INFORMATION FLOW OPTIMIZATION AS A WAY OF IMPROVING BUILDING LOGISTICS PERFORMANCE
Logistics Information flow Optimization

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ABSTRACT

Effectiveness of building logistics can be enhanced through the implementation of efficient communication channels. For logistics support production in the construction process it is crucial that information smoothly flow through the channels among all the actors involved.

For this purpose, accuracy, timeliness and completeness are the main information characteristics required. Skilful design and control of data flow would be necessary if this goal is to be achieved.

Based on case studies conducted in two different building construction firms in São Paulo (Brazil) this paper seeks to identify and discuss the characteristics of their logistic information processes, the way these firms manage this type of information and the impact of information technology in their current logistic processes. Logistical integration as a result of efficient information systems is also discussed. Finally, some recommendations in order to improve logistical information flow are presented.

Keywords: Building Logistics, Information Flow, Information Technology.
INTRODUCTION

Logistics is defined by the Council of Logistics Management [CLM (1999)] as: “the part of the supply chain process, that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information, from the point of origin to the point of consumption in order to meet customers' requirements”. Even though, this definition basically refers to the manufacturing industry, it is also valid for the construction industry.

The importance of logistics in the building construction industry has been recognized by academics relatively recently [Agapiou et al. (1998), Bertelsen (1995)]. For years, construction firms have neglected their logistics area, but this is beginning to change, logistics is currently seen as a way of obtaining competitive advantage. Clausen (1995) apud Agapiou et al. (1998) states that the concept of logistics constitutes an important management tool to ensure an overall strategic perspective on the flow of materials within the production process. Thus, for logistics develop its real potential, efficient information systems are called to support its information flows.

The main purpose of modern building logistics is to have the required resources (materials, labor and equipment) on the right place, at the right time, in the right quantity without prejudicing cost and quality. In other words, production should not be interrupted because of the lack of supplies on-site. The only way to achieve this objective is through careful planning and controlling.

If we think about the information that supports this process, we will see that it passes through various stages before it returns to site transformed in the required resource. These stages can be grouped in:

- Resource identification: this is the departure point and it is given when someone identifies the need of a particular resource (material, labor, or equipment) to attend production demand. This identification generally takes place on-site, but sometimes (i.e. when the construction is beginning), the need can be identified by the budgeting department or similar.
- Resource requisition: it is the transmission of the need, it refers to the formal application for the resources needed to the person in charge on the firm.
- Requisition approval: this is a control stage and it does not necessarily exist in all firms, the idea is to check the requisition in terms of specification and quantity and also to verify if it is time to buy the demanded resource. Usually the one who gives this approval is a member of the firm, with major hierarchy and experience than the one that made the resource requisition.
- Quotation requisition: refers to the formal application for the resources needed to one or many suppliers.
- Quotation: refers to the reply given by the suppliers to the quotation requisition. It usually indicates the resource specification, quantity, price, payment conditions and delivery date.
• Quotation approval: when quotations are received, an election to choose the best proposal is made. Suppliers are normally chosen by bidding, but factors such as quality and delivery time are also taken under consideration.
• Purchase.
• Delivery, receipt and inspection.
• Payment.

The important point to note is that since the first information is generated it passes through many departments of the inside and outside the firm and each of these adds new features to it until it is finally transformed into a purchase and delivered to site. To complete each stage, data and information from other departments are required. This generates a constant information trade among areas of the firm.

To help identifying these areas Cardoso (1996) distinguishes two main divisions, which integrate the main logistical functions in a construction firm:

• supply logistics (external): responsible of the purchase and distribution of the resources to site;
• site logistics (internal): responsible of the physical flow of resources on-site.

These two divisions include many areas in a firm, as purchasing, budgeting, planning, accounts payable, sites, and so forth. Each of these departments has its own rules and procedures, which influence on the information processing time. Moreover, in most cases, they need the same data or information to develop their activities but the information systems that support them are not integrated, this increases the response time and also causes data redundancy.

According to Silva and Cardoso (1998), logistics rationalization must pass through the rationalization of its information flow, these authors also give some suggestions in this respect:

• to create a logistics information system, this system should organize and normalize the ways of sending, receiving and recording data and information;
• to define a decision support system;
• to eliminate noises that affect information quality during transmission;
• to increment the speed of data processing;
• to eliminate data and information redundancy.

In addition to this, it is important to note that in order to ensure efficient communication, the information generated in each stage must accomplish certain characteristics, like: accuracy, timeliness, accessibility, clarity, among others. Therefore, it is crucial that each stage have effective controls that ensure that only valuable information flow through the communication channels.

Based on two case studies conducted on two Brazilian building construction firms, this paper analyses and discusses the way these firms organize their data and information related to logistics. It also focuses on the systems that support these processes. Finally,
some recommendations in order to optimize their way they manage this type of information are given.

**METHODOLOGY**

The research methodology was based on a literature review and on two case studies. To develop the case studies, two building construction firms were chosen. The first one had a traditional information system, this means that each department worked with its own software and there was little functional integration among them. The second one was implementing an information system that would integrate the areas of budgeting, planning, supplies, sites and accounts payable.

The idea was that through an analysis of the way these firms managed their logistical information flow it should be possible to identify the main parameters that make logistical information flow efficient and in what degree this performance depends on the information systems that support them. The tools for studying the case studies included casual and structured interviews as well as observation on building sites.

Burch *et al.* (1979) suggest that for studying and analyzing the information system in an organization, two types of information should be collected:

- General information: firm’s size, organizational structure, and management philosophy. These kinds of characteristics are inherent to each organization and define their information requirements.
- Specific information related exclusively to the studied topic. In this case, we refer to the way the firm organizes its information in order to support its logistics.

In order to collect this information, three types of interviews were developed. The first type of interview was applied to one member of the directory; its main objective was to obtain general information about the firm. The second type was applied on the firm central office. In this case, the idea was to collect information about how the departments of purchasing, budgeting and planning worked and how they managed their information. The third type, was applied to the resident engineer of a construction site, the information collected with this interview was related to site logistics.

The idea was that through these interviews, a clear panorama of how these firms organize their logistics and the information that support it could be obtained.

To help organizing this data, data flow diagrams were built. These diagrams helped to identify positive and negative features on the information processes.

In this paper we will refer to these firms as X and Y.

**FIRMS DESCRIPTION**

**Firm X**
Both firms studied were medium size building construction firms and had main operations in São Paulo City (Brazil). Firm X basically worked on housing and commercial private projects and had twenty years on the market. When the research was developed, its production management philosophy was in transition. It was passing from a traditional production management philosophy to a rationalize type.

During the last eight years, this firm has been implementing a production rationalization program which focused on new technologies development with the aim to improve site performance (reduce waste, optimize resources). These new technologies refer to the replacement of traditional construction technologies for rationalized technologies. The objective of this production management philosophy was to reduce waste introduced to the process by traditional construction technologies. In most cases these traditional technologies did not have a scientific support. For this, a technological development department was created. Besides developing technologies this department had to implement these technologies in the process, this was obtained by training programs.

Given that the information flow in a firm is closely related to its organizational structure, in order to understand these flows a brief description of firm X organizational structure will be presented.

Similar to almost all building construction firms of São Paulo, firm X has a hierarchical functional organizational structure. This structure is divided into four main areas: technical, marketing, administrative and designs coordination. In this paper we will only make reference to the technical due to its relationship with logistics.

The technical department is divided into the areas of budgeting and cost control, purchasing, technical assistance, and site coordination. All these areas are centralized and report to the manager director, who is one of the key elements of the firm.

The budget and cost control department has the function of elaborating the budget and cost control for all the projects. Given that the budget elaboration depends on the designs, and that these are usually completed some months after the construction is begun, budgets are normally finished on the first three months of the construction stage. When this document is completed it is sent as a report to site. This report includes the budget, price structure, resources quantities and production schedule.

This department also realizes a monthly evaluation of the construction cost comparing the expenditure in that period with the one projected in the budget. This information is a useful tool for managers on the process of decision making.

Construction planning depends on the resident engineer and his abilities to manage site. Firm X does not have formal rules for identifying their materials needs. In spite of the existence of a production schedule for the entire project, materials requirement planning is not done. For this reason, we can affirm that the need of materials is usually identified when stocks reach a certain level. Bertelsen (1997) refers to this as a logistics based on consumption. According to this author, logistics should be based on a planning approach on the overall level and a consumption approach in the day-to-day operation.
In spite of that, the information flow that support the materials requirement has a quite formal procedure, the needs are identified using the inventory and the production plan, this information is transformed into a material requirement and it is sent to the central office via modem. Sites have the authorization to enter to the purchasing software with a password. When this information is online, it has to be approved by the technical director so that the purchasing department can be able to order a quotation to suppliers. When quotations are received, depending on its amount, the technical director or the purchasing manager can approve them. The approved quotation generates a purchase order, and this information is printed and sent to site and accounts. When products are delivered on-site, two types of controls are usually done. The first control permits to verify if the materials meet the requirements that appear on the receipt procedure, this is a written document which include receipt specifications. The second control permits to check the delivery against the purchase order (quantity, price and date). If everything is correct, the resource is received on-site, the bill is sent to the budget and cost department to record the purchase and, finally, it is sent to accounts payable, to be paid.

It is important to add that the purchasing department does not have formal procedures for evaluating its suppliers’ performance. When a problem with a supplier appears, the purchasing manager is notified without a written document.

Even though the firm is trying to rationalize its production, it is not paying much attention to the information system that supports this process. As already pointed out, their information system is not integrated. Construction sites and budgeting, cost control and purchasing departments work with different non-compatible softwares. A network for the purchasing department exists, but it is only used to link the building sites, the purchasing department and the technical director. This enables on-site requisitioning and online approval.
Table 1 presents a description of the stages that information related to logistics has to pass through. It also presents the data generated in each stage, the place where it is recorded and the information technologies used to transmit it.
Table 1. Material Requirement – Firm X

<table>
<thead>
<tr>
<th>Stage</th>
<th>Responsible Functionary</th>
<th>Area to which it belongs</th>
<th>Information Generated</th>
<th>Record</th>
<th>Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource requisition</td>
<td>Resident engineer</td>
<td>Site</td>
<td>Resource specification, quantity and delivery date</td>
<td>Purchasing database, site record</td>
<td>Modem</td>
</tr>
<tr>
<td>Requisition approval</td>
<td>Technical director, Purchasing manager</td>
<td>Technical department</td>
<td>Approved Resource Requisition</td>
<td>Purchasing database</td>
<td>Network</td>
</tr>
<tr>
<td>Quotation requisition</td>
<td>Purchasing manager</td>
<td>Purchasing department</td>
<td>Quotation Order</td>
<td>Purchasing dep. record (paper)</td>
<td>Telephone, fax</td>
</tr>
<tr>
<td>Quotation approval</td>
<td>Supplier</td>
<td>Supplier office</td>
<td>Quotation (includes, price material specification, quantity, delivery date and payment conditions)</td>
<td>Purchasing dep. record (paper)</td>
<td>Telephone, fax</td>
</tr>
<tr>
<td>Purchase</td>
<td>Purchasing manager, Purchasing manager</td>
<td>Purchasing department</td>
<td>Purchase order</td>
<td>Purchasing database</td>
<td>Courier, telephone, fax</td>
</tr>
<tr>
<td>Delivery</td>
<td>Supplier</td>
<td>Supplier</td>
<td>Bill</td>
<td>Suppliers record paper</td>
<td></td>
</tr>
<tr>
<td>Site reception</td>
<td>Engineer</td>
<td>Site</td>
<td>Delivery Approval</td>
<td>Site record (paper)</td>
<td>Courier, telephone</td>
</tr>
<tr>
<td>Cost Control</td>
<td>Budget manager, Budget and cost control</td>
<td>Budget and cost control</td>
<td>Payment approval</td>
<td>Budgeting department file (paper)</td>
<td>Paper</td>
</tr>
<tr>
<td>Payment</td>
<td>Accounts Payable</td>
<td>Accounts Payable</td>
<td>Payment</td>
<td>Accounts Payable department file</td>
<td></td>
</tr>
</tbody>
</table>

Analyzing
Table 1 we see that almost all the data generated on the process is recorded by many departments, this makes data difficult to retrieve and to be recover when needed. Moreover, some of the communication channels used to communicate and transfer these data are informal and affect data and information quality.

**Firm Y**

Similar to the other firm, Firm Y is a building construction company that works on housing and commercial private projects. An important characteristic of this firm is that it is currently implementing an information system to achieve functional integration among different areas in the firm. The main departments that it will integrate are sites, budgeting, purchasing, and accounts payable.

The idea of implementing a new program appeared as a response to the need to share data among different departments. This new software is based on a program developed for another construction company, but it was adapted to the firm’s way of working. The implementation of this new software has helped the firm to formalize its procedures for recording, sending and receiving information. The system works with a centralized database that enhance multilevel and cross-functional flows of information as well as permit users to get quick information to specific inquires.

As Firm X, this firm organization structure is hierarchical in nature. The technical area is divided into six departments: designs coordination, site coordination, planning, purchasing, subcontractors’ procurement, and technological development. The planning department is subdivided into budgeting, labor organization, schedules, equipment management and cost control. It is interesting to note that all these departments are centralized at the home office.

Before the construction phase starts, budgets begin to be elaborated based on designs. Similar to what happened in Firm X, designs are usually not completed before the first two months of the beginning of the construction phase. As a consequence of this, budgets are not finished before this period. When finished, they are sent to site and they are also available through the system. For this firm, budgets are one of the most important control documents. They collect valuable data like resource quantities, unitary cost composition and resource prices. Based on this information financial and production schedules are elaborated. Besides this, budgets are used for material requisition, cost control and purchase.

A rule that has appeared with the new information system is that building sites can not require resources that do not appear in the budget nor order a quantity bigger than the one registered in it. To do so, sites have to ask for a special authorization to the planning department, justifying the reasons to incorporate this new material or new quantity. If their demand is approved, these new features are added into the budget, and only then, the system permits them to make the requisition.

To help in the purchase and reception of materials, the technological development department is beginning to elaborate a manual, which includes the specifications for purchasing and receiving materials. This establishes the standard against which
inspections and quality checks should be made. The idea is that in the future this manual should be online and become accessible to the entire firm (including sites).

Sites identify their need of resources with the inventory report and production schedule but materials requirement planning is not usually done. Similar to what happened to the other firm, production planning depends on the resident engineer but in this case, from four to four months, the planning department demands resident engineers to update their project schedules. This somehow makes engineers effectively plan their production but it does not assure the reliability of this planning.

As Firm X, this firm presents a formal procedure for the requirement of resources. Resource requisition is done online directly from site, the responsible to do so is the resident engineer. Before the purchasing department receives this requisition it has to be approved by the site coordinator. Depending on the amount of the purchase, quotations can be approved by the technical director, purchase manager or the buyer. When this is done, the supplier is notified and the purchasing department creates a purchase order in the system. The data included in this order are: resource specification and quantity; total cost; data delivery and payment conditions. When resources are delivered on-site, quantity and specification have to be compared against the firm’s receipt procedures and the purchase order; if the resource is accepted this information is registered on the system and accounts are authorized to pay the supplier. Table 3 describes the material requirement procedure for Firm Y, it also present the data that is generated in each stage and the information technology used to transmit it.

Table 3. Material Requirement Procedure – Firm Y

<table>
<thead>
<tr>
<th>Stage</th>
<th>Responsible Functionary</th>
<th>Area to which it belongs</th>
<th>Information Generated</th>
<th>Record</th>
<th>Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>Resident engineer</td>
<td>Site</td>
<td>Material specification, quantity and delivery date</td>
<td>Centralized database</td>
<td>Modem</td>
</tr>
<tr>
<td>requisition</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Requisition</td>
<td>Site Coordinator</td>
<td>Coordination</td>
<td>Approved Resource Requisition</td>
<td>Centralized database</td>
<td>Network</td>
</tr>
<tr>
<td>approval</td>
<td></td>
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</tr>
<tr>
<td>Quotation</td>
<td>Purchasing manager</td>
<td>Purchasing department</td>
<td>Quotation Order</td>
<td>Purchasing department</td>
<td>Telephone, fax</td>
</tr>
<tr>
<td>requisition</td>
<td></td>
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<td></td>
<td>record (paper)</td>
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</tr>
<tr>
<td>Quotation</td>
<td>Supplier</td>
<td>Supplier office</td>
<td>Quotation (includes, price material specification, quantity, delivery date and payment conditions)</td>
<td>Purchasing department</td>
<td>Telephone, fax</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>record (paper)</td>
<td></td>
</tr>
<tr>
<td>Quotation</td>
<td>Technical director /</td>
<td>Technical department /</td>
<td>Chosen Supplier</td>
<td>Purchasing department</td>
<td>Paper</td>
</tr>
<tr>
<td>Approval</td>
<td>Purchasing manager /</td>
<td>Purchasing department</td>
<td></td>
<td>record (paper)</td>
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<td>buyer</td>
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</tr>
<tr>
<td>Purchase</td>
<td>Purchasing manager</td>
<td>Purchasing department</td>
<td>Purchase order</td>
<td>Centralized database</td>
<td>Network</td>
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<td>Delivery</td>
<td>Supplier</td>
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<tr>
<td>Site</td>
<td>Engineer</td>
<td>Site</td>
<td>Delivery Approval</td>
<td>Centralized database</td>
<td>Network</td>
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<td>reception</td>
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<tr>
<td>Payment</td>
<td>Accounts</td>
<td>Accounts Payable</td>
<td>Payment</td>
<td>Centralized database</td>
<td>Network</td>
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</table>

**CASE ANALYSIS**

**Common problems identified**

It is easy to note that despite the differences between the information system that support logistical procurement, both firms present a very similar way to realize their activities, the differences were given in the way they send, receive and record their information (see
Moreover, in both cases it was possible to identify common problems related to logistical information, which did not depend on the information system but on other factors, like:

- unreliable designs: this means incomplete designs; poor design specifications; design changes and modifications.
- unreliable production planning;
- unreliable supplier performance;

The first two factors depend are inherent to the firm’s production process while the last one depends on an external agent.

Design unreliability generates innumerous problems on-site and it is one of the main reasons that planning be so difficult to be made. During the entire project and especially on the construction phase, a great number of changes and modifications are constantly introduced to designs. This makes budget and production plan not valid unless they were updated. In spite of that, updates are seldom done. When asking both firms about the reasons for not updating this information, the answers varied from lack of time to difficulty to manage the information. Firm Y was optimistic, they believed that the new software should help them organize this information, at least budgets should be constantly updated in order to make a resource requisition.

On the other hand, production uncertainty causes great losses to the project. It generates waste of resources and time. Without a reliable project planning, that indicate the activities to be realized as well as the place where they will be done, it is quite impossible to identify the need of resources. Resources procurement has to anticipate production and the only way to do so is through a reliable planning. In both firms it was verified that they did not meet this requirement. Production planning was done to satisfy a formal procedure but it was seldom used as a useful document. In one case (firm X) it was not updated while in the other case (firm Y), even when it was, it was not reliable.

The last factor, unreliability on supplier performance, is given when the supplier fails to fulfil the purchase order and the firm’s quality requirements. The most common problems are delivery delays, quantity mistakes and quality problems. All these situations generate production problems and in some cases make production stop.

Beside these problems, other problems related to the way the firm managed its information were also identified:

- Lack of accuracy on information: even though in both cases studied, the procedure to make requirement of resources was quite formal, in many cases, the data that passed from one step to the other was imprecise. For example, the supply manager of firm Y complained that he always had to verify resources requisition before passing it to a buyer because it was common to find specifications errors even in requisitions approved by site coordinators. The justification was that there were no formal controls that verified the quality of the information generated in each step. Problems
appeared when realizing the purchase, or even worse, when resources were delivered on-site.

- Data redundancy: resource quantification was realized at least twice times, when elaborating the budget and when elaborating the resource requisition. In some cases it was also done to elaborate the physical financial report. The justification was that the resource quantities that appeared in the budget were global, while the ones needed for the other reports were partial they also argued that it was very difficult to recover the partial data generated by the budget department. Other example of data redundancy was given when Firm X evaluated the construction cost for a fixed period, despite the accounts department had a file with all the payments made in that period, this information was also generated by the budget and cost department. In this case they argued that they preferred to have their own files because the format used by the accounts department was not useful for them.
- Lack of timeliness in the information: firm X presented difficulty to recover information because it was dispersed all over the firm. This caused problems when making decisions given that quick information was not available.
- Loss of data: the multiple changes and modifications introduced in the project generated new information that in most cases it was not recorded.
- Lack of system feedback: even though both firms presented this problem, firm Y believed that the new information system would help them to have a feedback for future projects.

**Recommendations to these problems**

As already pointed out, two types of problems that affect efficiency on the logistical information flow were identified. The first type of problems was caused by factors that did not depend specifically on information processes, like deficient production planning, design unreliability and unreliable supplier performance. On the other hand, the second type was specifically related to information problems.

In the first case, the factors described above make construction process uncertain. Uncertainty is one of the principal aspects that have to be taken into consideration in order to improve both, production and the information process. The simplest way to protect the system against uncertainty is generating stocks, but as it is well known stocks are synonymous of waste [Christopher (1992)]. For this reason, it is better to find key metrics for each of these sources (designs, production, suppliers) that can help us identify and understand the reason for these uncertainties in order to protect the system against them or be prepared to deal with them. The idea is to make the process as reliable as possible.

A reliable production planning is crucial to help the process be transparent and ensures a reliable materials requirement planning. Three levels of planning is recommended to achieve this purpose, one contemplating the whole project, a second based on a month approach and a third based on a day-to-day approach. The next step is controlling, effective controls assures that production is being done as it was planned. When controlling production, it is important to record the reasons of planning failures in order to prevent them from happening again.
It is also important that firms have records of their supplier performance and have a formal procedure and form to qualify their suppliers. Dobler and Burt (1996) suggest monitoring and assessing the supplier’s overall performance just after the selection of the supplier. Both firms studied did not have a formal supplier qualification procedure; furthermore, when a supplier did not have a good performance it was verbally communicated to the purchasing manager.

In the second case, the best way to minimize problems related to information would be through a skillful design of the flow that supports these data. It is necessary to formalize this flow and to clearly define the people in charge for each stage of the process. It is also important that each stage have control procedures that ensure accuracy in the data and information generated.

Despite the fact that in both firms, the resource requirement procedure was quite formal, in many cases the information generated in each stage had quality problems. Analyzing each step we will find that there are at least three sources that can influence on the resulting information quality:

- input data or information;
- additional information required to accomplish each stage;
- personnel in charge.

The first factor, input data or information, is usually the one generated by the previous step, if this information is not accurate it will introduce error to the process or it will delay the process. For this reason it is necessary to clearly define which is the data output required in each step. For example, materials requisition has to indicate quantity, specification, when it is needed, for what it is needed, etc. It is best if this procedure is standardized using a form.

According to Dobler and Burt (1996) the purchase description forms the heart of the procurement. Whether or not a purchase order will be performed with satisfaction of the buying organization frequently is determined at the time the purchase description is selected or written, specifying the quality requirements. Specifications are the most detailed method of describing requirements. Developing proper specifications is an important management task and should count with the collaboration of many areas in the firm like: production, design, purchasing, etc. Firm Y has already noted this and is developing specifications not only for purchasing but also for production and controlling; as already commented, it is trying to disseminate the use of these specifications all over the firm through the use of information technology.

Besides input data, for accomplishing each stage it is required of additional information. Generally, this information depends on other departments. It is important that this information be available and accessible when required. A centralized database for each project is recommended. According to Burch et al. (1979), the use of databases helps to standardize record names and formats, interrelate common data elements, synchronize file updates, and reduce data redundancy. They also make data consistent with the functional aspects of the organization’s users. As it has already been discussed, Firm Y is
optimizing its information flow with the use of an information system with a central
database. Table 3 shows that almost all information generated in the process is recorded
on a central database which is available to the entire firm through the network system.

It is important to take into consideration when introducing a new information technology
(IT) on a firm, that the benefits of IT vary from improving individual efficiency to re-
engineering the entire organization [O’Brien and Al-Soufi (1993)]. For this reason, it is
necessary to study and carefully analyze the current information process so they can be re-
structured and adapted to the new technology in order to potential its benefits. This has
been done in Firm Y that has obtained functional integration with the use of IT while
Firm X has only automated some of its functions using IT.

The next factor that can affect information flow quality is the personnel that will
participate in the process. Many information problems in the firms studied were caused
because people in charge were not able to make decisions, were disorganized, etc. For
this reason, it is important that each firm clearly define the responsibilities and job
requirements for each post inside the firm. Selection criteria when hiring personnel
should be done with the purpose to meet these requirements. Training is also important.

**FINAL COMMENTS**

It was verified that the information flow related to material procurement is difficult to be
managed due to the number of people and departments involved. However, for
optimizing these flows, formalization is the first step. This means to clearly identify the
requirements in each stage of the resource requisition and also to define the
responsibilities of the people that will interact with the system. Procedures are the most
detailed method of describing requirements. Formalization makes the process more
reliable and transparent.

Information technology can be used for achieving functional integration and also can help
on the formalization process. As it was already discussed, databases helps to standardize
record names and formats, interrelate common data elements, synchronize file updates,
and reduce data redundancy. They also make data consistent with the functional aspects
of the organization’s users, enhance multilevel and cross-functional flows of information
and permit users to get quick information to specific inquires [Burch et al. (1979)].

Finally, it can not be forgotten that for logistics effectively support production, a reliable
production planning and supplier performance is required.

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REFERENCES


