THE INVOLVEMENT OF BUILDERS' MERCHANTS IN THE DEVELOPMENT OF IMPROVED CONSTRUCTION LOGISTICS

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Abstract: Supply chain management (SCM) has been heavily emphasised in research for a number of years within the construction industry. Essentially this interest can be traced to the publication of the Egan report in 1998. By comparison, logistics is a developing field within the industry. This represents a huge paradox for research. Firstly, construction is uniquely suited for benefiting from an improved capability within logistics, since the majority of its components and raw materials are both high volume and low value. This means that transportation is a disproportionately high element of the cost of construction (or manufacturing) than in other industries. Secondly, the effective functioning of a logistics system is a prerequisite to an effective SCM process (Bowersox and Closs, 1996). However, currently there is a very limited understanding of the logistics function within the construction industry as a whole. This must of necessity compromise the ability of the industry to have effective SCM processes. Indeed at the 'lower' end of the construction supply chain, particularly around local builders' merchants (BM), this understanding is practically non-existent. This paper aims to show the development of a new research project that seeks to identify, quantify and improve the effectiveness of the logistics systems around builders' merchants. The paper demonstrates the most effective methods of conducting the study and identifies the critical parameters and variables for measurement. These variables will lead to the generation of a model in order to develop a simulation of a generic construction logistics system.

Keywords: Builders' Merchants, Building Materials, Logistics, Transportation.

1. INTRODUCTION

In recent years, construction has sought to learn from industries outside its normal terms of reference. In particular manufacturing has been seen as the source of many 'best practice' principles leading to enhanced performance. Lean production and Just-in-time (JIT) delivery systems are extensively cited as being of potential use in construction (Egan, 1998; Fairclough, 2002). Such systems are manipulated in order to accommodate the special nature of construction projects and characteristics of construction industry. Additionally seminal industry reports like those of Egan and Latham (Egan, 1998; Latham, 1994) highlighted the need for collaboration, trust and open agendas among the contributors of construction's industry performance. A holistic approach is starting to be seen as necessary in order to address all the longstanding problems of the industry, and overcome its fragmented nature. Overall, Supply Chain Management (SCM) represents in an axiomatic way this more holistic thinking. The adoption of SCM links each element of the operation and supply processes, cutting across organizational boundaries by creating a unified value chain (Tan et al., 2002). This view of the industry implies that it is necessary to examine all links of the value chain in order to best generate improved performance. In effect this has forced research and thinking away from a contractor-centric view, to a more holistic view of the problems in construction.

In order to develop a more holistic view of the construction supply (or value) chain, it is necessary to expand the scope of current research. At present, in spite of the need for SCM to address the totality of the supply chain, there still tends to be a contractor emphasis in current research. Primarily, it is contended, because research is generally easier when the subject for study is large and easily identified – i.e. contractors. This does not however fulfill the implicit requirements of SCM research. The aim of the research outlined in this paper is to redress the current imbalance in SCM research within the construction industry. The paper begins by developing an appreciation of the fundamental role of logistics within SCM and the size of the market for builders' merchant's (BM) products. The paper goes on to identify the critical role of BMs in the construction supply chain. Having identified transportation as a critical aspect of the supply role of BMs, key parameters governing BM performance in the construction logistics system are identified. The paper concludes by proposing a methodology for the sampling and modeling of current BM performance within construction logistics systems as a means of optimizing BM performance and reducing costs within the construction value chain.

2. BREAKING DOWN THE CHAIN

The effective function of a logistics system is a prerequisite to an effective SCM process (Bowersox and Closs, 1996; Cooke, 2001). Therefore it can be said that enhanced understanding of the logistics process could significantly contribute to improved construction industry performance. However, currently there is a very limited understanding of the logistics function within the construction industry as a whole. Even in publications where logistics are examined, they are considered on a project basis and/or from a contractors' point of view. The role of the contractor is undoubtedly important in the construction supply chain. The contractor can normally be seen as either the 'end' – final destination – of a supply chain. More correctly the contractor should be seen as the centre – or 'hub' – of a network of supply chains. Because of the pre-eminent position of the contractor, most SCM research focuses on the view from the contractor standpoint. For example the work of Bertelsen and Nielsen (1997) and Wegelius - Lehtonen (2001). Notwithstanding this emphasis, the performance of the set of linkages in the chain(s) is acknowledged to be of utmost importance (Tan et al., 2002). The literature reveals little mention of construction supply chain behaviour outside of the contractor (Agapiou et al., 1998a; Wegelius - Lehtonen and Pahkala, 1998; Dainty et al., 2001), or indeed the other links that form this much debated 'unified value chain'(Normann and Ramirez, 2000). The issues of collaboration, trust and networking seem to be left for consideration only under generic SCM theories outside the built environment. Since 1995 Hameri and Paatela have recognised that there is no longer sustainable policy to consider solely one's own interests, the true competitive advantage stems from the efficiency in networking (Hameri and Paatela, 1995; Vrijhoef et al., 2001).

Studies attempting to introduce SCM principles in construction have been undertaken by various authors initially founded upon SCM's contribution to the manufacturing industry. Recently construction focused approaches have been developed and published including works of Wegelius - Lehtonen and Pahkala (1998), Vrijhoef and Koskela (2000) and Briscoe et al. (2001). Logistics application in construction is still thought to be in its infancy but studies from Wegelius - Lehtonen (2001), Shakantu et al. (2003)

and Shakantu (2005), have introduced and developed logistics thinking in construction. These studies share one common goal, the optimization of materials and information flow from their point of origin to their point of use. Their results have been extended to include logistics' contribution to:

1. Cost savings (Agapiou et al., 1998b; Shakantu et al., 2003),
2. Increased productivity (Bertelsen, 1995; Wegelius - Lehtonen, 2001),
3. Lean thinking (Salagnac and Yacine, 1999),
4. Sustainability (Shakantu, 2005).

The role of BMs has been acknowledged as of a great importance for the operation of construction business (Bertelsen, 1995; Agapiou et al., 1998a; Nicholas et al., 1999; 2000). However, current literature does not demonstrate significant evidence of research into the function of SCM using logistics channels as a unit of analysis. Furthermore, BMs and their critical role in the flow of materials in construction supply chains have barely been addressed (Agapiou et al., 1998a). In order to understand the importance of BMs in efficient construction logistics, it is necessary to further examine the BM market.

3. THE BUILDERS' MERCHANTS MARKET

A review of the UK's construction industry structure is the initial step in assessing BM's role in construction. Also, considering the economic performance of the BM market will allow for measuring its contribution to total construction output. Contractors form the majority of construction firms. BMs are ranked in second place in terms of both the number of firms existing and total number of employees. Table 1 (Construction News Plus, 2005) demonstrates the physical and financial size of BMs in the UK construction industry relative to other firms (2003 figures).

Table 1: Proportion of types of firms in the UK's construction industry

Type of firms	Number of firms	Employees	Contribution to construction's output
Contractors	192,404	1,665,000	52%
Builders' Merchants	81,997	591,000	15%
Professional Services	57,636	308,000	16%
Products Producers	20,863	382,000	15%
Quarrying Firms	2,248	23,900	2%

Source: Construction News Plus (2005)

Demand for building materials is directly linked to fluctuations in the level of activity in the construction sector. Thus, in common with the remainder of the industry, reduced or increased activity levels will have a directly proportional coupled effect in BMs. The market's worth in the 5 years' period ending at 2003 increased by 18%. This year by year increase is explicitly described in Table 2.

Table 2: Builder's merchants market worth for the period 1999 - 2003

The Builders' Merchant market by value 1999 - 2003					
Year	**1999**	**2000**	**2001**	**2002**	**2003**
Value (£bn)	8.57	8.98	9.3	9.5	10.1
% change year on year	4.5%	4.8%	3.6%	2.2%	6.3%
Source: Key Note Ltd (2004) and AMA Research (2003)					

Structurally, the market can be characterised as highly consolidated. Three major companies - Wolseley, Jewson (owned by St Gobain) and Travis Perkins - dominate the market. Their total market share is estimated to be around 50% (Grafton Group plc, 2004) and is continuously increasing. Indicatively, Wolseley and Travis Perkins have added 636 new branches to their branch network, including those obtained through acquisitions, over the last three years (2002 to 2004). The principal activities of these companies are the distribution of building, plumbing and timber materials. According to Key Note Ltd (2004) and AMA Research (2003) reports, factors that will affect the market during the forthcoming years, are thought to be:

- Further consolidation within the market,
- Competition with DIY stores,
- Domination of electronic trade.

However, it is not only the size or the financial performance of the market that indicate that BMs represent an essential link in the supply chain of building materials. Indeed, there are some special issues associated with the unique characteristics of construction that allocate merchants a key role in the production process of any construction operation. These issues, analysed from a financial perspective, are associated with the trade conditions within the industry and the physical nature of construction materials.

4. CONSTRUCTION INDUSTRY STRUCTURE

A review of the available literature would appear to demonstrate three major issues that determine the interdependency between the BM market and the wider construction industry. These issues are so closely linked with construction common practices and physical nature that they should be considered as facts. These 'facts' in turn allow for stable syllogisms about the significance of BM involvement in construction logistics.

1. *Construction is highly competitive with low profit margins and large risks.*
   Because of these prevailing conditions, the nature of the supplier / contractor relationship is primarily determined by contractual conditions. In particular, it is noted, by the credit facilities for payments provided by the BMs. Agapiou et al. (1998a) and Nicholas et al. (2000) have underlined the fact that one of the major functions of a merchant is to act as a channel for credit to the construction industry. Such credit is a vital source of working capital for most contractors. It is interesting that research undertaken by Nicholas et al. (1999) identified that over 60% of suppliers have 70% or more of their turnover, accounted for by credit sales. Detailed results can be found in Table 3. For this reason, not surprisingly the

construction materials suppliers have earned the reputation of being the Builders' Bankers (Lowe, 1997; Agapiou et al., 1998a; Nicholas et al., 2000).

Table 3: Suppliers: credit to turnover ratio

Proportion of credit sales to turnover	Percentage of materials suppliers	Cumulative percentage of materials suppliers
90.1 – 100	5.8	5.8
80.1 – 90	32.1	38.5
70.1 – 80	23.1	61.6

Source: Nicholas et al. (1999)

2. *Materials indirect costs affect in a great extent final construction costs.*
   Materials constitute a large proportion of the total cost of construction. Regarding the type of the project they usually account for between 40% (Agapiou et al., 1998a) and 50% (Bertelsen and Nielsen, 1997). Materials prices are not manageable since they are affected both by trade deals between merchants and contractors and by factors external to construction (political, social, etc.).

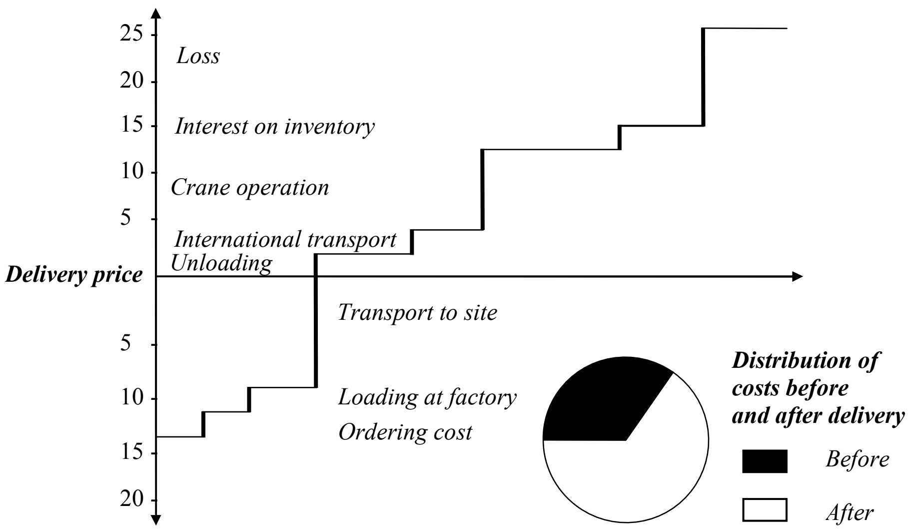

Figure 1: The cost staircase - Mineral wool for insulation (Soderman, 1985)

However, indirect costs associated with the materials could be minimised. An analysis conducted by Soderman (1985), for a number of building materials, calculates the "cost staircase", which is illustrated in Figure 1. This illustrates the increase of the material price from the moment that the order was placed until that the material was used. Apparently, one can observe a remarkable increase because of the loss on site and the cost of the transportation function (the role of transportation in logistics is discussed later in this paper). Also, it is estimated that around 40% of these indirect costs arise before the delivery on site, when the product is still handled by the supplier. If BMs managed to minimise these costs, the material price would consequently reduce. This would lead to a significant reduction of the cost of the building project.

3. *Uncertainty of demand in construction projects imposes a need for maintaining high level inventories.*

> BMs play a key role in the construction industry as an intermediary between the manufacturer and the contractor. Because of their physical position, BM facilities represent a natural storage and consolidation point for construction supply chains. The important role of interstitial storage and movement of materials within supply chains has been frequently remarked upon and is well into the mainstream of logistical understanding (Bowersox et al., 2002). By retaining high level safety stocks, because of the fluctuating demand, BMs have to bear the cost of carrying these inventories. The annual inventory carrying cost is estimated to be around 20% of the average inventory value (Bowersox and Closs, 1996). Actually, it is not only the direct cost of it, but especially the cost of the capital invested in it. If these inventories were carried by contractors, already subject to cash flow problems (a record of 10% annually of the total number of construction companies to have gone insolvent over the last 15 years (DTI, 2004)), the consequences would be catastrophic to the industry.

Thus it would appear manifest that BMs in construction have a pivotal role in the continued performance of the industry. As a means of offsetting risk and providing additional credit, BMs are an essential element in the supply chain. Also, indirect costs associated with construction materials are particularly important in the overall performance of the industry. BMs and their activities are a primary component of the indirect materials costs. The role of storage within the construction supply chain is massively important, and yet widely unresearched. Storage per se becomes critical in order to achieve the 'stockless' or 'just in time' construction site. Materials should be delivered as late as possible, but without causing any delays to the construction process. Thus, the problem of storage is transferred to the suppliers who consequently bear the inventory carrying costs. Once again the BM has a critical function to play in the storage and issue of materials to site in order to facilitate construction. Similarly BMs must never impede construction progress through a 'stockout' of materials at the point of need.

Given the nature of the demands on the BMs listed above, it can be seen that the logistical role of BMs is the common theme through their activities. Thus it becomes necessary to begin to analyse the logistical context of the BM role in the construction industry. In terms of the study currently being undertaken by the lead author, the conceptual framework for the analysis will be based on the node-and-link perspective. According to Coyle et al. (2003) the complexity of a logistics system often relates directly to the various time and distance relationships between the nodes of the system. Time and distance are essential parameters of transportation. Consequently, transportation links that a company utilizes in order to gap the distance among different nodes in the logistics system are deterministic. Apparently the role of transportation becomes more crucial for construction especially when considering that "construction is fundamentally an assembly operation utilizing materials that are generally low value and high volume, moving at irregular times to geographically mobile points of distribution" (Shakantu et al., 2003).

5. CONSTRUCTION MATERIALS LOGISTICS

While figures compiled by Diamond and Spence (1989) indicate that transport costs account for 2.6% of motor vehicle part production, 7.7% for pharmaceuticals and 12%

of wholesale distribution, as a percentage of operating costs, it is highlighted that in sectors like construction the figures can be significantly higher (SACTRA, 1999). Indeed, transport accounts for 10-20% of construction costs according to BRE's report "Construction site transport: The next big thing". Furthermore, in the same report, it is indicated that BAA has estimated that its workforce spend 10-40% of their time dealing with ordering and transporting materials (BRE, 2003). The need for materials storage on site, their high volume and special natural characteristics together with the uncertain place of their use and the temporary location of the construction site contribute to the determinative role of transportation for construction logistics systems. Considering the increasing proportion of overheads represented by transportation within the construction process, it would seem apparent that construction logistics management optimization is likely to be "the next big thing".

Additionally, according to Johnson and Wood (1993) the importance of transportation for the successful operation of any logistics system is based upon the fact that transportation mode defines in a great extent the:

- packaging requirements;
- inventory levels;
- materials handling equipment;
- customer's service level requirements.

Therefore, the analysis of the relation between transportation basic aspects and logistics core concepts will potentially ameliorate the design of a construction logistics system. In order this relation to be analysed the parameters associated with vehicle movements from BMs warehouses to construction sites have to be identified and measured.

6. CRITICAL PARAMETERS

It is a major concern in this research to avoid analysing construction logistics solely from the contractor's point of view. In a construction contract various work packages are nominated to sub-contractors. In this case, the sub-contractors trade with a limited number and type of suppliers. The situation becomes more complex when all the suppliers have to be managed on a project level. In this case a logistics strategy, which involves mainly the planning of materials deliveries, becomes necessary. Actually, this emanates from the need for better use of the limited storage area available at the construction site. Additionally, one can say that issues of variability in demand come to an end as soon as the building is designed. Although variation in the design due to requirements evolution in the construction phase are very common in the industry.

On the contrary, when supply chain is viewed from a BM standpoint the demand is very difficult to be predicted. This, in sequence causes a series of logistical problems that concern mostly the supplier rather than the contractor. Ballard and Cuckow (2000) have identified the main difference when supply chain is viewed from a supplier standpoint (see Figure 2).

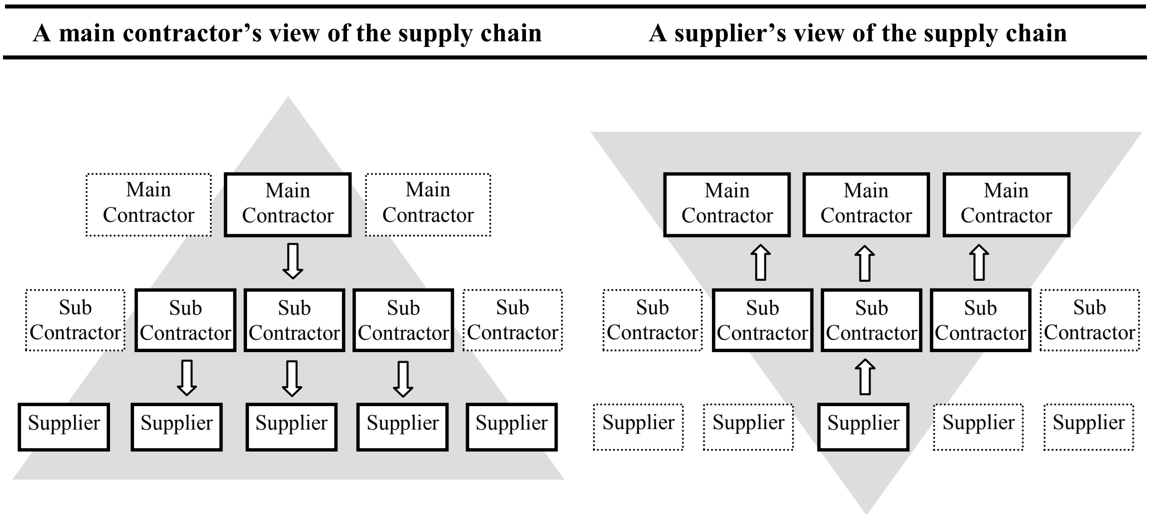

Figure 2: A main contractor's and a supplier's view of the supply chain (Ballard and Cuckow, 2000)

From this point of view in the supply chain fluctuation in demand is most likely to occur. There are many sub-contractor customers at any time, just as there are many building contracts. The role of the BM is to follow the schedule of different sub-contractors regarding material deliveries. Simultaneously, the BM should ensure that the uncertainty of demand is accommodated by the adopted logistics strategy at the lowest cost. In logistics terms this means that BMs seek to maintain high level of customer satisfaction while reducing inventory levels and increasing resources' utilisation.

Therefore, the critical parameters for measurement will be divided in two groups. The first group contains the parameters associated with the logistical operation of the BM warehouse. The second one includes those linked to the transportation of the materials and their demand. Figure 3, is split in two parts in order to demonstrate the two different groups of variables.

Figure 3 represents the delivery mechanism of different materials from the moment an order is received to the moment the materials are delivered. The flow is designed deliberately consisting of Work Centers and Storage Bins in order to introduce the use of the SIMUL8 software package in the design of the model. In the simulation model, Work Centers (WC) should be considered to act as dynamic decision objects which determine the required time for the completion of a task. Additionally, they can change certain aspects of a work item in order to direct it through different channels inside the model. Storage Bins (SB), are passive objects whose main purpose is to hold work items that are waiting to be processed by a work center. They could be used simply as queues or as inventories of different types of products (Hauge and Paige, 2001).

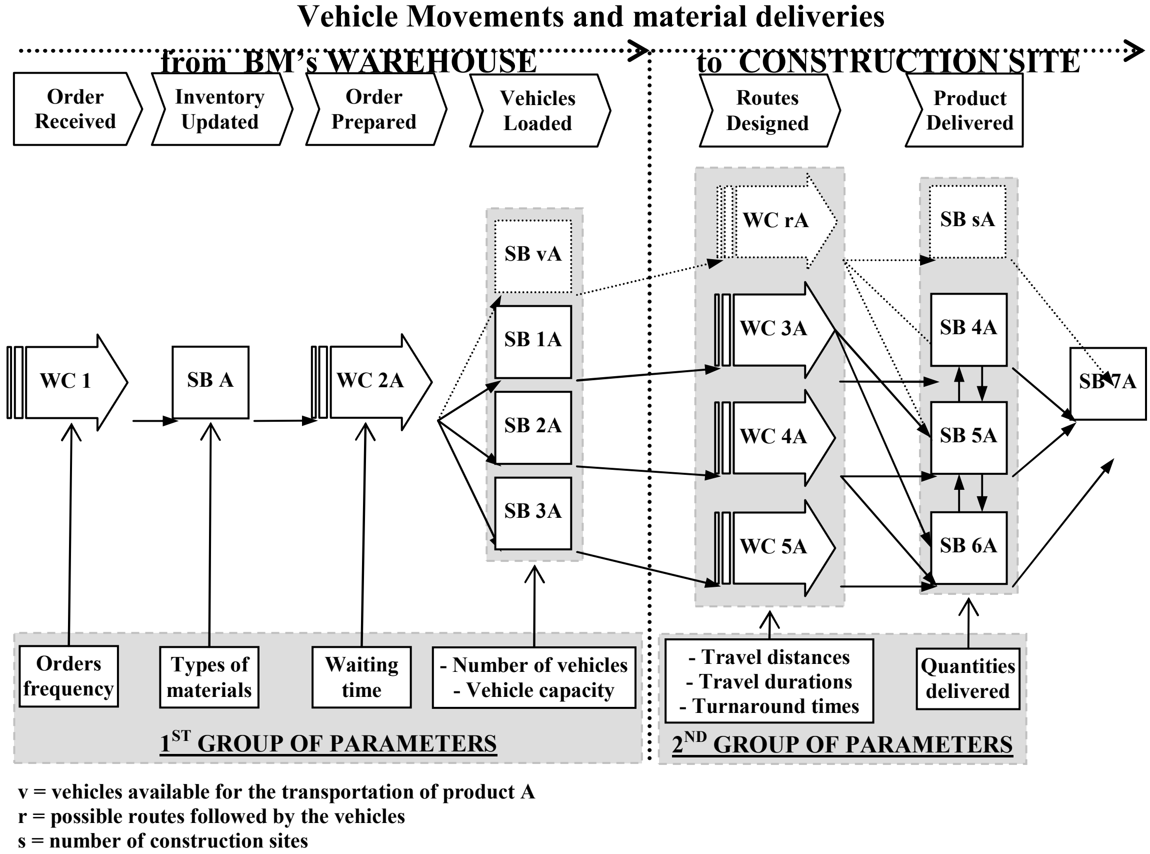

Figure 3: Parameters associated with the logistics of a single product deliveries.

The left part of figure 3 represents the operation of the BM warehouse. An order, which includes a number of different products and quantities, is received by WC 1. This information is distributed to the relevant inventories (SB A for product A, SB B for product B, etc). WC 2A removes the required quantity of the inventory and places it to available vehicles that serve the warehouse. These vehicles, which are of different type, tonnage and cubic capacity, are illustrated as SB 1A, SB 2A and SB 3A.

The right part of the figure illustrates the vehicles movements and the delivery of the product at different construction sites. WC 3A, WC 4A and WC 5A represent the transportation of the product through different routes. Additionally, they contain information about the location of the site and the time vehicles spend there (i.e. turnaround time). Finally, SB 4A, SB 5A and SB 6A are used to depict construction sites where a certain quantity of the product is delivered. The total quantity of product A delivered will be indicated at SB 7A.

The above discussion facilitates the identification of the critical variables that drive the model. These parameters for measurement are demonstrated in Table 4 and are the input data for the model that simulates the logistics systems within construction industry.

Table 4. Critical parameters for measurement

1st Group of Parameters	2nd Group of Parameters
• Frequency of orders	• Travel distances (between the nodes of the system)
• Type of materials & product families	• Travel durations (for every link of the system)
• Number of vehicles serving the warehouse	• Turnaround times at construction sites
• Vehicle tonnage and cubic capacity	• Quantities transported
• Waiting periods at merchant's warehouse	

This simulation model will provide a comprehensive analysis of the construction logistics and an assessment tool for alternative logistics strategies. By the use of special simulation software (Simul8), the distribution strategy of building materials will be examined in terms of cost-effectiveness and responsiveness. Additionally, the fluctuations in demand due to changing customer requirements and sufficient supply lead times will be more accurately assessed.

The two distinct groups of parameters identified will provide results and information pertaining to:

1st Group of Information	**2nd Group of Information**
Inventory levels	Lead times
Safety stocks	Fleet utilisation

The provision of reliable information for these major issues in terms of any logistics system will fulfill the aim of understanding and improving the functions of logistics in the UK's construction industry.

7. METHODOLOGY

The theoretical framework of the research includes both logistics and transportation management issues bound together with modeling techniques. These together will help unraveling the numerous and complex interactions that exist in the construction supply chain. The nature of the problem under analysis is multifaceted, dealing with inventory levels, safety stocks, lead times and fleet utilization. Together these elements will allow the researcher to develop a logistical model governing the function of the BM in construction. Although the role of the BM is generic, the depth and context of the data that needs to be recovered, makes the task impossible with a wider sampling approach. Thus it is intended to initially conduct a study that allows a 'working' model of the process to be developed which can in future be evolved and enhanced to give it wider applicability. Probability based or random sampling strategies are not appropriate in the circumstances of this study. In order to generate useful information as to the nature and role of the BM in the logistics process in construction, a purposive sampling approach needs to be adopted (Marshall and Rossman, 1999). Longer term, the research is expected to lead to further efforts to expand the use of the model created. This in turn will require further purposive sampling to 'fill in the blanks' left in the preliminary study.

The envisaged research is that of a field study, used to address the uncertainty of demand in building materials and the measurement of the numerous variables affecting materials' deliveries. Objective observation of a limited number of case study examples will preferably result in the creation of a stable and comprehensive basis of the logistic processes in construction. However, there is an acknowledgement that there will be a need to interpret certain data and extrapolate other data into a more widely appropriate model. This in turn militates towards adopting a triangulation approach to the research effort (Easterby-Smith et al., 2002).

8. THE CASE FOR USING SIMULATION

The final stage of the research is the generation of a model and the test of alternative scenarios, i.e. different logistics strategies, in order improvement actions to be evaluated. Models can be divided in two main categories (Shapiro, 2001; Bansal, 2002):

- Descriptive models and;
- Optimization models

The first type of models are used in order to describe a system that is to provide a better understanding of the systems function, while the second enables managers for making better decisions. The selection of a particular type of model should not be an obstacle for this research in providing both an understanding of logistics processes in the built environment and an optimum logistics strategy through the test of alternative logistics techniques. Indeed, a descriptive model can be extended to an optimization model through sensitivity analysis (Shapiro, 2001; Greasley, 2004; Kleijnen, 2005), which is perfectly accommodated by a simulation model.

The complexity of the construction's supply chain, not in terms of structure but in terms of uncertain interactions between participants requires the generation of a detailed model which will allow the application of different logistics techniques. This is possible by developing a simulation model (Bansal, 2002; Biswas and Narahari, 2004). Then, by incorporating sensitivity analysis the system's reactions to alternative scenarios (model input data) will be investigated and optimum decisions will be made. Additionally, according to Kleijnen (2005) by simulating the supply chain an insight into the causes and effects of the supply chain performance is given. This is the fundamental aim of this research: Understanding causes and effects of the supply chain performance in the built environment so as a better understanding of construction logistics to be established and areas of improvement to be identified.

9. CONCLUSION

An examination of the supply chain from a supplier point of view can provide a comprehensive analysis of the logistics in the UK's construction industry. BMs are positioned in the heart of the flow of building materials from the point of production (manufacturer) to the point of consumption (construction site). From this position a better view on the roots of materials delivery problems is given. Besides, it is common sense that for the majority of the builders there is not a particular strategy upon logistics. Therefore a more judicious analysis, outside of the "noisy" construction site environment, takes place.

This paper has established some of the issues associated with the need to increase understanding of the function performed by BMs within the construction logistics system. The most appropriate approach of addressing this need was discussed and the related parameters were identified. The use of simulation will allow the application of alternative logistics techniques in a risk free environment providing both an understanding of the construction logistics system and a platform for testing improvement actions.

Whilst new production theories and practices emerge, the objective will remain the maximization of the return on investment made in every industrial project. Any development that contributes to cost savings leads to the fulfillment of the above objective. This is the main reason why logistics have been widely used in all kind of industries. The additional advantage of their application in construction is that logistics will not only accomplish cost reducing but also make a step forward by applying logic in the uncertainty of materials and information flow, against the risky nature of the industry.

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