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## SUPPLY CHAIN INFORMATION INTEGRATION METHODS FROM QUALITY ASPECT

**Abstract:** Considering the great importance of the role of supply chain management (SCM) for the ability to positively influence the corporate profitability, the different ways of SCM development in organizations are a topic of great interest. Processes that occur in the supply chain such as customer relationship management, service management for customers, bid, supply and production management and relationships with suppliers include flows of products, services, information and knowledge. In addition, information aspect is a key prerequisite for achieving the goals that management sets for itself, such as meeting the needs of end customers, minimizing the overall costs and maximizing the total value of the product generated.

Essential links in the supply chain are procurement and relationships with suppliers. In this paper, one view of information integration method for supply chain network is given as well as performs analysis of procurement functions in the supply chain in accordance with the requirements of quality management system.

**Keywords:** information integration, supply chain, quality

### 1. INTRODUCTION

The supply chain is a concept that is rapidly developing in recent years. One of definitions could be – supply chain is a system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer (Picture 1).



Picture 1. Supply Chain Model [12]

In 80's of the last century emerged the need for efficient management of supply chains which led to defining a brand new concept. That concept became known as supply chain management (SCM) as a set of harmonized approaches to the integration of suppliers, manufacturers, warehouses and stores so that produces and delivers the defined quantities of products, on defined locations just in time and minimizing costs in transportation system with appropriate services, all these in favour on consumer requests satisfaction [7].

The concept of supply chains in recent years evolved into the concept of a supply network due to the rapid development of

modern technology and the globalization of business.

This paper analyses the influence of the process modelling approach for procurement function in accordance with the requirements of the quality to the concept of information integration of small and medium enterprises in the existing supply network. The company exports data that are of common interest in e-hub (information hub) so that the current data is always available to all members of the network. The underlying assumption is that the processes are modelled in accordance with the requirements of quality and that the obtained data model contains the necessary information to be integrated into the e-hub.

We analysed the function of procurement as one of the most important in order to obtain suppliers-oriented supply network management.

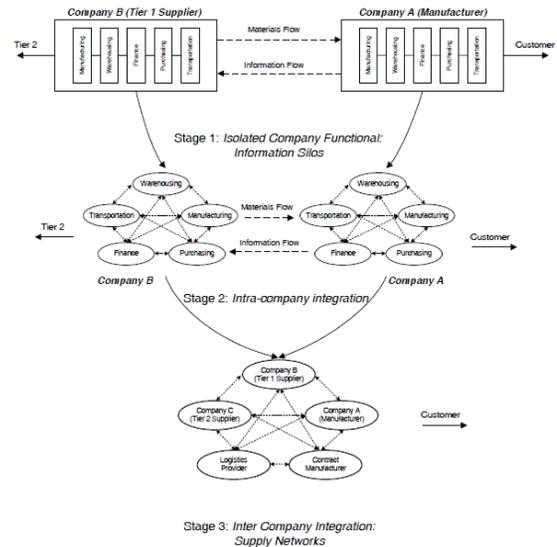
## 2. SUPPLY CHAIN

Supply chain integration refers to both internal and external integration – i.e. joining internal company business segments and integrating with outside companies [13].

Internal supply chain integration is the process of joining otherwise separate activities such as purchasing, warehousing, transportation, distribution and customer service within a single enterprise. It is arguable what extent in integration and coordination of internal functions companies could achieve.

Consequently, many companies have focused on external integration with partners, with emphasis on coordinating information sharing. No longer can companies compete as isolated entities that are disconnected from their supply chain partners. In order for firms to succeed in markets, it is necessary for companies to create strong information linkages with their chain partners. External integration,

based on information sharing, is the primary building block and coordination dimension among companies to improve performance.



**Picture 2. Supply Chain Integration Process [13]**

In the past, supply chains were very rigidly designed, in the form of precisely defined sequence, which has greatly hampered their rapid change. From the aspect of the modern business processes that are capable for continuous change, these supply chains have proved to be very inefficient. Companies that use rigid supply chains are not able to adapt to rapid environmental changes and thus remain uncompetitive. Obsolete linear and sequential supply chain (Picture 2) now is change to adaptive supply chain network. The essence of adaptive supply chain is that companies that are involved in their network, share information and resources in a way that allows them to effectively adjust the constant changes in the market.

Visibility is a very important feature of flexible supply chains. Consider the life cycle of an order created on the Internet by buyer. In a perfect adaptive network, information about the order should be

available to suppliers along the supply chain immediately. They can check the availability of the required components in their inventories and simultaneously respond to the request. All organizational units in the enterprise or external partners who participate in the supply chain may be involved in order realization and can track it through all stages of the supply chain, all through delivery the requested products to the buyer eventually. The possibility of tracing the status of orders is the core of visibility. The challenge that arises regarding the visibility is that the majority of companies still keep their data in separate systems, and the fact that external suppliers are generally not integrated into the enterprise information system.

Another important characteristic of modern supply chains is the velocity of response, i.e. the speed with which the company is able to respond to an event. For example, how quickly one can respond to an order in terms of dissemination of information, raw materials and finished products through the supply chain to the delivery of ordered products to the end user.

Most enterprises are not able to respond to events in the environment without the help of its partners. Supply chain management concept forces companies to break the walls and establish direct relationships among them. Only few of them are able to design new products, produce, sold and deliver them independently. On the contrary, almost all of them have suppliers of raw materials or components, and use the services of external partners to distribute their products. These distributions of responsibilities, which lead to make products and services available to the customer, produce a certain visibility of information between enterprises, regardless the information protection systems and regulations on the preservation of business secrets. The

existence of information barriers between the partners causes delays in delivery and time consumption for resolving misunderstandings and errors in communication.

Small and medium enterprises (SMEs) have an advantage compared to large enterprises because of its great flexibility and possibilities of rapid growth and development, but also face challenges such as strong competition and lack of resources. An efficient IT infrastructure enables these companies to use available resources in the best possible way, and resolve some of the difficulties that could occur. For example, with the market globalization more SMEs compete with each other, however, widening the spectrum of potential consumers increases opportunities for success.

The procurement function in a company is small, but of course a very important part of supply chain management throughout the distribution channel [2].

The task of procurement is to provide the required materials necessary for the smooth operation of the production process and the overall operation of the production system, with low costs. From suppliers, through warehouses, manufacturing process and final storage or shipment to consumers in the form of finished product, numerous problems can occur of which the most important are:

- large number of products in production line affects to a large number of different materials and finished products,
- lack of required quantities of material by type over time, as a result of customers need for finished products,
- numerous and various difficulties related to market of production materials and
- financial limitations connected to providing funds for inventory and unfinished products.

In this way, procurement became an

integral part of the supply chain in order to ensure production continuity, provide raw materials and stores at low cost.

### 3. QUALITY ASPECT

Request that the customer receives a product with quality defined in contract primary was solve at the national level. Later international quality standard defined under the series ISO 9000. Checking and evaluating the quality system of suppliers is a key parameter for establishing a contractual relationship, i.e. involving the company into a supply chain (network).

In accordance with eight principles of quality management system it can be noticed that three of them are closely related to the procurement function within the supply chain (network):

- Principle 1 (an organization focused on the customers) - organizations depend on their customers and therefore should understand current and future customer needs, meet their requirements and tends to exceed customer expectations.
- Principle 4 (process approach) - the desired result is achieved more effectively when the resources and activities are managed as a process.
- Principle 8 (relations with suppliers for mutual benefit) - the organization and its suppliers are independent and their relations increasing their ability to create new value to the mutual satisfaction.

In practice, the best principle of process identification is based on the training of employees for the development of working procedures. Upon completion of training, each employee is required to identify and describe any process within the scope of his work. While describing the process, employee must identify the responsible persons from whom he got input, and responsible persons who receive output. In this way, efficient and fast

identification of all the processes in the enterprise performed, as well as realization schedule and interactions. After realization, this procedure should be described in the Quality Rules Book and thus satisfies the requirements of standard for the process identification.

The function of procurement is a key feature for ensuring the quality of purchased products. The main tasks and duties of the procurement function are:

- identification of potential suppliers, (3.2)
- assess the suitability of the supplier or the ability to fulfil the mandatory requirements, (3.3)
- reviewing requests for new products, (3.1)
- defining and issuing requests for bid, (3.6)
- bids gathering and analysis, (3.6)
- price adjustment, (3.4)
- regulation of commercial relations with suppliers, (3.4)
- agreement definition and reconciliation, (3.4)
- coordination and monitoring of the new products process verification, (3.5)
- procurement plan realization, (3.6)
- issuing orders, (3.7)
- monitoring the procurement realization, (3.8)
- resolving complaints, (3.10)
- resolving of all misunderstandings that may arise with suppliers, (3.10)
- the establishment of close cooperation and feedback systems with suppliers, (3.10)
- monitoring the quality of suppliers and taking measures to improve the quality. (3.11)

In brackets are given references that indicate the relation between tasks and duties given above with identified processes in accordance with the requirements of quality systems that are also given in brackets below:

- 3.1 Defining requirements for new products procurement (ISO 9001: 7.4.1, 7.4.2; ISO 9004: 7.4.1)
  - 3.2 Data collection and analysis of potential suppliers (ISO 9001: 7.4.1; ISO 9004: 7.4.2)
  - 3.3 Gathering and processing data on possible suppliers (ISO 9001: 7.4.1; ISO 9004: 7.4.2)
  - 3.4 Creating contract relationship (ISO 9001: 7.4.1; ISO 9004: 7.4.1, 7.4.2)
  - 3.5 Batch production/Delivery agreed (ISO 9001: 7.4.1, 7.4.3; ISO 9004: 7.4.1, 7.4.2)
  - 3.6 Purchase planning (ISO 9001: 7.4.2; ISO 9004: 7.4.1)
  - 3.7 Purchase realization (ISO 9001: 7.4.1, 7.4.2, 7.4.3; ISO 9004: 7.4.1, 7.4.2)
  - 3.8 Verification of the delivery quality (ISO 9001: 7.4.1, 7.4.2, 7.4.3; ISO 9004: 7.4.1, 7.4.2)
  - 3.9 Reception and storage of incoming materials /parts (ISO 9001: 7.4.1, 7.4.2, 7.4.3; ISO 9004: 7.4.1, 7.4.2)
  - 3.10 Resolving complaints with suppliers (ISO 9001: 7.4.3; ISO 9004: 7.4.1)
  - 3.11 Quality improvement (ISO 9001: 7.4.3; ISO 9004: 7.4.1, 7.4.2)
- Process model [1] and data model [3] are implemented based on defined requirements of quality.

#### 4. INFORMATION INTEGRATION

The core of SCM is integration. Supply chain integration constitutes the following three dimensions: information integration, coordination and organizational linkage. It is obvious that information integration is the foundation of broader supply chain integration.

Information integration exchanges information and knowledge through information sharing, collaborative planning, forecasting and replenishment. Coordination and resource sharing exchanges decision, work through decision

delegation, realignment and outsourcing. Organizational relationship linkage exchange accountability, risks/costs/gain through extended communication and performance measurement and realignment [12].

First appearance of term information integration can be found in papers of Norman Anderson [8]. Information Integration theory explores how attitudes are formed and changed through the integration (mixing, combining) of new information with existing cognitions or thoughts. This theory assumes the existence of three algebraic functions: valuation, integration and response. However, in recent years, his theory has evolved into a modern information technology concept with the same name.

Information integration (II) is the problem of combining data from different information sources and providing the user with a unified view of these data. The idea is to provide transparent integrated access to relevant data, concealing information about the sources, such as their location, data model or query language.

There are three points of view for II analysis:

##### 1. Procedural or declarative

In the procedural approach, data are integrated in a specific way with respect to a set of predefined needs (e.g. typical queries or specific requirements about the sources). In this case, the idea is to develop software components that access the sources according to the predefined requirements. The main advantage of this approach is making simplifying assumptions in order to improve the performance of the query processing. Otherwise the system should be changed every time a new source is added because a new query pattern is identified.

In the declarative approach, the idea is to model the data of the sources with a suitable language in order to have a unified representation to make queries on. The main advantage of this approach is that the

mechanism to answer queries is general, i.e., it is not imbedded into the system, which provides scalability regarding the queries and the sources handled by the system.

## 2. Virtualized or Materialized

In the virtualized approach, the Information Integration System (IIS) accesses the sources every time a query is made. The IIS acts like an interface between the user and the sources. The idea is to have a representation of the content of the underlying data residing at the sources, but not the data itself. A clear advantage of this approach is that the IIS can delegate the problem of having up-to-date information to the underlying sources. It implies accessing the sources with every query. This kind of approach is useful in situations in which the relevant sources are constantly being updated and/or scenarios where it is needed to have up-to-date information.

In the materialized approach, the sources are accessed in advance in order to provide a replicated view of the data within the IIS. Querying is typically more efficient, especially where it is not necessary to have up-to-date information (e.g., a data warehouse) and/or when information does not change frequently.

There are some systems that provide both alternatives.

## 3. Centralized or Peer-to-peer

The centralized approach (also called mediator-based approach) implies the development of a unified view that represents the application domain and describes the data residing at the sources. Developing a centralized IIS is a challenging task, classical challenges include the construction of the global schema, the definition of the mapping between the global schema and the source schema and the choice of the method to compute the answer to queries.

The peer-to-peer approach is a generalization of the former approach that considers the existence of several

autonomous components called peers. Roughly, a peer-to-peer IIS can be seen as a collection of centralized systems that cooperate with each other.

Information integration is a leading aim for many supply-chain managers. Although the benefits of successful information integration are desirable, the barriers are quite daunting [9].

There are at least three problems that negatively affect information integration process: difficulties in software implementation, cutting purchase prices to the detriment of small suppliers and lack of openness in information sharing.

Companies interested in applying information technology in daily business invest in software in order to improve business. Examples of such software are web catalogues for all types of procurement, systems based on web technologies that enable suppliers to obtain the updated offer and the current state of inventories and systems for selection of suppliers. Although investments are huge, a number of communications between partners are still done by fax or phone. Moreover, even though there are EDI standards implemented in the communication between partners, the order is re-entered into the computer upon receipt.

New technologies allow information to be gathered, manipulated and disseminated more quickly and in larger quantities than ever before, and enable a new level of communication and decision-making. By contrast, the people-management side of information exchange brings with it misunderstanding of supply chain needs, lack of trust among decision makers, and a lack of willingness that is needed for managers to feel comfortable sharing sensitive information.

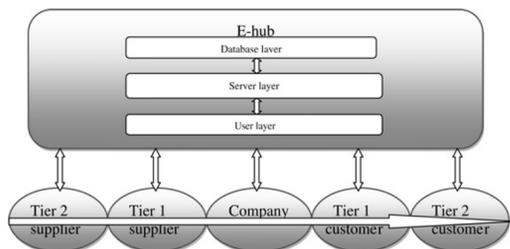
In one of studies [9], authors recognize two aspects of information integration in supply chain: connectivity, as technical ability to obtain, quantify and distribute information by using software,

and a willingness to share current information with other participants.

In recent years, there has been a growing interest in accessing, relating and combining data from multiple sources. Indeed, Information Integration is one of the core problems in distributed databases, cooperative information systems and data warehousing, which are key areas in the software development industry. [6]

## 5. INTEGRATION METHODS

In order to build an integrated B2B supply chain network, there must be an exchange and market place that understand all document structures to facilitate business data interchange services. While the need of the supply chain integration has been recognized there was not a single supportive technology that could integrate the varying demands of the channels for smooth flows of information. One important approach to B2B supply chain integration is e-hubs that instantly process and forward all relevant information to all appropriate partners along the supply chain, so that the entire supply chain can work as a whole (Picture 3). From a general systems theory viewpoint, e-hubs have great potential to link all supply chain partners to function as a whole. [12]



**Picture 3. E-hub architecture [12]**

Currently there are thousands of B2B marketplaces providing various services depending upon their business goals, some of which are offering overlapping services in the same industry. When it comes to

B2B, researchers and business community have focused more on procurement function, which usually takes place between buyers and sellers. While there is no doubt that procurement is one of the most important functions for any business-to-business transaction, it is also important to note that the transaction relies upon myriad number of functions and involves various channels. [10]

The rise of the Internet has made it possible to virtually integrate various channel members and functions of a supply chain. All participants can transfer the information in real time with least transaction cost and global reach by using the Internet as the main medium.

B2B e-hubs are also known as exchanges or marketplaces, and the name signifies the potential that has been hidden underneath the concept. There are various e-hubs for different industries and various functions, providing unique and overlapping features. The industrial e-hubs basically facilitate buying and selling processes, whereas functional e-hubs provide exchange information on transportation, logistics or selling facilities.

Technical compatibility presents a great challenge in B2B e-hub and supply chain integration, which typically involves communication across a variety of hardware and software.

E-hubs are defined as neutral Internet-based intermediaries that focus on specific industry verticals or specific business processes, host electronic marketplaces, and use various market-making mechanisms to mediate any-to-any transactions among businesses. These hubs create value by aggregating buyers and sellers, creating marketplace liquidity and reducing transaction costs.

At least six types of e-hubs exist. These covering one-to-many to many-to-many trading relationships. [11]

- One-to-Many Hub - covers communications among one buyer and many suppliers. Buyer influences on

suppliers in a way to force them to behave in his best interests.

- **Aggregator Hubs** - for the purpose to give offers to potential buyers these are using the content of several suppliers' catalogues. Some of them provide contracts, authorizations and other content.
- **Broker Hubs** - gather many buyers and many sellers, plus a broker. Main goal for these hubs is a pairing buyers and sellers based mostly on product pricing. Buyers send their offers to this hub, which collect these offers into summary offer that is more appropriate for massive buying and discounting.
- **Collaboration Hubs** - provide tools and environments where many buyers and many sellers can share information and actually correspond and collaborate around certain key pieces of functionality. For example, buyers can show their product designs to suppliers, or they can share forecast information so suppliers have a better understanding of what they need to respond to in terms of products, time and service.
- **Translator Hubs** - similar to Collaboration Hubs with enterprise application integration (EAI) capabilities which integrate different and incompatible software environments at the different partner sites. Mechanism for data translation is necessary to achieve communication among partners. These translation technologies include electronic data interchange (EDI), email, eXtensible Markup Language (XML) and fax.
- **True e-marketplaces** provide wide-open many-to-many e-commerce between buyers and sellers. It is necessary for partners to adopt technology standards within and across industries before integration into this marketplace. In many firms, management has not achieved **internal integration of information systems and business processes. Internal integration is needed for achieving external integration on e-hubs.**

Many different marketplaces have

been created on different platforms. Linking these environments together is another level of integration. However, as the technology progresses, several key aspects will be consistent:

- **Richness of data model.** Data models must reach a balance between all the types of data needed to describe the realization of various business processes on the way that is appropriate for the trading partners. Now, different data structures exist even among the applications from a single software supplier; integrating these is technologically a lot less efficient than having a single data model.
- **Integration and collaboration orientation; data versus process.** Integration and collaboration approaches can typically be characterized by their focus on either **data access** (or transformation), or on **business processes**. A true e-marketplace needs to focus on both.
- **Transaction processing and process optimization.** While processing transactions is an important function of the true e-marketplace, the emphasis should be on decision-making before the actual transaction has occurred.
- **Availability.** A true e-marketplace must handle the large volumes of data, transactions and communications associated with Web access.
- **Security.** Security encompasses such functionality as authentication, authorization, encryption and validation keys. Security can be a problematic issue since many organizations do not want to participate because they do not want to share their data.
- **Content/catalogue management.** Content and catalogue management are supported by vendors' products that have the capability to create and manage website elements, such as text, graphics, embedded files, applets and catalogues.
- **Personalization and customization.** Heuristics that analyse a user's browsing behaviour and preferences, and then

customize a site accordingly, leads to personalizing the user experience, increasing both customer satisfaction and the sales effectiveness of the trading exchange.

True e-marketplaces are inter-organizational information systems through which multiple buyers and sellers interact to accomplish market-making activities for corporate purchases.

Suppliers can securely log in to the site and the online server confirms their information. Suppliers can create their online catalogue, give access privilege to different users and distributors, approve buyers' identities and offer customized catalogues for buyers. On the other side, buyers are allowed to see the availability of the products and track the order status in real time.

True e-marketplaces help in reducing transaction costs and search time. The easy access for the suppliers or buyers helps **small companies** enter into the market where they did not have place before.

The other prospective advantage of the true e-marketplaces can be obtained if small and global players are allowed to get easy entry in the market. The entry of small suppliers could offer more cost-effective solutions to buyers. **High dependency on technical infrastructure** and language related issues may become hurdles for small players all around the world to enter into the market place.

To resolve problems which can occur in e-hubs, their possibility of connections with all partners can be expanded when used with some supporting technologies such as ERP or SCM. SCM, as discussed before, coordinates within and between various supply-chain members and provide decision-making processes. Based on the functionality of existing e-hubs and SCM the integration concept is possible. The e-hubs can unify various sources of information and provide the complex solutions. Depending on request of each partner, flow of the information can be

protected and customized. The partners do not need to install various software packages that match the needs of different supply chains, but **they can transact the information** with the help of the SCM software installed on a single e-hub.

Sales, forecasting and order related information can be uploaded to e-hub by using Internet. Gathered information is elaborated on e-hub with the help of SCM software. This information can be available in real time to any partner of the supply chain in the customized formats. Since the information disseminated from the single source in real time, it is guaranteed that it will be correct with no doubt.

On the other side, manufacturer can retrieve the information useful for forecasting, procurement, production, inventory control, sales, marketing and distribution functions. Real time production plan can be made and uploaded with information about materials requirement. If the manufacturer follows the systematic purchasing plan then this information can be obtained at supplier level in real time. Inventory will be replenished with respect to retailers. The supply chain becomes more responsive and timely.

## 6. CONCLUSION

Small and medium enterprises that cannot afford expensive software applications are forced to focus on information integration in the supply network through e-hubs.

The possibility for information integration of this type of companies in the supply network is facilitated by applying a process modelling approach of the business processes of procurement function that follows the data model that contains all relevant information that can be easily integrated into the e-hub and made available to other companies in the

supply network.

In addition, with this approach companies meet a necessary guideline to guarantee the required level of quality of

manufactured products and services offered to other companies in the supply network, which is a condition without they cannot be integrated.

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