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Supply Chain Management in Constuction Procurement System

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Abstract:
Implementation of the idea of supply chains proved beneficial in many branches of industry and commerce. However, it is impossible to transfer the concepts of supply chain management directly from manufacturing industry to construction. The construction project procurement may be analysed as a supply chain with consideration to variability of its configuration dependent on procurement system. The latter is determined by the particular aim of the project and preferences of its owners and funders. The possibility of organising the project's participants into supply chains depends on e.g. their willingness, technical preparation and know-how necessary for entering tight cooperation and mutual commitments. This varies according to branch and sector and is conditioned by the state of economy and level of organisational development of potential links of supply chains. The paper focuses on a particular aspect of construction supply chains, i.e. supply logistics, and investigates into logistic processes concerning material flows. The authors researched on the logistics of Polish builders to examine possibilities of applying supply chains ideas to construction, to trace changes in logistic management and establish directions of development.

Keywords Supply Chain, Logistic Chains, Construction Procurement, Logistic Processes

1. Introduction

The term supply chain relates to logistics, a branch of knowledge based on technology, economics and IT dealing with resource and information flows inherent to any organised, especially economic, activities. According to Christopher (Christopher, 1994) logistics is the process of planning, implementing, and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming

to customer requirements. Between the manufacturer of goods and the consumer there are often numerous intermediaries as wholesalers, retailers, forwarders, agents etc. They all form a supply chain. Supply chain management is aimed at tightening cooperation between the organisations involved to improve their efficiency to mutual benefit and to optimise value added to the product by each of the consecutive organisations on the product's way to the end user (Hoover et al, 2001). Extending this idea to all functions of cooperating organisations allows to define the supply chain as approached currently. This concept is of wider meaning than logistic chain, which focuses on logistic processes and activities. The definition of supply chain and supply chain management in construction, presented by Love (Love et al, 2004) is as follows: "the network of facilities and activities that provide customer and economic value to the functions of design development, contract management, service and material procurement, material manufacture and delivery, and facilities management". Although this broader concept of supply chain management appears currently in analyses of construction project participants cooperation (Love et al, 2004), the authors consider it from the point of supply logistics, narrowing it down to organising deliveries of material or equipment to the building site. All involved processes compose the project's logistic system. A contractor that participates in the project is a link of the project's logistic chain. The contractor's internal organisation has also the form of a chain that has to be linked with logistics chains of the project.

The project is serviced by many logistic chains delivering a variety of resources. Among them are materials, some consumed in huge amounts, requiring unique handling methods, most of them crucial to the success of the project. The cost of acquiring and handling them is usually a considerable share of total project cost. Thus, any factors affecting the volume, structure and organisation of their consumption are vital for the project, which calls for a search for efficient logistic management methods. The basic concepts of logistic chain management are integration of logistic processes, coordination of logistic processes, JIT, lean production, outsourcing and benchmarking.

In order to estimate the potential of applying principles of collaboration, partnering, integration and communication between customers and suppliers throughout the construction project supply chain, a survey on logistics of the Polish building contractors has been conducted. The results, collected for many years, indicate that the patterns of logistic management of the companies change. These observations may be the basis for evaluation of possible implementation of supply chain philosophy to project procurement in order to raise its efficiency. The authors stress the necessity of planning logistic processes on each stage of a project, from its inception, planning, design to execution and commissioning.

2. Logistic Processes in Polish Contractors' Practice

A survey among Polish construction enterprises was conducted in the years 1996-2004. Its results allow the authors to describe patterns of development of logistic activities in construction companies and changes in their supply routines. The survey covered sources of supply, delivery contract routines, criteria of suppliers selection, reasons of delivery inaccuracies, bases of material demand forecast and distribution of responsibility for supply decisions. Two groups of contractors were interviewed: one group originated from the Lublin region (south-eastern Poland, economically underdeveloped), the other were 14 companies from the 100 listed as the best performing Polish construction companies (according to one of the leading popular construction magazines) (Sobotka et al, 2004). In the case of the latter, the survey was conducted by the end of 2003 and the beginning of 2004, the respondents were active on the construction markets and all of them were ISO quality standard certified.

The results of the survey are presented in figures below. Figure 1 shows an average share of value of purchase according to supply source. There is a tendency of decreasing direct purchase from manufacturers for the benefit of wholesalers. This is because of specialisation arising from economic development:

manufacturers often focus on production, provide no transport services and offer best prices to wholesalers – their steady customers and sales agents. Contractors also avoid fixed costs of stores and means of transport, which is possible due to growing market of logistic services rendered by specialised companies.

In most cases, delivery contracts between a contractor and a supplier concern a particular project and there are no exclusive suppliers. A long-time cooperation with a number of suppliers is common. Such partnership allows the contractor to negotiate better terms of delivery contract. The long-time contracts regard usually selected ranges of goods. Figure 2 shows the proportion of long-time and short-time delivery contracts. The cooperation between contractors and suppliers tends to grow as the suppliers offer services of warehousing and deliver on request in batches. Each batch may be paid separately and delivered "just in time".

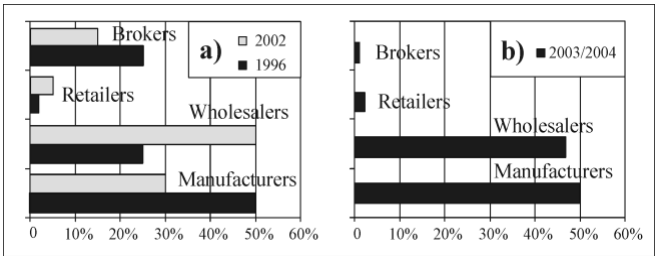

Figure 1: Purchase value according to the type of supplier a) survey among companies from Lublin region, b) survey among 14 companies from the list of best performing in Poland

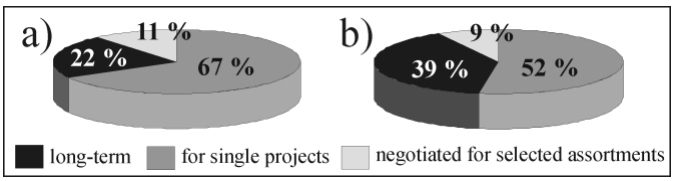

Figure 2: Distribution of long-time and short-time delivery contracts: a) survey among companies from Lublin region, 2002, b) survey among 14 companies from the list of best performing in Poland

The most common criteria of supplier selection and methods of supplier acquisition are presented in Figure 3. As for distribution of responsibility for logistic decisions in construction companies, there are usually a number of decision-makers. Their scope of operation differs according to the organisation structure of the company, but in general, most of the decisions are taken by construction managers and purchasing departments (Fig. 4).

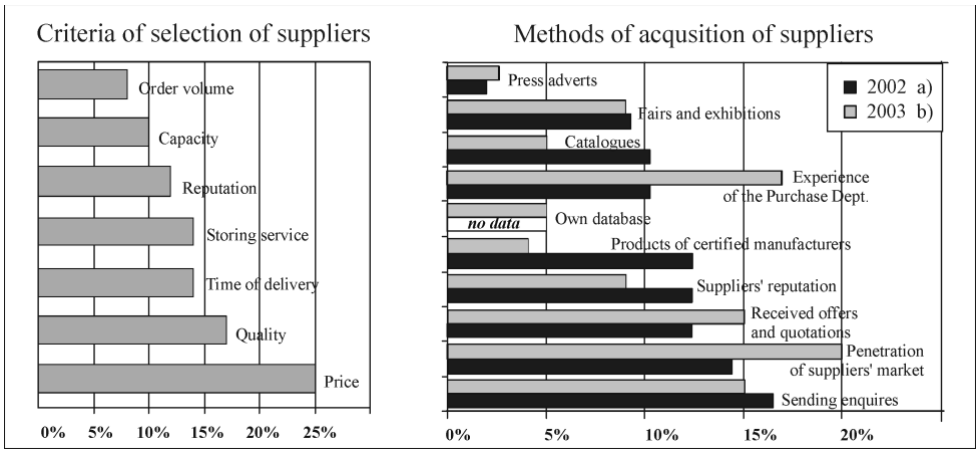

Figure 3: Criteria of supplier selection and methods of supplier acquisition, a) survey among companies from Lublin region, b) survey among 14 companies from the list of best performing in Poland

According to all survey respondents, the size of deliveries to the building site is dictated most often by the estimations of the construction manager, but it also depends on the capacity of the means of transport available, financial capability and project or delivery schedule. The contractors from Lublin region forecast their material demand on the basis of the construction schedule (57%), the detailed bill of quantities (14%) and experience (29%). Among the contractors from the list of 100 best prospering in Poland the proportions are different: schedules are the most common basis of material consumption forecast (80%), the bills of quantities help 10% to establish the material demand and 10% base on experience. Delivery inaccuracies occur quite often in spite of the domination of consumer on the market. Basic grounds of them are financial difficulties caused by employer's delay of payment and change of sequence of works on the building site. Further reasons are errors in the design, errors in orders, difficulty in obtaining uncommon materials. Typical supplier failures such as problems with transport are rare.

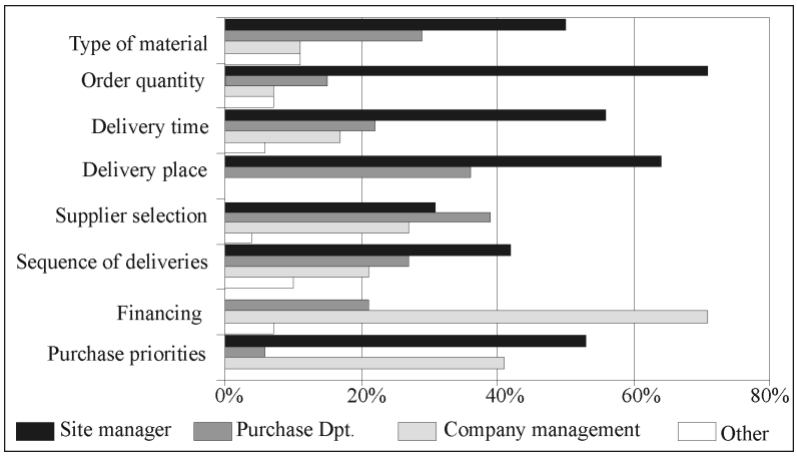

Figure 4: Scope of responsibility for logistic decisions, contractors from the list of best performing in Poland, 2004

The results of the survey point at changes in the contractors' supply systems, i.e. reduction of the scope of logistics tasks performed by their own departments. Firstly, own transport and warehousing are being kept to a minimum. Only about one fourth of respondents of 2004 survey kept buffer stocks of materials and only few types of materials were bought in advance in amount of their total consumption during the project.

Secondly, processes connected with information flows, e.g. supplier selection, are being limited. Some tasks and functions connected with supplying the project with materials are often taken over by the members of the external logistic chains such as transport companies, wholesalers or manufacturers. The project management, designers or even owners often select materials and suppliers. Also the project managers, hired logistics professionals or specialised wholesalers take over supply planning.

Generally, a tendency to outsource logistic processes has been observed. The reasons for diversion from the "traditional" way of keeping stocks and a fleet of vehicles is development of the market of logistic services and oversupply of construction services. Contractors adjust their organisations to the requirements of the market, cut fixed costs, i.e. reduce employment in purchasing departments as IT and methods of communication develop and resources are easy to obtain, and concentrate on their core competencies. Currently, the employers dominate the highly competitive construction markets and their decisions are binding for any actions of designers, contractors and suppliers. This reflects in the network of relations of the project's actors and affects the project's logistic system. The ultimate model of relations depends also on the procurement system of the project.

3. Supply Chain Management of Construction Projects

Construction projects involve massive deliveries of materials. A building site is a complex, though temporary, production system, supplied by many logistic chains formed by manufacturers, forwarders, agents etc. The project's supply system is determined not only by the technical nature of the project but also by the procurement system and conditions of the market. Considering supply system, which is only one of many elements of project logistics, the following models are possible: a) independent supply chains for individual contractors, where selection of suppliers, supply planning and scheduling is the duty of each contractor; b) centralised supply system managed by general contractor or other party managing the whole project, by means of own logistic department; c) centralised supply system managed by an external logistic company, either existing as an independent business organisation or created to serve the project; d) a combination of the above. According to Tenah (Tenah, 2003), project procurement systems may be generally classified into "traditional" (the "design-bid-build", "design and build" or "turnkey" systems) and the professional construction management systems. The latter are better conditioned to integrate and coordinate all participants of project. Supply systems based on independent chains or services of external logistic contractor are possible in any type of project procurement system. However, transferring responsibility for supplies on many subcontractors may result in conflicts on the building site, work stoppage and resulting losses. On the other hand, there is a potential of integrating logistic processes of actors of a construction project – to eliminate unnecessary repetitions of some tasks by combining them and bringing under one management in order to reduce cost and improve efficiency i.e. to use the economies of scale and synergetic effects. To manage the whole project logistics, a specialised organisational unit must be created or hired by the project participants (Stevans, 1989). In case of systems with a general contractor or other party that disposes of necessary logistic resources, it is reasonable to use them to create and manage the whole project's supply system to advantage of the project. As for professional management systems, the necessary managerial skills to organise logistics may be present and the execution of logistic processes may be ordered on behalf of all project participants by specialised companies according to wishes of the manager.

To illustrate the necessity and benefits from integrating logistic responsibilities under one management, the currently largest project in Poland, *Złote Tarasy* business and leisure centre, may serve as an example. The works are being carried out in the very centre of the capital city of Warsaw by a general contractor and a large number of subcontractors. Due to location in the centre of a large city and scope of works requiring massive deliveries of materials, equipment and machinery, centralised logistic management unit was indispensable and was established within the general contractor's organisation. The economies of scale are exploited: most of the resources needed by subcontractors are being ordered directly by the general contractor – a large and renowned company able to negotiate good terms of payment. Deliveries follow according to a tight schedule

in “just in time” system as there is no space for stocks in the cramped building site. This is done to the benefit of the general contractor, the owner and the subcontractors, whose responsibility and risk are thus reduced.

Another example of managing integrated supply logistics of a project is the logistic centre for the development of Potsdamer Platz in Berlin (Baumgarten, 1997). This was a large and complex project crucial for the development of the city, to construct residential, office and commercial buildings and modern infrastructure. It comprised massive earthworks and construction works in the middle of a large city and involved many employers, contractors and suppliers working in a number of building sites. The existing network of roads was not adequate to bear the traffic concerned with the development and serve the city at the same time. The complex approach to the project’s logistics resulted in establishing the logistic cenre to plan, design and manage all material and information flows involved. All the construction sites were subject to the logistic centre and the decisions of its managers. The activity of the logistic centre resulted in reducing the project duration and cost and in minimising the impact on the environment and life of the city.

The modern complex approach to project’s logistics indicates that there are important logistic tasks and processes that occur at every stage of a construction project or even the whole life cycle of an enterprise that includes the project. The scope of them is broad and entrusting them to experts may be an effective solution, especially in the case of complex projects involving many participants, executed under tight constraints, e.g. in city centres. These logistic tasks may include, according to project stage:

- checking the concept from the point of logistics; preparation of logistic guidelines for site planning; preparation of logistic strategy for project management (initiation phase);
- preparing schedules and charts of labour and plant utilisation, subcontractors work and material consumption; logistic concept of the building site; design of site installation and disassembly; guidelines for purchase or lease of machinery; selection of suppliers; plans of logistic processes (models and methods of control), assessing logistic service efficiency and impact on environment; scheduling deliveries, planning information flows and waste management (planning phase);
- preparing logistic guidelines for the design; analysis of alternative structural designs and materials utilisation; material requirement specification; feasibility study of logistic concepts; logistic guidelines for tender preparation; quality system of logistic services(design phase);
- monitoring work progress; updating schedules and plans; adjusting orders to current demand for resources; creating operation centres to serve contractors; planning and coordinating transport on the site; planning and coordinating deliveries, unloading and warehousing, distributing deliveries to contractors; implementing logistic service quality standards; recording feedback on the effects of implementing integrated logistic systems; managing waste; managing information flows and documentation, implementing and maintaining of the information system (construction phase);
- dismantling of site installation; managing information flows, documentation (commissioning)

4. Conclusion

Construction logistics deals with many technical, organisational and environmental issues affecting the project’s cost, duration and quality. Traditionally, each contractor manages own supply chains. In case of larger projects involving a number of contractors, incompatibility of logistics concepts and lack of coordination impedes material and information flows. According to modern ideas of management, centralising logistic functions and management allows the actors of a construction project to reach the synergetic effect of their efforts. Implementation of integrated logistic systems such as these offered by logistic centres may be effective especially in larger construction projects executed in confined space with limited transport possibilities, where massive flows of material have to be managed. The main task of an integrated logistic system is to provide on-time deliveries, eliminate material handling on site, reduce project’s duration by eliminating reasons of work stoppage, minimise disturbances in local traffic and

damage to the environment. Shifting most of the logistic processes on logistic professionals allows construction companies to reduce their fixed costs and to concentrate on their core competencies.

5. References

Baumgarten H., Penner H (1997). *Baustellenlogistik Potsdamer Platz. Akzeptanz-Wirksamkeit-Übertragbarkeit*. Technische Universität Berlin, Fachbereich Wirtschaft und Management, Berlin.

Christopher M.(ed.) (1994). *Logistics. The Strategic Issues*. Chapman&Hall, London.

Hoover W,E., Eloranta J.E., Holmstrom J., Huttunen K. (2001). *Managing the Demand-Supply Chain. Value Innovations for Customer Satisfaction*. Jon Wiley&Sons, New York.

Love P.E.D., Irani Z., Edwards D.J. (2004) "A seamless supply chain management model for construction". *Suplly Chain Management. An International ournal*, Vol.9, No.1, pp.43-56.

Sobotka A., Czarnigowska A., Stefaniak K.(2004). "Logistics of construction projects" *Proceedings of the 8th International Conference Modern Building Materials, Structures and Techniques*, Editors: Zavadskas E.K. Vainiunas P, Mazzalani M, Vilnius Gediminas Technical University Press, Lithuania, pp. 273-278.

Stevans G.C. (1989). "Integrating the supply chain:". *International Journal of Physical Distibution and Materials Management*, Vol. 19, No. 8 pp. 3-8.

Tenah K.A. (2004). "Existing and emerging delivery systems for construction projects". *Proceedings of the International Conference System-Based Vision for Strategic and Creative Design*, Bontempi (ed.), Lisse, Swets&Zeitlinger 2003, pp. 151-156.