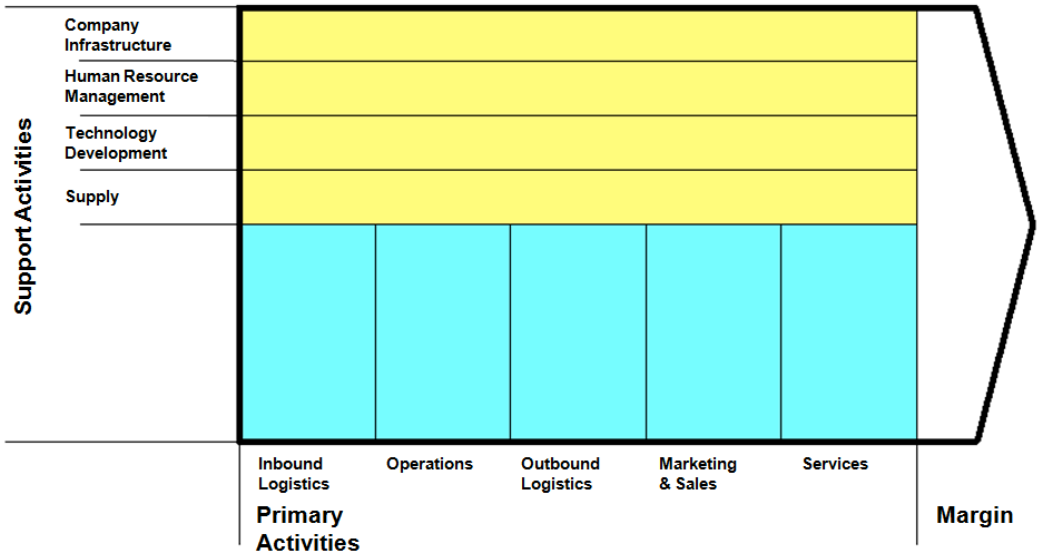


Figure 5 – The Value Chain
Source: Porter, 1980

3 - The Domain of Information in Production: For the ISA, production information has its domain distributed throughout the architecture of applications (Figure 6) which provides support to production and is composed of 5 levels:

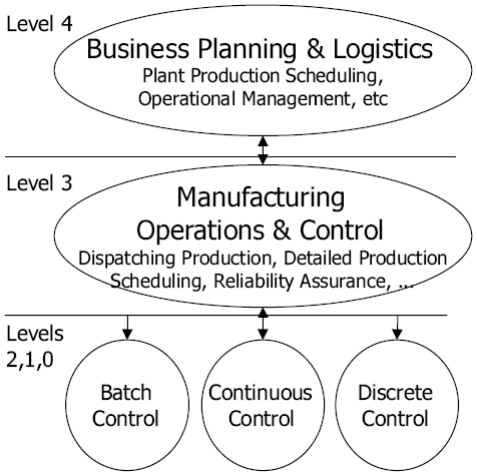


Figure 6 – Functional Hierarchy
Source: ISA, 2000

Levels 0, 1 and 2: encompass all the automation necessary to the operation of the production process, i.e., the automation of all the factory floor operations.

Level 3: is the level of execution of production (MES), intermediate between automation and management systems. At this level, the functions of integration with management systems are executed, performance analyses, production history, maintenance management, production sequencing, resource allocation, quality management, document control, data collection and storage.

Level 4: are the management systems that carry out the company administrative, accounting, logistical, and comptroller functions, among others.

Establishment of IT governance should therefore consider this structure as not limited just to the layer of level 4, usually represented by ERP.

4 – Functionalities contained in the MES layer: the ISA (2000) proposes the flow below, as a functional model for production control, composed of 10 macro functions, which are: *Production Scheduling* (2.0), *Material and Energy Control* (4.0), *Maintenance Management* (10.0) and *Product Inventory Control* (7.0) in the domain of the MES layer or the domain shared with the ERP systems that are at the service of production goals.

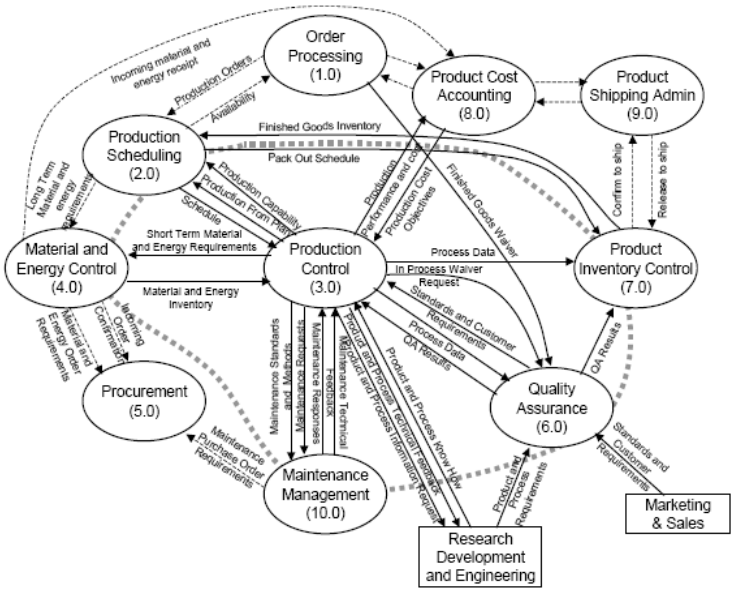


Figure 7 – Functional Management Model – Control
Source: ISA

5 – Production: Slack (1991) defines production administration as a complex process, with some basic elements presented in Figure 8. In this model, the system is responsible for converting entry resources, “Input” into specific exits, “Output”. At the center of this process, is planning and production control which is responsible for the execution of production with performance objectives specific to each organization.

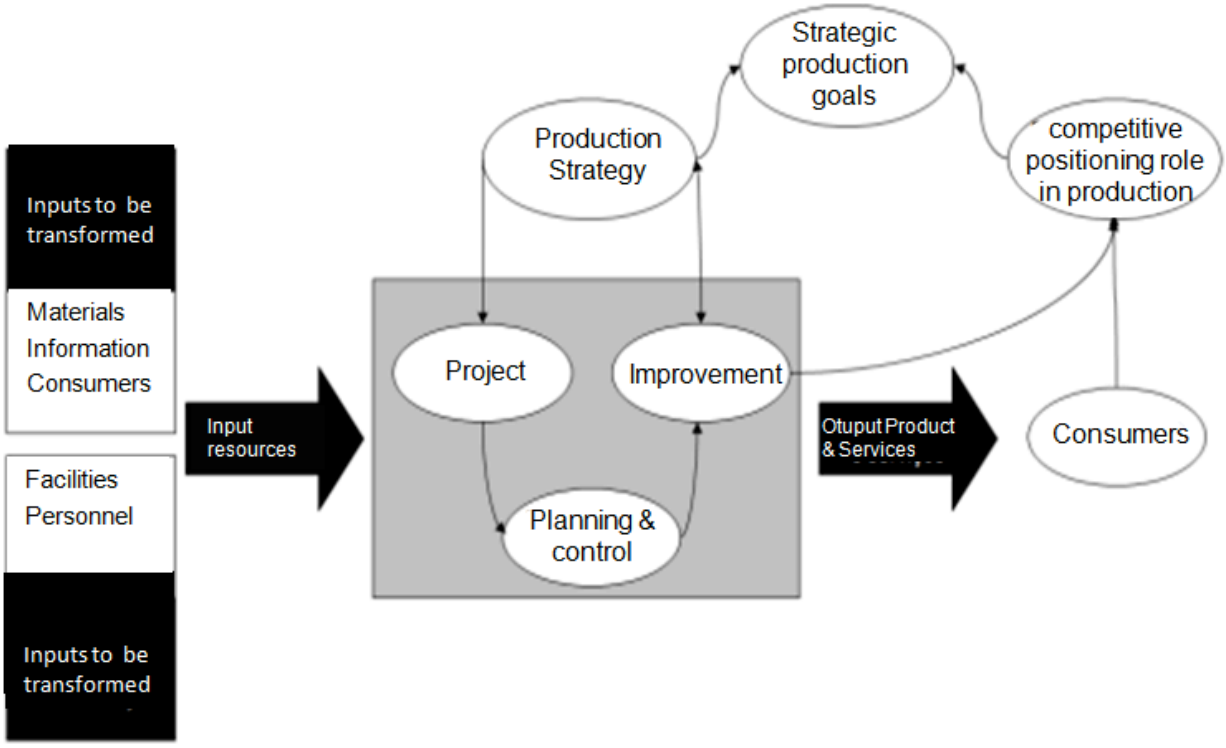


Figure 8 – Production Competencies
Source: adapted from Slack, 1991.

6 – Process of Identifying Requirements: The process of identifying requirements that will be controlled by the COBIT is, in essence, configured as an understanding of production, of its information requirements and of an adequate prioritization and validation. This process includes:

Figure 9 – Process of Identifying Requirements
Source: Authors

6.1 – Validation of requirements: the validated information requirements are inputs for COBIT. For the software engineering area (Kotonya & Sommerville, 1998) system of requirements are identified through a collaborative process, in which the user areas, in conjunction with the specialists, define the requirements, passing through a number of stages where requirements are elicited, analyzed and negotiated, finalized with documentation and validation of requirements. These requirements thus would be the products of an alignment which is the gap in the process of implanting governance, utilizing COBIT in IT, according to Fernandes & Abreu (2006).

6.2 - Alignment tools: for Fernandes & Abreu (2006) the IT alignment process can be understood as a statistical and dynamic search for correspondences between the company strategy and its IT. Laurindo (2003) proposes that the alignment tools for this process can be classified in 4 large groups: diagnostic models; prescriptive models, models focused on action and integrative models.

Among these classes, the focus of this work is on the group that has the goal of identifying and prioritizing requirements, i.e. focusing on action, represented mainly by Rockart (1979). According to Laurindo (2003), two further approaches, the Balance Score Card and Business Process Modeling can be included in this group.

6.3 – Production Strategy: In the view of Slack (1991) companies are selected by the market in function of their ability to outperform the competition in meeting performance goals, flexibility, reliability, quality and speed. These objectives are defined from the client's perspective and are reached by processes carried out by production which are set off by a system of logic, in the vision proposed by the SCOR (Supply Chain Council Reference) model as cited in Lockamy III and McCormack (2004), composed of planning, mobilization, execution and delivery of products and services.

2.3 Establishing a model for the use of COBIT in governance of the MES layer

To establish information governance in production utilizing COBIT, the key point in the model proposed in this article is to identify the requirements that depend on a precise understanding of production. The authors belong to the action focused line of thinking (Rockart, 1979, Ross, 1996); Farbey, 1995 cited in Laurindo 2003), i.e., the line which requires identification and prioritization of requirements. This approach is frequently marked by a vertical view of production, beginning with a mapping of the present situation by capturing the company strategy and deriving the information requirements as a function of this. .

The transactional issue inherent in the systems that support the execution of production, focused on supporting the execution of the flow of the process is very sensitive. It therefore requires a broader approach in the phase of understanding, including the requirements necessary to the processes of planning, source, execution and delivery of products, like that proposed by the SCOR (Supply Chain Operation Reference) model. It thus creates a horizontal view of production process workflow and established this model as a base, proposing the following steps to trace this alignment.

The first step is to understand the company through its strategy and production process workflow. The models of Porter (1980) and Rockart (1979) are used for this, and for their production processes workflow the model of Scheer (1998) is used as a base. The product of this first stage, therefore, is the complete set of information requirements. The second step consists of classifying the information requirements in relation to the performance objectives: cost, quality, flexibility, reliability, speed and support for each stage of production workflow execution. It also consists of prioritizing in what order these requirements will be met. The third step is aimed at validating and classifying the requirements by considering the strategy adopted and the operational demands, the desirable behaviors defined by corporate governance and the viability of meeting the criteria proposed by the COBIT. This is valid for each of the business requirements which are: the available from the information needed to support business requirements; the risks of lack of integrity and reliability of the information, efficiency in the costs of processes and operations and confirmation of the reliability, effectiveness and conformity of the information.

3. Final Considerations

We hope this article provides a viable way to expanding IT governance to the factory floor using the best practices in the market. We believe that the model proposed will be used in companies to contribute to the adequate use of a new and possible strategic technology. It can collaborate in the creation of singular capacities will lead to significant competitive advantages.

The route outlined in this article is only one of the possibilities and thus we recommend developing other projects using other alignment tools aimed at identifying the most efficient and effective route or possibly validating this proposal through empirical research.

It is important to stress that the responses from the research undertaken here, should not be generalized and to keep in mind that the reduced size of the sample, allows it to be treated only as an indication of the relevance of the theme and as a support for future work.

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