Land Use Constraints in Locating Intermodal Terminals

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Intermodal freight terminals are land intensive, in that each requires a substantial dedicated land area, and they are usually sited within urban areas. Some are locationally constrained due to mode dominance (e.g., a container port must be located at waterside). For these reasons, developers and users of new intermodal freight terminals may find themselves limited in their choice of locations. Existing facilities may also have limited opportunities for redevelopment or expansion or both. In addition to natural locational constraints on intermodal freight terminal site selection, there can also be a number of social or environmental constraints. Noise and around-the-clock operation are but two examples. Existing intermodal terminal facilities are often only tolerated in urban areas, and the land may be rezoned to a higher use by those who advocate urban redevelopment. Thus, due to possible zoning restrictions based on environmental or other similar constraints, developers and users of intermodal freight terminals may find their locational and operational options severely limited, or exercisable only at drastically reduced levels of efficiency. Special land use zoning or urban land development under the joint-use concept is recommended in order to assure user viability of new or expanded intermodal freight facilities to serve all forms of goods transport. Community education and involvement may also be required to prevent unwarranted restraints.

Applied to freight transport, the term intermodal may have become one of the most used--and misused--of terms. To a water carrier, intermodal means transferring goods to or from ships at dockside. To the railroads, intermodal normally connotes piggyback [trailer-on-flatcar (TOFC)], which involves rails and motor trucks.

The people who draft intermodal cargo container standards have adopted a broader definition of the term. They define intermodal as "the carriage of goods by two or more modes of transport" (1). From this, it would appear that intermodal terminals may be defined as locations where freight is transferred between any two or more freight modes, including airports, piggyback (TOFC) yards, pipeline terminals, and sea, lake, and river ports. The freight modes that use such facilities would be any appropriate mix of trucks, railroads, ships, barges, aircraft, or pipelines.

In real-world operations, some intermodal transfers are unlikely (e.g., pipeline to aircraft) while others are encountered frequently (e.g., ships to trucks or railroads). However, any transfer of freight between two or more transport modes is intermodal, and where such a transfer occurs is, in fact, an intermodal terminal.

INTERMODAL FREIGHT TERMINAL REQUIREMENTS

The requirements for viable intermodal freight terminals, in and of themselves, provide insight into why such facilities may face locational or operational constraints. Therefore, it is essential that these requirements be categorized and classified. Some intermodal terminals are basically mode dominant in that their location or function is determined primarily by a single transport mode. Ports fall within this category because their location is dictated by the presence of navigable water. To a lesser degree, the same may be said of airports, where the primary consideration is unencumbered space to accommodate aircraft operations. Pipeline terminals, too, represent a marginal form of a mode-dominant facility.

At the other extreme, trucking operations can adjust to nearly any locational environment. Therefore, intermodal terminals that involve trucking may be considered unconstrained insofar as that mode is concerned. Occupying a middle ground, so to speak, are piggyback terminals operated by railroads. Although these must be adjacent to rail trackage, some latitude can be provided by constructing spur or feeder tracks that connect the terminal to main rail lines.

Regardless of the modes involved, intermodal terminals, by their nature, are land intensive. This is to say that they require substantial dedicated land areas if they are to function efficiently. A 1981 conference of transportation specialists put this succinctly in noting that (2, p. 48) "land availability is an important prerequisite for the larger intermodal terminal complexes. Since land assembly can be difficult in large urban areas, it constitutes a major challenge in land use planning."

Here, also, another vital aspect of intermodal freight terminals was brought into focus, which is that these facilities are nearly always associated with an urban area. This association can further complicate intermodal freight terminal requirements. All urban-goods movements have long been the subject of intensive study and analysis simply due to the added costs and congestion inherent in moving freight within areas of high traffic densities.

Earlier on, urban freight movement research had concentrated on such micro land use problems as loading zones and off-street parking. Model solutions for these micro problems seem to now be well in hand (3). In the process, the overall roles of the cities have likewise been examined and delineated, and both their strengths and weaknesses have been noted (4).

Regarding single-mode freight terminal requirements, basically only those applicable to trucking have been addressed as they relate to locational needs within urban areas. However, the high level of trucking flexibility provides considerable latitude in siting facilities (5). Initial investigations have been attempted, which relate trucking industry requirements to those of other transport modes in terms of intermodal terminals (2, pp. 46-47; 6), but to date such efforts have lacked specific input from the other freight modes.

LOCATIONAL NEEDS AND PROBLEMS

Empirically, intermodal freight terminals may be characterized as (a) requiring relatively large tracts of land, and (b) being almost always located within an urban area. Operating from these basic assumptions, the 1981 Engineering Foundation Conference on Goods Transportation in Urban Areas (GTUA) raised five questions that the conferees considered germane to the problems of intermodal terminal location (7, pp. 43-44):

1. Does the quantity and quality of freight movement availability influence land use in urban areas? If so, can transportation planners help desired land use patterns? Are certain modes of goods movement preferred for special types of land use or site development? Does lack of specific quality of goods transportation inhibit urban land use or economic development?
2. Can efficient freight operations, especially terminal operations, be carried on without significant adverse economic, environmental, or land use impacts? Where such impacts exist, do they vary significantly between different modes of transportation?

3. What can be done with land now considered unproductive because of obsolete or underutilized freight transportation facilities?
4. Are there certain transportation activities which are potentially so harmful to the urban environment or to society (e.g., hazardous material wastes, coal terminals) that they require protected areas?
5. How can goods movement requirements be incorporated into an overall urban land use plan in both the long and the short range?

These concerns vis a vis freight terminals and land use are by no means a new issue nor one unique only to the 1981 GTUA conference. Eight years earlier, in 1973, a similar conference produced a probe group report on the social, environmental, economic, land use, and technical problems in this area (8). Specific motor carrier terminals had been the subject of a 1976 FHWA study concerned with ameliorating neighborhood impacts and that also considered buffers (against) noise (9). Nor were the more recent concerns merely a repetition of earlier findings. Participants in the 1981 GTUA conference received status reports dealing with such problems as the redevelopment of 4,000 acres of underused multimodal terminal sites in St. Louis. Further, they received detailed information concerning community disruptions being caused by new and expanded intermodal coal terminals. Some specifics here included severance of community services, emergency vehicle delay, and lowered community growth and vitality (10).

LAND USE CONSTRAINTS

Clearly, a case was being made (at the 1981 GTUA conference) for recognizing the special and unique nature of intermodal freight terminals insofar as land use is concerned. Just as clearly, there was a realization by the attendees that this unique nature exposes such facilities to one or more land use constraints. Such constraints can be categorized as locational, operational, and environmental.

Locational Constraints

Locational constraints may take the form of denied zoning or of restricted-use zoning that could limit intermodal facilities to specific areas or even to specific locations. Here, one would hope that enlightened planning and unbiased appraisal would permit the placement of intermodal terminals at locations viable for both users and developer-owners. However, in real-world terms, this may be more than can be reasonably expected. Intermodal freight terminals are land intensive, and there is competition for sizable land parcels in virtually all urban areas.

As examples, major modern airports seldom occupy less than 1,000 acres of land. Seaports can easily use an equal amount of landside area, with container terminals being particularly land intensive in this regard. Rail piggyback terminals can require up to several hundred acres for full operational control and on-site vehicle storage. Even the single-mode motor carrier terminal--if it is a major break-bulk facility--may occupy 80 or more acres of land. In virtually all instances, as noted earlier, these large land parcels are within or immediately adjacent to an urban area, where conventional wisdom indicates that land is at a premium.

To return to a point made in the opening section of this paper, overall locational constraints may be dictated by the mode or modes of transport being served. That is to say, a seaport cannot be separated from water nor can an airport be reasonably located on hilly terrain. Here the line between locational and operational constraints becomes, of necessity, blurred.

An example of locational constraints may be found at the Potomac intermodal rail terminal in Arlington, Virginia, which is immediately adjacent to Washington, D.C. This long-used site is literally locked in on all four sides by highways and recent commercial developments. Short of complete demolition and reconstruction, improvements are virtually impossible; in any event, expansion is impossible. The site is also viewed as a prime candidate for high-type commercial redevelopment by local real estate agents and government land use planners.

Operational Constraints

Operational constraints may be characterized as those constraints on intermodal terminal facility sites that are dictated by the day-to-day requirements for economic viability. Ease of access, economic siting, and proximity to markets are prime examples. A specific example could be the new intermodal freight facility at Long Beach, California (11). There, an integrated terminal at portside will permit rapid intermodal freight transfer, which previously required an inefficient bridging leg between Long Beach and Los Angeles.

Accessibility can be one of the most serious operational constraints at many intermodal terminals (6). It is essential that goods moving intermodally be able to flow freely both into and out of a modal transfer area. Thus, a piggyback terminal located in a congested urban area provides less-than-optimum accommodation for the trucks that deliver and pick up trailers. Similarly, airports with restricted commercial vehicle access (which is not uncommon) cannot offer a land and air interface with minimum delays.

In economic terms, siting an intermodal facility in an area of high land values, in a high tax location, or in an area subject to such adverse conditions as flooding or fog can impose operational constraints of a different type. Because intermodal terminals are land intensive, developers and operators want to minimize both acquisition and operating costs. Further, use of irregular terrain involves excessive site preparation costs or maintenance or both. It must also be recognized that limited accessibility (as discussed above) will have an adverse economic impact on the operation of an intermodal terminal in terms of time, fuel consumption, and the like.

Two current examples of operationally constrained intermodal facilities are the Delaware Avenue docks in Philadelphia and Dulles International Airport, which is some 20 miles outside of Washington, D.C., in Virginia. At the Philadelphia facility, trucks, railroads, and ships all vie for limited dockside space and even more limited access. Predictably, it has difficulty attracting business. At Washington's Dulles Airport, commercial vehicles are currently barred from all direct access routes and literally must use back roads. Again, predictably, most air freight movements are being diverted to the more accessible Baltimore-Washington International Airport some 60 miles to the east.

Market proximity in an urban area is sometimes looked on as being relative over time. For example, there is an observable continual shift in business and commercial patterns within urban areas. Industries move farther from city centers over time, while new satellite communities may develop in somewhat unpredictable locations. Redevelopment of older areas can sometimes arrest, or even reverse, these movements.

Again, conventional wisdom based on experience indicates that intermodal terminals be located so as to provide both proximity to current markets and a best estimate of future markets. In terms of highway links, proximity based on minimum transit times, rather than minimum mileage, has been found to result in the best overall facility siting. In this instance, advantage may be taken of major highway arteries.

This approach is not necessarily applicable to all intermodal facilities, however, due to the locational constraints noted earlier. Thus, a compromise may be required in which all factors are weighed, i.e., mode-specific needs, land availability, access, costs, and market proximity. Although such an approach can never yield an ideal solution, if properly done it can provide for a best available location.

Environmental Constraints

Environmental constraints on intermodal freight terminals could take a number of forms. Hours of operation might be specified, as may the maximum permitted noise levels. A major facility might be classified as a point source, which requires an environmental impact analysis of the air pollution that would be generated. Because the very term environmental impact carries such a wide range of connotations, it is most difficult to predict or evaluate all of the aspects of an intermodal freight terminal operation that might be affected.

However, it is apparent that any time-of-day or day-of-week constraints on the operations of such terminals would severely inhibit both efficiency and productivity. Today, many modal as well as intermodal freight terminal facilities operate literally around-the-clock. Time restraints would result in unacceptable back-ups or an uneconomically large facility in order to provide required capacity based on limited operating hours.

Already some major airports have limited their operating hours due to environmentally generated noise constraints (no night flights). These airports can exhibit such (expected) problems as underuse and artificial volume peaks. National Airport in Washington, D.C., is a prime example. This heavily used facility bans commercial flights from 10:30 p.m. to 7:00 a.m.--the most preferred times for air freight. Flight patterns and noise-abatement procedures are also enforced, as are maximum noise levels.

Environmental constraints based on noise or on visual intrusion from high-intensity yard lights could affect all types of intermodal freight terminals at one time or another. Trucks entering and exiting, aircraft, shift-side cranes, and rail cars being shunted are all phenomena that can and do occur in intermodal operations.

NEW TERMINALS VERSUS REJUVENATED FACILITIES

All of the above requirements and constraints can come into play when a decision must be made regarding continued use of an existing intermodal freight terminal versus construction of a new facility. Questions to be addressed are, Can the present terminal be expanded, modernized, or otherwise made more efficient? and Is there a better intermodal terminal location available?

Users have sometimes discovered that land developers, community redevelopment groups, and even the general citizenry are eagerly awaiting the time when an existing facility becomes outmoded. Their goal is to rezone the land such a facility occupies to what is sometimes referred to as a higher use, but which in reality may represent a device for removing what is considered to be a local eyesore.

At the same time, terminal developers and users may find that their alternatives are severely limited. Land parcels of sufficient size to support new, relocated, intermodal operations may be unacceptable from an operational standpoint, or the costs involved in purchasing and preparing the site may make the proposed location uneconomic. Zoning restrictions, access limitations, and all of the other factors that must be considered when siting a new facility may militate against the establishment of a new intermodal terminal. Even the expansion of existing facilities could be affected by all or some of these constraints.

SOLVING THE CONSTRAINT PROBLEMS

The problems described above are neither new to the intermodal terminal planner nor are they necessarily insoluble. Transportation requirements and land use planning need not be an adversary procedure as, for example, has been demonstrated in Maryland (12).

In addressing the overall problem of freight terminals within generally urban areas--and, as noted, such terminals are primarily urban-area oriented--the 1981 GTUA conference attempted to place the issue in perspective with a series of recommendations. The conference report recommended "use (or reuse when currently deteriorated) of parcels of transportation-oriented land within the inner urban areas, in such a way as to improve urban goods flows, reduce overall transportation requirements, and generally enhance the economic viability of the region" (7, p. 44).

The same conference went on to make other, more specific, recommendations. These included, "where necessary zoning ordinances should be modified to include freight terminals specifically as a preferred land use in the most appropriate locations" (7, pp. 45 and 49), and that there should be a "master guide to terminal location and zoning" (13). Other groups, too, are examining the interrelations between land use and transportation. A recent report from TRB (14) explored the implications and opportunities associated with joint development under the land use concepts.

CONCLUSIONS AND RECOMMENDATIONS

Developers and operators of intermodal freight terminals must be prepared to recognize that such facilities are not universally accepted as ideal land users. Communities and community groups may view these terminals as being undesirable neighbors, with possible reactions ranging from tolerance all the way to militant opposition.

As intermodal terminals are redeveloped, constructed, or expanded, it is probably inevitable that the developers and users will encounter constraints that may render their operations less-than-optimally efficient. Such constraints could, conceivably, literally result in evicting an intermodal terminal from its existing site. More probable would be environmental restrictions on operations that could at least partly incapacitate a terminal by limiting hours of use, access, on-site storage, and so on. Presence of hazardous cargoes at an intermodal terminal could only exacerbate possible constraint scenarios.

Following recommendations that emerged from the deliberations of the 1981 GTUA conference, intermodal freight terminal designers should be prepared to present convincing arguments in favor of special-use zoning that would recognize the requirements of

such facilities, and the limited viable available alternatives.

Further, they must be prepared to justify such zoning through any available appeal processes, such as mobilizing, when necessary, business, industry, and civic leaders in order that the community as a whole may be made aware of the need for intermodal facilities. Emphasis should focus on reduced overall transport costs, energy conservation, reduced congestion, increased employment, and, most important, a more efficient and less publicly intrusive transport network.

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Rail and Water Terminal Interface

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A discussion of how the growth of bridge traffic and today's competitive industrial environment have forced changes in marine intermodal terminal design trends is presented. The objective of the changes is to improve productivity of both the terminal operation and the transportation system in which the terminal participates. Specific examples and case studies of productivity improvements in terminals and in transferring containers to and from the marine terminal and the railroad are presented.

The marine terminal is an increasingly important partner in a more complex, competitive, and integrated world transportation network. Competition among terminals for local traffic has spurred design changes to improve productivity and lower the costs of container moves. Also significant are design changes in response to the requirements for terminals to interact more efficiently with railroads; therefore, the overall productivity of intermodal transportation networks is raised. This requirement results from the growth of bridging, which is a relatively new segment of the transportation industry. Bridging involves the use of both rail and ship for transporting containers moving under a combined bill of lading.

There are different types of bridges. A land bridge involves moving containers from port to port by rail. For example, a shipment from Japan to France would be off-loaded at a U.S. West Coast port, shipped by train to the East Coast, and then loaded onto a vessel to complete the journey to Europe across the Atlantic Ocean. Also, combined bills of lading are used increasingly to ship containers from a port by rail to inland destinations--a microbridge. A minibridge is for when a container is unloaded at one port, shipped by rail over a high-volume route to another port, and then shipped from this second port by rail (or truck) to its final destination.

Since 1972, bridging has been one of the fastest-growing segments of the transportation industry. It was made possible by the maturing of the marine container freight transportation system that began about the same time. Figure 1 shows that the level of U.S. import minibridge traffic has grown from approximately 0.7 million long tons per year in 1976 to 1.1 million long tons per year in 1981. (Note: Traffic data in this paper are based on import minibridge movements because of data availability. Although indicative of trends, actual growth rates of total bridge traffic may vary.) This growth rate of approximately 10 percent/year is substantially higher than the annual growth rates of 5 percent or less for all waterborne and rail traffic during the same period.

The growth in bridge traffic is due to the relative economic advantage of using railroads to transport containers from the first landfall port to inland points rather than using all water routes. This is true even when the hinterland destination is another port on the other side of the North American