tion in their departments of transportation that is responsible for port development. Clearly, the river states and cities will have to give more priority to ports and their investment in ports. They would be assisted in such a shift in transportation priorities and investments if federal assistance were given to water ports in the same proportion as it is given to airports, highways, transit, and other modes. A positive statement of federal interest in port development would also assist in rearranging state priorities.

But such a policy declaration does not appear to be forthcoming. Moreover, the federal government appears to be so preoccupied with deregulation that it is not apt to recognize the need for coordinative types of regulation in the near future. Inland ports must be assured of equitable inland access if they are to perservere in the face of almost arbitrary bridge rates to coastal ports. Laws that require rates that are not unduly discriminatory against regional ports, make through routes and rates mandatory, and provide for equitable divisions of through rates are already on the books. Unless they are enforced, the barge lines will not enjoy equitable inland access to diversified general cargoes by rail and truck. Instead of acting as intermodal feeders, the trucks and railroads will cut parallel long-haul rates and keep short-haul rates for the river ports prohibitively high.

CONCLUSIONS

1. The IFTFC is potentially the best answer to the urban goods movement problem.
2. The IFTFC is one of the few ideas that is beneficial to carriers, shippers, consumers, and the urban public.
3. The IFTFC is difficult to implement because of archaic regulation, some union opposition, some shortsightedness by carriers, and some lag in public port and terminal policy.
4. The inland waterway ports form a good but not an ideal network for launching a regional network of IFTFCs.
5. Implementation of an intermodal terminal network at the inland ports will require (a) the barge lines to diversify and expand their penetration of the general cargo markets, (b) the river port cities and states to consolidate terminals and increase the priority accorded to ports in transportation financing, and (c) a positive federal ports policy and enforcement of coordinative regulations that require equitable interchange at the river ports.

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Publication of this paper sponsored by Committee on Inland Water Transportation.

Local and Regional Socioeconomic Impact of the Intermodal Freight Transportation Facilitation Center

Don Lang, Jr., Washington University
Donald E. Lang, Civic Systems, Inc., Kirkwood, Missouri
David Wuenscher, Real Estate Analysts, Limited, Clayton, Missouri

The objective of this research is to formulate a methodology that can be used to evaluate the feasibility of developing an intermodal freight transportation facilitation center (IFTFC) for a region. The purpose of this methodology is to test the feasibility of the IFTFC and to examine its regional effect.

This paper is concerned with the regional socioeconomic impact of an intermodal freight transportation facilitation center (IFTFC). Because of the importance and growing awareness of the concept of IFTFC, the following thoughts on the subject by John T. Norris of the Office of Facilitation, U.S. Department of Transportation, should be reiterated.

Traditionally, a measure of the economic impact of a coastal port on local and regional interests has been a criterion of measurement to justify (a) the existence of the port and (b) the alteration or expansion of the port or both. In more recent years, social impact has become a required consideration, primarily in the context of environmental protection. Even more recently, social impact is occurring in a few major port areas from the point of view of aesthetic and environmental beautification. In almost all cases, however, considerations of socioeconomic impact have been either shortsighted or even after-the-fact processes. The emergence of the inland waterway-Great Lakes port "system," however, provides a new opportunity. That emergence is motivated by new transport technology such as LASH, Seabee, containerization, and roll-on/roll-off (ro/ro); by new techniques of transportation facilitation such as feeder support systems that penetrate the coastal and inland waterways of the nation; and by intermodalism. Thus, the timing is right for before-the-fact, long-range considerations of socioeconomic impact with regard to U.S. inland waterway and Great Lakes ports in the context of IFTFCs.

Systematic analysis through research will ensure advance (before-the-fact) consideration of the local-regional socioeconomic impact of the IFTFC concept for waterway ports. The predicted impact should be

portrayed in two distinct time frames: 1990 to 2000 and beyond the year 2000.

The first time frame is important because it relates to the period during which total national transportation demand is expected to double that of today. Without proper or adequate regard, that can be a period of irrationality and shortsightedness, particularly as to decisions of land acquisitions. That could lead to an adverse impact on society and decisions on investment and expansion that could in turn provide a false economic stimulus. That period is also potentially dangerous because of the difficulty of rationalizing what is essentially a long-term investment commitment into a short-term development situation.

In considering the time frame beyond the year 2000, we must do so in terms of projected technological advancement of the transportation industry and the effect such advancement can be expected to have on the transportation industry and the supporting infrastructure. Such projected effect will be interpreted in terms of labor requirements, qualifications, and skill; land and facility requirements including, for example, feeder highways; and supporting (service) industry requirements. The latter requirement will have a peripheral (indirect) economic impact.

Furthermore, an assessment must be made of the ability of a modern waterway port IFTFC to attract new industry and labor to the local and regional areas. A measure must be taken of the impact of such a facility on the character of business in the area, i.e., domestic commerce versus international trade. The premise is that a well-equipped port that offers efficient access to foreign and domestic markets can be expected to have an impact on the character of business in the area. Social impacts beyond the environmental aspect and including but not limited to land use must be identified and analyzed.

In carrying out the needed research, much benefit can be derived from a review of the experiences of the deepwater (coastal) ports, more to avoid than to reproduce or copy their mistakes.

MODELING METHODOLOGY

Figure 1 shows a flow chart of the modeling methodology for examining the socioeconomic aspects of the regional feasibility of IFTFCs. Each of the 14 steps of the operation is further subdivided into areas that require individual examination.

Step 1 begins with the local and regional analysis of the region and is made up of eight areas that are analyzed for past, present, and future growth patterns and trends. The specific subject areas of step 1 begin with area 1.1--an examination of the population of the region for its mix or distribution levels as to age, sex, race, religion, education, household type, and income. In area 1.2, the housing of the region is examined for its mix, value, condition, acreage, design type, and makeup. The employment of the region is determined in area 1.3: the number of employed persons working in basic industry, local service industries (retail, services, and education), and the unemployed. Area 1.4 is concerned with the amount of land area and its value for the region. The various categories of land use considered are basic industry, local serving, residential, streets and highways, open, undeveloped, and other. In area 1.5, the public facilities of the region are examined as to their type and location, and in area 1.6 the region's tax base and authority are investigated as to tax revenues generated and the associated services provided. In area 1.7, zoning patterns and current purposes of zoning throughout the region are analyzed. Finally, in area 1.8, the financial strength of the region and its ability to generate funds for public works projects are analyzed.

In step 2.0, regional modal and intermodal transportation stock is inventoried as to its condition and location. In area 2.1, the primary transportation modes--rail, pipe, water, motor, and air--are examined. In area 2.2, the primary transportation carriers (e.g., freight forwarders, parcel post, air express, and shippers' associations) are examined. Finally, area 2.3 concentrates on the intermodal capabilities and linkages of piggyback, trailer ship, LASH, ro/ro, and Seabee.

In step 3 the information form step 2 is used to review the modes and their operating characteristics concerning costs, revenues, profits, regional capabilities, energy use, environmental effects, employment, and ability to use containerization.

In step 4 the extent and type of actor groups that exist throughout the region are determined. The inventory begins with area 4.1, the examination of the political and governmental makeup of the region. In area 4.2, the political officials of the local, county, state, and federal governments that represent the region are examined. In area 4.3, the rest of the actors that have an effect on the region are studied. This group would be composed of chambers of commerce and other business, labor, and transportation-affected groups (modal actors, shippers, and manufacturers), environmentalists, and so on. In areas 4.4 through 4.8, sociopolitical pressures, environmental pressures, funding capabilities, implementation processes, and the inherent bureaucracy as well as specific problems and objectives peculiar to the region are reviewed.

In step 5, the ways in which the above groups, structures, and constraints react and interact given certain situations or stimuli are examined.

Step 6, which is made up of 10 parts, is concerned with analyzing physical and locational factors that affect IFTFC development. Area 6.1 begins with the definition of the market areas that are relevant to and affect an IFTFC project. Then, in area 6.2, the existing supply and demand capabilities for handling the various types of commodities are studied. Area 6.3 estimates the general market characteristics and their trends, and area 6.4 estimates future demand. In area 6.5, the competitive nature of the market in the transportation of goods within and through the region is evaluated, and in area 6.5 the outline of a tentative development approach begins. In area 6.7, the input-output model is used, and in area 6.8 multiplier analysis for the region is performed. The general project development plan, which uses all the data developed above, begins to take shape in area 6.9. Finally, in area 6.10, the project development life cycle is determined.

In step 7, the determination of the future states of the region is completed, and in step 8 a set of possible development options, given the possible system states, is provided. Given the above two inputs, a Markovian approach is applied to determine the level of development of IFTFC operation that would be best for the region. Given this level, the best operation and makeup of services that should be offered are determined in step 9. Tables 1 and 2 (2) give possible transportation and information services that could be offered by an IFTFC.

In step 10, site-location analysis of the IFTFC is performed; the final site location is determined in area 10.1. In step 11, the financial implications of development costs of the IFTFC are examined. Areas 11.1.1 through 11.1.3 determine the final IFTFC development costs, operating expenses, and projected operating income for the size of operation to be developed. Then, in area 11.2, the net operating income or losses attributable to the IFTFC can be determined. This task also examines the region as to any net benefits that will result from the develop-

Figure 1. Study methodology.

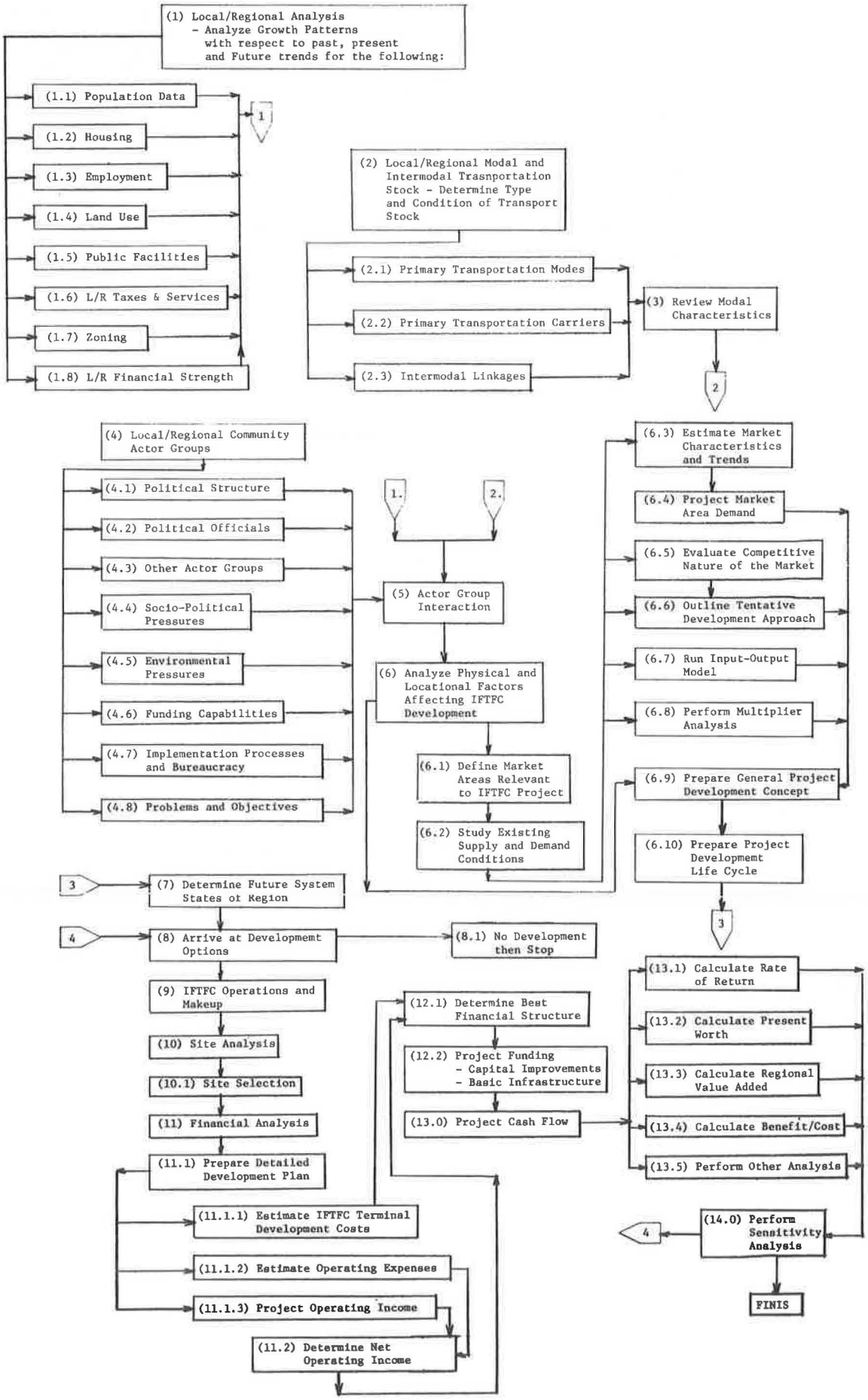

Table 1. IFTFC services.

Service	Mandatory	Desirable
City delivery	X	
City pickup	X	
Consolidation of pickups for delivery to carrier's terminal	X	
Consolidation of pickups for line-haul by carriers		X
Consolidation of pickups for carrier pooling		X
Receipt and breakdown of inbound freight for local delivery	X	
Automated billing	X	
Automated tracing	X	
Over, short, and damaged reporting	X	
In-process (short-term) storage		X
Weight and size determination	X	
COD collections	X	
Palletization		X
Containerization and unitization		X
Interline and intermodal transfers	X	
Automated documentation processing	X	
Management information and reports	X	
Pooling of equipment		X
Container exchange		X
Equipment rental and leasing		X
Equipment service and storage		X
Bonded pickup, delivery, and handling		X
Bonded storage (temporary)		X
Specialty pickup, delivery, and handling		X
Financial services		X
Transportation consulting services		X

Table 2. Services of IFTFC management information system.

Function	Service
Preparation of master bills of lading and waybills	Prepares uniform master bill of lading for consolidated shipments (computer-prepared and forwarded via communication link to carrier or destination IFTFC or terminal) and also accompanies shipments
Recording of shipment status	Maintains on-line status record of in-process shipments
Pickup-and-delivery service routing and scheduling	Optimizes routing and changes in routes and schedules to increase equipment utilization and customer service
Pickup-and-delivery truck load planning	Plans truck loading sequence to minimize time at each stop
On-line shipment tracing	Traces lost and special shipments between IFTFC, carriers, shippers, and consignees
Reporting of loss and damage	Prepares and processes reports and maintains statistical records of manner, location, incidence of occurrence, and disposition
Claim status	Prepares and processes claims and maintains records of disposition of claims
Price auditing	Conducts thorough price audit of IFTFC and others using IFTFC
Consolidated billing	Provides individual memos and generates central billing to carriers using IFTFC
Communications	Provides total integrated communications network including interface with carrier systems and other IFTFCs
Equipment and container status	Maintains on-line record of current location and status of IFTFC equipment and containers and carrier equipment operating in the IFTFC network

ment of the IFTFC (e.g., less pollution, less energy used).

In step 12, the best financial structure for IFTFC development, as well as where and how much of these funds will come from the potential services available, is determined.

In step 13, the projected IFTFC cash flow for years 0 to 25 and expected rate of return, present worth, regional value added, and regional benefits versus costs are calculated. Finally, in step 14, a sensitivity analysis is performed on the steps given above so that reasonable conclusions can be drawn concerning IFTFC development.

FUNDING

Because of the large cost investment in the IFTFC, combinations of the following methods of funding would be the best strategy for developers to follow.

Categorical Granting

One method of funding the various entities involved in the IFTFC is to use the ongoing categorical grant approach. This approach deals with programs that are administered at the level of the state department of transportation (DOT) (in some cases where state DOTs do not exist, modal agencies within the state would administer the program) and coordinated through the local A-95 clearinghouse. Basically, implementation relies on existing legislative structures subject to typical local matching requirements. In this way the individual modes rely on the existing implementation methods in order to develop the public and private intermodal transportation facilities at the IFTFC site.

Arterial Roads and Transit Needs

Arterial roads and potential site-related transit needs currently have categorical granting capabilities. Arterial roads have the federal-aid urban system and transit has the National Mass Transportation Assistance Act of 1974 for possible funding capabilities.

Rail, Air, Pipe, and Industrial Guideway System

Currently, no capital funding categorical grant capability exists for federal funding of rail or rail-yard activities. U.S. DOT-Federal Railroad Administration policy may change on this in the near future. A practical source of funds for rail capital projects that are the property of the IFTFC authority may be the Economic Development Authority capital granting as a "qualified public project."

Air, pipe, and industrial guideway systems (as automatic vehicle movement and automatic cargo-handling facilities) currently have no DOT categorical capital granting avenue open to them.

Water

The U.S. Army Corps of Engineers administers all matters that relate to construction, maintenance, and improvements of rivers, harbors, and waterways for purposes of navigation, flood control, and shore protection. The Corps can also respond (with congressional authorization) to requests for assistance from local interests concerning navigation, flood control shore protection, and other related projects within the region. Though the Corps has not as yet provided assistance for port development, it has provided channels from ocean lanes to port areas.

Site Block Grants

The site block grant method of funding groups all intermodal transportation facilities of water, rail, air, motor, pipe, terminals, and cargo handling into an intermodal "package" program (3). This group package would then be funded as a site block grant and would allow moneys to be used anywhere within the project that is most efficient.

Integrated Grant Administration

The integrated grant administration approach is proposed as a middle ground between current categorical

granting and site block grants. This approach is an effort to simplify funding procedures for more than one federal assistance program. The funding process begins with the designation of one of the several federal agencies involved in the project to be implemented as the legal agency for the project. If it is approved, then the process will have required only one application for funds in conjunction with only one audit trail. This approach to multiproject, multiagency funding may ultimately prove the most valuable for IFTFC capital implementation.

Local Funding Sources

Possible local sources of funding include general obligation (GO) and revenue bonds. GO bonds require a referendum that pledges the faith and credit of the city with collateral security of all taxable property. Cities are, however, limited as to the amount of GO indebtedness they can have by state law. In addition, the IFTFC would compete with other city needs and so might be given low public priority.

Revenue bonds can also be used for financing when the issuing agency can provide assurance that income for repayment of the bonds will be in excess of the debt service requirements. Normally, interest rates for revenue bonds are higher than those for GO bonds because of their greater risk.

Other Sources

One final possibility for funding would include general and special revenue sharing for the local government. Revenue sharing, however, would most likely encounter difficulty in meeting the intent and requirements of the 1974 Community Development Act. Further, the IFTFC would be competing with ongoing uses of funds and thus would encounter enormous difficulties.

BENEFITS OF IFTFCs

The major benefits of planned IFTFCs are

1. Lower cost for equal service;
2. Better cost control in delivery of services;
3. Better services and capacity available to carriers;
4. Improved control, safety, and security;
5. Better use of land and equipment;
6. Relief of congestion in urban areas;
7. Lower sunk costs and savings in dollars to the federal, state, and local government;
8. Reduction in energy use;
9. Reduction of regional pollution; and
10. Improved regional employment, economy, and industrial development.

In conclusion, the benefit of conducting research by using the IFTFC concept involves a deeper and more orderly understanding of the processes and interactions that occur with respect to transportation modes and goods movement within a region. It is for this purpose that the methodology was formulated and, through its use, greater understanding of these interactions will result.

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Publication of this paper sponsored by Committee on Inland Water Transportation.

Risk Analysis for Marine Transportation

Eugene Chen, Science Applications, Inc., La Jolla, California

Personnel, valuable commodities, and hazardous materials being transported by sea or inland waterway have been lost or released to the environment after serious ship collisions, rammings, or groundings. The quantitative determination of the risks of such events is therefore of substantial importance to marine transportation. Previous studies of ship collision probabilities have been semiempirical in nature, involving various assumptions for navigational behavior or functional dependencies. This paper derives the necessary physical relations implied by stochastic behavior through the introduction of a ship collision probability flux. The model yields analytical expressions for the probabilities of ship collisions and includes rammings and groundings as special cases. In addition, explicit expressions are given for the probabilities of a ship's being the struck versus the striking vessel. Suggestions for various applications of the stochastic flux model are presented.

It has been customary to begin any discussion of ship collision probabilities by stating that, in principle, collisions should not occur at all since the movement of ship traffic supposedly takes place under rules of the road and operating plans that are designed to prevent collisions. Collisions are, therefore, indisputable evidence that the movements of at least a small number of ships for short periods of time are not orderly. Hence, it appears reasonable to assume that the movement of ships will sometimes, though infrequently, be stochastic. Indeed, this behavior has usually been either explicitly or implicitly assumed in studies of ship collison probabilities because the specific errors or malfunctions that sometimes result in collisions