

Revised

UNITED NATIONS
ECONOMIC
AND
SOCIAL COUNCIL

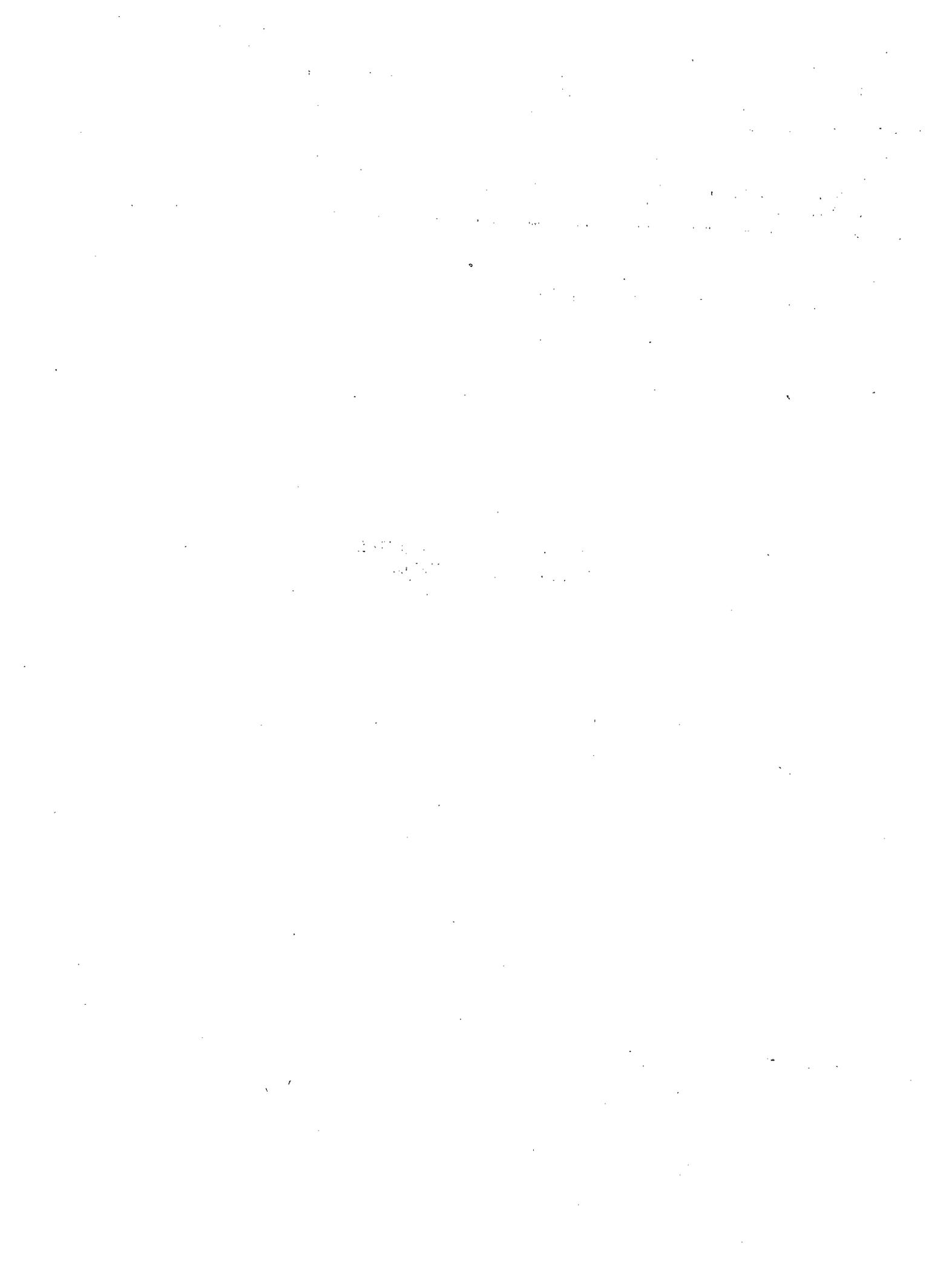


LIMITED
E/CEPAL/L.143
9 December 1976
ENGLISH
ORIGINAL: SPANISH

CEPAL
Economic Commission for Latin America

TECHNICAL ASPECTS OF THE UNITIZATION OF CARGO
AND THE NEW MARITIME TRANSPORT MODES

76-11-2358-400



CONTENTS

	<u>Page</u>
1. Introduction	2
2. Presentation of cargo	3
(a) Containers	4
(b) Trailers	8
(c) Barges	9
(d) Pallets	10
3. Maritime transport systems	13
(a) Container-vessels	13
(b) Ro-ro ships	16
(c) Barge-carriers	18
(d) Multi-purpose ships	21
4. Ports and the new technology	23
5. Modern modes of maritime transport	25
6. Choice of appropriate modes	38
Annex	41

1. Introduction

1. The developing countries do not generally have either enough information to be able to evaluate the option of adopting new technologies or the opportunities and conditions to obtain the optimum benefits which would result from them. In recent years this has been particularly true in maritime transport; the notable advances made are being applied and expanded in the developed countries, which are obtaining significant benefits from their utilization.

2. The purpose of the new technologies is to rationalize the operations of loading, unloading, handling, transferring and storing cargo by means of unitization which results in presentation in modules of identical form. The main types are containers, trailers, barges and pallets and their use increases the productivity and efficiency of ports and ships.

3. In order to make the utilization of these technologies more viable, major investments have been made in the industrialized countries for the construction or acquisition of ships and specially-designed transport equipment and for the adaptation of the port infrastructure and equipment so as to provide efficient service for these ships. Thus the maximization of the benefits to be derived from the utilization of these advances generally depends on whether the developing countries which carry out maritime trade with the industrialized countries adopt the same technology. This gives rise to the need to make extensive investments in port improvements or to the establishment of agreements with maritime transport enterprises which make the necessary investments in return for the monopoly of the transport of particular types of cargo.

4. The question which then arises in the developing countries is whether the benefits they would obtain would compensate sufficiently for the investments that would have to be made and whether agreements made with shipping lines would effectively safeguard their interests.

/5. This

5. This document is essentially descriptive and is confined to drawing attention to aspects and problems related with the method by which the merchandise is presented for transportation and the relevance of that method in the face of the modern systems of maritime transport. One of the main purposes of the document is to show that the options of combining different forms of unitization of cargo with different maritime technologies are broader than is commonly believed.

2. Presentation of cargo

6. The traditional methods of manual handling and stowage of individual packages of cargo have three major disadvantages:

(a) The vessels' port-stay time is too long because of the inevitable slowness of manual handling;

(b) The costs of such handling, which represent a considerable proportion of the operating cost, have risen rapidly in many areas of the world;

(c) Small and loose packages are liable to be damaged or pilfered and this causes inconveniences to the interested parties and increases the costs of insurance and safeguarding.

7. In order to overcome these disadvantages, which mainly occur in the port section, modern technology investigated methods leading to greater speed and mechanization in the transfer of goods between land and maritime means of transport. The first results benefited dry and liquid bulk cargo because of their homogeneity and fluidity. Industrial engineering specialists designed high-productivity installations for the loading and unloading of bulk cargo. This resolved, as far as these products were concerned, the problem of excessive port-stay time and, through increased navigation time, made it feasible to construct big tonnage vessels the greater cost of which was offset by higher productivity.

8. In attempting to utilize the new designs for the handling of general cargo, which is neither homogenous nor fluid, modern technology began to apply the idea of unitization, which consists of transforming

/the various

the various packages into the necessary homogeneous form so as to handle identical units. This makes it possible to use a single mechanical device for the continuous handling of such units which is undoubtedly much more efficient than the handling of numerous different packages and cargoes with varying mechanical devices.

9. The system of unitized cargo offers various solutions which counterbalance the problem of the increasing cost of general cargo handling since it is designed mainly to prevent the bottlenecks which occur in the conventional flow of small packages. This means that unitization is more efficient and less costly than the system of loose packages of merchandise which it has completely replaced in the trade between developed countries. The changeover has only been partial in the trade between developed and developing countries; in the latter, a high percentage of the flow of cargo has not yet been unitized, particularly boxes, barrels, drums, bales, sacks, etc.

10. The most common methods of unitizing cargo are palletization and containerization, which considerably increase the productivity of the loading and unloading operations compared with the traditional systems. The limitations on the containerization of certain cargoes and the high investments needed in ships, containers, specialized terminals and shore handling equipment led to a search for other methods of unitization. This produced the trailers and barges.

(a) Containers

11. The development of the containerization of cargo began in the coastal trade of the United States in the decade immediately following the Second World War. Later, the Sealand company initiated its Atlantic overseas services using container-ships. The traditional maritime interests at first resisted this innovation, but were obliged to counteract the competition from this new technology of unitization by forming container consortia. After this the interest of all the maritime nations of the world was aroused.

/12. Many

12. Many operators began by using receptacles of varying sizes, according to their needs, before standardization came into application. Even today there are some non-standard containers although the vast majority meet the specifications of the International Standards Organization (ISO) which began to study this subject in 1961; the standardization established was accepted internationally in 1967.

13. According to the definition of the ISO, adopted by the Panamerican Technical Standards Commission (COPANT) a freight container is an article of transport equipment which meets the following requirements:

(i) Of a permanent character and accordingly strong enough to be suitable for repeated use;

(ii) Specially designed to facilitate the carriage of goods by one or more modes of transport without intermediate reloading;

(iii) Fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another;

(iv) So designed as to be easy to fill and empty;

(v) Having an internal volume of one cubic metre or more (35.3 cubic feet).

The ISO and COPANT have specified that the term container does not include vehicles or conventional packing.

14. Although containers should generally be of rigid construction, there are some in use which are collapsible and others which can be dismantled. They can be made of steel, aluminium, plywood or fibre glass, or a combination of these materials. As they are impermeable, the containers protect the goods from adverse weather conditions.

15. With regard to cubic size and gross weight, the two main types of containers currently used are:

(i) Containers 20 feet long, with a maximum gross weight of 20 tons, and some very special containers of up to 22 tons;

(ii) Containers 40 feet long with a maximum gross weight of 30 tons.

16. The majority of the containers, however, are of the 20-foot type and for this reason the statistics on container transport and the capacity of container ships are expressed in container units of

20 feet, known as TEU (Transport Equivalent Units). The standardized modular design makes it possible for two 20 foot containers to fit in the same space as one 40 foot container and they can be lifted simultaneously. All containers are 8 feet wide, but the height can vary between 8 feet and 8 feet 6 inches. The dimensions are always expressed in the following order: height, breadth and length; the capacity refers to the total interior volume.

17. The special devices, or corner fittings on the eight corners of the container serve to lift it with a manual spreader-gear fitted out with hooks or shackles or an automatic or manual spreader twistlock gear which passes through these fittings. They also serve to lash the containers once they are loaded onto the transport vehicles and to stack them using interconnecting fittings which prevent horizontal and vertical movement.

18. The following terms are used for the weight of the container:

(i) Maximum gross weight = maximum allowable total weight of freight container and its payload;

(ii) Tare weight = weight of empty freight container;

(iii) Maximum payload = maximum gross weight less tare weight;

(iv) Actual gross weight = total weight of the freight container and its payload;

(v) Actual payload = difference between the actual gross weight and the tare weight.

19. Containers can be classified in five groups according to the nature of the cargo for which they are designed:

General cargo. These containers can be closed with doors at one end or in the side walls; open topped; with open side walls; with open tops and ends; of half height, that is half the standard height of 8' or 8' 6", and can or cannot be ventilated;

Perishable cargo. These are isothermic containers which can be isolating, refrigerated or heated;

Liquid or gas cargo. Tank-containers can be used to transport bulk liquids and compressed gases;

/Bulk dry

Bulk dry cargo. These are special containers which load and unload dry bulk goods by gravity or under pressure;

Special cargo. There are containers for livestock and platform-containers; the latter are basically flat trays without a superstructure for lifting, and thus do not benefit from advantages of the fully automated systems for loading and unloading containers.

20. The ISO has regulated the location and size of the identification marks of containers, including: the name or trade mark of the proprietor; the capacity in respect of volume and weight; the class or type of the container and the international registration code.

21. The current prices of some of the most frequently used containers, based on quotations from manufactures in the Federal Republic of Germany ^{1/} are approximately:

<u>Class</u>	<u>Feet</u>	<u>Dollars</u>
Steel container	20 feet	2,050 to 2,700
	40 feet	4,200 to 4,860
Refrigerated container	20 feet	4,860 to 7,550
	40 feet	11,900 to 15,100

22. In order to serve its full purpose container traffic must, in addition to having a balanced and abundant flow of containerizable goods, meet with the following requirements: (i) a port suitable for container handling with corresponding transfer equipment available to ensure the throughput of the projected cargo-flow; (ii) availability of diversified means of transport and an integrated network of roads, railways and water-ways; (iii) equipment for the handling of the containers at the interior transfer points, and (iv) an administrative organization to facilitate the flow of units in transit.

23. The limitations of the maximum weight levels admissible per axle, rail width, height of tunnels and structural resistance of bridges which domestic means of transport may encounter represent a restriction on

^{1/} UNCTAD, Technical and financial aspects of the modern transport technologies used in multimodal transport operations (TD/B/AC.15/15), September 24, 1975.

the optimum use of containers as a door-to-door service. These factors partly explain why, except on a few very favourable routes, it has not been possible to optimally utilize containers in Latin America, and the use is generally limited to a door to port terminal service and vice-versa.

(b) Trailers

24. This system consists of trailers which are pulled by tractors onto the ships, which are equipped with ramps for this purpose. This is known as the roll-on/roll-off or ro-ro system.

25. The trailers can be of any size, but much of the rolling stock in use is already standardized. The prices vary according to the characteristics which range from small trucks to isothermic trailers. In the United States in 1974 a trailer with a capacity of 20 tons was worth 8,000 dollars and a tractor, according to size, between 7 and 15,000 dollars.^{2/}

26. This system functions best in countries which have a complete road connexions from a choice of ports to the interior, without physical or administrative restrictions on the transit of tractors and attached vehicles. This means that the least congested port can be selected for the loading and unloading of trailers.

27. The trailers can also be placed on railway flatcars (piggyback) or lighters. The equipment for the transfer to railways is relatively cheap, and the same is true of loading onto lighters except when there are great tidal differences; this can be remedied by waiting for the water to reach a level within the operational limits or by constructing a floating ramp with a gradient not exceeding the maximum permitted for the equipment used, generally 12 per cent.

28. As in the case of containers, the trailer system has the advantage that there is little damage or pilferage of the merchandise. Another advantage is that in many cases simple or domestic packing is sufficient

^{2/} United Nations, Technical aspects of the systems of transport in large containers (ST/ECA/170), New York, 1974.

(c) Barges

29. Barges are rectangular vessels without propulsion which are like large floating metal receptacles with a hatchway taking up almost all of the upper surface, thus facilitating direct vertical stowage. Once loaded they are hermetically sealed with metal hatch-covers. They can be used to transport any type of dry cargo, from bulk goods to containers, and there are plans to construct barges suitable for liquids. In some types of barge, the cargo can be ventilated while on board the barge-carrier. Tests are now being carried out for the construction from fibreglass with refrigeration.

30. No special handling equipment is needed for the loading and unloading of the merchandise; cranes with a maximum capacity of 3 tons are sufficient to open and close the hatchway and handle the cargo, and tugs are used to move the barges from the wharf - which does not need to be particularly long or have much draft - to the barge carriers or vice-versa. The water transport between the hinterland and the ports is carried out in trains of barges attached in pairs, propelled by a small draught pusher-boat of which the rectangular hull design facilitates the pushing and manoeuvring of the barges.

31. There are three types of barge, designed in accordance with the characteristics of the carriers, namely LASH (lighter-aboard-ship), Seabee and BACAT (barge-aboard-catamaran); however the BACAT vessel, designed for traffic between the United Kingdom and Rotterdam, is already out of operation because of labour problems; LASH and Seabee are used intercontinentally. The dimensions of the LASH-type barges are: length 18.74 m; beam 9.50 m; depth of hold 3.96 and draught 2.66 m. They have a hatch-way of 13.41 m x 7.92 m with three covers weighing 2.5 tons each. The capacities and prices of the barges are shown in table 1.

/Table 1

Table 1

CHARACTERISTICS OF STANDARD BARGES

	LASH	Seabee	BACAT
Dead weight (metric tons)	374	847	140
Volume (bales, cubic feet)	20 000	40 000	9 000
Weight (metric tons)	87	171	25
1974 prices, in dollars	30 000	60 000	23 000

Source: Fairplay International, 3 April 1975, page 7; Norwegian Shipping News, No 22, 1971, pp. 927-928, Navitecna, No 7, July 1974, page 67.

32. The barge system could open up new areas to trade, especially those with direct access to navigable waters, either on the coast or in inland and remote areas situated along rivers or canals suitable for the navigation of barges and the propelling pusher boats. Barges are also useful in congested maritime ports.

(d) Pallets

33. This method of unitization is the most well-known in Latin America and is used in many ports, factories, local transport companies, etc.

34. A pallet is a platform on which a certain number of packages can be placed to form a unit of cargo which is easy to transport, handle or stack, particularly with the use of forklifts. It is generally made of wood and basically consists of two platforms separated by supports (or one platform with legs); its height is the minimum suitable for handling by mechanical devices and it may or may not have a superstructure.

35. The term pallet includes the flat pallet, the cargo cage and the box pallet. Their characteristics are as follows:

/(i) The

- (i) The flat pallet is a simple or double-decked base without any superstructure;
- (ii) The cargo cage, as its name suggests, has a structure in the form of a box and collapsible sides towards the interior which can be made of meshing or fibre, and it may or may not have a cover; it is easily damaged and thus infrequently used;
- (iii) The box pallet consists of a flat pallet on which hinged boards are vertically placed, forming a box the size of the base-pallet. The box can be made higher by adding more hinged boards, which for this purpose are fitted on the upper side with a metal corner structure to hold the next boards or a cover. The dismantled and flattened boards take up very little space in storage or return.

36. The last two forms of palletization are used for loose parts, such as tubing couplings, tiles, valuable goods with fairly weak packaging, etc. In general, they are used at the choice of the transport operator, since intensive manual handling is needed for the transshipment of loose packages. For this reason large lots of identical packages generally arrive pre-palletized from the factory.

37. There are some reusable pallets which are rigid and can be stacked loaded. The return of reusable pallets represents an additional cost and makes it necessary to transfer the cargo to the pallets of another transporter, so that the advantage of rapid and cheap handling is lost. Because of this there has been a gradual introduction of one-way pallets which can be disposed of afterwards. Consideration has been given to the formation of pallet-pools for the interchange of pallets, as has been done with containers, but no concrete results have been reached, except in closed circuits, due to the variety of characteristics and quality and because the actual cost of the pallets is lower than the administrative expenses which would be involved in the operation of pools.

38. The use of disposable pallets was encouraged by the shipping conferences which established a reduction in freight charges for pre-palletized cargo. At first this produced pallets which were so fragile that damage occurred in the first links of the transport chain, but frequent claims for damages to the merchandise led to the emergence of a stronger type of disposable pallet.

39. The size of the pallets may vary according to the dimensions and type of cargo to be palletized. It can be estimated that there are some 25 different sizes, ranging between 1.20 x 2.40 metres and 90 x 90 centimetres, depending on whether they are for storage, shipment or other purposes. The only pallet which is sufficiently strong to be used in the integrated transport system is the 1 x 1.20 metre type, since it permits block stowage of 2, 2.20 and 2.40 metres, and these dimensions are compatible with the capacity of most vehicles and the standard size of containers.

40. The pallet design for only two-way entrance of the prongs of the fork-lift causes handling and stowage problems, and hence delays, and thus adversely affects the entire transport operation. Although more expensive, the four-way entrance design allowing the prongs to enter through any of the four sides is better since it is sufficiently versatile to allow a truck to be loaded by the sides and unloaded from the back or vice-versa. The same holds good for the optimum stowage in ships, containers, etc.

41. The pallet with "wings" - to facilitate the placing of the bars of the lifting gear (connected to the crane or similar instrument) - is not considered important outside the port area. The benefits of this feature should however be borne in mind, not only in the ports but also for use within the interior of the country, for example in factories and construction companies equipped with cranes; there are also trucks which carry permanent hydraulic cranes.

42. The cost of a pallet varies according to the size, quality, production site, etc. In July 1976 a disposable pallet in Europe was worth approximately 8 dollars, and a reusable 1.5 ton capacity

/shipping pallet,

shipping pallet, up to 30 dollars. It is of course feasible to manufacture pallets in the developing countries at a significantly lower cost.

43. The only implements generally needed to transfer palletized cargo are a fork-lift or some manual lifting implement similar to a hydraulic jack; the latter, however, is not suitable for stacking.

3. Maritime transport systems

44. The economy of the use of a particular type of ship depends on the volume and characteristics of the traffic in which it is to be operated; other important factors are the time spent in port and the navigational distances which have to be covered.

45. The conventional ship remains in ports to load and unload for up to 70 per cent of the time of a round trip, and sails for the remaining 30 per cent. Unitization can reduce the time spent in port, which is an unproductive period, to ten or fifteen per cent of the total time, thus considerably increasing the transport capacity of a particular ship.

46. Various types of ships have been designed and put into service for the transport of unitized cargo, some specialized in carrying only containers or barges and the majority suitable for the transport of various combinations of unitized and ununitized cargo.

47. These modern ships can be classified as container-carriers, ro-ro ships, barge-carriers and multipurpose ships.

(a) Container-vessels

48. The container-vessels are characterized by their enormous productivity, in terms of the cargo transported by a ship during a particular period of time, compared with the transport systems in the conventional cargo ships. Thus the introduction of containerization on a given route leads to a sharp reduction in the number of carriers required although each vessel costs several times as much as the conventional type of ship it replaces.

49. The need to agree on a reduction in the number of vessels of each shipping company serving a particular route led to the formation of

/consortia. This

consortia. This also remedied the trend towards freight-rate competition which had developed when attempts were made to operate the new container vessel services within the traditional structure of the maritime conferences. The reduction in the frequency of the services offered by each individual company and the disappearance of major differences in the quality of the services made the formation of these consortia even more viable since fully-integrated standard services could now be offered.

50. In some cases the establishment of a consortium made it possible to reduce the costs of constructing these expensive ships and additional hardware since it was feasible to negotiate building-orders for a number of carriers simultaneously and it was even possible for two or more companies to share the high cost of a single vessel.

51. The first-generation container-vessels can transport approximately 500 containers of the 20 foot type at a speed of some 18 knots and are equipped with ship-board gear to handle the containers; in many instances they are adapted general cargo ships. The vessels of the second generation can transport between 1,000 and 1,800 containers of the same type at some 21 to 25 knots; they do not usually have cranes on board and therefore the containers have to be handled by special shore-based gantry cranes. The ships of the current third generation are giants which transport up to 3,000 20-foot containers at a speed between 28 and 33 knots; the loading and unloading is carried out by the gantry cranes of the specialized terminals.

52. The container-carriers have been increasing in size and speed; the correspondingly higher investment is counterbalanced by the excellent rotation of each vessel due to high-productivity container handling. The unexpected increase in the prices of fuels in 1973, however, introduced a variable which did not exist when the economies of scale and speed were calculated and, as a result, some of them now sail at reduced speeds on certain routes.

Table 2

CHARACTERISTICS OF THE CONTAINER-VESSELS

Year of entry into service	Capacity of 20 foot containers (TEU)	Capacity (DWT)	Total length (m)	Beam (m)	Draft (m)	Speed (knots)	Estimated price (millions of dollars)
1968 1st. generation	700	12 000	171	25	8	18	
1970 2nd. generation	1 500	30 000	215	29	11.5	21-25	50
1972 3rd. generation	2 400 3 000	43 000	289	32	13	28-33	90

Source: Containerization International, 1974; Lloyd's Register of Shipping 1976/1977.

53. The containers are stowed in permanent cellular structures below deck in vertical stacks of up to six, or, in the largest ships, sometimes nine. Stacks of up to four can be placed on deck, but when this maximum height of stacking is used the average weight of the container load must be less than the maximum permissible weight for ship stability reasons and special care must be paid to the athwartship lashing, for which tensors are used; the containers are stacked parallel to the longitudinal axis of the ship.

54. In this type of ship adequate planning of the stowage is particularly important, since it has to be vertical in order to avoid as far as possible both the shifting of the containers and the list and tilting of the ship, while ensuring stability at all times.

55. In some cases small feeder vessels are used which can transport up to 200 containers from a base port to secondary ports and vice versa.

/(b) Ro-ro

(b) Ro-ro ships

56. These ships have several decks linked by ramps or elevators where the vehicles are parked on their wheels, and lashed with special gear. The loaded vehicles enter and leave the ship by ramps which open from the stern or the bow or from both ends, and either move independently or are pulled by tractors. The productivity of these ships is high and can reach 1,500 metric tons per hour.

57. The ro-ro operations, whose origin comes from the ferry-boats, have been very successful over short distances in various parts of the world for some time. Great interest continues to be shown in their development, since the costs of handling the cargo are lower and the round trip periods are shorter than in the container vessels and they are now being successfully operated over long distances.

58. The ro-ro system, however, involves greater broken stowage than the cellular lift-on/lift-off ship since while in the latter approximately 20 per cent of the space is lost because of the cells and the containers themselves, in the ro-ro ships some 30 to 40 per cent is wasted because of the gaps underneath the vehicles. In order to remedy this loss of space in long voyages the cargo of vehicles can be lowered from the vehicles and stowed as in multipurpose ships. The ro-ro ships have suitable equipment to carry out this operation. In any case the time saved in the round trip over short distances offsets the disadvantage of the loss of space.

59. Another compensatory advantage is their flexibility, which makes them suitable for the ports which do not have special cranes. Furthermore, it is possible to transport packages by the ro-ro system which are unsuitable for containerization because of their weight or volume; some ro-ro ships have ramps which can sustain the weight of mobile loads of up to 365 tons and which can take cargo as specialized as transformers, helicopters, drilling equipment, etc.

60. Because they are equipped with ramps in the bow and the stern or both, the ships have to moor in a particular way which requires a berth at least as long as the beam of the vessel, or two perpendicular

/wharfs so

wharfs so that the bow ramp or stern ramp is supported by the other sites than the one to which the vessel is moored. Other vessels only need berths suited to their length and are equipped with a so-called "quarter-ramp" - this ramp is lowered from the stern at an angle of 45° or less to connect with the wharf. This type of ship can also carry out two more operations simultaneously, one vertical (lift-on/lift-off) and the other horizontal, by means of the side ports which are designed for this purpose.

61. The vessels which have quarter-ramps can use any conventional wharf suited to the length and draught of the ship, since these ramps can adapt to differences of levels between the wharf and the main deck ranging from -2.5 m to +7.4 m. By constructing a shore-connecting floating ramp even greater differences of tides can be overcome.

62. As to the operational aspects of the vehicles, it is normal for the tractor to remain ashore because it is the most expensive piece of equipment. Exceptionally, and only over short distances, the tractor accompanies the trailer and thus the complete unit makes a door-to-door trip.

63. The ro-ro ships are being used increasingly in long distance traffic where the cargo is difficult to containerize or has very varied characteristics. They can be very useful for the heterogeneous trade of the developing countries if the ports and transit points have equipment to handle containers and if the ships have side ports for pallet handling; it is even feasible to transport small lots of dry bulk cargo. In some routes they are very useful in combination with accommodation for passengers travelling with or without vehicles.

64. No special facilities are needed in the terminals; generally it is sufficient to have a free area for vehicles and cargo and also a flat surface without obstacles so as to facilitate the speedy maneuvering of motorized equipment. This factor was decisive in the rapid development of ro-ro traffic to the Persian Gulf; because of the explosion in trade, congestion developed which could be solved by using high productivity ships which did not require special terminals. The weight which has to be borne by the wharf when the ramp is placed on it

/is largely

is largely alleviated by a tension winch on board the ship which automatically regulates the suspension of the ramp so that the pressure per square metre can be borne by any wharf.

Table 3

CHARACTERISTICS OF SOME RO-RO SHIPS

	Transport capacity (TEU)	Length (m)	Beam (m)	Loaded draft (m)	Capacity (DWT)	Speed (knots)	Estimated price (millions of dollars)
Small	212 (or 106 trailers of 12 m)	133	19	6.4	5 300	20	28
Large	1 200	207	28	9.9	20 650	22	70

Source: Marine Week, 25 June 1976, p. 26; Containerization International, 1974; Lloyd's Register of Shipping 1976/1977.

65. The prices are extremely variable and depend on the capacity, propulsion potential, quantity and type of ramps, side ports, cargo handling equipment, etc. It is estimated that the cost of construction in the Kawasaki Heavy Industries shipyards of two ro-ro ships (of 23,000 DWT), which will be the largest so far constructed in the world, will exceed 100 million dollars each.

(c) Barge-carriers

66. The ships to transport barges as modular units introduced an interesting innovation into the maritime transport of unitized cargo. The barge-carrier effects transport from port to port without berthing and the barges are loaded and unloaded by a crane or special elevator which the vessel carries for this operation.

67. During the Second World War the United States used L.S.D. (landing-ship-dock) ships to transport selfpropelled barges. This may have been the origin of the idea of the naval architect Jerome L. Goldman, of New Orleans, to create the barge-carrier.

68. Various projects were devised; the LASH, Seabee and BACAT, based on the principle of the dry hold, and the European system E.B.C.S. (European barge carrying system), based on that of the wet hold. The latter system never got beyond the drawing board but the idea of the wet hold has been applied in some LASH-feeder vessels without propulsion.

69. Of some thirty units constructed between 1969 and 1975, there are only three Seabees and one BACAT, so that the great majority are of the LASH type, which are constructed under license from the LASH System Inc., of New Orleans, the holders of the world patents for this technology.

70. A LASH ship is basically a hull with the bow of a clipper and a transom stern. The hatchway covers the length of the ship and measures about 19 m wide and 180 m long; the bridge is on the forecastle. The hatchway is hermetically closed by means of Mac Gregor hatch-covers.

71. Most of these ships only carry barges, but there are some which also carry containers, in which case they have two gantry cranes (overhead travelling cranes). On deck, along the length of the ship, there are two rails on which one or both of these cranes can run. When there are two cranes, one is used to handle twenty and forty foot containers, and its lifting equipment is designed in such a way that a suspended container can rotate 360°. The other gantry crane, which is the basis of the LASH concept, has a capacity of 500 tons and is used to load and unload the barges, the rail-lines for this crane continue beyond the stern, forming a special area where the barges are handled.

72. The lifting part of this crane has a hydraulic closing device known as a spreader which can engage the barges and also open and close the hatchways of the ship. Once a barge is picked up behind the stern it is raised to a level above deck and then transferred and lowered into the selected place in the hold or on top of the hatch covers. The average complete cycle per barge lasts about

/15 minutes.

15 minutes. The lifting part of the crane is equipped with a swell correction which facilitates operation in turbulent waters since movements of up to 2.40 metres can be overcome. During the transfer, special pulleys hold the barge to prevent it from oscillating with the listing and pitching of the ship.

73. The capacity of the LASH ships varies between 73 and 89 barges of 374 metric tons each, that is between 29,000 and 33,000 metric tons of dead weight. However, since the barge carrier can load or unload four barges an hour, its productivity amounts to some 1,500 metric tons per hour. This productivity of the ship itself should not be confused with the rate at which the contents of the barges are loaded and unloaded in the port. In New Orleans in 1973 the price of constructing a barge-carrier was some 28.5 million dollars, including a State subsidy, but not the barges, which cost 10 million. Some shipyards maintain that this price could have been considerably lower in other parts of the world. Thus the price of the two LASH ships of the Combi-Line, constructed in 1972 in Amberes under license of the LASH System Inc. of New Orleans, which up to now are the only vessels which have been constructed outside the United States, was approximately 18,500,000 dollars each.^{3/}

74. The Seabee barge-carrier system differs from LASH in that the stowage of the barges is longitudinal and have a volume capacity of 44,320 cubic feet or 847 metric tons of dead weight, thus being suitable for transporting packages of exceptional volume. The loading or unloading is carried out by a submergible platform-elevator of vertical movement situated at the stern. This platform can lift 2,000 tons, that is two barges of 847 tons dead weight, simultaneously. The platform can also be placed at the level of the wharf, and this makes it possible to load rolling stock of the ro-ro type.

75. The Seabee ships can carry barges on three decks, arranged in two lines; the barges are moved horizontally by rolling. They can transport 38 barges, or approximately 30,000 metric tons. Productivity is of some 2,480 tons/hour with remote control of all the operations. In 1972 it

^{3/} International Shipping Journal, 25 May 1972, page 43.

was estimated that the cost of constructing the three ships with a total of 246 barges was some 125 million dollars.^{4/}

76. Only one-barge carrier of the BACAT system has been constructed to be operated in the North Sea, where distances are short. It has a dead weight of 2,700 tons and is of the catamaran type, with two hulls whose linkage is less than half the length of the ship. The system is essentially based on the same principle as the others; it carries 18 barges with a capacity of 140 tons each. It can transport up to three barges of the LASH type, as well as ten of its own, and thus functions as a feeder vessel for LASH units.

77. Some characteristics of the LASH and Seabee vessels are shown below. (The composition of the present fleet is shown in an annex.)

Table 4
CHARACTERISTICS OF SOME BARGE-CARRIERS

Type	Transport capacity (number of barges)	Length (m)	Beam (m)	Loaded draft (m)	Capacity (DWT)	Speed (knots)	Maximum production (metric tons/hour)	Estimated price (millions of dollars) ^{a/}
LASH	73 to 89 ^{b/}	262	32.5	11.25	41 000	20-22	1 520	40
Seabee	38 ^{c/}	225	32.0	10.00	39 000	21	2 480	42

Source: Fairplay International, 25 January 1973, page 25, and 23 March 1972, page 49.

^{a/} Both values correspond to transactions carried out in 1972 and include the barges. The price of each barge can vary from 30 000 to 80 000 dollars, the latter being the price of a refrigerated barge.

^{b/} Barges of 374 metric tons.

^{c/} Barges of 847 metric tons.

(d) Multi-purpose ships

78. From a transport point of view, it can be considered that the multipurpose ships are equivalent to the ro-ro ships, since they can carry either break-bulk or unitized cargo or both types simultaneously, except for barges. The term, however, refers to a type of ship which is quite a sophisticated version of the conventional vessel.

^{4/} Fairplay International, 23 March 1972, page. 49

79. It is basically a hull with a flush tweendeck, holds which are as far as possible square so as to contain units such as pallets or containers, simple cargo handling equipment, a pair of derricks or a crane for each hatchway, and with or without tanks for liquid cargo; the engine room is located in the stern. It has five holds with single or twin hatchways, whose dimensions should be a multiple of the size of a container and which facilitate direct stowage with derricks, without obstacles for the use of fork-lifts and suitable for general cargo, unitized cargo and various kinds of bulk cargo. The speed varies between 14 1/2 and 16 1/2 knots.

80. On this basis larger ships were constructed in various parts of the world, such as the SD-14 and currently the SD-15, of a dead weight tonnage between 12,000 and 15,000 tons and a volume capacity of approximately 600,000 to 720,000 cubic feet.

81. In Japan, the Sasebo Heavy Industries Co. Ltd. is offering two types of standardized multipurpose vessels: one of 21,600 DWT, 153 m long, 25.80 m beam with a depth of 13.70 m and maximum draught of 8.70 m; and another of 25,000 DWT, 164 m long, 25.80 m beam with a depth of 14.70 m and a maximum draught of 9.50 m. It is estimated that the prices - which vary according to the characteristics - start at some 21 million dollars. They have automated engine room control and can be adapted for special conditions and particular types of traffic. They are manned by a crew of 28 persons, instead of the 40 or more needed for the conventional models.

82. Many multipurpose ships have sophisticated handling equipment, with mechanically rigged derricks and Stulcken type jumbos, automated and computer-controlled engine rooms, variable pitch propellers, bow-thrusters, up to three tweendecks, side ports, hydraulic opening and closing of the hatches, refrigerated spaces, electric fork-lifts, etc. To increase productivity, a quarter ramp is sometimes added which gives access to a limited space, so that this produces a variation of a ro-ro ship. The purpose of all these refinements is to reduce the port stay time and increase navigation time.

4. Ports and the new technology

83. When a shipping company chooses a type of vessel to put into regular service on a specific route, it takes into account not only the nature and volume of the cargo it will carry, but also the port conditions and facilities it will serve. In the case of services between developed countries, the shipping company can often have a direct influence on port facilities, since in some of these countries it is common practice to rent sectors of the port to shipping lines, who modify the facilities as they wish and are responsible for the investment necessary for whatever technology they choose.

84. In Latin America, however, the practice is that the national port authority provides all the facilities and furnishes the services required by the ships calling at the port. Thus, each port must service ships plying different routes, for which the shipping companies have selected suitable vessels, which, however, require different technologies. Moreover, these technologies are developing rapidly and there is always the risk of investing amounts which are not subsequently amortized.

85. The description of the various forms of unitization of cargo in chapter 2 and of maritime technologies in chapter 3 shows that port requirements vary widely between one case and another. There are, however, some common characteristics which should be noted.

86. In the first place, there is a steady trend towards the use of bigger and bigger ships. Even multi-purpose ships, which are a development of the traditional cargo vessels, are reaching a size of 25,000 tons deadweight. This increase in the capacity of the ships is accompanied by a number of direct implications for the ports:

- (i) Shipping companies are reducing as far as possible the number of ports served on each route and give preference to such ports as have the highest productivity in terms of tons handled per ship-hour. As a result, some ports which traditionally maintained direct services with the rest of the world now use feeder services via transshipment ports.

/Similarly, ports

Similarly, ports in the same country or within the same region are now competing with one another to be chosen by the shipping lines and thus acquire the status of transshipment port;

- (ii) There is a general decrease - even in ports where cargo is concentrated and transshipped - in the number of calls by ships, which means less demand for berths. Nevertheless, the berths used (except in the case of barges) should be deep enough for the increased draught of the new ships;
- (iii) As a counterpart to the reduction in the number of calls, there is a significant increase in the number of tons discharged and loaded during the ship's time in port, which calls for the introduction of radical changes in the traditional systems of operation and documentation aspects both by the port authority and by customs, health and other authorities. It is also important that the port should operate continuously during the ship's time in port.

87. Secondly, the traditional layout of the port area is not suitable for the handling of large quantities of unitized cargo in containers and semi-trailers. Most Latin American ports have transit sheds, and even storage depots a few metres from the berth with only a small paved area free of obstacles within the port premises. The provision of efficient services for container carriers and roll-on/roll-off ships requires large open spaces both where the ships berth and in more distant places for the storage of containers and semi-trailers. On the other hand, the handling of pallets which are carried in multi-purpose and roll-on/roll-off ships and the reception and dispatch of cargo carried in barges call for less radical changes in the use of port space. In practice, however, if a port is to provide efficient service to different types of ships, specialized sites are required according to whether they are container, roll-on/roll-off, multi-purpose or other types of vessels; such specialization results in a low level of utilization of each berthing site.

/88. Thirdly,

88. Thirdly, both the volume of cargo handled during each call and the nature of the unit loads resulting from the new technologies call for a much higher degree of mechanization than that traditionally used. A container, for example, can only be moved by large-scale mechanized equipment, whereas the pallet was designed to be moved by means of a small fork-lift truck. The cost of this equipment is high and increases still further when a port wishes to give efficient service to different technological systems. The use of this equipment also requires specialized personnel for handling and maintenance purposes. Lastly, much of this equipment only operates on paved surfaces free of obstacles and with sufficient space for manoeuvres.

5. Modern modes of maritime transport

89. The tendency to treat the new forms of unitization of cargo as synonymous with the maritime technology for transporting it on the port-to-port voyage obscures the many choices that exist in electing the most suitable combinations to facilitate international trade with the minimum of undesirable repercussions. Although the choice of a new system of transport takes into account both the form of unitized cargo and the type of ship to be used for the sea route, there has been some confusion of the two concepts in many discussions on the subject. In fact, one form of unitized cargo can be carried in different types of ships and a distinction should be made between the implications of using one or another type of vessel and one or another form of unitization.

90. The distinction between the form of unitization and maritime transport technology is important since instead of analysing only four maritime systems it is necessary to consider at least eight modes of transport, each of which in itself represents a different technology. Through this analysis it may be deduced that it is possible to derive some benefits from the introduction of unitization without necessarily suffering the disadvantages of one or another type of maritime transport technology, which are frequently ascribed to unitization itself. The eight transport modes are shown in table 5 and are illustrated in the following figure.

/Table 5

Table 5
IDENTIFICATION OF TRANSPORT MODES

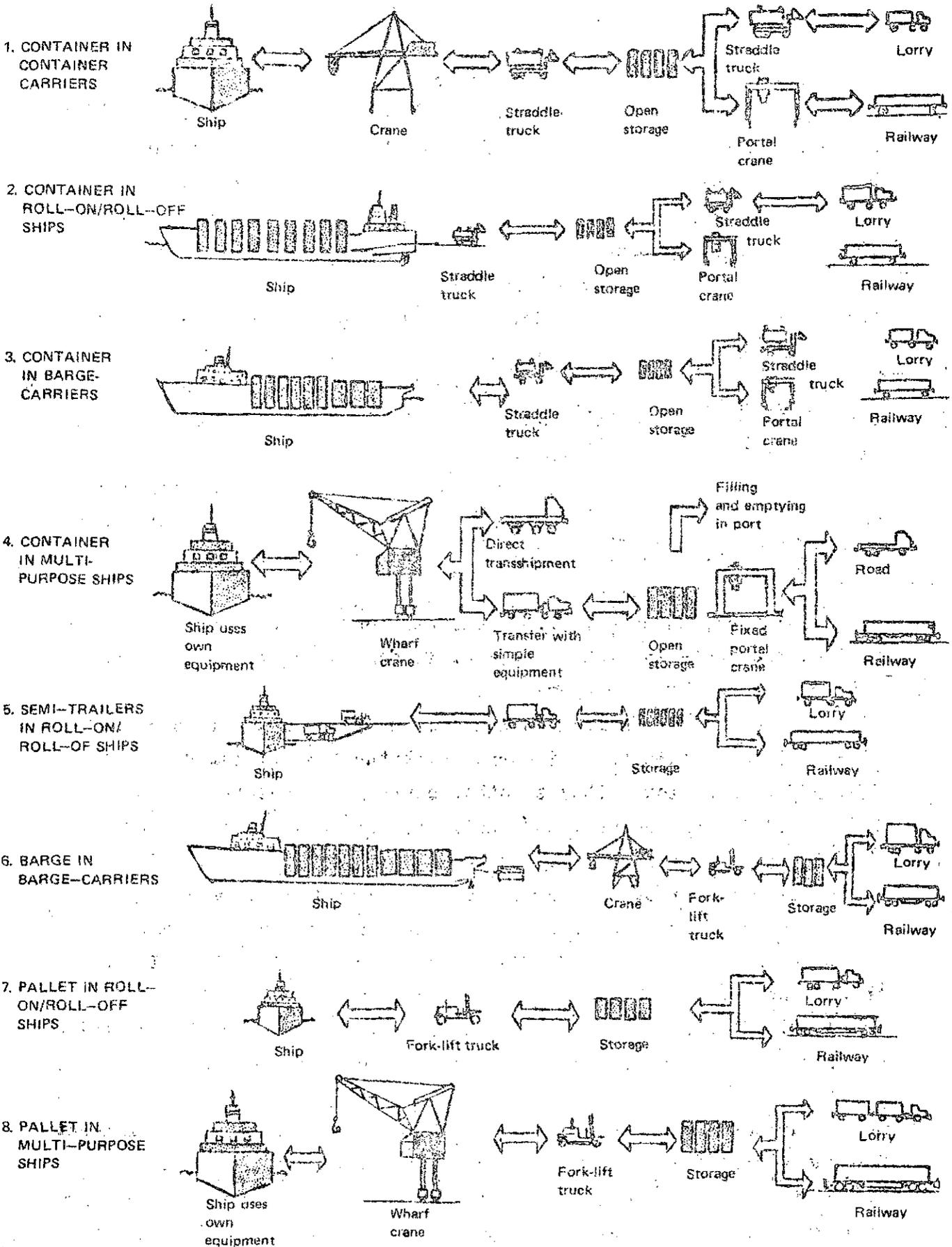
Units of presentation of the cargo	Type of vessel			
	Container ship	Roll-on/roll-off ship	Barge carrier	Multi-purpose ship
Containers	1	2	3	4
Semi-trailers		5		5 ^{a/}
Barges			6	
Pallets		7		8

Source: CEPAL.

a/ This is a variant of system 5, since some multi-purpose vessels facilitate the use of semi-trailers, for which they are equipped with a ramp.

91. The greater relative convenience of one system compared with another depends on the balance of the advantages offered by each in a certain type of situation. The variables most influencing this balance - which vary in magnitude and nature for each system - are: productivity and efficiency of the types of vessels and complementary equipment; the ships' requirements in terms of port facilities and infrastructure; the nature of the cargo handled locally and elsewhere and the balance between the flows in both directions; magnitude (in terms of weight and volume) and routes of the flows; characteristics of the existing port infrastructure; maritime conditions prevailing at the ports included in the routes; geographical location of the centres generating the international trade and their relationship with the land infrastructure; state and extension of the road and railway infrastructure and the physical limitations involved; and finally the institutional structure (administrative, customs and health) for the transshipment and transit of unitized goods. A qualitative analysis of the influence of these variables in each system is given below.

SYSTEMS OF TRANSPORT



Adapted from: B.N. Hoffmaster and C.A. Noidegard, "Containerization: international-intermodal integrated", a study presented at the Third Inter-American Conference on Ports of the Organization of American States, Viña del Mar, Chile, 15-24 November 1963. In Coastal shipping, feeder and ferry services (ST/ECA/134), New York, 1970 (United Nations publication, Sales No: E.70.V.111.3).

First mode: the container in container vessels

92. (i) Advantages of the system. It is particularly efficient in cases where there are large volumes of containerizable cargo in both directions of the route between pairs of ports, or within a circuit of a few ports which both absorb and generate cargo.

93. The high productivity of this ship, due to its speed in loading and discharging the large volume of goods it carries, means that it spends little time in port compared with its navigation time. It is therefore unnecessary to increase the number of berths in ports currently congested with conventional ships for want of mooring space, which appreciably reduces both the port charges and loading, discharging and transshipment costs.

94. Another significant advantage is its relative versatility as regards the nature of the cargo, since there are special containers, such as insulated and tank containers, and containers suitable for small lots of dry bulk cargo.

95. Container ships can also indirectly serve other ports located outside the route through the use of feeder ships, thus extending the area served by this system.

96. These advantages lead to significantly lower total door-to-door transport costs than those incurred with the traditional systems; they may also be lower than in other container transport modes.

97. (ii) Infrastructural and institutional requirements. The efficiency of this system depends basically on the volume and balance of the flow of cargo. Since the cost per ship-hour is very high, the volume of cargo received and generated at each of the ports served should be such as to economically justify the ship's call. If the traffic is not well balanced, the containers would have to return empty, with the consequent waste of capacity. Moreover, the container carrier should serve few ports in order to obtain the best possible results.

98. The port infrastructure should also meet some major requirements. The characteristics of these ships, particularly those of the third generation, call for port facilities which are still somewhat unusual in developing countries. To expand the infrastructure of a port and

/provide it

provide it with adequate equipment generally requires considerable investment, which could be compensated for only by a big demand for containerizable cargo.

99. The berth should be able to accommodate a ship 289 metres in length, with a draught of 13 metres, and the port should be equipped with cranes, rolling stock and open storage space to handle efficiently large numbers of containers. In addition, each transshipment point (railway and highway terminals, dispatching and receiving factories, free ports) should have the equipment necessary to handle containers.

100. Furthermore, since the optimum use of containers lies in door-to-door service, the land infrastructure should be extensive, efficient and integrated in order to permit their transport to and from the plants; otherwise, the main purpose of the system is defeated since the speed of rotation of the containers diminishes, which in its turn affects the turn-round time of the container ship.

101. Nor should there be limitations on the movement of large or heavy container-carrying vehicles. Barriers are frequently encountered in the shape of low structural resistance bridges and low tunnels, and also of limits on the maximum admissible weight per axle and on the total weight of the lorry adopted by some Latin American countries, compliance with which prevents the movement of container-carrying lorries.^{5/} The railways also present similar restrictions, particularly as regards the maximum dimensions.

102. Another basic requirement, of an institutional character, is that there should be administrative arrangements, such as customs and health regulations, to facilitate the flow of containers from the ship to the land control point nearest to the final destination, and vice-versa.

103. A secondary requirement which is also important is that the countries concerned should have efficient multimodal transport companies able to take charge of the distribution to the interior.^{6/}

^{5/} See CEPAL, Evaluación de la influencia de las restricciones de peso máximo admisible por eje en el caso del transporte automotor en la subregión andina (CEPAL/Borrador/TRANS/145), August 1976.

^{6/} See CEPAL, Evolution of the Latin American position regarding the negotiations for a Convention on International Multimodal Transport (E/CEPAL/L.141), 4 November 1976.

104. To meet all these requirements entails wide-ranging technical, financial and administrative action. This has been possible in industrialized countries with enormous trade flows, which therefore benefit significantly from any savings in transport achieved on the basis of economies of scale.

105. (iii) Limitations. The situation is very different in Latin America where the relatively small volume of trade in general cargo and the imbalance between the flows in both directions, in addition to the great number and variety of destination ports, make it doubtful whether it would be desirable to adopt such broad action. The main limitation in the adoption of a mode of this type lies precisely in the limited capacity to make full use of it, which cancels out the advantages it offers.

106. The nature of some products constitutes a partial limitation since, for the present, bananas, fish meal and some agricultural commodities in general cannot be successfully containerized. Coffee is an exception since container ships provide ventilation by means of ducts connected to the containers. Bananas may be shipped in refrigerated containers, provided the ventilation is properly controlled however, the use of these special containers is limited, because they return empty to the shipping ports and the interior of the producer country.

107. Fish meal, in spite of being technically containerizable, requires protection against contamination, thus entailing additional costs, besides which it is difficult to control the tendency of this product to spontaneous combustion.

108. Optimum use is made of containers when their capacity, in terms of both weight and volume is fully utilized on both the outward and the return voyage through the same port. This is not generally the case in Latin America, where it frequently happens that empty containers have to be carried to the export ports. Some fairly important flows in the region are composed of a great many different consignments; in such cases, therefore, the whole purpose of

/containerization would

containerization would be defeated, since it would be necessary to open the container at destination and handle, dispatch and remit separately a large number of small loose packages.

109. Lastly, the nautical conditions prevailing in ports may also represent serious limitations for this system, since to place a container in a cell of the container ship is always a task requiring great precision which is more difficult in bad weather or a swell.

Second mode: the container in roll-on/roll-off ships

110. This system presents a number of similarities with the first, the difference being that its advantages, requirements and limitations are proportionately less (see tables 2 and 3).

111. The main advantage lies in the relatively high productivity of roll-on/roll-off vessels, which have handled as much as 1,500 tons per hour.^{7/} Moreover, they have less capacity and speed than the large container ships, which appreciably reduces the need for the flows to be very large and the ports served to be few in number, which is an indispensable requisite in the first mode. In addition, roll-on/roll-off ships are more versatile as regards stowage.

112. At the same time, these ships' requirements in terms of port infrastructure are not exceptional, since they are 207 metres in length and have a draught of 9.9 metres (see tables 2 and 3).

113. Naturally, no shorebased cranes are needed for this system; on the other hand, towing vehicles are required to mobilize the trailers, and there must be enough open space in the port for them to move between the wharf and the place where the cargo is to be stored.

114. As with the first system, the use of containers is less efficient in roll-on/roll-off ships when flows are unbalanced or composed of many small consignments, or in the case of cargo that gives rise to health, ventilation or environmental problems.

115. This system, too, is limited by unfavourable nautical conditions in artificial or open ports, since any sudden movement of the ship hinders or prevents the flow of cargo.

^{7/} Marine Week, 25 June 1976, p.13.

116. The requirements concerning land infrastructure have a predominating influence in this mode, greater than in the first system since overland transport of semi-trailers is an indispensable element if it is to be really efficient.

117. Therefore, it yields the best results in countries which have medium-sized cargo throughput and an adequate port and land infrastructure and institutional structure. Such flow and port infrastructure conditions are frequently found in many Latin American countries, so that this mode is evidently a feasible option.

118. Another additional advantage of the roll-on/roll-off system is the possibility of combining in the same ship the transport of containers either separately or on semi-trailers.

Third mode: the container in barge-carriers

119. There is an evident contradiction in this system, since the chief merit of the barge-carrier is to load and discharge cargo without having to berth, which is contrary to what is implied by container transport. In practice, however, it has been possible for these two techniques to complement each other, the result being a model barge-carrier with a cellular hold for containers and the necessary gantry crane. It is used on routes where there is sufficient containerized cargo to be transported over land, combined with unitized cargo in barges which are moved by inland waterways to the interior of the country.

120. The main requirement is, therefore, that the port should permit a sufficiently efficient operation of loading, discharging and handling containers to minimize the barge-carrier's time in port.

121. It is interesting to note that containers can also be carried in barges.

Fourth mode: the container in multi-purpose ships

122. This system was conceived for those cases in which containerized cargo absorbs a small or medium share of total demand. As explained in the corresponding section, the multi-purpose ship has very sophisticated and complete handling equipment.

/123. Because

123. Because of its diverse uses, the transport capacity and speed of this ship are necessarily less than in the systems referred to previously, which means lower levels of productivity in the transport of containers than in the other three systems analysed. Comparatively speaking, the multi-purpose ship offers the advantage that it can be serviced basically with the same port facilities and infrastructure as those required by conventional ships.

124. The above-mentioned requirement for the effective use of this system fits the characteristics of some routes of several Latin American countries; it is therefore a perfectly feasible option for them, particularly if overall demand does not allow more specialized solutions, or during a transition period.

125. Finally, this mode presents the same limitations as the use of containers under the previous systems.

Fifth mode: the semi-trailer in roll-on/roll-off ships

126. This, like the first system, combines harmoniously the technological advances both in the presentation of the cargo and in maritime transport, which makes it a highly specialized system.

127. (i) Advantages. The main advantage is that no port equipment is required for loading and discharging at ports of origin and destination, and any handling on board the vessel or within the port premises is avoided. This makes for a high level of efficiency in port connexions and, since the ship's time in port is relatively short, of operational productivity.

128. This system imposes less drastic conditions than the first. The size of the flows need not be large, since the capacity and cost of this ship can be adapted to the volume of cargo. Nor is it so limited to serving only a few ports, and the wharves do not have to be specially designed to take deep draughts. It also has the great advantage of being able to berth by the bow or by the stern, for which it needs only a small space approximately the same length as the ship's beam.

129. The system is particularly useful in congested ports which were designed to service conventional ships and have little equipment. It also has the advantage of imposing no limitations as regards the nature of the cargo, except in the case of large bulk shipments.

130. (ii) Requirements. The ports must have adequate berths and spacious port premises free of obstacles for the manoeuvring of motorized equipment.

131. The commercial areas served should be efficiently linked with the ports by means of a complete and efficient road infrastructure without physical, structural or institutional limitations, which is a specially important requirements in this system since its essential purpose is door-to-door service. If this requirement is not met, the handling operations would have to be performed by conventional methods, in addition to which the total cost would increase owing to the unproductive use of semi-trailers and tractors.

132. The road infrastructure should meet the following requirements: it should be extensive enough to link efficiently and directly the centres where cargoes are generated and received with the ports; design specifications should allow for the use of large and quite heavy transport vehicles, whose effects can be absorbed by the structural resistance of the bridges and pavements, and tunnels and underpasses should be sufficiently high. The railways may carry out complementary activities, in which case they must provide efficient, timely and regular services.

133. On the institutional side, particularly in respect of the circulation of vehicles and customs and health regulations, the aim should be to facilitate the operation of this mode of transport. If this is not the case, its benefits are lost and the transport costs, instead of being lower, could rise in comparison with conventional transport.

134. The type of ro-ro vessel with side ports or lift-on/lift-off equipment and a ramp lowering in same direction as the longitudinal axis of the ship call for port infrastructure in the form of two perpendicular wharves.

/135. The

135. The adoption of this mode of transport obliges users to invest in rolling stock, the fleet of which must be sufficiently large to enable them to accompany the cargo from origin to destination and also to carry out loading or unloading operations at both ends of the maritime leg. The investment cost is offset when the mode works efficiently.

136. (iii) Limitations. This mode, like the preceding ones, requires that the components of a flow should be balanced in both directions, since otherwise the expected benefits are lost.

137. In addition, in this mode some of the ship's capacity is lost by not using the space under the semi-trailers. One method of using some of this wasted space is to offload the goods on board ship, but the main advantage of the system is thereby lost. In any case, when this method is used possible imbalances in the two directions of the flows are not important.

138. Strong swells hinder or prevent land vehicles from boarding ships, but much less than the stowage of containers in a cellular container ship.

139. A diversity of consignments, as in the case of containers, hinders the proper use of this system.

140. A seeming limitation is that the mode is not appropriate for serving centres close to a port. This mode was certainly designed for centres in the interior of countries, but it does not follow that it cannot be used for the centres close to the port; the advantages are mainly the same, unless the frequency of shipping is so low as to lead to under-utilization of the semi-trailers.

Sixth mode: Barges in barge-carriers

141. This highly specialized mode was specifically designed for the maritime transport of loads from centres at a distance from ocean ports but close to waterways suitable for barges; in these conditions it is very efficient and productive.

142. (i) Advantages. As the barges are loaded on or unloaded from the carrier in the bay or off a port, berths are not required and port congestion is avoided. In addition, the productivity of the barge-carriers may reach 1,525 metric tons per hour for the LASH type, and 2,475 for Seabees.

/143. For

143. For the same reasons as in the case of container ships, the efficiency of this mode lies in the minimization of idle time and thus it is efficient when it serves a small number of ports and demand is significant.

144. This mode combines well with ports which are congested or lack sufficient equipment or infrastructure to serve large ships, since the barges act as floating warehouses. Besides being in themselves a form of unitization, they can transport pallets and containers and are suitable for a great variety of types of cargo, such as grain, ores and refrigerated products, not to mention unusually large packages.

145. (ii) Requirements. One of the main requirements is of a technical-financial order, since for the mode to work efficiently there must be three times as many barges as the mother-ship can hold; there must be complete fleets at the point of origin, at the point of destination and on board the ship. This is the key factor for productivity in loading the barges on the carrier; the barges must be ready for the arrival of the carrier in order to be hoisted continuously and sufficiently rapidly.

146. The ports must have safe anchorages for the barges and a sufficient number of tugs. The labour force will sometimes have to work extra hours to meet the mother-ship's deadlines.

147. Barge navigation implies that there must be a flag for the barges; which are the property of the shipping company and must be operated by their own specialized staff. This means that there must be suitable institutional and organizational arrangements for the use of this mode.

148. Finally, another requirement is that the cargo must be lashed in the barges, which means higher skilled-labour costs.

149. (iii) Limitations. A train of barges cannot be shunted through rough water, because of the inflexibility of their couplings. There must also be a safe anchorage for the carrier, since the barges, particularly the Seabee type, cannot be lifted in big swells.

150. If the flows are unbalanced, the return of empty barges leads to higher costs, probably more than in the case of empty containers and semi-trailers.

/151. Like

151. Like containers, barges have limitations for the transportation of coffee and fishmeal but present greater pollution problems, especially with regard to the space lost in transport of pollutant goods at less than full capacity.

Seventh mode: pallets in roll-on/roll-off ships

152. This system is very similar to the second, the container on roll-on/roll-off ships, and the same type of objectives, the differences arising only from the form of unitization. The use of pallets is less efficient than that of containers but, particularly in the case of the throw-away type, the flows do not have to be balanced and there are fewer limitations with regard to specific cargoes.

153. The nautical limitations and the requirements for the kind of ship are obviously likewise valid for this system.

154. This mode is particularly suitable in cases where the volume or imbalance of the flows, the type of cargo and the port equipment prevent the efficient use of containers or semi-trailers.

Eighth mode: the pallet in multi-purpose ships

155. This is the least specialized of the eight systems and, perhaps for that reason, its advantages, requirements and limitations are significantly smaller. Nevertheless, it represents an advance over conventional forms. It is particularly suitable for linear routes, covering many ports which generate or absorb small flows made up of a variety of loads.

156. There are no great obstacles to the type of cargo, contamination of the cargo, balance of flows or port infrastructure and equipment; nor are they greatly affected by nautical problems, their only requirement being that the ports must possess smooth surface areas for the operation of fork-lift trucks.

157. The counterpart of this great versatility and absence of limitations lies in less efficiency, since besides lower productivity and longer transportation time between origin and destination, there is the manual handling of the cargo between pallets in intermediate legs, unless throw-away pallets are used.

6. Choice of appropriate modes

158. In earlier chapters we have described both modern technology used in the unitization of loads and the design of the ships transporting them, as well as the form in which the combination of both factors has generated a variety of new and economical modes of maritime transport of goods. These modes represent the real physical options available for international multimodal transport and thus an analysis of them should be the focal point of any choice of technology in this field.

159. The above description of eight modes and their advantages, requirements and disadvantages clearly shows that it is a complex task to assess them. Unfortunately, it is even more difficult because of the following important considerations.

160. In the first place, the technology which serves as the basis for the present modes is developing rapidly and the modes described in this paper only represent a cut in a continuous process. The rapidity of this development, compared with the necessary durability of investment in Latin America in ports and ships, means that there is a high risk associated with any decision. Furthermore, the choice of suitable modes depends on the soundness of forecasts about the direction, level and composition of international trade, which are notoriously difficult. While the adoption of international standards on certain characteristics of the new technologies, such as dimensions of containers and barges, will help to reduce these risks, it will not eliminate the threat which the appearance of totally different new systems represents for such investments.

161. Secondly, the decision centres which influence the choice of modes are scattered, and there are conflicts of interest among them; furthermore, there are no systems of communication through which to harmonize decisions taken independently. A partial list of those centres follows:

162. (a) Exporters. The exporter decides on the form of unitization of his cargo, bearing in mind, besides the importer's wishes, the options offered by the infrastructure and the land transport services

/between his

between his plant and the shipping port, and the latter's features, as well as the shipping services to the port of unloading, the features of that port and the land transport services from it to the final destination. His decision is influenced not only by these physical considerations but also by his own economic ability to use one or another mode of utilization and the tariff treatment it will receive throughout the transport chain, as well as the intervention of the different authorities in each link such as the customs authorities.

163. (b) Shipping companies. Traditionally, the shipping companies have decided on the kind of ship they use on the different routes they serve. This decision has generally been taken unilaterally, and sometimes at a level of a partial group of shipping companies or of a complete shipping conference serving a specific route. Since they operate under different flags, the cost structure varies from one company to another, with the result that the type of maritime technology chosen is the one best suited to the particular interests of each company. Thus, for example, some shipping companies have direct access to high government subsidies for the construction of ships incorporating advanced technology; other ship-owners take advantage of sailing under flags of countries whose general levels of wages and salaries enable them to hire officers and crews at a much lower cost than their competitors.

164. In deciding on the features of the new vessels they purchase, the shipping companies also take into account other facts which equally affect all ship-owners operating on the same route. These include the characteristics of the cargo, the port installations throughout the route, the attitude of the trade unions in the ports and institutional obstacles. They are also influenced by the real or potential competition of the shipping companies operating outside the shipping conferences.

165. (c) Ports. Ports, particularly those competing for the same traffic, play a particularly difficult role: they must serve

/simultaneously ships

simultaneously ships of different routes which require various forms of accommodation; they must anticipate the needs of exporters, consignees and shipping companies and provide suitable installations, but without exaggeration; finally, they must take into account in each case the cost of the resources available, such as, for example, labour or capital for new investments.

166. It may be seen from the above how difficult it is to harmonize decisions so that the choice of modes of transport may satisfy as far as possible the interests of the different centres which participate in international trade and transport. The more specialized the mode of maritime transport, the more difficult this harmonization, since specialization in itself reduces some costs and increases others. This is why the need for harmonization has only arisen in recent years, while in the past, when cargo was transported in the traditional break-bulk ships, it had very little importance.

167. There is also a clear need to create machinery with which to analyse and take decisions jointly on the modes to be chosen, and to put an end to the practice of taking unilateral decisions which are subsequently imposed upon the other interested parties. Far from solving a particular problem, unilateral decisions increase the danger of mistakes, with the corresponding damage, since some elements will necessarily be lacking in the analysis.

168. It is just as damaging not to take conscious decisions on the new modes or to refuse to participate in a joint analysis. The march of technology is inexorable and to play the ostrich would be fatal both for trade and for the transport companies and the port.

169. At present there are no fora in the region which bring together the interested parties and enable them to decide jointly on the particular combination of modes which best satisfies the needs and interests of all concerned. The creation of such fora is a pressing need, and while different international bodies can provide technical assistance for the complex studies defining the advantages and disadvantages of each option, only the governments can take the initiatives which will create or institutionalize suitable regional fora of this kind.

Annex

Composition of the present fleet of barge-carriers

Central Gulf Lines	3 LASH ships	Capacity 89 barges, between the Gulf of Mexico and northern Europe, and
	3 feeder ships	Capacity 8 barges.
Combi-Line (Hapag Lloyd Holland America Line)	2 ships	Capacity 83 barges, total number of barges 410, velocity 18 knots, between northern Europe and U.S. Gulf and Atlantic.
Delta Lines	3 ships	Capacity 74 barges and 288 TEU, velocity 18-22 knots, total barges 250 of 368 LT/490 Metric Tons, between U.S. Gulf - Caribbean - Atlantic coast of South America.
Pacific Far East Line	6 ships	Capacity 50 barges and 534 TEU, velocity 23 knots, total capacity 1.3 million feet, dead weight 29,820 tons.
Prudential Line	5 ships	Capacity 73 barges, 20,263 LT/1,428,500 cubic feet, velocity 22 knots, between United States - Atlantic Coast - Mediterranean.
Waterman Steamship Corp.	3 ships	Capacity 89 barges, between U.S. - Atlantic Coast - Persian Gulf, India - Pakistan.
Lykes Bros. Steamship Corp.	3 Seabees	Capacity 38 barges of 847 TW/1,108 Measurement Tons, velocity 18.6 knots, total barges 246, between United States and northern Europe.
Rudkobing VI, Denmark	1 BACAT	Capacity 18 barges of 140 MT, or 10 own barges and 3 LASH barges, total own barges 63.

BIBLIOGRAPHY

1. United Nations, Containers, pallets and other unitized methods for the intermodal movement of freight: application to the developing countries, ST/ECA/120, New York, 1971.
2. United Nations, Coastal Shipping, Feeder and Ferry Services, ST/ECA/134, New York, 1970.
3. United Nations, Physical requirements of transport systems for large freight containers, ST/ECA/170, New York, 1973.
4. United Nations, Economic Commission for Asia and the Far East, Transportation by Unitized Loads and Co-ordination With Other Modes of Transport, E/CN.11/TRANS/Sub.1/60, New Delhi, 26 September 1969.
5. United Nations, Economic Commission for Asia and the Far East, Impact of Technological Developments in Shipping on the Choice of Ships Suitable for the Maritime Traffic of the Developing Countries, E/CN.11/TRANS/Sub.3(X)L.6, Bangkok, 14 September 1973.
6. UNCTAD, Unitization of cargo, TD/B/C.4/75, New York, 1970.
7. UNCTAD, Technological Progress in Shipping and Ports. Technological change in shipping and its effects on ports: a note on the problem, TD/B/C.4/129, Geneva, 9 October, 1975.
8. UNCTAD, Technological change in shipping and its effects on ports: The impact of unitization on port operations, TD/B/C.4/129/Supp.1 Corr.1., 20 February 1976.
9. UNCTAD, Technological change in shipping and its effects on ports: Cost comparisons between break-bulk and various types of unit-load berth, TD/B/C.4/129/Supp.2, 4 November 1975.
10. International Trade Centre UNCTAD/GATT, Unitization: The Transport Revolution, "International Trade FORUM", Volume VIII, No 4, October-December 1972.
11. Juan Coeymans R., Transporte Intermodal Internacional de Carga, Universidad Católica de Chile, Departamento de Transporte, Documento de Trabajo No 11, Santiago, december 1975.
12. National Academy of Sciences - National Research Council, Roll-on/Roll-off Sea Transportation, Publication 471, Washington D.C., 1975.