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Beyond Egan's supply chain management: advancing the role of logistics in the South African construction industry

Abstract

The construction industry has globally been identified by investors and portfolio managers as under-performing in terms of return on investment (ROI), while simultaneously exposing the capital investment of investors to the highest levels of risk compared to any significant industry. In some cases, construction firms have received rates of return of as low as 1.5 to 2%. This is typically an unsustainable level of return for investors as they can gain a considerably higher ROI through much less risky financial vehicles such as gilts and bonds. Given such a low rate of return, the construction industry has for a number of years attempted to increase efficiency and reduce costs as a means of winning further business and increasing profitability.

One of the methods that have been espoused as offering significant potential benefits for construction has been the industry-wide adoption of the principles of supply chain management (SCM). However, at present the bulk of SCM practice is focussed on high level strategic issues, whilst largely ignoring more operational issues related to logistics. This is a major omission, given the fact that a recent study by the Building Research Establishment (BRE) in the UK indicates that as much as 30% of the cost of construction is attributed to transportation of materials. This article examines, through a review of literature, the role of SCM in construction and the contribution an effective logistics system can make to increasing efficiency and reducing construction costs.

Keywords: SCM, supply chain management, logistics, process optimisation, construction, transportation

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Abstrak

Die bou-industrie word wêreldwyd deur beleggers en portefeuljebestuurders vereenselwig met die onderprestasie van opbrengs op belegging. Terselfdertyd stel dit beleggers se kapitaalbelegging bloot aan die hoogste risikovlakke in vergelyking met dié van enige betekenisvolle ander nywerheid. In sommige gevalle verdien konstruksiefirmas opbrengste van slegs 1.5% tot 2%. Vir beleggers is dit 'n onvolhoubare vlak omdat hulle 'n veel hoër opbrengs deur veel laer risiko middele soos verbande en borgaktes kan verdien. As gevolg van hierdie lae opbrengs het die bou-industrie gepoog om doeltreffendheid te verbeter en kostes te beperk om sodoende verdere besigheid te genereer en winsgewendheid te verhoog.

Een van die metodes wat uitstaan as 'n metode om betekenisvolle voordele vir konstruksie te bied is die industrie-wye aanvaarding van die beginsels van leweringskettingbestuur. Maar, tans is die omvang van leweringskettingpraktyk afgespits op hoëvlak strategiese kwessies terwyl die meer operasionele kwessies van logistiek ignoreer word. As in ag geneem word dat 'n resente studie deur die Building Research Establishment (BRE) in die verenigde koninkryk aandui dat soveel as 30% van konstruksiekoste aan vervoer toegeskryf kan word, is hierdie 'n groot weglating. Hierdie artikel ondersoek die rol van leweringskettingbestuur in konstruksie en die bydrae wat 'n effektiewe logistieke stelsel kan maak om doeltreffendheid te verbeter en kostes te sny.

Sleutelwoorde: leweringskettingbestuur, logistiek, optimalisering van proses, bou-industrie, vervoer

1. Introduction

The construction industry plays an indispensable role both directly and indirectly in any nations' economic growth. The industry has a substantial contribution to make to the quality of life. Its products, buildings and other structures change the nature, function and appearance of towns and countryside (DETR, 2000; van Wyk, 2004). The construction industry also provides governments in many parts of the world with economic, regulatory and public sector policy and capacity delivery mechanisms (DETR, 2000; Hillebrandt, 2000; Fellows *et al*., 2002; van Wyk, 2004). Construction products provide the basis for the property and infrastructure market which generates economic opportunities for investors (Cain, 2003).

However, in terms of investment performance, the construction industry has for a number of years been identified as one of the poor investment sectors in economies around the world (Harvey & Ashworth, 1997; Fellows *et al*., 2002). The industry has globally been identified by investors and portfolio managers as under-performing in terms of return on investment (ROI), and simultaneously exposing the capital of investors to the highest levels of risk in any significant industry (Harvey & Ashworth, 1997; Fellows *et al*., 2002). In the UK for example, construction firms have traditionally received rates of return of 1.5 to 2% (Macalister, 2003). This is typically an unsustainable level of return for investors as a significantly higher ROI can be achieved through much less risky financial vehicles such as gilts and bonds. Indeed, even in the current economic situation in the UK, where interest rates have been low and stable for many years, bank base rates are still in the region of 4% (Bank of England, 2006). Given such a low rate of return, the construction industry has for a number of years attempted to increase efficiency and reduce costs as a means of both winning further business and increasing profitability (Cartlidge, 2002; Cain, 2003).

One of the methods that have been espoused as offering significant potential benefits for construction is the industry-wide adoption of the principles of supply chain management (SCM) (DETR 2000; Cartlidge, 2002). Supply chains usually comprise three flows: two directional flow of information between customers and suppliers; one directional flow of materials and products to customers, except where reverse logistics may arise; and the flow of cash from customers to suppliers, designating completed transactions as illustrated in Figure 1.

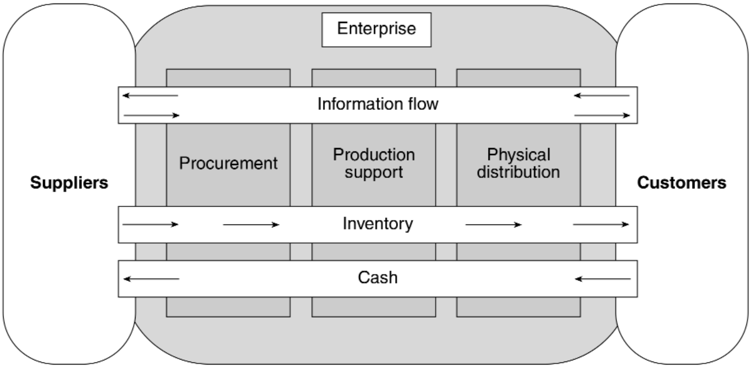

Figure 1: The supply chain concept
Source: Muya 1999

The adoption of SCM principles has become a priority following the publication of the watershed *Egan Report* (1998) and *Quality of Life Report* published by DETR UK in 2000. These principles have been echoed around the world. For instance, in Australia, the Commonwealth Department of Industry, Science and Resources (DISR) published a report on best practice supply chain management theory and practice. *The Report* demonstrated through case studies how companies can improve their performance and competitiveness (Tucker *et al*., 2001). In South Africa, the principles of the *Egan Report* (1998) were included in both the 1999 government White Paper on Creating an Enabling Environment for Reconstruction, Growth and Development in the Construction Industry and in the *Construction Industry Interim Report* (2004).

In the UK, the *Egan Report* (1998) assumed the role of a banner under which government, industry and clients worked together for radical change and improvement in construction performance, efficiency and quality. A central theme of *the report* was the need to reduce waste at all stages of construction and throughout the supply chain (Cartlidge, 2002; Kelly *et al*., 2002; Cain, 2003).

However, for the construction industry to benefit from SCM, it is necessary to understand exactly how the supply chain functions and what its components are. To this end, a variety of attempts to understand the workings of SCM in the construction industry have been made (Agapiou *et al*., 1998; Formoso & Revelo, 1999; Barker *et* *al*., 1999; Vrijhoef & Koskela, 2000; Kumaraswamy & Palaneeswaran, 2000; Briscoe *et al*., 2004. On one hand the above works point to the benefits, functions and components of SCM and on the other hand, the authors also pointed out numerous problems that hinder full exploitation of SCM in construction. In the work of Voordijk (1999), for example, it was found that the fragmented organisational structure of the construction industry prohibited development of efficient supply chain relationships. This fragmented state of the construction industry is a direct result of its historical development (Satoh & Morton, 1995; Fellows *et al*., 2002; Morton, 2002; Cain, 2003; Murray & Langford, 2004; Kalidindi & Varghese, 2004).

2. Structure of the construction industry

Extensive sub-contracting has led to strategic and operational fragmentation of the industry as companies become heavily out-sourced and 'slimmed down'. 'Slimming down' in this context can be seen as externalising key skills and disciplines from traditional general contractors into sub-contracting organisations but retaining skeleton skills to manage contracts. This significantly reduces the level of integration within and between organisations (Gray & Flanagan, 1989; Edum-Fotwe *et al*., 1999).

Moreover, the components manufacturing process occurs off site in specialist manufacturers' plant where technical specialisation and much of the product knowledge is held (Gray & Flanagan, 1989). Such specialist subcontracting has become a very diverse, fragmented and complex sector of the construction industry, further reducing the level of integration between organisations (Edum-Fotwe *et al*., 1999).

Regionalisation has also been endemic within the construction industry. Reduced main contractor size, increased numbers of sub-contracting organisations, and increasing fragmentation has had a significant impact on operational capability of contractors. The generally smaller, leaner companies remaining have reduced resources and capitalisation. The reduction in resources has led to a limitation in the scope of operations of small organisations to act locally or regionally, rather than nationally and globally (Lansley, 1987). The reduction in scope of operations forced by a reduced size creates two main effects. Firstly, smaller companies start to operate tactically, concentrating on the micro rather than macro view of the world. This has a significant impact on the inability of a locally focused company adopting best practice approaches. Secondly, smaller companies move into an economic mindset that emphasises short-term expediency, rather than investment in a longer-term integrative and strategic approach to operations (Edum-Fotwe *et al*., 1999; CIDB, 2004).

Traditionally the construction industry exhibits other characteristics detrimental to taking a longer-term view. The industry is project-based, making the creation of long-term teams very difficult and virtually unnecessary. Architects and other designers traditionally create designs in isolation from the engineers and technicians who construct the industry's product. This means that constructability becomes a secondary issue compared to the aesthetic qualities of the built environment. Although artistically and culturally laudable, it could be seen as of no benefit to the cost effectiveness and timely delivery of construction. Recently, these issues have been central to the problems faced in the construction of the new Scottish Parliament Building in Edinburgh. The problems of massive overspending and delay led directly to the commissioning of the Fraser Inquiry (Fraser Report, 2004; online).

By extension, components supply is similarly sub-optimal. The specified sub-assemblies and components that are required for the total construction of a building are selected by the architect on the basis of architectural merit rather than technical performance (Gray & Flanagan, 1989). Particular lack of understanding is demonstrated by the fact that designers have limited knowledge and experience of the capability of the companies selected as suppliers. The skills and tools required to select and monitor supplier performance tend to be held by either quantity surveying or construction management disciplines. However, these disciplines have minimal, if any, input into the design process.

The above characteristics form a unique combination, which reinforces the preponderance of subcontracting. These key issues have been the generic challenges of the industry in the last 200 years and continue to-date. Success has been attributed to the cutting of the cost base and externalisation of functions. This has led to a highly confrontational approach in the supply chain system of the industry. Stiff competition among the contracting companies has led to lower profitability in the industry. Risk is high and many new entrants become bankrupt within the first three years (CIDB, 2004).

In summary, the industry has over the past 200 years developed and maintained a system of construction with little fundamental change.

As a result, it has consistently been critiqued for lack of innovation. For the past 70 years, the industry's clients have demanded improvement. Yet as late as the 1990s and early 2000s, the industry was found to be underachieving and in need of radical change (Latham, 1994; Egan, 1998; Morton, 2002).

3. Catalyst for radical change

The *Latham Report* (1994) proved to be a major catalyst for radical change in client attitudes because it put a figure of 30% on the cost of inefficiency and waste in the industry. For individual repeat clients, the message about the high level of unnecessary costs was a powerful driver for them to take a more active role in the industry (Cartlidge, 2002; Kelly *et al*., 2002; Cain, 2003).

The *Egan Report* (1998) strongly reinforced the concerns of clients regarding the high levels of inefficiency and waste, and equally strongly supported the earlier message of the need for integration. The *Egan Report* differed from earlier reports by urging the adaptation of best practice principles from other sectors of the economy, reflecting perhaps, Sir John Egan's own experiences in the automotive sector. Egan called for the investigation of total integration and management of design development and most importantly, construction SCM. It resulted in tools for the systematic and managed approach to the procurement and maintenance of constructed facilities based on integrating all the activities of a pre-assembled supply chain under the control of a single point of responsibility (Cain 2003; Cavinato, 2005).

The overall goal is to harness the full potential of the supply chain to deliver optimal value to the client while improving the profits earned by all parties and reducing waste in the system (Kelly *et al*., 2002; Kalidindi & Vargesse, 2004). These high aspirations assume that lower level operational issues of logistics are well understood and function efficiently. However, notwithstanding the pivotal role of logistics within SCM, at present little work has been done to ascertain the functioning of the logistics process in the construction supply chain.

4. The road to improvement

As both a regulator and client of the industry, the South African government, in line with its U.K counterpart, is actively promoting an efficient and effective construction industry that uses resources efficiently, reduces waste and transforms the working environment of its people for better employment and greater productivity (CIDB, 2004; Van Wyk, 2004).

Notwithstanding the pressure on the industry to reform, construction remains confined to its old ways of doing business. Risk is regularly and consistently shifted to others in the supply chain. Typical methods include through non-payment, retention and ‘pay when paid’ practices (Ashworth & Hogg, 2002). While most industries have undergone significant transformations over the past three decades, the South African construction industry presents an obvious and glaring exception to such trends. It is renowned for its inefficiencies as well as the reluctance of its participants to adopt significant improvements (CIDB, 2004; van Wyk, 2004).

Surveys undertaken by the South African Council for Scientific and Industrial Research (CSIR) indicate that clients are not satisfied with the quality of outputs; and products are too expensive and take too long to build (Wyk, 2004). The primary cause of the industry’s performance weaknesses is the segregation of design and construction which forms a barrier to any consideration of buildability, savings in labour usage, ease of maintenance and consideration and inclusion of safety at the design stage. The fragmentation reduces the efficiency of the industry and leads to much rework and wastage downstream (Morton, 2002; CIDB, 2004; van Wyk, 2004). Construction projects in South Africa rely on a variety of firms with poorly integrated professional and contractor organisations. Each firm performs a variety of wasteful activities within its own discipline. These fragmented processes create inefficiencies resulting in substantial delays and costs. South African clients, like their counterparts across the world, have begun demanding for radical improvements in construction performance. Clients’ focus is on the effect construction has on other industries’ performance through its contribution to overheads.

In contrast to construction, most firms in other industries have striven to improve their competitiveness by measuring and driving down unnecessary costs in their manufacturing or retail supply chains (Hooley *et al*., 1998; Gripsrud *et al*., 2006). At the same time, they have improved the quality of their products to more effectively meet the requirements of their customers (Cain, 2003). With this in mind, the highly effective customers of the construction industry are demanding that their performance be replicated by the construction industry. Because of their knowledge and skills in supply chain integration, these ‘supply chain savvy’ clients can clearly see the inefficiency and waste that occurs at all stages of the design and construction process. It may be supposed that the experience of such clients in reconciling conflict in their own supply chains would give them a reasonable understanding of the likely problems of construction (Lim *et al*., 2006). It seems imperative that the construction industry recognises the benefits and improvements that can accrue from adopting SCM and attendant logistics practices from other industries (Egan, 1998; Cartlidge, 2002; Kelly *et al*., 2002; Cain, 2003).

5. The role of Supply Chain Management (SCM) in construction

The supply chain is the network of organisations that are involved through upstream and downstream linkages in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer (Cooper *et al*., 1997; Lambert *et al*., 1998; Handfield & Nichols, 1999; Lummus & Vokurka, 1999; Bowersox *et al*., 2002; Coyle *et al*., 2003). Parties in the construction industry include clients, designers, contractors, sub-contractors and materials suppliers as illustrated in Figure 2. All these provide inputs of one form or another that go towards the realisation of projects. All the direct resource inputs are supplied and managed by a linkage of companies that can, in aggregate, be termed construction supply chains. SCM implies the management of upstream and downstream activities and relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole (Proverbs & Holt, 2000; Bowersox *et al*., 2002; Ellram, 2002).

It therefore follows that the object of effective SCM is the co-ordination of the spectrum of all supply activities of organisations from their suppliers and partners to their customers referred to as clients in Figure 2 (Ganeshan & Harrison, 1995: online; Bowersox *et al*., 2002; Coyle *et al*., 2003). These tenets of SCM contrast sharply with traditional construction procurement (Vrijhoef & Koskela, 2000; Vrijhoef *et al*., 2003).

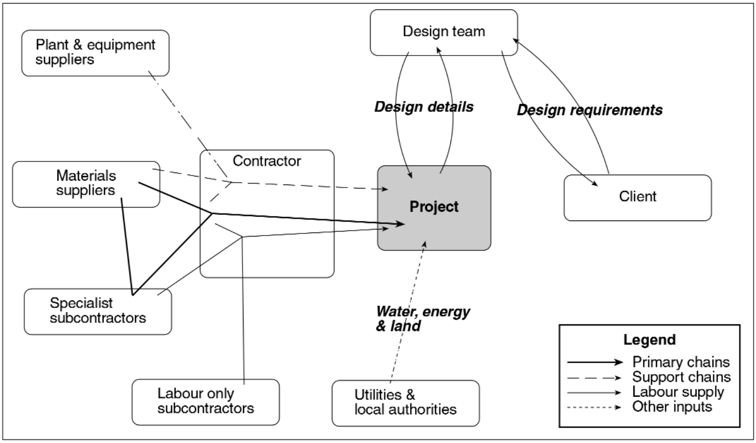

Figure 2: Resources supply in Construction Supply Chains
Source: Muya 1999

Various authors have noted the fact that the construction industry's traditional approach to procurement has been characterised by a largely fragmented, inefficient, sequential, wasteful and adversarial process (Cartlidge, 2002; Fellows *et al*., 2002; Kelly *et al*., 2002; Cain 2003). Principally, this is manifested in little, if any; contribution made at the briefing, design and cost planning stages by main contractors and specialist suppliers (Masterman, 1994). Hill & Ballard (2001) have argued that failure to adequately capture construction supply chain expertise at an early enough stage in the project delivery process is one of the primary causes of uncertainty, delay, increased costs and contractual conflict.

To improve project delivery, Egan (1998) recommended the use of integrated teams and integration of the processes (Fellows *et al*., 2002; Kelly *et al*., 2002). In essence, *the report* recommended the application of SCM in the construction context (Egan, 1998). This involves looking beyond the product of construction itself, into the processes, components and materials that make up the output (Cartlidge, 2002; Cain, 2003).

SCM can bring benefits to all involved when applied to the total construction process. The process should start with a detailed definition of clients' business needs through the use of value management and end with the delivery of a product that provides an environment in which the client's business needs can be carried out with maximum efficiency and minimum facilities management costs (Morton, 2002; Cain, 2003).

The overall role of SCM in the construction industry is twofold. Firstly, to deliver improved value to the client in cradle-to-grave performance of facilities. Secondly, to improve the profits earned by all involved. This can be achieved through the measurement and elimination of unnecessary costs in the construction supply chain. Measurement can help to identify and eliminate inefficiency and waste occurring at many stages of the design and construction processes (Morton, 2002; Tansey *et al*., 2004; Tookey *et al*., 2004). SCM also focuses on free information flow up and down the supply chain; feedback and learning that leads to continuous improvement and value chain analysis to determine where cost and/or value creation can be improved (Fisher & Morledge, 2002; Cain, 2003; Tookey *et al*., 2004).

Generally it is important to view the philosophy of SCM in construction as an extension of the concept of partnerships into a multi-firm effort to manage the total flow of goods inventory from supplier to the ultimate consumer (Bowersox *et al*., 2002; Coyle *et al*., 2003). Within the concept of SCM there is an assumption of planning, forecasting and delivery efficiency leading to reduced inventory, waste, and defects (Bowersox *et al*., 2002; Fisher & Morledge, 2002; Coyle *et al*., 2003).

Given the predominance of the subcontracting practice and other disintegrative practices in construction, research needs to be conducted to ascertain how SCM processes work and how they can be improved in the South African construction sector. Various reports and research over the years have identified disintegrative behaviour as being the root cause of many problems in the industry. Prominent among the studies were those conducted by the CIDB (2004) and van Wyk (2004). It is important to understand that construction is fundamentally a manufacturing operation generally utilising low cost and high volume materials. These materials have to be moved to constantly changing geographical locations. Consequently, the SCM function in construction should be of strategic importance. Given the risk-averse nature of modern construction, effective planning should be taken as an essential precondition to the successful execution of projects. Construction planners must take into account all the dynamics related to production and other operational issues of projects. The construction planner, therefore, ought to plan materials distribution, movement to site and related information distribution and management and other SCM and logistical activities carefully (Agapiou *et al*., 1998; Voordijk, 1999; Vrijhoef & Koskela, 2000; Briscoe *et al*., 2004. There have been a number of studies undertaken on the supply chain management (SCM) concept and its contribution to construction process optimisation. Notable among these were those undertaken by Lambert *et al*. (1998), Larson & Rogers (1998) and Marbet & Vankataraman (1998) These studies were well received and recently were enhanced through the contributions of Vrijhoef & Koskela (2000), Ofori (2000), Briscoe *et al*. (2004) and Saad *et al*. (2002).

Therefore, it is not surprising that SCM research has been driven by the need to improve the efficiency with which the construction industry operates its supply network (Briscoe *et al*., 2004). The emphasis of construction procurement is currently on value adding supply chain relationships (Cartlidge, 2002). This is because good lessons have been learnt from other sectors of the economy such as vehicle manufacturing which, by taking a holistic view of supply chain interactions, have developed closer value adding relationships (Lamming & Hampson, 1996). Following successes in other sectors, a small but increasing number of construction organisations are beginning to adopt SCM principles as a means to improving performance and to addressing their supply chain relationships.

SCM literature on construction has focussed considerably on lean production (Vrijhoef & Koskela, 2000) largely ignoring the more operational issues of SCM such as the logistics function. This is a significant omission as the performance of materials handling, distribution and information flow in both upstream and downstream linkages are crucial in the SCM process for the construction industry (Agapiou *et al*., 1997; Agapiou *et al*., 1998; Voordijk, 1999; Vrijhoef & Koskela, 2000; Edum-Fotwe *et al*., 2001; Briscoe *et al*., 2004. A recent study by the Building Research Establishment (BRE) in the UK indicted that 30% of construction costs are attributed to the transportation of construction materials (Hill & Ballard, 2001; BRE, 2003). Therefore, construction is uniquely placed to benefit from improved logistics because of the nature of materials consumed and the methods and volumes involved. Currently, the transportation of construction materials from the point of production to the point of consumption is uncoordinated and inflexible with the majority of construction materials suppliers using their own vehicles assigned to dedicated delivery schedules, delivering *ad hoc* to various locations (Agapiou *et al*., 1997, Agapiou *et al*., 1998). It is important to examine construction vehicle transits in order to understand these operational issues of logistics in the construction industry.

5.1 Construction vehicle transits

The construction industry utilises millions of tonnes of materials and generates large quantities of waste. Moving these volumes of materials and waste requires large numbers of loaded vehicle transits. For instance, the UK and South African construction industries utilise 1000 million and 400 million tonnes of materials and generate 100 million and about 10 million tonnes of waste annually respectively (DETR 2000, Lazarus, 2002, Shakantu *et al*., 2003; Shakantu, 2004). Given the above figures for material consumption and waste generation, the requirement for transportation of materials to and waste from construction sites is clearly significant. For instance, transporting 100 million tonnes of construction and demolition (C&D) waste from sites around the UK alone equates to 5 million loaded vehicle transits, assuming that vehicles transporting waste were fully loaded to their maximum capacity (Shakantu, 2004). When the volume of materials being transported to sites, which is approximately 10 times that of C&D waste, is taken into account, the shear scale of the transportation problem can be comprehended (Koskela, 1999; DETR, 2000; Shakantu, 2004).

A recent study seeking to optimise the logistics of construction found that construction materials delivery and C&D waste removal are usually considered to be entirely separate business activities (Shakantu *et al*., 2003). A consequence of this scenario is that each vehicle type, when travelling to or leaving a construction site moves full in one direction and empty in the opposite direction. There is therefore a significant opportunity to utilise some of the concepts of logistics management to achieve process optimisation (Coyle *et al*., 2003; Nilsson, 2006). For instance, optimisation could be achieved through the application of reverse logistics solutions that merge the forward and reverse flows into one process (Srivastava, S.K. & Srivastava, R.K. 2006; Wu & Cheng, 2006).

5.2 Logistics management

Logistics management is a complex task within both the modern manufacturing and construction industries. Effective logistics management implies a mastery of various key processes including planning, implementing and controlling 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 fulfil customer requirements (Council for Logistics Management, [CLM], 1991). The above definition by CLM reflects the need for the total management of movement from the point of origin of materials to the location of the finished product. Additionally, logistics involves the integration of information, transportation, inventory, warehousing, material handling and packaging. Logistics management includes the design and administration of systems to control the flow of materials, work in progress and finished inventory to support business (Bowersox *et al*., 2002). To manage these flows, leading firms have developed logistics systems capable of monitoring logistical performance on a real time basis, giving them the ability to identify potential operational bottlenecks and to take timely corrective action (Bowersox *et al*., 2002). Operational strategies of the fast moving consumer goods (FMCG) sector such as quick response (QR) and electronic data interchange (EDI) which facilitate efficient transmission of data throughout the supply pipeline and allow stores to link supply with real time demand could be utilised.

5.2.1 Logistics systems

Logistics management provides a systems framework for decision making that integrates transportation, inventory, warehousing space and other related activities that together encompass appropriate trade-offs involving cost and service in the supply chain. A logistics system is a set of interacting elements, variables, and parts or objects that are functionally related to one another and form a coherent logistics group (Bowersox *et al*., 2002; Coyle *et al*., 2003).

A large part of the logistics system is transportation. Transportation is one of the most visible elements of logistics operations (Bowersox *et al*., 2002). Transportation provides a major function in the logistics system, namely, product movement. In the construction industry, the size of the transportation problem is very significant as sub-optimally loaded vehicles move frequently through cities at inappropriate times. More often, adjacent sites fail to synchronise their activities and substantially contribute to the creation of congestion in the road transport system. Construction traffic also fails to 'back-haul' materials from sites to the points of disposal. This contributes to increases in vehicular traffic as additional vehicles need to be made available to remove waste from sites. Increased vehicular traffic exacerbates noise and air pollution across cities. Concerns with gridlock and pollution have led to increasing analysis of approaches to controlling the flow of traffic in cities. Waste reduction and increased recycling have also received more attention in recent times. There is a growing interest in the industry in reverse logistics systems to support recycling and waste management (Coyle *et al*., 2003).

5.3 The emerging role of logistics in construction process optimisation

Latham (1994) recommended the establishment of well-managed and efficient supply chains. According to Cartlidge (2002) this was to be achieved through a reduction of development and production costs by 30%. For this reduction to happen it is important that operators and contractors work more closely together, pool information and knowledge can help drive down costs and thus indirectly promote efficient supply chains and value for money. Conversely, operators should assist to remove waste from the construction process. Within the supply chain this can be done through value adding activities that increase logistical and operational benefits.

The role of physical distribution is critical to the logistics process. It requires skilful design and control of data flows connected with products and production. An integrated supply chain strategy creates a seamless supply chain for production and associated logistics processes. Logistics integrates stocks, materials acquisition, transportation and other systems. Effective logistics management reduces costs. According to Tan (2001), the transportation system allows organisations to deliver products and services in a more timely and effective manner. Therefore, the role of logistics is to satisfy the up-stream and down-stream members of the supply chain. Integrated logistics activities provide supply chain members with the opportunity to optimise system performance. This represents a major departure from current logistics practices in the construction industry that are characterised by disparate efforts with limited or no coordination between organisations (Handfield & Nichols, 1999).

Catlidge (2002), Kelly *et al*., (2002), Cain (2003) and Tansey *et al*., (2004) revealed that there are many stages of the design and construction process where inefficiency and waste occurs. Value chain analysis can assist to determine where costs and value creation can be improved (Fisher & Morledge, 2002).

Currently, many firms do not understand or address the operational element of logistics. This position appears paradoxical considering that logistics is widely cited as the pre-eminent subset of SCM (Bowersox *et al*., 2002; Coyle *et al*., 2003). Earlier studies showed that construction does not isolate logistics expenses and therefore there is no effort to reduce these costs. This is undesirable considering that transportation accounts for a large proportion of logistics costs, and up to 50% of some basic materials such as sand (Shakantu *et al*., 2003). Consequently, there appears to be a significant need for an enhanced understanding of logistics in a construction context in order to deliver the full benefits of SCM.

6. Conclusion

SCM in construction is a way of working in a structured, organised and collaborative manner shared by all participants in a supply chain. Each company is a link in a chain of activities adding value at each stage designed ultimately to satisfy end customer demand (Cartlidge, 2002; Cain, 2003). SCM in a modern context emphasises delivering customer value without compromising the ability of each member of the supply chain to maintain a viable business, that is, everyone makes a fair profit.

The supply chain encompasses all those activities associated with processing, from raw materials to completion of the end product. This includes procurement, production, scheduling, order processing, inventory management, transport, storage and customer service and all other supporting information systems. Logistics management is concerned with optimising flows within the supply chain.

Because the supply chain works as one team and does not pass unnecessary risk from one member to the next, supply chain optimisation benefits spread throughout the procurement system. Risk is managed collectively. Moreover, the problem solving / win-win attitudes lead to avoidance or reduction of further risk. Improved collaboration means clients do not have to pay for risks that do not materialise. The entire team is more committed to economic sustainability of the construction process (Cartlidge, 2002). This benefits both the client and the supply chain.

Given construction clients' propensity to demand reductions in construction costs, facilitating effective and improved SCM and logistical performance will be an increasingly attractive position for the construction industry. Improved SCM and logistical performance would invariably result in reduced cost, reduced risk and economic sustainability of the construction process.

Primary points of interest to logistics should be the interfaces between parties, exchange of data and development across organisational boundaries. The primary focus of the logistics function in construction, should therefore, be to improve coordination and communication between project participants during the design and construction phases. It should provide accurate scheduling of materials, coordination of supplies and organisational planning and control of the supply chain. It should seek to minimise non-value adding activities and drive operating and investment costs and time in the supply chain down. Consequently, there appears to be a significant need for an enhanced understanding of logistics in a construction context in order to deliver the full benefits of SCM. This calls for going beyond Egan's SCM and advancing the role of logistics in a construction context.

7. Limitations of logistics and SCM in the construction industry

While the introduction of SCM concepts is generally accepted as a worthwhile development, the project nature of construction poses unique challenges when compared to other industries. In the vast majority of cases, construction projects are one-off and location dependent, requiring that resource inputs be obtained in the proximity of projects, thus often rendering organisational relationships required in SCM ineffective. However, given the scale of the construction logistics problem and its inherent cost to the industry, even a modest improvement would have significant results. Any envisaged future logistics optimisation will have implications on the selection criteria for suppliers. For instance, the logistical abilities of the contractors with regard to contracts, appropriate mix of vehicles required to fully service the logistics requirements of the projects in question, adherence to environmentally sustainable logistics norms and characterisation of the materials ordering processes all need to be enhanced before the benefits espoused in this article can be realised.

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