CONCEPTUALISING REVERSE LOGISTICS IN A CONSTRUCTION CONTEXT: RE-DEFINING ITS CONTOURS

WM Shakantu (Department of Construction Economics and Management, University of Cape)
M Muya (Department of Civil and Environmental Engineering, University of Zambia)
JE Tookey (School of the Built and Natural Environment, Glasgow Caledonian University)
PA Bowen (Department of Construction Economics and Management, University of Cape)

Logistics management is a complex task within both manufacturing and construction industries. Effective logistics management involves the integration of information, transportation, inventory, warehousing, materials handling and packaging. Until recently, investment in logistics was focussed mainly on the flow from companies to markets. However growing concerns for the environment and the conservation of resources have created new logistical approaches to manage the distribution function more effectively, and make better use of the resources available to an organisation. One such approach is the concept of reverse logistics. Reverse logistics uses various methods to give scope for back-loads of finished products, components, waste and reusable packaging from consumers to manufacturers. Back-loads, which are logistics against the forward flow, allow manufacturers to reduce costs by using distribution vehicles' return journeys to create income or value addition. This concept is now being developed to create novel solutions to the reduction of pollution, costs and vehicle movements, while maintaining high customer service levels. This paper develops the concept of reverse logistics in a construction context in order to improve materials availability whilst simultaneously improving construction and demolition (C&D) waste management and reducing vehicle movements. The paper ends by describing a case study in Cape Town, South Africa in which the concept was applied in modelling the integration of materials delivery and construction and demolition (C&D) waste removal operations in order to reduce costs and vehicle movements.

Key phrases: Reverse logistics, materials delivery, C&D waste, integration, vehicle movements, construction

INTRODUCTION

Logistics management is a complex function requiring the mastery of various key processes including planning, implementing and controlling the efficient 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 1999). This definition reflects the need for total management of movement from the point of material procurement to the destination of the finished products. Implied in the definition also is the notion that logistics involves the integration of information, transportation, inventory, warehousing, material handling and packaging (Tan 2001). Therefore, the logistics process is expected to provide 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 well functioning logistics system is, therefore, a set of interacting elements, variables, and parts or objects that are functionally related to one another and form a coherent group (Bowersox *et al* 2002; Harrison & van Hoek 2002; Coyle e*t al* 2003).

Transportation is one of the most visible elements of logistics operations (Bowersox *et al* 2002). The transportation system is the physical link that connects customers, raw material suppliers' plants, warehouses and channel members in the logistics system. Typically, transportation represents a major cost component of the logistics supply chain. Transportation costs represent approximately 39 to 58% of total logistics costs and up to 4 to 10% of the product selling price for many companies (Coyle *et al* 2003).

REVERSE LOGISTICS

To improve vehicle transits, logistics managers can use supply chain optimisation tools such as reverse or back-haul logistics management. Reverse logistics refers to all activities that collect, move, store, disassemble and process used or outdated products and packaging, product parts and materials in order to ensure sustainable recovery (Bowersox *et al* 2002; Coyle *et al* 2003). Reverse logistics continues to rise in prominence, value and volume as environmental laws tighten and e-commerce related returns increase (Sharma *et al* 2005; Yao 2005). Reverse logistics uses various methods to give scope for back-loading of finished products, components, waste and reusable packaging from consumers to manufacturers or suppliers (Vaidyanathan 2005). Back-loads or logistics against the forward flow, allow manufacturers to reduce costs by using distribution vehicles' return journeys to create income or value addition. In the simplest sense, for example, reverse logistics happens by a distribution vehicle picking up pallets previously deposited at the warehouse where it makes its deliveries. The return trip adds value to the process by returning those pallets back to their point of origin (Stock 1998). This concept is now being developed to create novel solutions to the reduction of pollution, costs and vehicular movements, while maintaining high customer service levels.

REVERSE LOGISTICS IN THE FAST MOVING CONSUMER GOODS INDUSTRY

There are several operational strategies in the Fast Moving Consumer Goods (FMCG) sector. The most common used ones are Quick Response (QR), Efficient Customer Response (ECR), Route and Vehicle Optimization (RVO) and Extended Producer Responsibility (EPR).

QR was developed specifically for the textile industry in order to manage wide product ranges with short product life cycles, high seasonality and high complexity (Lowson *et al* 1999). Elements of QR include information sharing with trading partners, use of Electronic Data Interchange (EDI) for rapid data dissemination, supply chain visibility using bar codes, and small order sizes to ensure activity levels match demand tempo. At the end of the product season, products are recalled to factory warehouses for storage or final disposal in factory shops. Reverse logistics here ensures that the reclamation of controlled inventory is performed under strict operating scrutiny that prevents possible redistribution and improper disposal (Bowersox *et al* 2002).

ECR was developed especially for the grocery sector, using components such as Electronic Point of Sale (EPOS) data, EDI, fast re-estimation and re-orders to drive supply to meet demand. It uses Universal Product Codes (UPCs) to generate and efficiently pass data into the supply chain (Lowson *et al* 1999; Lowson *et al* 2001; Burgess *et al* 2002). When a product is purchased, product data and information is sent from the store to the manufacturers, who are second tier suppliers, and raw material suppliers, who are first tier suppliers. EDI facilitates data transmission throughout the supply chain, allowing the store to link supply with real time demand. Knowledge of real time demand is essential to the grocery industry, as most products sold have a limited shelf life (Ellram *et al* 1989). Each of the components assists in the effectiveness and efficiency of operations in producing their desired output. UPCs enable linkages between firms in a mutual operational network. EPOS information sharing helps initiate the flow of sales data, and enables production to be tailored to real time demand (Whiteoak 1994). EDI forms an interface between sectors in the logistics chain responding to customer pull exerted upon the retailer or provider. EDI technology improves order management and invoice issue throughout the supply chain members. In the ECR system, reverse logistics integrates firms in a seamless supply chain in order to optimise each stage of the procurement-production-distribution process (Marien 1998).

Materials, especially component type materials, have fixed product lives. They require replacement at the end-of-life stage. The concept of Extended Producer Responsibility (EPR) has emerged as a waste management model in which negative externalities from product use and end-of-life are incorporated in the supply contract (OECD 2005; OECD 2006). One of the extended producer responsibilities is producer take-back requirement at end-of-life point. The take-back requirement ensures that producers are responsible for collection and recycling of end-of-life products (Murphy *et al* 1995). The EPR thrust places the ‘cradle-to-grave’ responsibilities on companies for products and processes (Murphy *et al* 1995; Bowersox *et al* 2002; Yoon & Jang 2006). According to Murphy *et al* (1995), the ‘cradle-to-grave’ responsibility means that a business must evaluate a product’s entire life-cycle from source of raw materials to final disposal. Murphy *et al* (1995) and Coyle *et al* (2003) noted that reverse logistics is well suited to deal with ‘cradle-to-grave’ issues because it focuses on supply chain management which emphasises the control of materials from suppliers through value added processes on to the customer. These strategies are currently being used to respond to environmental requirements to recycle, reduce consumption and re-use materials (Murphy *et al* 1995). This is in line with frequent references in literature that reverse logistics encompasses all the issues relating to supply chain activities carried out in source reduction, recycling, substitution, re-use of materials and disposal (Stock 1992; Murphy *et al* 1995; Carter & Ellram 1998).

CONSTRUCTION LOGISTICS

Transportation provides contractors with the ability to position resources in the correct location in order to be able to deliver the final product or service. Transport forms a large and costly part of the logistical system for the construction industry in particular. Given the cost/volume ratio of construction materials, a similar or greater level of costs associated with construction materials purchases, likely to be in excess of 50% or more of the cost of basic raw materials such as sand comes from transportation (Lambert & Stock 1993).

Therefore, understanding the dynamics of transportation requirements is a key competency required for cost control and reduction. However, current, knowledge of logistics in general and transportation in particular within construction is relatively limited. Emphasis is more frequently placed on supply chain management (SCM) without real reference to the fundamental need to understand its pre-eminent subsets, such as transportation. The main reason for this emphasis has been cited as the complexity and organisational structure of the construction industry making the adoption of logistics management concepts extremely difficult (Voordijk 1999). Van Herk *et al* (2006) also found the organisational structure of the construction industry to be prohibitive to the development of efficient logistical systems.

An additional problem is that currently, the movement of construction materials from the point of production to the point of consumption is uncoordinated and inflexible (Pooler & Pooler 1997; Ballou 1999; Vogt *et al* 2002). The majority of construction materials suppliers have their own dedicated vehicles and delivery schedules, delivering *'ad hoc'* to various locations. As a result, the method most commonly used to deliver materials to construction sites is that of dedicated, single use vehicles such as cement and concrete-carrying trucks from manufacturers to points of consumption on sites. Materials such as wooden frames, plasterboard and bricks are also delivered in the same way.

Concerns regarding gridlock and pollution on public roads have led to increasing analysis of approaches to controlling the flow of traffic in large cities. The reduction of waste materials and increased recycling has also received more attention recently. There is a growing interest in the manufacturing industry in reverse logistics to support recycling and waste management (Bowersox *et al* 2002; Coyle *et al* 2003). The benefits of this concept are still largely not being felt in the construction industry. Construction could learn from operational strategies of fast moving consumer goods (FMCG) industries.

This paper develops the concept of reverse logistics in a construction context in order to improve materials availability while simultaneously improving construction and demolition (C&D) waste management and reducing vehicle movements.

SCOPE FOR REVERSE LOGISTICS IN THE CONSTRUCTION INDUSTRY

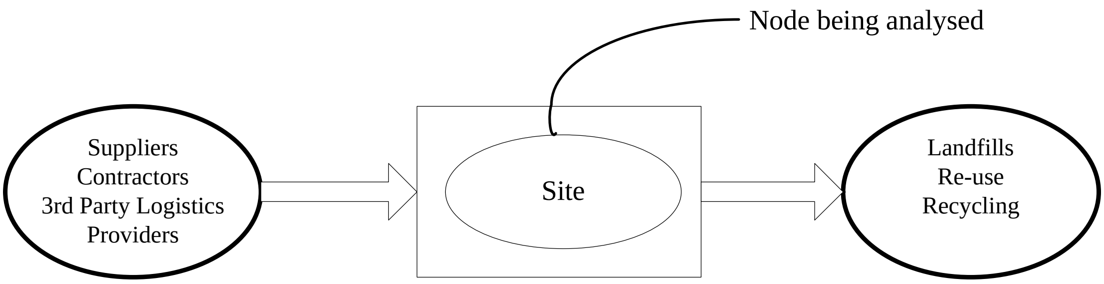
The construction industry utilises millions of tonnes of materials and generates large quantities of waste. Moving these quantities of materials and waste requires millions of loaded vehicle transits. The requirement for transportation is clearly significant. Construction materials delivery and C&D waste removal are usually considered to be separate businesses and activities. A consequence of this separation is that each vehicle type, when moving 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 the concept of reverse logistics to achieve process optimisation (McKinnon 1996; Bowersox *et al* 2002; Coyle *et al* 2003; Roper 2006). The concept of reverse logistics, operationalised through utilization of spare capacity of either delivery vehicles departing from construction sites or waste management vehicles arriving at sites is elegant in its simplicity. The use of the spare capacity would immediately increase the utility of assets such as vehicles and roads, reduce unit costs, the total number of vehicular movements, hydrocarbon fuel usage and the social costs associated with vehicular transport. Reverse logistics can therefore be seen as a means to improve vehicle utilisation and reduce vehicular movements while simultaneously improving the service being provided to customers. To illustrate the utility of reverse logistics in a construction context, the following case study was conducted on 7 sites in Cape Town, South Africa, from July to November 2005.

A CASE STUDY FROM CAPE TOWN ON THE APPLICATION OF REVERSE LOGISTICS IN A CONSTRUCTION CONTEXT

To illustrate the concept of reverse logistics in a construction context it was essential in the first instance, to establish the dynamics of the relationship between construction materials and C&D waste from which it was possible to develop methods and systems that can optimise the flow of materials and waste to and from site, respectively.

There are four approaches for analysing logistics systems: materials management versus physical distribution; cost centres; logistics channels and nodes versus links (Coyle *et al* 2003). Given that the nature of construction is input versus output from sites, the node versus links approach is by far the most appropriate concept by which to view the logistics system in a construction context. This approach was therefore adopted as the methodological framework for the analysis of the dynamics between construction materials supply and C&D waste removal. The nodes are spatial points where goods stop for storage or processing. The links represent the transportation network connecting the nodes in the logistics system. Figure 1 illustrates the concept. A node versus link approach allows analysis of a logistics system's two basic elements, transportation and the processing of materials. This approach also represents a convenient basis for assessing and analysing the logistics of building materials and building waste transportation to and from site respectively.

Figure 1: The node versus link in a logistical system (After Coyle *et al* 2003)



It also represents a convenient basis for seeking possible system improvements as it allows analysis of the supplier-site and site–disposal links. The complexity of the logistics system relates directly to the time and distance relationship between nodes and links, as well as to the flow of goods entering, leaving and moving within the system (Kay & Jain, 2002; Coyle *et al* 2003).

In this case, only two links needed to be thoroughly investigated because they gave a detailed picture of construction materials delivery to and C&D waste removal from sites or within the unit of analysis. By using the node versus link, volumes of both delivery vehicles entering and departing construction sites or waste removal vehicles arriving at or departing sites could be measured.

THE CAPE TOWN CASE STUDY

Practical considerations dictated that in order to get meaningful data regarding construction logistics, it would only be possible to monitor a limited number of sites during the research effort. Therefore a sample of sites needed to be identified that would provide sufficient vehicular movements for analysis within a reasonable time period. Consequently, the selected sites needed to be logistically, rather than statistically significant. The primary selection criterion was physical size of the development. The secondary consideration was that of construction technology. A total of 7 sites were selected for observation, all of which were high rise, mixed use though predominantly residential developments. This represented about 80% of all such developments in the Cape Town metropolitan area.

METHOD

A two phase pilot study was conducted during the observation period. The first phase was an exploratory study conducted on a large construction site in the Cape Town Central Business District. The main purpose of this phase was to identify the types and classifications of vehicles and their cubic and tonnage capacities, as well as the patterns of their movements. It involved both observation of vehicle movements and talking to some drivers and site personnel about vehicular movements to and from site.

The results obtained were used in the design of a template used for data collection during the field study. In the second phase of the pilot study, the template was pre-tested on another large construction project in the Milnerton area of Cape Town to determine the practicality of using the instrument on site and the ease with which data could be captured. Specifically, the aim of the second phase of the pilot study was to test the instrument on a trial run before full use and to examine how it would work in practice. At this stage data capture problems such as the actual loading levels of vehicles were resolved by utilising visual identification of vehicle fill. Depending on the body type, fill was measured by deducting the area of the body length and height that was not taken up by the materials being transported. The observation protocol adopted was full, ¾ full, ½ full, ¼ full and empty. The quarter scale system was more appropriate as it was easy for the researchers to obtain a higher and consistent accuracy.

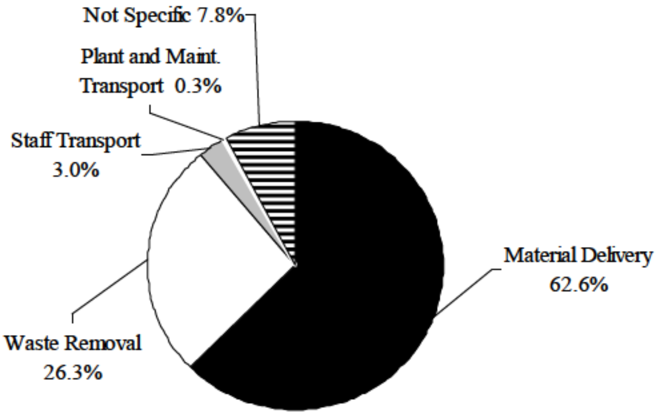
The parameters that came out of the pilot study for establishing the logistics of building materials and C&D waste and for identifying potential improvements were summarised as follows:

- classification of vehicle (material delivery/waste removal);
- number of vehicle movements delivering building materials:
- number of vehicle movements for C&D waste removal;
- state of vehicle on arrival by volume (Full/ ¾ / ½ /¼ / empty); and
- state of vehicle on departure (Full/ ¾ / ½ /¼ / empty).

RESEARCH FINDINGS

Of the 911 vehicular movements to and from the seven (7) construction sites, 570 were for materials delivery while 240 involved waste removal. There were also vehicle movements relating to staff plant and maintenance and 'other' transport, such as for consultants, inspectors and visitors. Figure 2 provides a classification of vehicles that transited the construction sites during the study period.

Figure 2: Classification of vehicles arriving on sites



The ratio of 570:240, which was 62.6% to 26.3%, worked out to be 2.4:1. Establishing the ratio was essential as it formed the basic tenet in the modelling process.

MODELLING THE FINDINGS

Figure 3 depicts the volumes of vehicle movements relating to the delivery of materials to and removal of waste from sites. The size of the arrows represented the volume of vehicular movements. There was a heavy movement of fully loaded vehicles to and a heavy flow of empty vehicles departing sites. The figure also shows light flows of ¼ full and lighter flows of ¾ and ½ full loaded vehicles.

Figure 3: Integrated materials delivery and waste removal logistics

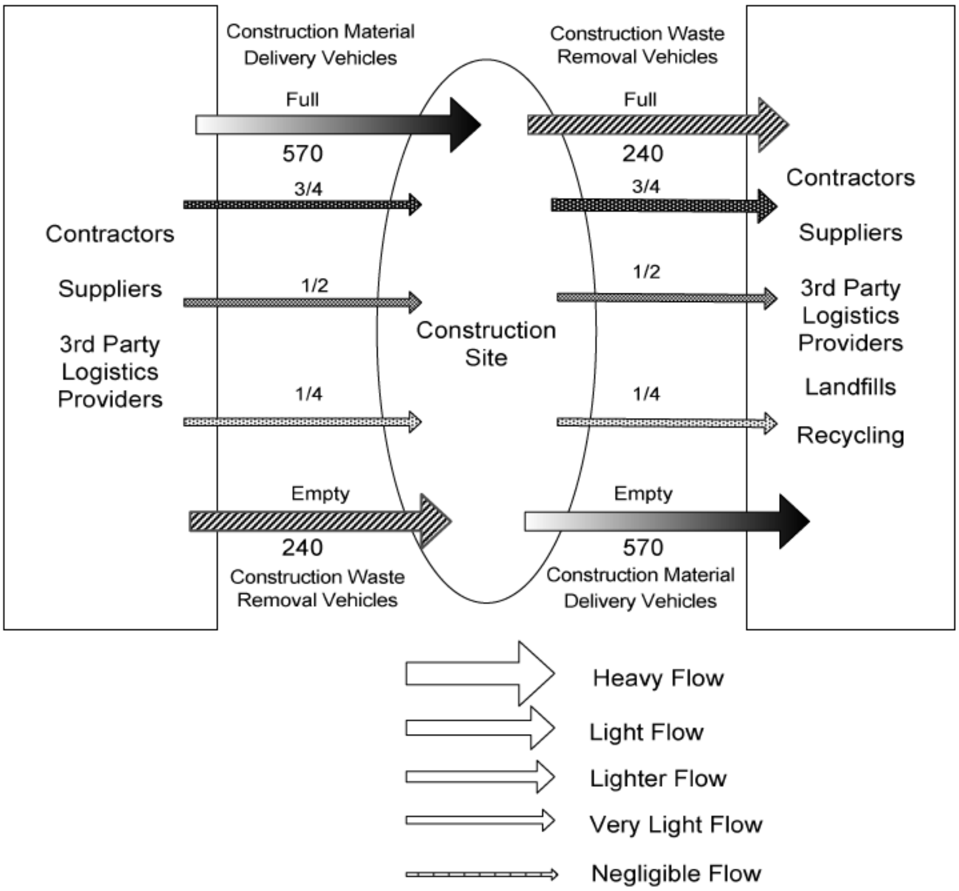
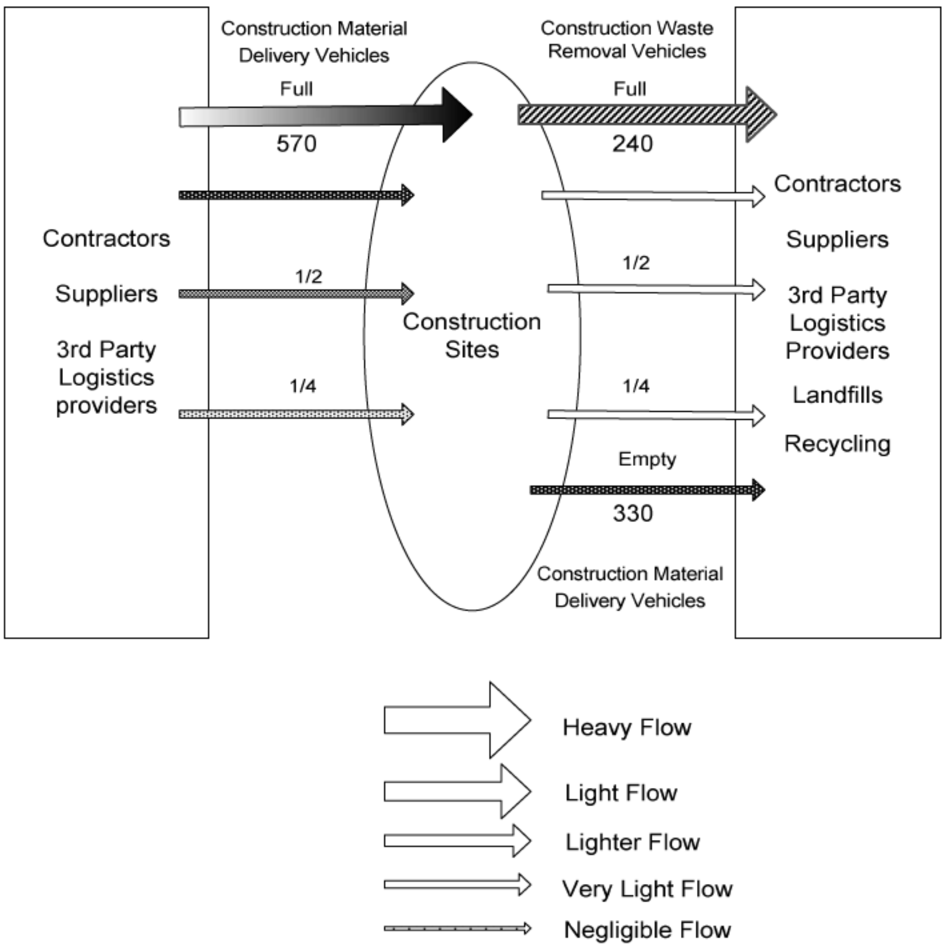


Figure 3 models the state of the logistics of construction materials focusing on vehicle movements relating to the delivery of construction materials to and removal of waste from sites. Therefore, Figure 3 models the combined state of site logistics results from the field study and highlights the fact that there was a substantial amount of empty runs in the logistical system. In particular, there was a heavy flow of fully loaded construction material delivery and empty waste removal vehicles on the inbound leg and a heavy flow of fully loaded waste removal and empty materials delivery vehicles on the outbound leg.

Using the ratio of 2.4:1 and assuming that the system started with 2.4 fully loaded material delivery vehicle movements delivering materials to sites, there would be 2.4 empty material vehicle movements after offloading. If one of the empty material vehicle movements was fully loaded with waste on its outbound journey then only 1.4 vehicle movements would travel back empty. If the one waste removal vehicle movement was made to carry material on its way to site then the volume of material being delivered would increase without increasing the total number of vehicles travelling to sites. This scenario is illustrated in Figure 4.

Figure 4: Optimised site logistics with the empty waste removal fleet to site eliminated



In Figure 4, the result of optimisation shows that the empty vehicles travelling to sites to collect waste could be eliminated because material delivery vehicles could be used to carry waste out to points of re-use, disposal or reclamation. By removing the forward movement of waste removal vehicles, 26.3% of vehicle movements would be eliminated.

IMPLICATIONS OF THE RESEARCH FINDINGS

The case study in this research showed that in terms of transport distribution, of all vehicle movements observed, 62.6% were classified as materials delivery and 26.3% as C&D waste removal. These percentages translate into a ratio of approximately 2.4 materials delivery journeys to one (1) waste removal journey**.** The significance of this finding is that it generates for the first time in literature a relationship between materials delivery and waste removal vehicle movements expressed in terms of a ratio.

Another issue that emerged from the field study was that the logistics of building materials delivery and C&D waste removal were not integrated and that the vehicle movements for both activities were sub-optimal. This was the case because the field study found that 570 of materials delivery vehicle movements were empty runs on their return journey and 240 C&D waste vehicle movements were empty runs on their forward journey. This was largely due to a failure by the construction industry to back-haul.

The study, thus, highlighted the potential for integration of logistics of building materials delivery and C&D waste removal. Integration would in the end improve the logistics of the construction industry. As the research demonstrated, there is scope for utilization of reverse logistics through utilisation of the available spare capacity. The utilisation of spare capacity would increase the effectiveness of vehicles, reduce unit costs and the number of empty vehicular movements. Based on the ratio of 2.4:1 established in this research, up to about 26.3% of vehicle movements transiting sites could be eliminated by allowing material delivery vehicles to back-haul waste to points of disposal, reuse or reclamation.

Another implication of the research findings is that in applying reverse logistics techniques, about 42% reduction in empty runs was possible. This reduction was possible because with a ratio of 2:4:1, it meant that for every 100 material delivery vehicle movements to site, there would be an equivalent of approximately 42 waste removal vehicle movements that would also go to site. By extension, the 42% potential reduction in vehicle movements implied that a benchmark for Cape Town would be that:

- at least 42% of all building materials delivery vehicles leaving construction sites could be fully loaded with waste; and
- on average 100% of all materials delivery vehicles could be loaded up to 42% of their payload capacity with C&D waste on their return journeys.

OBSTACLES AND PRECONDITIONS TO OPERATIONALISATION OF REVERSE LOGISTICS IN CONSTRUCTION

The difficulties associated with changing practices and attitudes regarding logistics in construction need to be acknowledged. Without doubt, the implementation of reverse logistics presents significant challenges to even the most technically advanced construction supply chains in the world, particularly in the context of dedicated vehicle platforms and cross contamination between new materials and C&D waste. However, it is contended that the nature of cost versus environmental controls necessary to create a sustainable construction industry is evolving rapidly. The introduction of SCM concepts has generally been accepted in most industries in the world. However, the introduction of SCM without addressing the core logistics function of transportation would be illogical. Given the magnitude of transportation requirements and the inherent costs to society and the industry, even a small improvement in construction fleet management through utilisation of reverse logistics would have a significant positive result.

DEDICATED VEHICLE PLATFORMS

Construction vehicles come in various shapes, sizes, types and bodies. The main vehicle types are goods vehicles and trailers. Largely, vehicle design is a response to demands of particular construction functions or their combinations. Vehicles are usually identified by the functional category in which they fall. These include ready-mix concrete trucks, general-purpose transport such as light and heavy-duty lorries, tractors and trailers, and dumpers. For the purpose of transporting materials, there is a wide choice of vehicle designs available. Most are used for transporting building materials on public highways. These include conventional trucks with attached rigid 2 or 3-axle and articulated semi trailers (Harris 1989).

Wagons are used for transporting excavated materials. They are usually of the rear dump type and ideally should have four wheel drive capability to overcome both difficult conditions and for travelling at relatively high speeds on smooth roads (Harris 1989; Rushton *et al* 2001).

The platform or flat-bed is the traditional body type. It consists of a wooden or metal base above the skeletal trailer. It may have a rear with drop sides and a range of heights. It is most commonly used for raw materials and weatherproof products. In construction, the flat-bed is used for transporting palletized bricks and blocks. Flat-beds with drop sides are used to transport timber and other building materials (Harris 1989; Rushton *et al* 2001).

Construction shipments for some raw materials depend on size of trucks. A consequence of this system is that contractors and transporters negotiate transport deals based on size of trucks. For instance stone and sand are normally loaded only to the size of a truck. Therefore, a $10m^3$ truck would be loaded to the $10m^3$ capacity. An $11m^3$ truck to $11m^3$ and so on. As a result, there is always an excess and consequently waste of sand and stone on site.

One of the consequences of the above vehicle designs and configurations is that the movement of construction materials from the point of production to the point of consumption is uncoordinated and inflexible with the majority of construction materials suppliers having their own dedicated vehicles and schedules, delivering *'ad hoc'* to various locations.

CROSS CONTAMINATION

There are several types of bodies used to carry various types of products. Their construction reflects the special needs and requirements of the products they transport. Body types include semi-trailers; swap bodies, box-body vans, platform trucks, multi-bucket or roll-off multi-buckets. Body types have advantages and disadvantages depending on the work to be undertaken and products to be carried.

The decision on the most suitable type of vehicle body to select for a job is based on both the stowability of the material to be carried and operating and load requirements. As a result, there is dedicated use of different body and vehicle types and independence of transport vendors resulting from problems of possible cross contamination especially between wet and dry materials, and new materials versus C&D waste.

PROPOSED SOLUTION TO OBSTACLES AND PRECONDITIONS

A solution to the problem of dedicated vehicle platforms and cross contamination is the use of independent third party logistics providers (3PLs) and roll-off multi-bucket container trucks (Vaidyanathan, 2005). There is also need for a paradigm shift in perceiving materials provision and waste removal as separate businesses.

Third Party Logistics Providers

By outsourcing all or much of a company's logistics operations to a specialized company, it is expected that efficiency gains can be made. As third party logistics providers (3PLs) are likely to synchronise their activities in geographical areas, it is likely that the use of vehicles that can resolve similar transportation requirements would be made available to adjacent sites in cities.

Roll-off multi-bucket trucks

The use of roll-off multi-bucket trucks is also espoused as providing significant benefits for construction transportation. By using multi-buckets, the problems of cross contamination can be resolved. In addition, because roll-off multi-bucket trucks need not be dedicated to specific material requirements, they also resolve the problem of dedicated platform transport.

Need for a paradigm shift

In order for reverse logistics to be operationalised, there is need for a paradigm shift in the perception of materials delivery and waste removal. Currently the two activities are perceived to be separate issues. As a result, empty trucks go to sites to collect waste while empty materials delivery vehicles simultaneously travel from sites. By using roll-off multi-buckets as already suggested, it is possible to use the empty return journeys of materials delivery fleet to take waste to points of disposal, reclamation or recycling.

CONCLUSIONS

Construction freight transportation is an indispensable service to construction business and overall economic growth. Transportation, however, generates adverse environmental impacts such as air pollution, noise, traffic congestion and health risks including the danger of accidents. As a result there is a rising conflict between functional requirements of freight movement and construction sustainability.

The conflict could, in part, be mitigated through improvement of freight traffic efficiency. Supply chain optimization tools such as integration of logistics functions, route and vehicle optimization and reverse logistics have proved to be effective tools that improve transport utility in other industries such as manufacturing. Optimisation of the usage of transport vehicles can significantly improve construction sustainability.

There are significant difficulties associated with the introduction and implementation of such concepts as reverse logistics in a construction context. To develop a workable method of using the approach may be untenable in the short term due to vehicle design and rigid business mindsets. However the research described in this paper demonstrated that there are potential economic and environmental benefits that can accrue from adoption of reverse logistics. These include the potential reduction of construction vehicle transits by about 26.3%. Such a reduction could generate substantial savings for the industry and make the industry more environmentally friendly.

Currently, reverse logistics in the construction industry appears to be a vision for the future. However, other sectors of the economy such as manufacturing enjoy substantial cost and environmental benefits resulting from its application. It would seem logical therefore, for construction to start working towards a viable logistics improvement plan.

BIBLIOGRAPHY

BALLOU H.R. 1999. *Business Logistics Management*. 4th Edition, Prentice-Hall International Inc., New Jersey.

BOWERSOX D.J., CLOSS D.J. & COOPER M.B. 2002. *Supply Chain Logistics Management*. McGraw-Hill/Irwin, Singapore.

BURGESS T.F., HWARNG H.B., SHAW N.E. & DE MATTOS C. 2002. Enhancing value stream agility: The case of the UK speciality chemical industry. *European Management Journal*, 20(2):197-210.

CARTER C.R. & ELLRAM L.M. 1998. Reverse Logistics: A Review of the Literature and Framework for Future Investigation. *Journal of Business Logistics*, 19(1):85-102.

COUNCIL OF LOGISTICS MANAGEMENT. 1999. *Logistics Management*. Ork Brook, Illinois.

COYLE J.J., BARDI E.J., LANGLEY C.J. Jr. 2003. *The Management of Business Logistics*. 7th Edition, West Publishing Co. Minneapolis.

ELLRAM L.M., LALONDE B.J., WEBER M.M. 1989. Retail logistics. *International Journal of Distribution and Materials Management*, 19(12):29-39.

HARRIS F. 1989. *Modern Construction Equipment and Methods*. Longman Scientific & Technical and John Wiley & Sons, Inc., New York.

HARRISON A. & VAN HOEK R. 2002. *Logistics Management and Strategy*. Financial Times/Prentice Hall, Essex.

KAY M.G. & JAIN A. 2002. *Issues in Agent-based Coordination of Public Logistics Networks*. Technical Report No. 02-01; Department of Industrial Engineering North Carolina State University, Raleigh.

LAMBERT D.M. & STOCK J.R. 1993. *Strategic Logistics Management*. 3rd Ed., Irwin.

LOWSON R.H., KING R & HUNTER A. 1999. *Quick Response: Managing the Supply Chain to meet Customer Demand*. John Wiley & Sons, Chichester.

LOWSON R.H., BURGESS N. & GEORGE T. 2001. Operational Strategies: Taxonomy and Application in Complex Consumer Supply Chains, Journal of Sales and Major Account Management. Special *Edition on E-Business and Supply Chain Management*, 3(3):13-32.

MARIEN E.J. 1998. Reverse Logistics as Competitive Strategy. *Supply Chain Management*. Spring. Cahners Business Information.

MCKINNON A.C. 1996. The Empty Running and Return Loading of Road Goods Vehicles. *Transport Logistics*, 1(1):1-19.

MURPHY P.R., POIST R.F. & BRAUNSCHWEIG C.D. 1995. Role and Relevance of Logistics to Corporate Environmentalism: An Empirical Assessment. *International Journal of Physical Distribution and Logistics Management*, 25(2):5-19.

OECD. 2005. *Analytical Framework for Evaluating the Costs and Benefits of Extended Producer Responsibility Programmes*. ENV/EPOC/WGWPR (2005) 6/FINAL, OECD, Paris.

OECD. 2006. *Extended Producer Responsibility (EPR) (Output area 2.3.4)*. WGWPR (2006), OECD, Paris.

POOLER V.H & POOLER, D.J. 1997. *Purchasing and Supply Management*. Chapman and Hall and International Thomson Publishing, New York.

ROPER W.E. 2006. Strategies for building material reuse and recycle. *International Journal of Environmental Technology and Management*, 6(3-4):313-345

RUSHTON A.R., OXLEY J. & CROUCHER P. 2001. *Handbook of Logistics and Distribution Management*. 2nd Edition, Kogan Page, London.

SHARMA S.K., WICKRAMASINGHE N. & SINGH M. 2005. Building systems around reverse value chain: a new system development approach. *International Journal of Management and Enterprise Development*, 2(1):93-105.

STOCK J.R. 1992. *Reverse Logistics*. Ork Brook Illinois, Council for Logistics Management.

STOCK R.J. 1998. *Development and Implementation of Reverse Logistics*. Programs, Council for Logistics Management, Ork Brook Illinois.

TAN K.C. 2001. A Framework of Supply Chain Management Literature. *European Journal of Purchasing and Supply Management*, 7(1):39-48

VAIDYANATHAN G. 2005. A framework for evaluating third-party logistics. *Communications of the ACM*, 48(1):89-94.

VAN HERK S., HERDER P.M., DE JONG W.M. & ALMA D.S.M. 2006. Innovative contracting in infrastructure design and maintenance. *International Journal of Critical Infrastructures*, 2(2-3):187-200

VOGT J.J., PIENAAR W.J. & DE WITT P.W.C. 2002. *Business Logistics Management*. Oxford, Cape Town.

VOORDIJK H. 1999. Logistical Restructuring of Supply Chains of Building Materials and Road Freight Traffic Growth. *International Journal of Logistics*, 3(2):285-304.

WHITEOAK P. 1994. The realities of quick response in the grocery sector: a supplier viewpoint. *International Journal of Physical Distribution and Logistics*, 24(10):33-39

YAO W. 2005. Logistics network structure and design for a closed-loop supply chain in e-commerce. *International Journal of Business Performance Management*, 7(4):370-380.

YOON H. & JANG Y. 2006. *The Practice and Challenges of Electronic Waste Recycling in Korea with Emphasis on Extended Producer Responsibility (EPR)*. Proceedings of the 2006 IEEE International Symposium on Electronics and the Environment, 2006, 8-11 May:326-330.