

CHAPTER ONE

INTRODUCTION

1.1 Background

Need for international maritime supply chains

A consequence of the liberalisation of world trade and the global sourcing of production factors and consumer products is the increasing reliance by manufacturers and traders on international chains of supply. The efficiency of those maritime supply chains has also become of critical importance for successful competition in the world markets that have emerged through the dismantling of trade protection. Distribution competitiveness in physical trade with the rest of the world is now essential for economic growth.

Trade liberalisation has intensified competition, not only in the world markets for goods, but also in the markets for services, including international transport services and especially marine transport. Owners and operators of ships trading in the supply of transport for both bulk and containerised cargoes are thus under constant pressure to meet the demand by shippers for efficient and seamless services, under the threat of losing business to their competitors.

That has necessitated the endeavour by the suppliers of line shipping to establish international supply chains in which control is exercised over the multi-modal movement of freight between the origin and destination of the consignments. While the implementation of the concept of multi-modalism is being widely pursued, full integration of international supply chains incorporating marine transport is difficult to achieve because of the many obstacles involving politics, law, finance and technology that first have to be overcome. As 90%¹⁾ of the world trade in goods by value is given physical

effect through the sea transport of containers alone, the need to succeed in raising the efficiency of international distribution through maritime supply chains is great if the world economy is to thrive.

The efforts by shipowners and container operators to extend their supply chain operations have involved mainly the backward and forward integration of land transport and intermodal transshipment into the transport that they supply²⁾. The extended operations have often necessitated the inclusion of warehousing into supply chains, thus fulfilling an integral function in production processes or in bringing perishable products onto markets. Where the acquisition of the ownership of carriers providing overland transport and terminals at which goods are transhipped has not been feasible or practicable, vertical and horizontal alliances aimed at achieving the seamless throughput of cargo and realising economies of scale have been entered into with other transport and terminal operators³⁾. Integration of even the management of international supply chains through alliances and agreements to co-operate has been difficult to accomplish in practice, however, as fundamental changes in the manner in which transport assets are owned and exploited may yet have to evolve for that to become generally feasible.

Profits of marine carriers

The initiatives of the marine carriers of containers to expand into the business of other modes of transport are not merely a consequence of the demand by cargo-owners for more efficient through services, but stem from the limitation on profits which shipowners and operators can realise when exploiting only a single link in the transport chain. By integrating both coastal shipping and overland feeder and distribution services, including rail and road transport services, into the scope of their business, as well as cargo transshipment and ancillary shipping services, shipowners and ship operators aim to increase their potential profits. That aim is not only directly achievable through the diversification into other transport activities, but through the acquisition or

management of networks of transport services that enable the supply to be monopolised, if not entirely, but at least in niche markets.

Railways and road transport

In particular, horizontal integration of marine transport and railways have provided the scope to achieve greater efficiency in distribution through the construction of “whole” supply chains over distances in which rail has a technological cost advantage over road transport in the transport of large quantities of cargo^{3, ibid.}). Such arrangements, comprising supply chains linking sea and rail transport, have provided opportunities for the integrated management of the bulk exports and imports of countries between origin and destination, with savings in the general costs of both the carriers and cargo-owners^{3, ibid.}). Control over the supply of road transport has also become essential for the business of marine carriers of containerised goods and a variety of arrangements involving ownership, alliances and broking have evolved in most countries in order to establish reliable distribution. However, the demand for the efficient management of supplies is requiring more effective multi-modal integration. That demand requires supply chain control to extend from the origin of the products into the market place.

Bulk and containerised cargo

Supply chains in South Africa at present tend to function more efficiently for the movement of bulk cargo than for containerised cargo. The reason is that the economics of moving large quantities of ores and minerals necessitate the links in the supply chain to be physically integrated through mechanisation and automation to a far greater extent than can be achieved in container supply chains at present. That involves substantial investment in infrastructure and equipment, which is unlikely to be undertaken without at least performance agreements between the cargo-owners, port authorities, cargo handlers, marine carriers and other participants in the supply chain. Such agreements often impose contractual obligations on the participants intended to ensure

that the supply chains function seamlessly and efficiently, in order to allow cargo-owners to conclude long-term arrangements for the supply of mining products and so retain their market shares in the commodity trades. However contractual arrangements do not always achieve seamless throughput and world best practice in the commodity trades is now to operate fully-integrated supply chains under single management. Fully-integrated supply chains are also evolving rapidly in the container trades.

Government intervention

While cargo-owners and liner companies need to integrate horizontally and vertically in order to incorporate the entire supply chain into their services, it is also essential for governments to co-operate with the industry so as to ensure that efficient supply chains are developed for successful competition by exporters in international markets (Neill, 2003:4).

Issues that need to be given specific attention by governments in collaboration with shipowners and operators, include:

- the scope for creating hubs with spokes in the construction of supply chains in order to achieve scale economies and to enable the optimal use of larger ships on deep-sea routes
- the opening of the landside transport regimes to private investment and management in order to allow operational flexibility in the design and utilisation of links in multi-modal supply chains
- the need for optimal security throughout the supply chains, especially at ports and other connecting points, in order to ensure the safety of the cargo and in keeping with the reaction required to increasing threats of international terrorism
- the manner in which shipowners and governments individually and collectively respond to the challenges with which the shipping industry is confronted (Cadwallader Memorial Lecture, 2003).

By successfully dealing with these issues the benefits of globalisation of production and trade can be realised more fully.

In South Africa, Government intervention in the form of the promotion of Black Economic Empowerment (BEE) in the maritime industries is also a factor in the development of supply chains and may prove to be an advantage if it renders schemes for public-private partnerships in such development officially more acceptable. Addendum A contains a copy of the scorecard of the charter entitled *Maritime Transport & Services Industry BEE Charter* (July 2004), which has been adopted by the maritime industry. The charter mentions the relevant legislation so far enacted.

One of the targets of the charter is to persuade local cargo-owners 'to increase the cargo carried in South African ships to 25,1% as against less than 5% at present within the next five years'⁴). As the number of commercial ships presently owned or operated by South African nationals is small, while all the major liner companies serving South Africa are foreign-owned with worldwide services, that target will be difficult to achieve. Intervention in the market by the South African Government in pursuance of the target could result in reluctance by foreign companies to invest in the development of more efficient or new maritime supply chains. If, however, the Government is willing to support its intervention to achieve the targets by facilitating joint ventures involving port and rail operations in supply chain links, and by ensuring that the requisite finance for black economic participation is forthcoming, maritime supply chain development could be promoted. However, the realism underlying the targets needs to be constantly reviewed in order to preclude setbacks resulting from the speed with which the charter is implemented, as adherence to the targets of the charter could deter the foreign investment on which the development of competitive maritime supply chains serving South Africa depends.

1.2 Issues in South African supply chain development

Spoornet (South Africa's only provider of rail transport), a division of Transnet Ltd (which is wholly owned by the South African Government), has lost much of its share of the market for break-bulk and containerised freight to road hauliers since the deregulation of road transport and, as a result of logistical deficiencies and their consequences, has been obliged to curtail capital spending during recent years. As an outcome, the quality of the rail infrastructure, rolling stock and services on some rail lines does not meet the requirements for the development of modern supply chains, although the operation of the rail services carrying huge quantities bulk commodities from mines to the ports is technically advanced.⁵⁾

Although the Government no longer intends to proceed with the privatisation of state transport enterprises as formerly envisaged, it is willing to enter into public-private participation schemes in the supply of railway and port services (Erwin, 2005). Among measures also being examined are improvements to asset utilisation, network configurations, cost and revenue management, logistics management, communication systems and documentation flow (Anon., 2003a). These are all intended to assist in the achievement of the seamless throughput of cargo in the rail link of supply chains. More progressive measures envisaged are the merging of the management of the participants in the chain, and the development of better data systems, with greater accessibility to information for all concerned with the transport of cargo (Pojie & Davids, 2002:46 - 59). One of the fundamental requirements of the process of improvement is that the infrastructure of the ports (which is also owned and managed by Transnet) and the railways must be rendered more functional and be well-maintained (Anon., 2003a). It has also become essential that the security of rail transport and port operations be raised in order to comply with the minimum requirements of supply chains.

The extent to which all these measures will be implemented, or at least the prospects for doing so, and the progress of Transnet in proceeding with the

promised public-private participations schemes, is an important consideration in potential maritime supply chain developments (Chalmers, 2003).

1.3 International challenges

The construction of efficient maritime supply chains in order to derive the benefits of the liberalisation of world trade and globalisation of production depends not only upon the response of the marine carriers to those trends, but on their ability to survive the other challenges with which they are presently confronted. Some of these challenges highlighted in the Sixth Cadwallader Memorial Lecture at Lloyds of London (2003) include:

- The lack of skilled seafarers, maritime training institutes, maritime economists, engineers and experienced entrepreneurs who will encourage new developments and accept the challenges needed to improve the maritime transport industry by identifying and rectifying weak links and service gaps in the existing and potential chains of supply,
- the need to improve the safety of sea transport and the security of cargo through measures to prevent unauthorised access to ships, cargo and confidential information and to protect ships and containers against piracy at sea and other criminal interventions in marine transport,
- the difficulty in forecasting the fortunes of the maritime transport industry, in which investment is necessarily long term, while the global economy is repeatedly being subjected to rapid changes as a result of unforeseen events, including those attributable to international terrorism,
- the increased awareness of environmental safety, which requires shipowners and ports authorities to adapt ships, routes, packaging and cargo handling to conform to international conventions and regulations intended to ensure clean seas, but which results in substantial increases in costs,
- internationally agreed regulatory frameworks and conventions to which all ship and cargo-owners must adhere notwithstanding the cost implications.

As South Africa depends almost entirely on foreign shipowners for the provision of marine links in the maritime supply chains serving the country, many of these challenges cannot be confronted nationally. However, security is as much a national as an international issue. The problems of security with which shipowners and port authorities are now confronted as a result of international terrorism are formidable. Countermeasures to reduce the risks identified are likely to impose costs and procedures that could seriously interfere with the establishment of efficient and seamless supply chains. The prospects of a nuclear warhead being concealed in a container for detonation by radio is a threat being taken seriously in the counter-measures planned against terrorism, especially as all the major ports in the world are vulnerable to interference with cargo. Technology has yet to develop X-ray systems at low cost for universal use, with the capability of penetrating steel containers sufficiently accurately to detect lethal explosive and biological devices. Other measures planned include equipping containers with electronic doors that would reveal tampering en route. In the meantime, agencies both in the United States and Europe employ satellite and aerial surveillance to track ships and detect changes in course and speed that might indicate the hijacking of those ships (Anon., 2003b:45). In any event, it is evident that until satisfactory security measures have been evolved, containers may be increasingly subjected to scrutiny at places of transshipment, which is unlikely to be conducive to their rapid and seamless transport, while suspect ships may be refused entry to ports unless cleared by inspection. At present, the contents of only some 2% of containers are examined (Anon., 2002a).

The identification of the weak links in maritime supply chains whether attributable to the exigencies of security, market prediction, environmental protection or international regulation is a two-way process in which importers and exporters, port authorities, shipowners and operators and the governments at both ends of the supply chain need to be involved. That can be difficult to achieve, especially when there is a great discrepancy between the countries involved in the efficiency with which distribution is undertaken, but remains one of the fundamental international challenges in the

development of efficient supply chains. An equally challenging problem for shipowners and operators and one that occurs in both developed and developing countries is the bureaucracy with which efforts to facilitate transport are confronted.

1.4 Motivation for thesis and scope

The development of the South African economy and the welfare of its population will continue to depend largely on the earnings from physical exports for many years to come. In order to improve competitiveness in global markets, existing maritime supply chains to and from South Africa must function efficiently and new efficient supply chains must be developed. In so far as many export industries are dependent on imported inputs, the efficiency of inbound supply chains is of as much importance to the economy as the efficiency of the outbound supply chains.

While the efficiencies of the supply chains on which the trade of many of South Africa's competitors in world markets depend have received concerted attention by industry and the government in those countries, the Government in South Africa has only recently awakened to the need for such attention (Neill, 2003:4). In pursuance of that need, questions for which answers must be sought in the South African maritime industry are:

- whether the existing maritime supply chains serving South Africa function efficiently and what improvements are necessary and feasible,
- whether the infrastructure on which existing and proposed supply chains must depend will be adequate in the future and how constant upgrading can be ensured,
- whether the legal, administrative, economic and financial environments in which the supply chains must function are conducive to their efficiency and development,

- what changes are regarded as essential to ensure that the supply chains required for South Africa's economic development will be able to function efficiently in the future.

Although the answers to several of these questions may emerge indirectly through studies, conferences and workshops that will be conducted at the initiative of the National Port Authority (NPA), Government and other bodies during the next few years, no research that collates in a comprehensive manner the facts and the considered views of those concerned with ports, shipping and supply chain operation and development has yet been undertaken. Furthermore, answers to the questions need to be brought into perspective through the economic assessment of the feasibility of the structuring and maintenance of maritime supply chains that afford South African importers and exporters sustainable competitive advantages in the movement of freight worldwide. That assessment must necessarily take account of South Africa's locational advantages or disadvantages and likely shipping developments, including the formation of new shipping alliances, changes in the logistics of deep-sea container movements and trends in the size of new ships.

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1.5 Objectives of the study

The objectives of this study are:

- i. To review the definitions and descriptions of 'supply chains' and 'supply chain management' in academic and business literature and to formulate the descriptions which best apply to the maritime supply chains serving South Africa.
- ii. To identify and analyse major South African maritime supply chains and their links and to determine through inquiry, surveys, comparisons with maritime supply chains serving other countries and research of literature, strengths and weaknesses in their structures and management organisation.

- iii. To assess whether ownership and operation of the ports and railways in South Africa by Transnet Ltd is an advantage or disadvantage in the development of efficient maritime supply chains.
- iv. To reach conclusions on whether there are impediments to the development of efficient maritime supply chains for the seamless throughput of cargo necessary to maintain South Africa's competitiveness in world trade.
- v. To establish the hypotheses:
 - That the structural integration of the links in South Africa's major maritime supply chains is required in order to raise their efficiency and thus their competitiveness in global trade,
 - that such integration requires the value-adding propensity of the chains as entities to be raised by eliminating the individual profit-orientation of the links,
 - that the leadership of the private sector in the integration of the maritime supply chains is essential in accordance with world best practice,
 - that mining investors should lead the development of integrated supply chains for the export of large quantities of minerals and ores and that liner shipping companies should lead the integration of container supply chains,
 - that the development of the maritime supply chains serving South Africa in order to raise their efficiency through structural integration is presently being constrained by the role of Transnet and its performance,
 - that the role of Transnet in the public-private partnerships intended to finance new rail and port infrastructure will need to be adapted to the requirements of world best practice in maritime supply chain structuring.

The study will contribute to the knowledge of maritime supply chains generally and in South Africa in particular; their features and management requirements; and the current constraints on their development.

1.6 Methodology

The methodology followed in this thesis comprises the following:

The gathering of information through:

- Literature research in the libraries of the Universities of Cape Town, Johannesburg, and Stellenbosch and other institutions as well as through internet searches and reviews of articles in technical and academic journals, magazines, conference papers and unpublished documents available in the maritime industry. In particular, information on the intentions of the Government as set out in the National Freight Logistics Strategy (October 2005) has been studied.
- Interviews with personalities concerned with the planning and operation of supply chains and transport links in South Africa and overseas, either in person, telephonically or through internet links.
- Personal participation in forums, workshops and national and international conferences.
- Studies of specific topics conducted through correspondence sent by e-mail, fax and the post to academic research institutes, academics and individuals concerned with aspects of transport and cargo handling relating to supply chain management and operation.

Economic principles and logic have been applied in order to derive the conclusions of the thesis.

The information gathered is analysed in a systematic manner in order to discern the characteristics of typical supply chains, determine their formation and inherent weaknesses and strengths and arrive at conclusions concerning their structural efficiency. The findings are analysed to identify the main requirements for the structuring of maritime supply chains and are compared with the features of existing and proposed supply chains serving South Africa, taking into account existing and planned infrastructure and equipment. The information elicited on the legal and administrative requirements for the structuring and management of maritime supply chains is similarly examined and viewpoints compared on the extent to which changes in South Africa are

needed to ensure the development of seamless supply chains. Conclusions are reached through an overview of all the information and results of the analyses.

1.7 Outline of thesis

After the introduction contained in this chapter, the development of supply chain concepts are explained in Chapter Two and definitions attributed to a variety of authors are discussed. The chapter continues with a description and discussion of the links and elements of maritime supply chains and the participants, and concludes with an explanation of the definition of a maritime supply chain that applies throughout the remainder of the study. As state-owned enterprises are large stakeholders in South African maritime supply chains, Government policy concerning such enterprises and their role and performance constitutes one of the topics in Chapter Three, the other being the Maritime Transport and Services Industry BEE Charter to which the Government requires firms in the maritime industry to conform. In Chapter Four, the major maritime supply chains currently functioning in South Africa are described, with respect to bulk, break-bulk and containerised cargo, and the performances of the links are discussed with reference to informed viewpoints. Chapter Five contains descriptions of relevant maritime supply chains overseas that are considered to serve as examples of efficient supply chains in their structure and operation. Some fundamental differences in the ownership and management of the transport infrastructure in other countries, which are significant for local maritime supply chain development, are also highlighted in that chapter. As the structure and operation of marine links in international supply chains necessarily depend upon developments in the shipping industry, Chapter Six contains a discussion of the international conventions and codes that determine the bounds within which international shipping is conducted as well as an examination of the supply of shipping services in the markets for bulk freight and liner services. The chapter also contains comments on trends in ship sizes and the logistics of worldwide container movement insofar as South Africa is concerned. Chapter Seven

deals with the structures of maritime supply chains that are conducive to greater efficiency than the structures of most South African maritime supply chains and with the leadership needed to develop efficient structures. It concludes with a critical examination of public-private partnerships in maritime supply chain development (to which the government is committed) and with the feasibility of developing more efficient maritime supply chains through such partnerships. Chapter Eight concerns the validity of the initial assumptions in the thesis and contains conclusions on the changes necessary to ensure the functioning of competitive maritime supply chains to serve South Africa in the future.

Endnotes:

1. 'Every day, over 15m containers are moving around at sea or on land, or standing in yards waiting to be delivered. They account for about 90% of the world's traded cargo by value.' (Anon., 2002a:65-67)
2. For example, the European Rail Shuttle in which Maersk Sealand and P&O Nedlloyd are shareholders (ERS, 2002).
3. For example, the coal line operated by Spoornet in conjunction with Richards Bay Coal Terminal and the Port of Richards Bay (Fourie, 2002:63-66).
4. The definition of a South African ship given in Addendum A to the charter is insufficient to explain some of the problems involved in meeting the target. For example, does a container beneficially carried by a South African company using a slot on a foreign-owned ship contribute towards the attainment of the target?
5. For example, the Orex iron ore railway owned by Spoornet (Fourie, 2002:59).

CHAPTER TWO

EVOLUTION OF SUPPLY CHAIN CONCEPTS

2.1 Origins of the supply chain concept with definitions

Brief historical background

The terms 'physical distribution management', 'logistics management' and 'supply chain management' are often used interchangeably in academic and business literature although their meanings differ. In most usage the emphasis is on management of a company dependent on physical distribution, procurement and supply logistics or chains of supply, rather than on the management of a firm in the business of undertaking physical distribution or logistical tasks or transport in a chain of supply. The concept of an integrated intermodal supply chain managed as a business itself has only recently evolved and has not yet generated much academic or business literature although supply chains that conform to that concept have existed for some time.

In order to arrive at a definition of an 'integrated intermodal supply chain' incorporating a maritime link, it is necessary to deal with the definitions of physical distribution, logistics and supply chains and supply chain management.

The physical distribution of goods originates far back in history with the realisation by communities dependent on subsistence economies that they could improve their welfare by producing and exporting produce not needed for their own consumption, in exchange for goods from elsewhere that would raise the quality of their existence. The trade stemming from that realisation created the need for shipping which was technologically more feasible than

overland transport¹⁾. Overland transport necessitated the use of pack animals and required the problem of feeding and watering en route to be solved. Ships relied on the wind and were often wrecked in storms apart from being under constant threat of piracy (Davies, 1954:576). Notwithstanding the transport difficulties that confronted the sea and overland traders in early times, the distribution systems were quite sophisticated and usually involved the exchange of ownership of the freight at each place of transshipment²⁾.

Shipowners, represented by the shipmasters, were essentially traders in goods and not professional carriers. Trade and transport were still integrated at the time of the middle ages and the ship or caravan was really a mobile shop, rather than a means of distribution³⁾. Physical distribution as currently defined evolved when transport itself became a specialist function, which occurred only a few hundred years ago with the advent of canal transport and railways in Europe. Shipping remained integrated with trading as exemplified by the East India Companies of the Dutch (Bouman, 1965:95) and English until the 19th Century when owners of the clipper ships (Cornwell, 1979:267)⁴⁾ and later tramp steamers offered transport services for cargo-owners. That led to the notion of the *distribution* of goods in the modern sense via maritime trade routes.

Definitions of physical distribution

There is no unanimity on the meaning of physical distribution, but a fair definition to start with is that provided by the National Council of Physical Distribution Management in the United Kingdom (Marchant, 1996:8) as follows:

The efficient movement of finished product from the end of the production line to the consumer, and in some cases includes the movement of raw materials from the source of supply to the beginning of the production line. These activities include freight transportation, warehousing, material handling, protective packaging, inventory control, plant and warehouse

site selection, order processing, marketing, forecasting and customer service.

This definition is not all-embracing as it does not include, for example, finance, insurance, information transfer and documentation, but it does imply that distribution encompasses the supply chain.

Magee, Copacino & Rosenfield (1985:2) distinguish 'distribution' from 'logistics', 'physical distribution' and 'physical supply' as follows:

- ~'Distribution' refers to the combination of activities and institutions associated with the advertising, sale and physical transfer of products or services.
- ~'Logistics' refers to the art of managing the flow of materials and products from source to user. It includes the acquisition of raw materials and the delivery of finished products to the ultimate users.
- ~'Physical distribution' refers to the outward movement of products from seller to customer or user.
- ~'Physical supply' refers to the inward movement of materials or products from sources or suppliers.

According to the meanings ascribed to these terms, the authors regard 'logistics' as defined to include the full material flows, although individual firms usually control only a portion of that system for their products. These authors also explain that their definition of logistics comes close to that of the National Council of Physical Distribution (in the UK) which defines logistics as:

the integration of two or more activities for the purpose of planning, implementing and controlling the efficient flow of raw materials, in-process inventories, and finished goods from point of origin to the point of consumption.....

Although these definitions seem to be quite acceptable for the study of supply chains, many other definitions of logistics with bearing on the meaning of supply chains have been formulated and need to be considered.

Logistics

Logistics is a term that embraces physical distribution, but did not evolve from that concept. It is a military term originally derived from the Greek word *logistike* meaning the art of calculating (Webster's Dictionary, 1970, s.v. 'logistike') and was applied even in ancient times to refer to the procurement, maintenance and transportation of military material, facilities and personnel. It was first used in recent times, with the original meaning, by the United States Army (Lambert, Stock & Ellram, 1998:5) although in modern literature, *logistics* now has many definitions.

The US Council of Logistics Management as quoted by Christopher in Cooper (1993:24) provides the following definition:

the process of planning, implementing and controlling the efficient flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.

This definition expands that of the National Council for Physical Distribution Management in the United Kingdom by including services and the flow of information and adds conformation to customer requirements as the purpose of logistics.

Gubbins (1996:187) furnishes two more definitions:

Logistics is the art of maintaining control over worldwide supply chains by a combination of transport, warehousing skills, distribution management and information technology.

Logistics is the process of strategically managing the movement and storage of raw materials, component parts and finished goods throughout the business from suppliers to final delivery to customers.

The first of these definitions describes logistics as an art limited to control over worldwide supply chains, which is hardly correct, as 'logistics' can apply to

control over domestic distribution systems as well as material flows within a factory. Furthermore, this definition implies that 'logistics' involves maintaining control by a combination of skills, whereas 'logistics', as correctly described in the second definition, involves the process of managing the movement of goods. Neither of these definitions is adequate because 'planning' which is fundamental to the application of logistics is omitted, while neither of the definitions emphasise that 'logistics' implies managing the movement of goods efficiently.

A wider definition provided by the US Council of Logistics Management in 1991, as quoted by Tilanus (1997:8) is:

Logistics is the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimising the goods- or service-producing network to fulfill customer requests; and utilising the network to fulfill customer requests in a timely way.

Yet another and later definition by the Council of Logistics Management (CLM, 1998) in the US is:

Logistics is that part of the supply chain process that plans, implements, and controls 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 meet customers' requirements.

In 2005, the Council of Supply Chain Management Professionals (CSCMP, 2005), which replaced the Council of Logistics Management (CLM), supplied the following related definition:

Logistics management is that part of Supply Chain Management that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.

Tilanus (1997:8) suggests that previous definition could be abbreviated to '*Logistics is customer-oriented operations management*', but he eventually adopts an older and more limited definition of the Council of Logistics Management in the US, as follows:

Logistics management is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements.

Tilanus (1997:9) also quotes a definition by Johnson & Wood (1996:4) reading:

Logistics describes the entire process of materials and products moving into, through, and out of a firm. Inbound logistics covers the movement of materials received from suppliers. Materials management describes the movements of materials and components within a firm. Physical distribution refers to the movement of goods outward from the end of the assembly line to the customer. Finally, the supply-chain management is somewhat larger than logistics, and it links logistics more directly with the user's total communications network and with the firm's engineering staff.

This is not a satisfactory definition. Firstly, it describes 'logistics' as a process of material movement, whereas it is an art according to the etymological derivation of the word and should now perhaps be regarded as a science. Secondly, it endeavours to distinguish between 'inbound logistics', and physical distribution as the outbound movement of goods (from an assembly line), whereas physical distribution applies to the distribution of goods irrespective of their origin or destination. Thirdly, it contains the explanation that 'supply chain management' is something more than 'logistics' and links logistics with the user's total communication network and with the firm's engineering staff. Why only the engineering staff are brought into the definition and why 'logistics' without supply chain management excludes communication, is obscure. Apparently, the authors have formulated the definition within the limits of their own experience.

Cooper (1993:4) as quoted by Tilanus (1997:9) furnishes a more acceptable definition as follows:

Logistics is the strategic management of movement, storage and information relating to materials, parts and finished goods in supply chains, through the stages of procurement, work-in-progress and final distribution. Its overall goal is to contribute to maximum current and future profitability through the cost effective fulfillment of customer orders.

Apart from the fact that the strategic management of goods need not take place in supply chains, the definition probably encompasses the best description of logistics, in practice, of all the definitions quoted so far in this chapter.

In 2005, the CSCMP described the “boundaries and relationships” of Logistics Management as follows:

Logistics Management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfillment, logistics network design, inventory management, supply/demand planning, and management of third party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. It is involved in all levels of planning and execution – strategic, operational and tactical. Logistics Management is an integrating function, which coordinates and optimises all logistics activities, as well as integrates logistics activities with other functions including marketing, sales manufacturing, finance and information technology.

Supply chains

The concept of a supply chain stems from the evolution of modern distribution during the past fifty years. According to Rushton & Oxley (1993:7), distribution systems in the United Kingdom were unplanned in the 1950's and early 1960's as goods reached retail shops through the haulage industry and

manufacturers' own vehicle fleets. In the 1960's and early 1970's, manufacturers realised the benefits of managerial involvement in the flow of their products and distribution was included in the functional management structure while retailers developed distribution chains to supply their regional stores. In the 1960's, realisation of the true costs involved brought a significant increase in professionalism within distribution and eventually the growth of the third party distribution service industry.

This outline of the development of professional distribution in the United Kingdom is obviously limited to domestic manufacturing and retailing and seems to overlook the long-standing professionalism in transport of shipowners and rail carriers who traditionally have also undertaken freight handling and warehousing, both essential links in supply chains. In fact, in South Africa, as far back as 1915, road motor services carrying freight were integrated with railways, transshipment and warehousing in goods sheds, under a single management (Van Lingen, 1960:72). Also in South Africa, freight imported by sea has for many years been transhipped at the ports and carried inland by rail as an integrated operation under a single professional transport operator.

While Drucker (1962) could state in 1963 that "we know little more about distribution today than Napoleon's counterparts knew about the interior of Africa", he obviously regarded distributing in a far more sophisticated manner than merely the collection, transportation, warehousing and delivery of goods about which there was already a great deal of knowledge. What was lacking was surely the knowledge of the costs of distribution, which even today remain largely unknown by the operators of some links in the distribution chain, notably by the operators of railways and ports. If knowledge of distribution is still lacking, it is no doubt knowledge of the marginal costs of carrying consignments and of the value added by transportation.

It is in this respect that the globalisation of production and markets has necessitated the construction of international 'supply chains' to reduce the costs of distribution. The term has thus evolved from expressions such as

'total distribution' and 'origin-to-destination distribution'. In practice 'supply chain' really describes the timeous distribution of goods from the origin to the destination in manner that endows goods with both place and time utility in a regular manner. But there are many facets to supply chains which are reflected in all the attempts at definitions.

For example, as defined by Kopicki (1999):

Supply chains link buyers and seller of goods. The work of completing transactions, of liquidating inventories, of managing transaction risk and of bringing buyers and sellers together is done through and with supply chains.

A *supply chain* is also defined by Chow and Heaver (1999) as follows:

The collection of all producers, suppliers, distributors, retailers and transportation, information and other logistics providers that are involved in providing goods to end consumers. A supply chain includes both internal and external participants for the firm.

According to those definitions, a supply chain comprises the participants in the movement of cargo rather than the intermodal arrangement of the physical movement of the cargo.

Ayers (2001), author of "Handbook of Supply Chain Management" carries the definition of a *supply chain* even further, as follows:

Life cycle processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements with products and services from multiple, linked suppliers.

Ayers (2004:16), mentions that many companies with an upstream supply side and downstream demand side take a centric view and identify supply and demand chains. He nevertheless favours the application of the term 'supply chain' for all the 'resources' needed to satisfy end-user needs. Furthermore, he considers that supply chain activities are a subset of the value chain and include 'inbound logistics', operations and 'outbound logistics', but not activities

concerning human resources, marketing and 'sales and technology development'. Nevertheless, he is of the view that supply chain and value chain activities are nearly synonymous. The notion of a supply chain in this study differs from that view and is more in line with that of Vogt, Pienaar & De Witt (2002) who adopt the literal meaning of supply chain as the chain of movement of goods in the course of supply or distribution.

Several of the definitions imply or seem to imply that there are different types of participants in the supply chains, i.e. primary members and supporting members. A *primary member of a supply chain* is defined as follows by Lambert, Cooper & Pagh (1998):

All those autonomous companies or strategic business units who actually perform operational and/or managerial activities in the business processes designed to produce a specific output for a particular customer or market.

These authors define *supporting members* as follows:

Companies that simply provide resources, knowledge, utilities or assets for the primary members of the supply chain.

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Supply chain management

Most of the literature relating to logistics and supply chains quoted in the previous section really concerns the management of supply chains and has been produced by authors who implicitly accept that the elements or links in the chains consist of individual services, the supply of which needs to be managed in order to achieve the purpose of the chain. Lambert & Stock (1993) and Coyle, Bardi & Langley Jnr (1996) all assume that the management of the supply chain is the main interest rather than the construction of the chain. That approach stems from the theory of distribution management introduced by Forrester (1958:37), as quoted by Mentzer, De Witt, Keebler, Min, Nix, Smith & Zacharia (2001:1), in an article which he considered the dynamics of organisational relationships in the '*in flows of information, materials, money, manpower and capital equipment*' in the industrial process.

Mentzer, *et al.* (2001:2) contend that Forrester identified '*key management issues and illustrated the dynamics of factors associated with the phenomenon referred to in contemporary business literature as Supply Chain Management*'. These authors point out that the term 'supply chain management' has risen to prominence in recent years and mention that at the 1995 Annual Conference of the US Council of Logistics Management, 13,5% of the session titles contained the words *supply chain* and that two years later, the number of sessions containing the term rose to 22,4%. They add that the term is frequently used to describe executive responsibilities in corporations and is a hot topic in periodicals on manufacturing, distribution, marketing, customer management and transportation.

The notion of supply chain management as used in most literature is coupled with the globalisation of industry and the trend for firms to source their requirements worldwide, which has placed the emphasis in their management on cost-effective ways of co-ordinating the flows of inputs or outputs where the supplier is responsible for delivery. As competition in world markets is increasingly dependent upon the timeous arrival of products as well as their quality, co-ordination between suppliers and professional distributors has become of critical importance in the chain of supply. Furthermore, market uncertainty requires supply chains to be readily adaptable to changes in the circumstance of trade. Such flexibility in supply necessitates alert and efficient management of the supply chain.

Notwithstanding the motivation for supply chain management and the great array of literature on the topic, confusion about its meaning and also the concept of a supply chain to which it applies is evident in academic and business literature. According to Mentzer, *et al.* (2001), some authors define supply chain management in operational terms involving the flow of materials and products, some regard it as a management philosophy and some as a management process (Tyndall, 1998; as quoted by Mentzer, *et al.* 2001:2), while others have conceptualised it as a form of integrated system between vertical integration and separate identities on one hand and as a management philosophy on the other hand. Few authors have visualised supply chains as

professional managed entities and examined the intricacies of integrated intermodal logistic systems.

The concept *supply chain management* as a specialised task has evolved apparently because of the difficulty in defining the supply chain itself, as evidenced by the existence of so many definitions. Chow, *et al.* (1999) define supply chain management as follows:

Supply chain management involves planning the number and role of participants in the creation of form, time and place utilities consistent with cost-effective, high-service product availability.

This definition is by no means clear, but is taken to mean that supply chain management requires the planning and management of the roles of all participants in the movement of cargo in order to ensure that it takes place cost-effectively and that the products of which the cargo is comprised achieve their intended time and place utilities.

The Supply Chain Forum⁵⁾ defines *supply chain management* as follows:

Supply chain management is the integration of key business processes from end user through original suppliers that provide products, services, and information that add value for customers and other stakeholders.

This definition is also by no means clear and could be better stated as follows:

Supply chain management is the integration of the business processes concerned in the distribution of products from original suppliers to end users in a manner that provides services of high quality and adds value to goods.

Ayers (2001) defines *supply chain management* as the ‘*design, maintenance, and operation of supply chain processes for the satisfaction of end-user needs.*’

A recent definition given by Mentzer, *et al.* (2001:18) is:

A systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chains as a whole.

In 2005, the CSCMP (2005), formerly the CLM, defined supply chain management as follows:

Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.

The Boundaries and Relationships of Supply Chain Management are described by the CSCMP (2005) as follows:

Supply Chain Management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the Logistics Management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology.

Table 2.1 contains further definitions in a summary of supply chain schools of thought prepared by Bechtel & Jayaram (1997).

Table 2.1: Supply chain schools of thought

AUTHOR(S)	DEFINITION
	Chain Awareness School
Jones & Riley (1985)	“Supply chain management deals with the total flow of materials from suppliers through end users.”(p.19)
Houlihan (1988)	“Supply chain management covers the flow of goods from supplier through manufacturer and distributor to the end user.” (p.4)
Langley & Holcomb (1991)	“Supply chain management focuses attention on the interactions of channel members to produce an end product/service that will provide best comparative value for the end user.” (p.14)
Novack & Simco (1991)	“... the entire sourcing, value-added, and marketing activities of the overall link of firm up to final customers.” (p.32)
Stevens (1990)	“Control the flow of material from suppliers, through the value-adding (production) processes and distribution channels, to customers.”
Lee & Billington (1992)	“Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute the finished products to customers.” (p.65)
	Linkage/Logistics School
Scott & Westbrook (1992)	“...supply chain is used to refer to the chain linking each element of the production and supply process from raw materials through to the end customer.” (p.23)
Turner (1993)	“... technique that looks at all the links in the chain from raw materials suppliers through various levels of manufacturing to warehousing and distribution to the final customer.” (p.52)

	Information School
Johannson (1994)	“SCM is really an operations approach to procurement. It requires all participants of the supply chain to be properly informed. With SCM, the linkage and information flow between various members of the supply chain are critical to overall performance.”
Towill, Naim & Wikner (1992)	“A supply chain is a system, the constituent parts of which include material suppliers, production facilities, distribution services, customers linked together via the feed-forward of materials and the feedback flow of information.” (p.3)
Manrodt & Harrington (1995)	“Product and information flow encompassing all parties beginning with the supplier’s suppliers and ending with customers or consumers/end users ... flows are bidirectional.”
	Integration School
Cooper & Ellram (1990)	“An integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user.” (p.1)
Ellram & Cooper (1993)	“Supply chain management is an approach whereby the entire network from which suppliers through the ultimate customer, is analysed and managed in order to achieve the ‘best’ outcome for the whole system.” (p.1)
Hewitt (1992)	“Supply chain integration is only a natural result of redesigned business processes not realignment of existing functional organisations.” (p.340)
	Future
Cavinato (1992)	“The supply chain concept consists of actively managed channels of procurement and distribution. It is the group of firms that add value along product flow from original raw materials to final customer. It concentrates on relational factors rather than transactional ones.” (p.285)
Farmer (1995)	“Instead of using the term supply chain management, we should use the idea of a seamless demand pipeline.”

Source: Reproduced from Bechtel and Jayaram (1997)

Table 2.1 and the preceding definitions of supply chain management show that there is no definitive concept and that the authors are all grappling with the problem that the management of a supply chain, as defined, and the management of any firm producing goods or services are inseparable and, furthermore, that the functions involved are too diverse to be incorporated in a succinct definition. The attempts at a definition thus become a play with words in order to produce an all-embracing statement of management functions. Indeed, Christopher (1992) as quoted by Mentzer, *et al.* (2001:3) is of the view that competition between companies is really supply chain against supply chain which implies that management of the supply chain is in fact management of the company. The search for a satisfactory definition of supply chain management may, therefore, be futile without first defining the supply chain itself. As supply chains differ in attributes and characteristics, definitions of supply chain management would perhaps be more plausible if they were couched to apply to specific supply chains, instead of a generic supply chain.

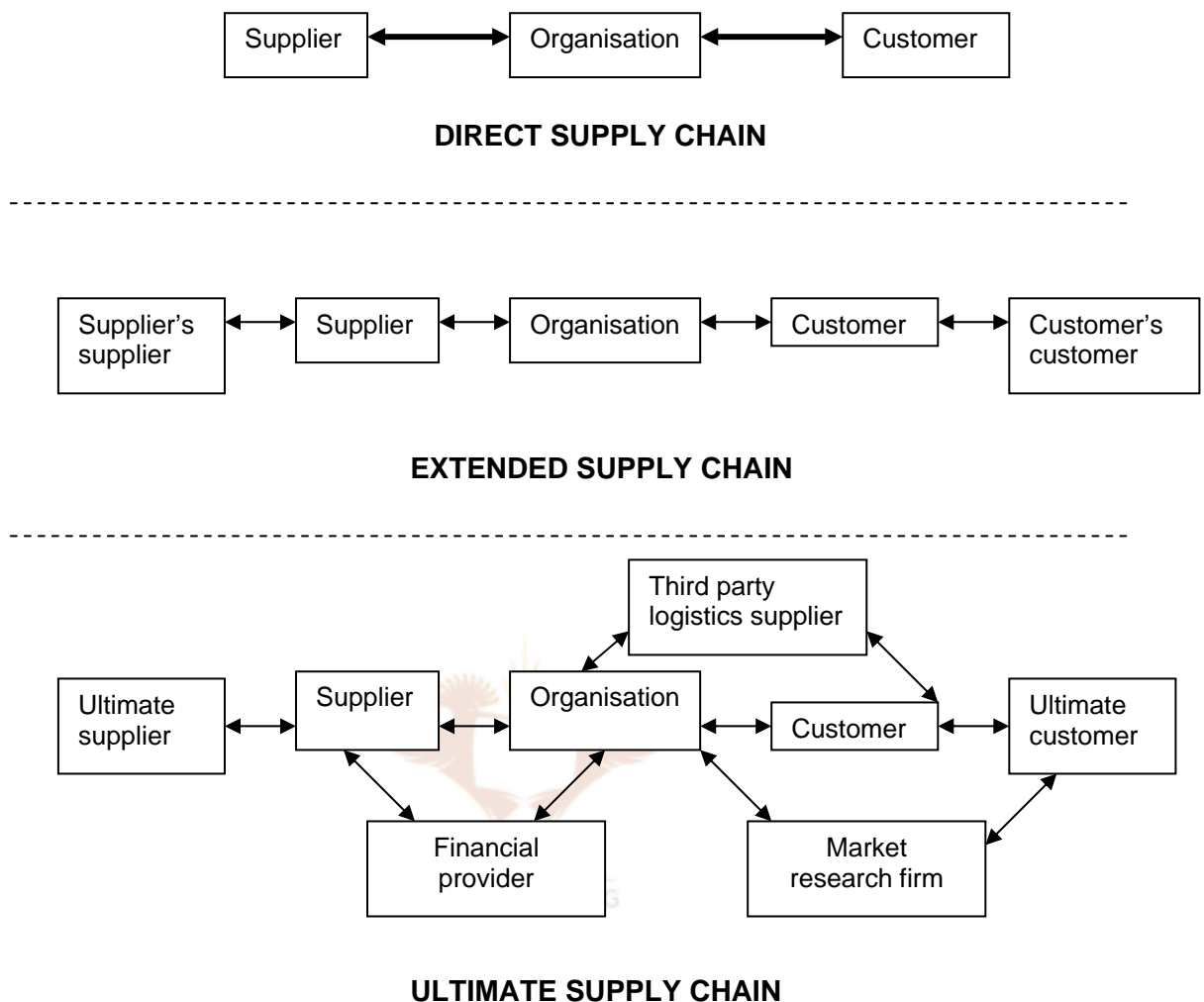
Some authors have attempted to identify a supply chain as merely a set of firms that pass material forward (Cooper & Ellram, 1993; La Londe & Masters 1994; Lambert, Stock & Ellram 1998, as quoted by Mentzer, *et al.* (2001:3). The firms these authors have in mind are raw material and component producers, product assemblers, wholesalers, retail merchants and transportations companies. Other authors (Lambert, Stock & Ellram 1998 as quoted by Mentzer, *et al.* 2001:3) have the same idea and conceive a supply chain as the alignment of firms that brings products or services to the market. Christopher (1992) as quoted by Mentzer, *et al.* (2001:3) also considers that a supply chain comprises upstream and downstream firms as well as the ultimate consumers, upstream providing for supply and downstream for distribution. Mentzer, *et al.* (2001:4), also define a supply chain as a '*A set of three or more entities (organisations or individuals) directly involved in the upstream (i.e. supply) and downstream (i.e. distribution) flows of products, services, finances, and/or information from a source to a customer*'. Again it is an attempt to furnish a generic definition which is neither adequate for that purpose, because it does not apply to all supply chains, nor applicable to any

specific supply chain. As a result Mentzer, *et al.* (2001:4) find it necessary to identify three degrees of supply chain complexity, a *direct* supply chain, an *extended* supply chain and an *ultimate* supply chain. A 'direct' supply chain according to Mentzer, *et al.* (2001:4) consists of a company, a supplier and a customer involved in upstream and/or downstream flows, an 'extended' supply chain includes suppliers of the immediate suppliers and customers of the immediate customers and the 'ultimate' supply chain includes all the organisations involved in all the upstream and downstream flows. These types of supply chain complexity are illustrated in [Figure 2.1](#).

Obviously more definitions or variations encompassed in the definitions could be given depending upon the nature of the supply chain and the elements it contains. In fact, there could be as many definitions as there are supply chains if all the features of each supply chain are to be expressed in a definition in the manner in which the authors quoted have approached the problem of defining a supply chain.

A straightforward definition of supply chain management is given by Vogt, *et al.* (2002:9) as the operation associated with one chain of movement of goods, who add that 'logistics includes revisiting alternative supply chains to ensure that the most effective one is utilised'. They also mention that 'service providers form the supply chain' and need to be controlled and co-ordinated to ensure that the overall chain is effective. 'Integrated services' are often regarded as functional entities within the business that are co-ordinated by a manager of the supply chain, which 'merely adds to the complexity and requires an unwanted level of logistics management'. These authors view supply chains as the arrangements to move goods from one place to another, which is far simpler than that of the authors who regard supply chains and their management as synonymous with the business and its management. However, when dealing with procurement, suppliers are considered by Vogt, *et al.* (2002:63) to form 'important links in the supply chain as the effective functioning of the business enterprises in this chain is in their hands', which does imply that the management of the supply chains and the enterprises should correspond.

Figure 2.1: Types of supply chain complexity



Source: rRproduced from Mentzer, *et al.* (2001:5)

What seems to be assumed by most of the authors mentioned is that as long as 'supply chain' is regarded as a term encompassing all procurement and distribution, supply chain management is synonymous with procurement and distribution *management* or simply distribution management and should be similarly defined. If, however, it can be accepted that a supply chain is a technical and organisational construction of physical links in the transport of specific goods in order to achieve scheduled throughput at the lowest cost, then the management of the supply chain requires to be defined for the specific tasks involved. For example, the management of a supply chain

constructed to ensure the procurement from South Africa of continual supplies of coal for a thermal power station in Europe will require to be defined altogether differently than the management of a supply chain constructed to move containerised goods between Europe and South Africa. As explained in Chapter Four, the management tasks of the coal supply chain feature procurement and shipbroking, which are not involved in the management of the container supply chain, in which freight forwarding, clearing and the transmission of information and documentation are all important. The differences in tasks cannot be encompassed in an all-embracing definition, which would either contain irrelevancy for either management task or be insufficiently specific.

The solution to the problem of devising a universal definition of supply chain management is thus to dispense with the notion that such a definition exists and to concentrate on the management requirements of individual types of supply chains. Such an approach requires recognition of *supply chains* as advanced, but specific organisational forms of procurement and distribution, constructed to cope with the competition brought about by the globalisation of industry. The fact that individual systems of procurement and distribution have existed for many years with all the features of modern supply chains does not detract from the notion that modern supply chains have evolved to meet worldwide competition. It merely illustrates that the importance of containing transport costs became of crucial importance in some industries, mainly those dependent upon world-traded commodities, long ago.

From the foregoing discussion, it should be evident that the maritime supply chains dealt with in this study are differently conceived than the 'supply chains' to which the various definitions of supply chain management quoted so far apply. In the next section of this chapter, integrated intermodal supply chains with maritime links are defined and are the main topic in the subsequent chapters. Such chains are constructed with links that are designed to facilitate the onward movement of cargo in ways to achieve their specific purpose, whereas the supply chains to which the many quoted definitions of supply chain management apply are conceived as fragmented operations in the

process of sourcing supplies, manufacturing and distribution, integrated through management (Cooper, *et al.*, 1997; Cooper, Lambert & Pagh, 1997; Ellram & Cooper 1990; Manrodt, Holcomb & Thompson, 1997; Novack, Langley & Rinehart, 1995; Tyndall, *et al.*, 1998; as quoted by Mentzer, *et al.*, 2001:9). As mentioned previously, some authors actually dispense with the notion that the supply chain constitutes a series of activities which need to be managed and consider supply chain management to be the management of processes involved in supply (Davenport, 1993; as quoted by Mentzer, *et al.*, 2001:10) or relationships, information and material flows in the process of supply (La Londe; as quoted by Mentzer, *et al.*, 2001:10). In effect, these authors are really concerned with supply and not chains of supply.

The emphasis on the management of processes rather than the management of a particular supply chain has led some authors to replace the term *supply chain management* by *supply chain orientation*, which is defined as the recognition by an organisation of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain and which, according to Mentzer, *et al.* (2001:11), stems from management philosophy. Thus supply chain orientation precedes supply chain management, which is the implementation consequence of orientation. Further discussion of the antecedents of the implementations of management and the processes that generally need to be managed in the function of supply, in contrast to supply chains, are outside the scope of this study.

Integrated supply chains

According to Shapiro (2001:7) supply chain management refers to integrated planning. He contends that it is concerned with the functional integration of purchasing, manufacturing, transportation and warehousing as well as with the spatial integration of those activities across 'geographically dispersed vendors, facilities and markets' and the intertemporal integration of the activities over strategic, tactical and operational planning horizons. When applying the latter term in practice (he explains) strategic planning involves resource acquisition

decisions to be taken over long-term planning horizons, while tactical planning and operations planning involves decisions affecting the short-time execution of the company's business.

Although Shapiro, (2001) envisages functional, spatial and intertemporal integration of the activities involved in a supply chain, it is evident that his concept of integration concerns the management within a firm of the process of obtaining supplies rather than the integration under one management of the links comprising a supply chain. That is borne out by his remark that 'improved integration of activities across multiple companies sharing components of a supply chain is a concern of increasing interest and importance.'

Intermodal transport

Intermodal transport is a concept that stems from containerisation. Since their employment as standardised boxes in which to ship goods, containers have been regarded as conveyances dependent for their mobility on a variety of separate powered vehicles or vessels. That has led to the use of the term 'intermodal transport' implying the transport of goods in containers using different modes of transport. 'Intermodal transportation' is now defined 'as a systems approach to transportation in which goods are moved in a continuous through-movement between origin and destination using two or more modes of transportation in the most efficient manner', according to Kendall & Buckley (2001:301). Whether the definition can rightfully include 'in the most efficient manner' is questionable as intermodal transportation is sometimes inefficient.

These authors also point out that 'intermodal' includes the interchange of cargo between any mode of transportation no matter the state of the cargo (i.e. whether containerised, packaged, or in bulk) although the container is really the package of choice because it can conveniently be transshipped. They add that the purpose of intermodal transportation is to give shippers those routings that will result in the least costly carriage of their goods. (The

requirements and implications of intermodal transportation are dealt with in the second part of this chapter. In this section only the definition is sought).

Integrated intermodal supply chains

The integration of intermodal transportation into a supply chain requires further explanation. Integration is a term common in definitions of logistics. For example, physical distribution and materials management became integrated in the late 1960's in an era described by Bowersox, as quoted by Langley (1995:21) as the years of maturity for physical distribution and materials management. However, integration with reference to intermodal supply chains in the sense of the term used in this study means the integration of the movement of cargo in containers between different modes of transport with all the technical, economic, legal and administrative functions involved. The integration may be forward or backward, but the end result is to create successive links in a supply chain that are managed and function as one intermodal chain, although the organisation and management of the linkages may be achieved only through the transfer of information. For the purpose of this study, an integrated intermodal supply chain is thus a supply chain effectively managed as an entity for the purpose of the chain (and not individual links). This meaning is more literal than that derived by Shapiro (2001).

Seen from another perspective, an 'integrated intermodal supply chain' is really a specialised means of physical supply and distribution comprising infrastructure, equipment, labour and management organised for the movement of containerised or bulk goods using different modes of transportation. Its organisation may require the application of supply chain logistics and its management may involve some, but not necessarily all the functions of physical supply and distribution management.

Value chain constellation

Before leaving this discussion on logistics, supply chain management and integrated intermodal supply chains, it is necessary to explain and motivate ideas recently researched in Australia on whether logistics is synonymous with supply chain management or whether supply chain management is logistics that includes suppliers and customers and whether an integrated intermodal supply chain is not really an element in a value chain constellation.

Robinson (2002) draws attention to the Annual Report 2000/2001 by the Chartered Institute of Logistics and Transport in Australia which implies that there are three industries involving freight handling and movement – the logistics industry, the transport industry and the supply chain industry. He also points out that the Australian Bureau of Economics suggests that in essence logistics is a system or set of interdependent activities performed by firms from various industries, but queries whether it is not really a management framework or the management of one or several or a set of activities which might be referred to as logistics activities or logistics functions. He then refers back to the definition of the US Council of Logistics Management in the USA in 1998 which describes logistics as ‘that part of the supply chain process that plans, implements and controls the efficient and effective flow and storage of goods...’

In pursuance of these views, Robinson (2002) explains that supply chain management requires the cross-functional integration of key business processes within the firm and across the network of firms that comprise the supply chain and also quotes the definition of the Global Supply Chain Forum in the USA.

The notion of a supply chain developed in this manner departs from its concept as a system of infrastructure, equipment and labour specially organised and managed to move freight and again renders it synonymous with the business itself. Thus, according to Lambert, as quoted by Robinson (2002), individual businesses no longer compete as autonomous entities, but

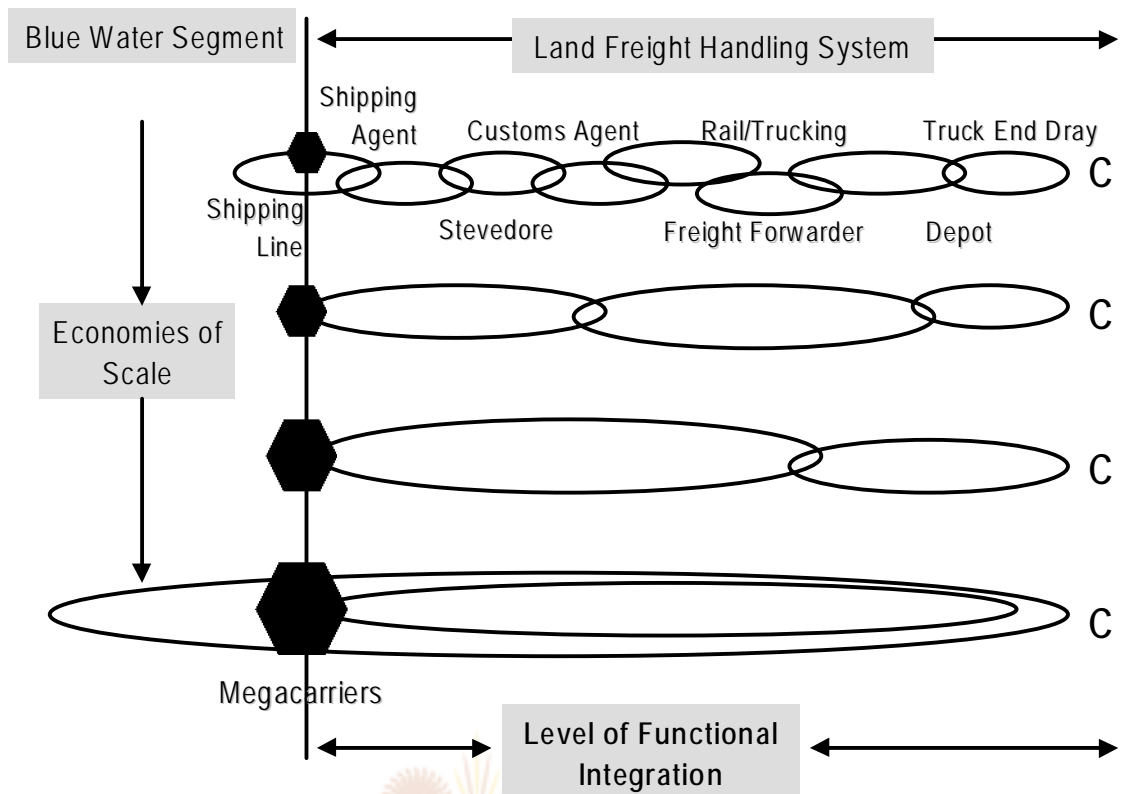
as supply chains and business management has entered the emerging competitive environment of supply chain versus supply chain as previously mentioned in this section. That requires integrated supply chain management as the core competitive strategy of the firm (Handfield & Nichols, 1999; as quoted by Robinson, 2002). These ideas have led to analyses of supply chain dynamics and the appreciation that regimes within a supply chain may inhibit its optimisation by exploiting their market power for own gain (Cox; as quoted by Robinson, 2002). That may be obvious if the links in supply chains are, in fact, separate business entities and are not constituted to add value in the supply chain process. However as Christopher (1998:15) points out, companies that transfer costs upstream or downstream do not become more competitive, because those costs are eventually reflected in the price paid by the end user. Instead they should realise that by reducing the overall costs of the supply chain they render it more competitive in their own interest, which is in accordance with the principle of supply chain against supply chain rather than company against company.

Porter, as quoted by Robinson (2002) has identified a value chain constellation as an organised network of firms working together sharing resources and rewards in pursuit of targeted markets and consumers. The network may include third party providers of logistics functions, such as road transport operators, as well as providers of more complex functions involving, for example, freight consolidation and forwarding, transportation, cargo handling, clearing and distribution. Robinson (2002) regards partial or end-to-end export and/or import chains, in which such third party service providers operate as elements, as chain systems rather than supply chains, but again that view is influenced by the assumption that the supply chain is managed by the first party. However, the range of functions that the service provider controls either through acquisitions and direct ownership or through alliancing arrangements may largely determine the efficiency of the value chain constellation envisaged by Porter and in effect the chain system may comprise an outsourced supply chain on which the business of the outsourcing firm depends.

Robinson (2002) concedes that third party service providers may have market power, which may be termed supply chain power, as elements in value-driven chains, and constructs the diagram shown in Figure 2.2 to show how a value-driven supply chain can become dominated through intermodal integration by service providers. The integration occurs through the rationalisation of the management and sometimes also ownership of marine and overland carriers in order to achieve economies of scale, scope and network density.

The efficiency of integrated intermodal supply chains as defined for the purpose of this study and the effect of the market power of the firms comprising elements in the chain are dealt with in Chapters Four and Seven. In this chapter, integration of intermodal supply chains by definition presupposes a single management although not necessarily ownership, which implies that the value accumulated in the chain process may largely be appropriated by the providers of the supply chain. It can thus be contended that the management of an integrated intermodal chain system (to use Robinson's term) really manages a supply chain which may be an element in another supply chain or a 'value chain constellation'. Furthermore, the management of the integrated intermodal supply chain as defined in this study may have sufficient supply chain power to appropriate much of the value accumulated by the value-driven constellation. The defined integrated intermodal supply chains managed by providers of transport services are thus supply chains in their own right and encounter all the attendant management problems.

Figure 2.2: Value-driven chains



Source: Robinson (2002).

(Note: "Truck End Dray" in the figure should be truck and dray and refers to a truck and trailer.)

The concept contained in [Figure 2.2](#) and derived in the preceding discussion is adopted in this thesis on the premise that the value accumulated in an integrated supply chain through economies of scale exceeds the aggregate value accumulated in a chain in which the links function as independent businesses. As a supply chain for the purpose of this thesis means all the arrangements for the movement of goods from one place to another, Vogt, *et al.* (2002:63), it follows that the integrated supply chain has a comparative cost advantage over unintegrated supply chains in international competition between supply chains. The cost advantage will accrue to the supply chain provider, who might not be cargo-owners.

2.2 Links, elements and participants in maritime supply chains⁶⁾

2.2.1 Basic supply chains

In the next section of this chapter, the links in intermodal supply chains over which management needs to be exercised are described and explained. Although supply chain management is equated to the management of the firms dependent upon supplies in many of the definitions discussed in the previous section, supply chains comprising the organisation of infrastructure, equipment and labour to achieve the movement of goods between their source and consumption as a service to the dependent firms, do exist and require management. The links in those chains constitute a variety of services that may be provided in-house by the dependent firm, or be outsourced, or may be provided independently in the market for transportation and related services. Each service may constitute a link or several links in the supply chain or may constitute the entire supply chain. Those links comprise a variety of elements and participants that need to be identified in order to understand what the management of the links and the entire supply chain entails. When management over the entire chain is exercised by a single entity, except for certain functions necessarily exercised by public agencies, the supply chains are 'fully integrated' and when the movement of the goods requires the use of different modes of transport they are described as 'intermodal'. When one or more links in a chain involves marine transport, it is usual to regard the chain as a maritime chain. Thus the description of all the elements and participants in the links of a supply chain could apply to a fully-integrated intermodal maritime supply chain, or to a portion of such a chain.

The elements in the chains depend upon the nature of the cargo. Supply chains involving the movement of containers are usually more complicated than those involving the movement of bulk cargoes, although the tonnage of cargo shipped and the investment in infrastructure and equipment in the latter may be greater than in the former. The basic supply chains dealt with in this

study are container supply chains and bulk cargo supply chains for imports or exports.

2.2.2 Container supply chains

Extent of chain

By container supply chains is meant supply chains involving the movement of goods in ISO containers from the place where the containers are stuffed to the place where the containers are unstuffed. These chains may extend further if goods comprising less-than-container-loads (LCL's) are fetched by the supply chain managers from consignors for consolidation at depots into full-container-loads (FLC's) and are delivered to the consignees after the unstuffing of the containers, although those extensions are not really links in the container supply chain as such. The functions of the participants in the links throughout the chain are explained in the sections that follow and the schematic movement of the cargo is shown in Figure 2.3.

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Consignors (senders/suppliers) and consignees (recipients)

Supply chains begin with consignors and end with consignees. They may be individuals or firms or intermediaries in the process of goods distribution from source to consumer. A typical consignee may be a manufacturer who seeks raw materials from primary industries and after processing, sells the products in consumer markets.

Supply chains will typically be created for the procurement of raw materials and the distribution of manufactured products to wholesalers or sometimes directly to retailers. A supply chain may also be established for the movement of products from a wholesaler to retailers. An efficient supply chain will ensure that products arrive just when needed and in proper condition at costs that sustain the demand for the supply chain service.

Competition may oblige the purchasers (or consignees) of the supplies to seek cheaper sources, but not necessarily to change all the supply chain arrangements. Supply chain managers thus need to understand the business of their customers and co-operate to ensure that although purchasers/consignees may change the source of their supplies, the supply chain arrangements can be adapted to accommodate new consignors. That is not always feasible, but the existence of the supply chain should constitute such a benefit for the trade that procurement arrangements will not readily be changed if the consequence will be a less efficient supply chain. To a large extent supply chains may thus link consignors and consignees in a more enduring manner than occurs in general distribution.

The modern view is also that the movement of freight from origin to destination or source to consumer, irrespective of the modes of transport involved and the need for transshipment, should be managed and offered as a comprehensive service at a price or cost that enables the trade that it serves to take place. There is no point in offering a supply chain service at a price or cost that precludes the trade taking place. While that may be obvious, it is emphasised, because often the need for professional managers of supply chains to have insight into the business economics of their customers is still not appreciated. The need for such insight applies irrespective of whether the consignor or consignee bears the cost of the service.

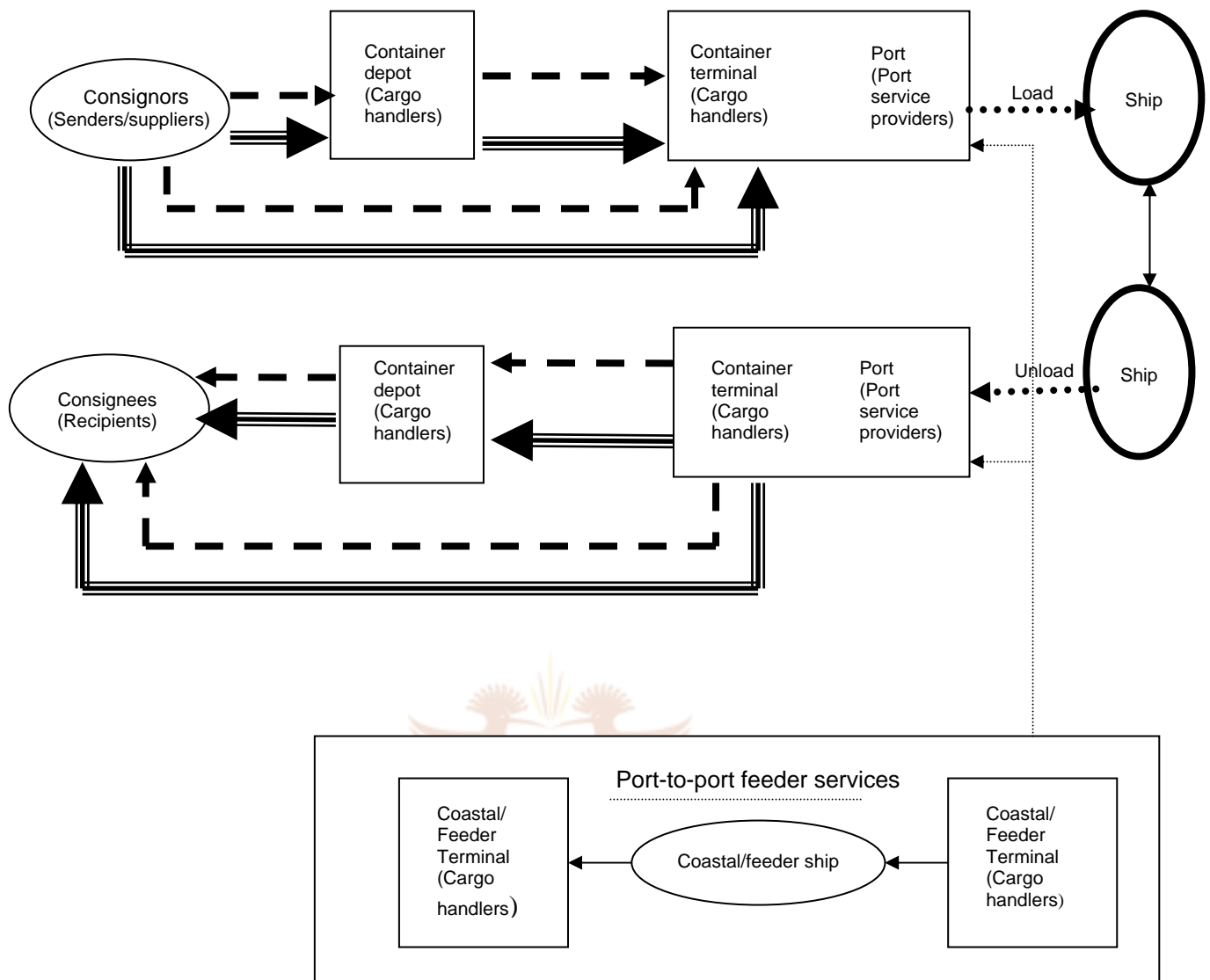
Container depots

Container depots provide for the stuffing and unstuffing of containers for consignments comprising less than a full container load (LCL). Cargo comprising such loads is sent by consignors to the depots where the consolidation into full container loads takes place, whereafter the containers are sent to port container terminals or inland container terminals for forwarding to port terminals for loading onto ships. Containers carrying consignments that do not comprise a full container load are received at container depots from

container terminals and are unpacked into individual parcels of goods for delivery to consignees. Customs clearance usually takes place at container depots and customs officers are participants in the supply chain. LCL's moving to and from container depots are often fetched from consignors and delivered to consignees by road hauliers under contract to the supply chain management.



Figure 2.3: Schematic movement of cargo in a container supply chain



Sometimes containers are moved through intermediate ports and coastal/feeder ships are employed between the intermediate port and the port of origin or destination of the cargo.

Source: Prepared by the author for the purpose of the study.

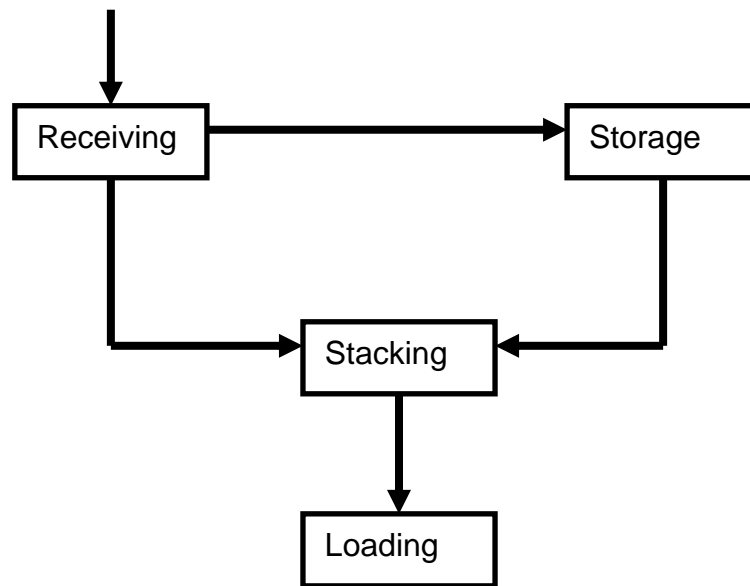
Container terminals

Container terminals are usually located at sea ports although there are inland terminals known as dry ports. Containers arriving at port terminals for transport by sea are organised into stacks according to the loading plans prepared for ships. That facilitates orderly and rapid loading and limits the time that ships need to remain in port (Chadwin; Pope & Talley, 1990:33).

Containers that arrive by sea are offloaded at the port container terminal and organised into stacks that facilitate the rapid removal of the containers by road or rail to inland terminals or container depots or directly to the consignees. Containers may also be removed by coastal and/or inland shipping using barges in countries with canals and navigable rivers, as happens at the Port of Rotterdam in the Netherlands. In some ports, the transshipment of containers from ocean-going to coastal or feeder ships is the main function of the terminal and, in fact, most of the ports with volumes of container throughput among the highest in the world are essentially transshipment ports, e.g. Singapore and Hong Kong (Stopford, 1997:376). The basic functions of a marine container terminal are shown in Figure 2.4.

At dry ports, the terminal operator organises and stacks containers for removal by road or rail to the seaport terminals and receives containers from those terminals. Such inland terminals are intended to provide the buffer between the long-distance transport of containers, often in block loads by rail, and the short-distance road transport to or from depots and consignees. Obviously, inland terminals fulfil an essential interface function when there is a substantial difference in the capacities of the long- and short-distance transport modes. Their function is less essential and effective when containers are carried by road transport over both the long- and short-distance routes and the terminal may then be an unnecessary or weak link in the chain.

Figure 2.4: Four basic functions of a marine container terminal



Source: Prepared by the author for the purpose of the study.



Terminal operators must ensure the efficient throughput at the terminal. Space utilisation, capacity management, inventory management, line balancing and efficiency, yard management and the co-ordination of throughput are essential tasks. The dwell-time of containers in a terminal is usually a measure of the efficiency of the throughput, but not always of the management of the terminal, as the latter may not be able to prevent the dwell-time increasing because of the many influences outside its control.

Cargo handlers

Cargo handlers fulfil important functions in the supply chain, but the modern aim is to reduce cargo handling as much as possible because such handling incurs extra costs, and wastes time, and increases the risks of damage to the

cargo. That is the reason for packing goods in standardised containers, which avoids the handling of individual items of goods once the container has been packed. Containerisation of full container loads enables goods to be packed by cargo handlers at the source of the cargo and unpacked at the ultimate destination, which eliminates the handling of goods at intermediate places of transshipment and contributes to the efficiency of the container supply chain.

Cargo handling may include the following tasks: sourcing of cargo, packaging, labelling, loading, unloading and unpacking, although some of those tasks are often undertaken by other participants in the chain. In recent years, cargo handling has, in fact, tended to become integrated with the activities of other participants, for example, suppliers, purchasers or transport operators.

The increasing containerisation of break-bulk cargo eliminates much of the need for stevedoring in supply chains, although stevedores still fulfil an important function in the handling of pallatised cargo, such as fruit. Stevedores are responsible for the stowing of uncontainerised cargo aboard ships.

Although cargo handling constitutes a link in a container supply chain, it is usually a function integrated into that of a container terminal and, in practice, the rate of ship-to-shore (and *vice versa*) handling of containers is universally quoted as a measure of the efficiency of a container terminal. In fact, the rate of throughput of the terminal as reflected in the dwell-time of containers in the terminal is more important.

Road hauliers

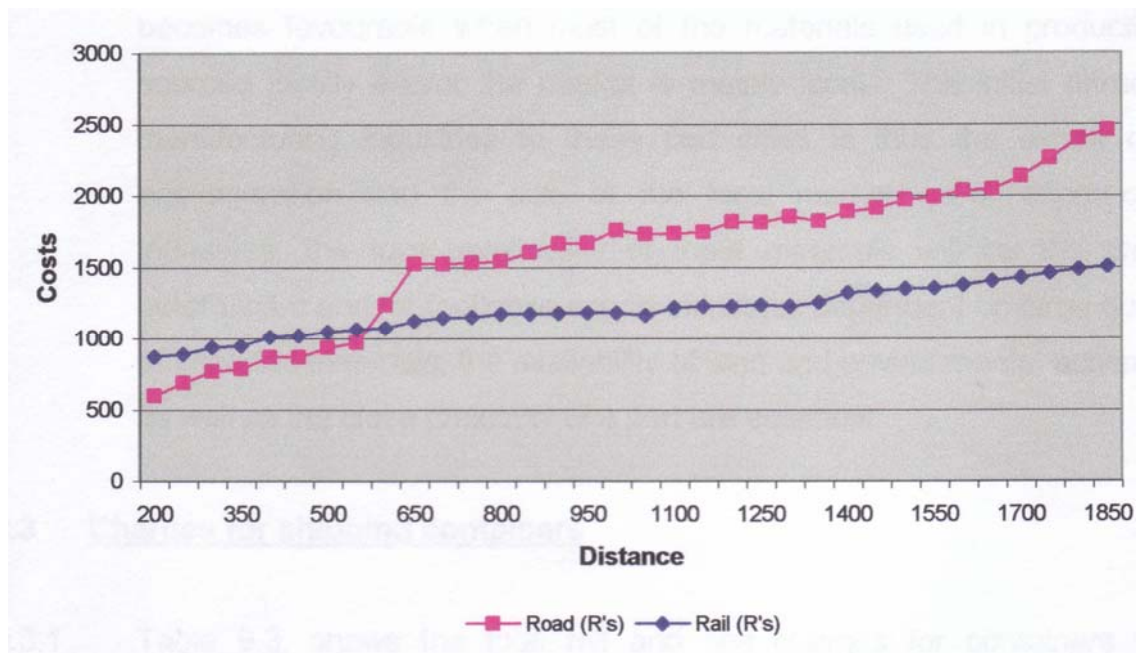
Since economic deregulation in 1993, road transport in South Africa has become a highly competitive industry. For road hauliers to be able to sell their services successfully they must continually adapt to customer needs and meet these in an efficient manner while remaining in constant communication with the users of their services. Their services under contract to consignors, consignees or supply chain managers may offer supply chains in their own

right that are operated to ensure the just-in-time delivery of supplies, so reducing inventory costs. Well-maintained fleets and vehicles equipped for security (with satellite tracking) are often essential in order to provide those services.

Road transport has a competitive advantage over rail transport to the extent that it can provide a door-to-door service. One consequence of the facility of road transport is that the van of the vehicle can be used as a container for freight carried from the consignor to the consignee without intermediate handling, so dispensing with the need for a separate container. Such a service can comprise a link in an intermodal or maritime supply chain, if cargo is carried in freight vehicles on RoRo ships which are usually operated on short sea routes. The use of road transport in container supply chains is thus mostly confined to the conveyance of containers carrying imported or exported goods or empty containers being repositioned for that purpose.

As road transport is considered to be more cost-efficient than rail transport over distances up to approximately 600 kilometres (RAPID Report, 2001), it dominates the conveyance of containers between the Port of Durban and Gauteng, which is the main route for the movement of containers in South Africa. The break-even distance between the modes is illustrated in [Figure 2.5](#), which shows the costs of carrying a container of 12.5 tonnes over various distances.

Figure 2.5: Break-even distance for road transport



Note: As determined by the author from data obtained from hauliers and Spoornet in 2002.

The disadvantages for users of road transport are that congestion occurs on some roads, which may disrupt schedules. Road vehicles are also vulnerable to high-jacking in some countries, while breakdowns do occur. Furthermore, the cost of fuel fluctuates frequently in some countries, which renders the estimation of the costs of road hauling difficult for the purpose of quoting rates far ahead. Large purchasers and suppliers of goods thus tend to employ their own fleet of trucks in order to have control over the supply of their transport and the costs involved, and to reduce the risks of unexpected disruptions in the delivery of the goods they need or their supplies. With the operation of integrated intermodal maritime supply chains under the management of liner companies, the tendency is for the managers to set up their own road transport broking firms or to employ road hauliers for their purpose. Some liner companies have acquired road vehicle fleets in accordance with their policies toward forward integration⁷⁾.

Rail transport operator

In South Africa, the rail transport operator, Spoornet, is a division of Transnet Ltd, which is wholly-owned by the Government. It is operated as a rail monopoly, but encounters severe competition from road hauliers. That gives rise to the problem that many of the railway lines and services are not profitable with the consequence that rolling stock and other assets are under-utilised.

Rail transport has a potential advantage over road transport in that the disparity between the capacity of ships and trains is less than that between ships and road vehicles. Containers offloaded from ships can thus be removed far more quickly from port terminals by rail than by road⁸⁾, resulting in fewer delays or dwell-time for containers (Stopford, 1997:58). Where the hauling distance exceeds 600 kilometres (RAPID Report, 2001), rail transport currently also has a cost advantage.

Railways also have a competitive cost advantage over road transport in the conveyance of large consignments of bulk goods and can usually offer lower rates than road hauliers, although even such traffic is sometimes lost by rail to road transport because of poor planning, lack of flexibility and indifferent management. Nevertheless, rail transport is often the only feasible means of inland transport in supply chains for the movement of dry bulk commodities, and efficient examples of such chains exist, as described in Chapter Four.

Seaports

Seaports fulfil an indispensable function as the interface between sea and land transport in supply chains. Not only does the port provide the infrastructure and marine services for the berthing of ships, but also the superstructure for the offloading and loading of cargo and the land on which the container terminals are located. In South African ports, cargo handling at public terminals (with a few exceptions) is still undertaken by South African

Port Operations (SAPO) as a division of Transnet, the parastatal transport operator, while in many overseas ports, container terminals and container handling are concessioned to private undertakings (Baird, 2001). SAPO also handles break-bulk cargo, but virtually all bulk cargo through South African ports is handled at private terminals (MERIT, 2000:17-21). The National Ports Authority of South Africa (NPA), also a division of Transnet, owns the land and infrastructure of South African ports and provides marine services (MERIT, 2000:17-21).

Port service providers

Port service providers are physically involved in the day-to-day operation of ports and therefore perform essential ancillary tasks in the function of a supply chain. These tasks include customs inspection, pilotage, towage, dredging, berthing, bunkering and warehousing. An additional task which has become of paramount importance is the provision of security. That has many facets. For example, security for cargo requires the service providers to control road hauliers entering and leaving ports in order to ensure that they have the requisite security clearance to do so. A more difficult security check is that on containers entering the port by land transport or by sea as reliable X-ray equipment to examine their contents has not yet been devised, while opening the containers will infringe insurance conditions. Yet seaports are more vulnerable to penetration by international terrorism than any other place of entry to maritime countries (Anon., 2003:45).

Shipping lines – ocean transport

Liner shipping provides regular scheduled services between maritime countries throughout the world. Those services are often the primary links in global supply chains. Although the transit time of seafreight is usually long in comparison with land transport, ocean shipping has the technological advantage of lower comparative costs than other modes of transport in the

shipment of large consignments, which in the liner trades enables shipowners to influence total supply chain costs to a greater extent than the other participants in the chain.

Ocean shipping as a link in supply chains has disadvantages that are not encountered to the same extent in the function of other modes of transport in the chains. The weather has a major influence on shipping and can affect the duration of a voyage, so disrupting schedules and even causing ports to be bypassed. Ships caught in violent storms can lose cargo, including containers, while shipwrecks with great loss of cargo still occur. Storms, mist and high winds can also prevent the loading/unloading of cargo in ports, which can result in a backlog in the throughput of a supply chain.

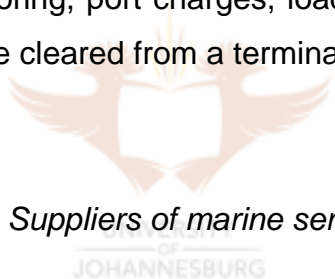
In order to maintain the efficiency of the supply chains involving maritime links, many liner companies have introduced satellite tracking for each container. That enables the liner company and customers to track containers and monitor progress in the procurement of supplies and distribution of goods and especially to anticipate delays. In that manner, senders and recipients of cargo can plan timeously for its arrival. Container tracking is a specialised service in the integrated supply chain.

As the main participants in the international movement of containerised cargo, shipping lines are no longer content to confine their services to sea transport, but are increasingly integrating those services with port terminal operations as well as the overland transport of containers. Not only does such integration give the liner companies virtual control over the movement of the cargo from origin to destination, enabling a reduction of costs, but it enables ship operators to earn higher profits through investing in the entire supply chain service, instead of only in the highly competitive liner service.

Another means of raising the profitability of liner services is to achieve greater economies of scale through the employment of larger ships. Although the unit costs of carrying containers decreases substantially as the number of containers carried per ship increases, there are constraints on the length,

breadth and draught of ships that can enter ports. Furthermore, the employment of larger ships without using their greater capacity merely raises unit costs. Such use can be achieved only with a substantial increase in demand, otherwise the frequency of the service needs to be reduced. No liner company can risk that step in a highly competitive market. In Table 6.9 the sizes of the existing container ships calling at South African ports are illustrated.

The size of a ship can be a disadvantage when it is too large to call at some ports, because that may necessitate the transshipment of containers to smaller vessels and so lengthen the transit time of cargo and reduce the efficiency of the supply chain in which it functions. Other considerations that need to be taken into account when planning the ports at which to call are the cargo-handling facilities required (size and type of cranes), availability of warehousing, stevedoring, port charges, loading days and hours and the rate at which cargo can be cleared from a terminal at the port.



Marine services consist of all services that can be supplied to a ship, which add value to the shipping service rendered. The most important marine services in ports are pilotage and towage, but there are many other ancillary services, such as mooring which is essential in a maritime supply chain.

Supplier of goods for marine purposes

Marine supply companies sell goods such as ropes, anchors and other equipment to ships, while ship chandlers supply provisions. Fuel companies supply bunkers. Maritime supply chains might necessarily need to incorporate the replenishment of supplies, especially bunkers, as links.

Documentation

Container supply chains cannot function without documentation that proceeds in tandem with the movement of the container. Although hard copies of documents are still in use, the trend is towards electronic data interchange (EDI), which may eliminate the problems that occur when the requisite documents become separated from the container to which they relate, although there are problems peculiar to EDI that also have to be overcome.

The flow of documentation associated with the transport of containers virtually constitutes a supply chain parallel to that of the physical flow of cargo, and is essential to its function, as inadequate documentation flow or EDI may break the chain.

The documents involved in the function of an integrated container supply chain and the process of documentation are not dealt with in this study as it is taken for granted that whatever the construction of the chain, management cannot function efficiently without the accompanying documentation or information transfer.

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2.2.3 Bulk supply chains

Although the notion of supply chains has evolved from the need for efficiency in the distribution of specific cargo, their construction also stems from the development of schemes for the export of large quantities of raw materials, mainly coal and iron ore. In order to reduce the cost of conveyance by sea of the vast quantities of coal required for the generation of thermal power and of iron ore for steel production, very large ships are employed. However, the economies of scale that such ships allow can be achieved only if the unproductive time of the ships, which is largely the time required in ports for loading and unloading, can be reduced. To do so, supply chains are required to facilitate continuous delivery of the cargo, usually by rail, almost simulating

a conveyor belt. Obviously, production at the mines must keep pace with the tempo required to maintain the stockpiles at the ports.

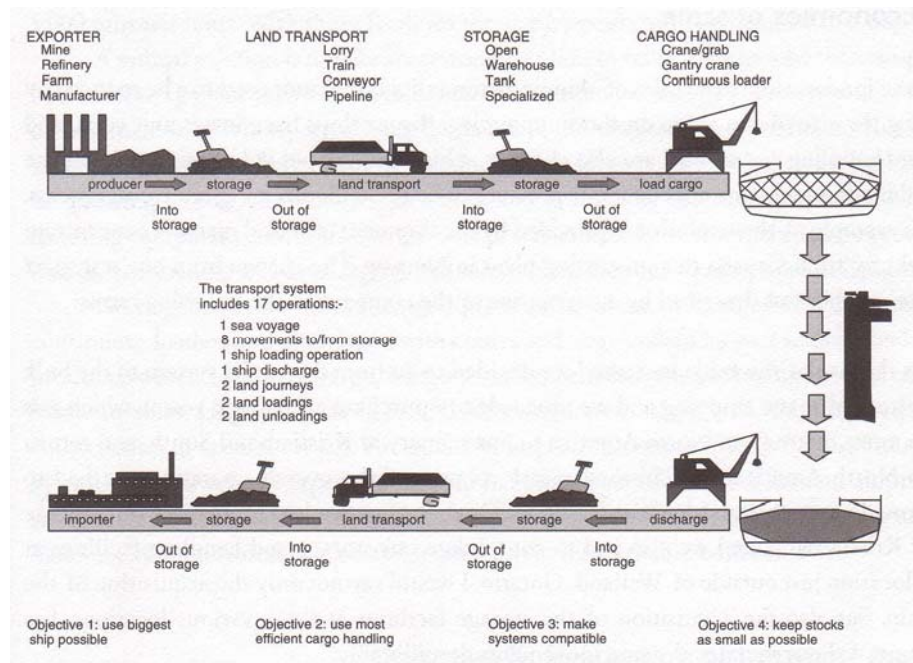
The transportation of crude oil, which by volume exceeds the transportation of any other cargo by far, has necessitated the development of supply chains dependent largely on shipping and pipelines, without relying on ports at which to transship the oil. Such supply chains have their own particular features.

The construction and organisation of supply chains for dry bulk materials originate in the global demand for huge quantities of such commodities and the need to ensure that deliveries occur regularly and reliably at the least cost, by achieving the maximum economies of scale. As described in Chapter Four, those supply chains are highly mechanised and automated. Documentation is kept to a minimum, which is facilitated by the fact that the cargo is homogenous.

Specialised terminals are required at the ports in order to ensure the seamless and efficient transshipment of such cargo. In South African ports, most of the terminals are operated by the cargo-owners, although the rail services between the source and the ports are operated by Spoornet. Integrated management of supply chains as defined in this chapter does not usually exist, which gives rise to problems, although a high level of co-ordination is achieved.

In Figure 2.6 the elements in the bulk transport system according to Stopford (1997:295) are shown.

Figure 2.6: Elements in the bulk transport system



Source: Stopford (1997:295)



2.3 Review

In the first part of this chapter, definitions of distribution, logistics, supply chains and their management have been quoted and discussed in order to place the meaning of the integrated maritime supply chains dealt with in this study in perspective. The conclusion is reached that most of the authors of the definitions quoted identify the process of procurement of materials and distribution of products to the market as a supply chain, the management of which corresponds to the management of the firm. However, the existence of supply chains that constitute services provided by third party undertakings to dependent firms is recognised in this chapter and the term 'integrated intermodal supply chain' is applied to the movement of goods using different modes of transport, but managed as a single operation. The management of such a supply chain can be the responsibility of a third party undertaking or the owner of the goods moved. When the goods moved are imports or exports,

the term maritime supply chains applies. All maritime supply chains are intermodal as the links invariably include both shipping and overland transport.

In the second part of the chapter, the links and elements of intermodal maritime supply chains and the participants are identified and briefly discussed. The purpose of doing so is to enable generic descriptions that will facilitate the examination of the existing and future maritime supply chains in South Africa and overseas and enable the fundamental strengths and weaknesses of their structures to be identified. A distinction is made in this section between supply chains in which commodities are moved in bulk and chains in which goods are moved in containers.

In Chapter Four maritime supply chains or sections of chains that convey South African imports and exports in bulk or in containers, their modal links and the extent of their integration, as well as their management, are described and discussed. Capacity problems and structural strengths and weaknesses are identified. Before proceeding to examine South African maritime supply chains, however, the stakeholding of the Government in those supply chains is explained and discussed in Chapter Three, as well as the implications for their development of the requirements of black economic empowerment, which are unique to South Africa.

Endnotes:

1. A map showing the sea and land trade routes serving Europe in the Middle Ages is contained in Fisher (1936:256).
2. A description of the trading by merchant shipowners is contained in the first two chapters of Davies (1954).
3. Hence the expressions 'trading ships' and 'merchant ships'.
4. The clipper ships initially carried immigrants from Britain to San Francisco and were available to return with tea.
5. Previously the Research Round Table of The International Center for Competitive Excellence, University of North Florida (UNF) (Dr Douglas M Lambert, director). In 1996, this group moved

with Dr Lambert to Ohio State University (OSU) and became The Global Supply Chain Forum. Beginning January 1999, the group was jointly involved with OSU and UNF.

6. Where specific references are not given in this section, the information has been obtained through personal interviews by the author.
7. P&O Nedlloyd owns 60 % of Cross Country Containers, a road hauling firm.
8. Containers can be cleared from a port far quicker by rail at 50 to 100 containers per train, than by road at a maximum of three containers per road vehicle.

