AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

PROCEEDINGS — Twenty-first Annual Meeting

Theme:

"Transportation Challenges in A Decade of Change"

October 27-28-29, 1980
Fairmont Hotel
Philadelphia, Pennsylvania

Volume XXI • Number 1 1980

T
R
F

TRANSPORTATION RESEARCH FORUM

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407
Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Integrated Terminal Management System

by Laurel A. Kent, Michael J. Merrick* and George T. Pappas**

INTRODUCTION

YARD AND TERMINAL expenses, including associated car hire costs, account for up to 40% of a railroad's operating costs. Since yard and terminal operations account for such a significant portion of total costs, industry officials have long recognized the economic need to manage terminal operations as efficiently as possible. Yet freight cars still spend 62% of their cycle time in yards, according to industry studies.

As a result, improvements to yard performance offer the greatest opportunity for improved system performance. There have been numerous studies and research projects on yard performance. The results of these are aptly summarized in a 1977 FRA report[1] which says, "There are substantial improvements that can be made by the railroads in their operations primarily through tighter management of their activities which will yield significant improvements in car utilization and service while at the same time reducing costs."

During the past 20-25 years, as a result of many factors including improved communications techniques, railroad companies have moved toward the consolidation of operations into large computerized hump yards and toward the centralization of both operations and data collection.

This consolidation process has had a number of operational efficiencies and economies which generally accrue from economies of scale. However, the expanded facilities also resulted in large scale and more complex systems of management. For example, as levels of organization have increased, specialization of responsibilities has been necessary. Such changes have resulted in a more complex management environment where decision making requires current and timely information, well established lines of communication and responsibility, and close coordination among several managers.

Recognizing these changes, many railroads instituted large scale data gathering and reporting systems as a means of assisting management. Much progress has been made but as industry statistics show there is still considerable room for improvement.

*Deloitte Haskins & Sells, Washington, D.C.

It appears that some major advances could be made toward improving the efficiency and effectiveness of terminal management by instituting a more structured information system. This additional structuring would provide a framework for decision making through the use of a system of control areas and control factors which are assigned to specific managers. Within each control area, the control factor becomes the "set point" for determining when corrective action must be taken by the responsible managers.

This paper describes a system of terminal management based upon three broad control areas—car scheduling, per diem costs, labor and other operating costs. Within each area are a series of control factors and actual results are reported to those managers who have direct operational responsibility for controlling results.

This system is intended to:

- provide a basis for improving service while controlling costs
- provide a basis for performance evaluation for each control area and factor within terminal operations
- be responsive to the complex set of human factors which comprise the terminal operations work force—both management and labor.

During the 1950's and 1960's, manufacturing industries, such as automobiles, electronics, electrical equipment, etc., developed structured integrated systems. These systems integrate production schedules, operations cost reporting and inventory cost reporting. They permit a level of planning and control the railroad industry is now capable of installing.

COMPONENTS OF ITMS

The unique characteristic of the Integrated Terminal Management System is that it integrates individual methodologies which have been developed in part, over the past several years. By using these as components, it is possible to acquire a new generation of terminal management techniques in a relatively short period. The Integrated Terminal Management System (ITMS) employs:

- tactical control of freight car scheduling by the use of the Terminal Sequencing System (TSS)

- tactical control of freight car per diem costs through a Car Hire Costing System (CHCS)
- control of terminal labor and other operating costs through the use of a Cost Accounting System for Yards and Terminals (CASYT)
- advanced technical training and management development methods to indoctrinate all levels of terminal personnel.

Each of these components is discussed below in terms of description, concept, what it does, outputs, and benefits.

Terminal Sequencing System

TSS is a tactical operations planning and control model for railroad freight car classification yards.[2] The TSS design premise is that the quality of service to shippers, yard processing costs per car and car hire expenses are greatly affected by the sequence and schedule in which cars are classified and assembled into outbound trains.

The TSS design concepts are based upon several broad principles.

- There is an optimum sequence and schedule for classifying cars and assembling them into outbound trains.
- Yard managers need a computerized tool to quickly evaluate the myriad of changing operational requirements and factors which must be considered.
- Yard performance goals are best reflected in a formalized schedule of car connections and outoutbound trains.
- A tactical planning and control tool must start with this formalized schedule of connections and outbound trains and calculate back to arrive at a schedule and sequence for performing yard operations. While this is the reverse of the actual car flow within a terminal, it is an essential aspect of the model.

As shown in Figure 1, control factors affecting railroad terminal through throughput can generally be classified into four categories. Some of these control factors are under the Terminal Superintendent's control; others are not, but must be considered in the management process.

System logic has been developed to maximize the number of freight cars to depart on time with scheduled outbound trains. Utmost consideration was given to assuring that yard personnel retain the decision-making role with respect to balancing local service priorities with system service priorities. Therefore, TSS calculates the times at which critical yard activities must be completed to

CONTROL FACTORS AFFECTING RAILROAD TERMINAL THROUGHPUT

	FACTORS NOT UNDER TERMINAL SUPERINTENDENT'S CONTROL	FACTORS UNDER TERMINAL SUPERINTENDENT'S CONTROL
1. PHYSICAL CONSTRAINTS	Yard Design — number of receiving yard tracks — number of departure yard tracks — number of bowl tracks — etc.	Assignment of Destination Blocks to Bowl Tracks Assignment of Tracks to Inbound/Outbound Trains Yard Maintenance Scheduling
2. INBOUND DEMAND	Arrival of Road Trains Release of Cars by Shipper	Pick-up of Local Industry Cars for Outbound Processing
3. RESOURCE CONSTRAINTS	Road Power Available Road Crews Available	Yard Power Assigned Yard Crews Assigned Clerical Forces Assigned
4. OUTBOUND REQUIREMENTS	System Schedule Requirements — Train schedules — Train blocking	Train Building Activities — classification of cars — building outbound trains/calling — delivery of cars to industry — waybill processing

FIGURE 1

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407 Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

meet system priorities. Yard managers must take deliberate action to override these priorities when necessary.

Six reports are generated by TSS as shown below.

- Current Working Schedule
- Inventory Available for Humping
- Class Track Overflow Projection
- Projected Status of Outbound Trains Using Recommended Schedules
- Recommended Pull Schedule
- Recommended Hump Schedule

The most important of these reports, shown in Figure 2, are the Recommended Pull Schedule and the Recommended Hump Schedule.

The Recommended Pull Schedule is used as a guide for assigning switch crews to couple and pull cars out of class tracks and to switch them into outbound trains in the departure yard. The yardmaster monitors progress in meeting schedule requirements and forecasts when outbound delays are likely. When delays are encountered, yard managers must decide what changes to operating requirements are necessary and input them to TSS in order to obtain revised schedules.

The Recommended Hump Schedule is used by the hump yardmaster for selecting cuts of cars in the receiving yard for humping. The hump sequence and schedule shown on this report will probably vary from the widespread policy of first in-first out processing in that the recommended sequence includes consideration of outbound requirements over an extended planning horizon of 16 to 24 hours. The report is also used for monitoring progress in classifying cars to bowl tracks before scheduled lockout times and for forecasting when additional resources will be needed to meet schedules.

TSS is designed to improve car transit times and transit time reliability, thereby improving freight car utilization. It should also help improve the capacity of rail yards to handle peak traffic loads. It is a unique tool in the railroad industry in that it introduces strict production management planning and control techniques into an operations area having a great impact on railroad profitability.

The TSS model has been developed through the detailed design stage. Actions to implement and test a pilot version of the system are not underway.

Cost Accounting System for Yards and Terminals

The Cost Accounting System for Yards and Terminals is designed to provide railroad management with effective physical and financial measures for control of yard and terminal operations.[3]

RECOMMENDED PULL SCHEDULE

RUN TIME 14:55 DATE 8/18/78

OUTBOUND ID	SCHEDULED DEPARTURE TIME	ESTIMATED DEPARTURE TIME	SET BACK REASON	LATEST PULL START TIME	PULL LEAD	LOCKOUT TIME	CLASS TRACK	BLOCKS
R27218	18 19:00	18 19:30	B	18 15:10	1	18 15:10-15:25	B11	WCA
						18 15:40-16:00	B12	NAS
						18 16:15-16:35	B17	MMP
R76018	18 19:45	18 19:45	-	18 16:50	1	18 16:50-17:15	B18	EVA
						17:25-17:40	B24	ESL
L24119	19 00:30	19 00:30	-	18 17:10	2	18 17:10-17:45	B44	CIS

RECOMMENDED HUMP SCHEDULE

RUN TIME 19:25 DATE 8/18/78

SUGGESTED HUMP ORDER	TRAIN/ CUT ID	TRACK	PRIORITY	LATEST INSPECT/BLEED COMPLETE TIME	LATEST CONSIST VERIFY COMPLETE TIME	LATEST HUMP START TIME	LATEST HUMP COMPLETE TIME	CARS TO CLASSIFY	PROJECTED OVERFLOW CARS
1	R27218	A04	1	Complete	19:35	19:50	20:25	68	0
2	R27118	A09		20:15	20:15	20:30	21:00	104	1
3	O82918	A03		Complete	20:55	21:10	21:55	83	0
4	HOLD18	A22		Complete	21:50	22:05	22:35	42	0

FIGURE 2

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407
Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0
Digitized by Google
Original from UNIVERSITY OF MICHIGAN

The system is based on responsibility accounting by cost center and encompasses both flexible budgets for control of operations and fixed budgets for corporate financial planning. Both types of budgets are based on standards for switch crew performance and standard, or budgeted, amounts for other costs.

The basic theory of this system is that the flexible budget reflects the true cost of yard and terminal operations and that (1) any differences between the flexible budget and actual costs are the result of either operating efficiencies and deficiencies or changes in prices, and (2) differences between the flexible budget and the fixed budget are the result of fluctuations in either the volume of switching or the mix of types of switching performed.

The fixed budget tells terminals management what its costs should be for a future period if the forecast switching volume and mix materializes. The flexible budget tells terminal management what its costs should have been based on the actual volume and mix of switching activity accomplished during a period. The flexible budget sets standards for costs with which actual performance can be compared.

Figure 3 gives an overview of the incorporation of switch standards in the fixed and flexible budgets. Both budgets incorporate the same monthly budgeted (or standard) costs for all terminal costs except switch labor costs. For the switch crew labor portion of the fixed budget, switch cost standards are multiplied by the forecast of switching activity to determine the anticipated level of switch crew cost for a future period. On the other hand, for the flexible budget the switching costs are multiplied by the actual accomplished switching activity to determine the earned standard crew cost for a past period. The operating and cost information this system provides can be used to improve operating plans and budgets. The improved cost data can be used for developing and checking prices, economic analyses, investment analyses and other analytical purposes. This information can also be used to show areas of unsatisfactory performance and aid in cost reduction.

In addition to monthly dollar flexible and fixed budget reports, the system produces daily and monthly switching performance reports which compare standard earned labor hours for each switch crew with its actual time-card hours. This comparison between actual and earned hours allows management to determine where too much time is being spent, which switch crews perform better, and what work activities need to be reorganized. It provides an effective tool to reschedule work based upon crew performance. Better planning and calling of extra crews can be accomplished by using the standard switching hours to estimate how many crews are needed to process the expected work volume. An example of a daily switching performance report is shown in Figure 4.

Car Hire Costing System

The car hire costing system computes the costs associated with holding cars in a terminal.[4] Through a variety of reports, it details and summarizes car hire costs of all cars in a yard, terminal or other operating entity. The system is based on the concept that the responsibility for controlling car hire costs rests with the operating department and as such are included in the operating department's budget.

Using a railroad's car inventory system and the Association of American Railroads' Universal Machine Language Equipment Register as its data base, the system applies car hire rates to cars on hand to determine the hire cost of those cars. The system is run daily and reports the car hire charges which have accumulated for each car in a yard from the time of arrival at the yard until the cut-off time of the report. The reports allocate costs among three responsibility areas for each yard: transportation, mechanical and miscellaneous.

By portraying the car hire costs resulting from delaying cars this system shows a major part of the cost of delaying cars. To a terminal manager, who must balance cost and service considerations, costs are tangible items, quantifiable and part of a budget. Any decision which has an adverse effect on costs will ultimately affect profitability. However, service is more abstract, not as easily quantified. Further, a single decision which has an adverse effect on service will probably have no immediate and no visible effect on profitability. In addition, the terminal manager is not held accountable for car hire costs which is the out-of-pocket cost for service delay. The Car Hire Costing System produces tangible evidence of the costs incurred by delaying cars and assigns responsibility for car hire costs to the managers most able to control those costs.

Car hire rates are a major component of operating expenses. The following table shows the car hire expenses paid by several Class I railroads in 1979.

The Boston and Maine system generates several reports at both the detail and summary levels. Figure 5 is an example of a Yard Status Detail Report. This report is prepared for each yard and computes car hire costs for each car in the yard.

An example of a summary report is

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407
Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0
Digitized by Google
Original from UNIVERSITY OF MICHIGAN

	RWY Optg. Expenses* (Freight)	Care Hire Expenses	% Of Optg. Expenses
Burlington Northern	$2,311,233	$178,319	7
Missouri Pacific	1,234,979	217,034	17
Norfolk & Western	1,123,604	145,966	12
Southern	807,399	115,932	14
Southern Pacific	1,866,363	239,953	12

*Includes car hire debits and credits.
Source: I.C.C. R-1 Reports
OOO's Omitted.

INCORPORATION OF SWITCH STANDARDS IN THE FIXED AND FLEXIBLE BUDGET

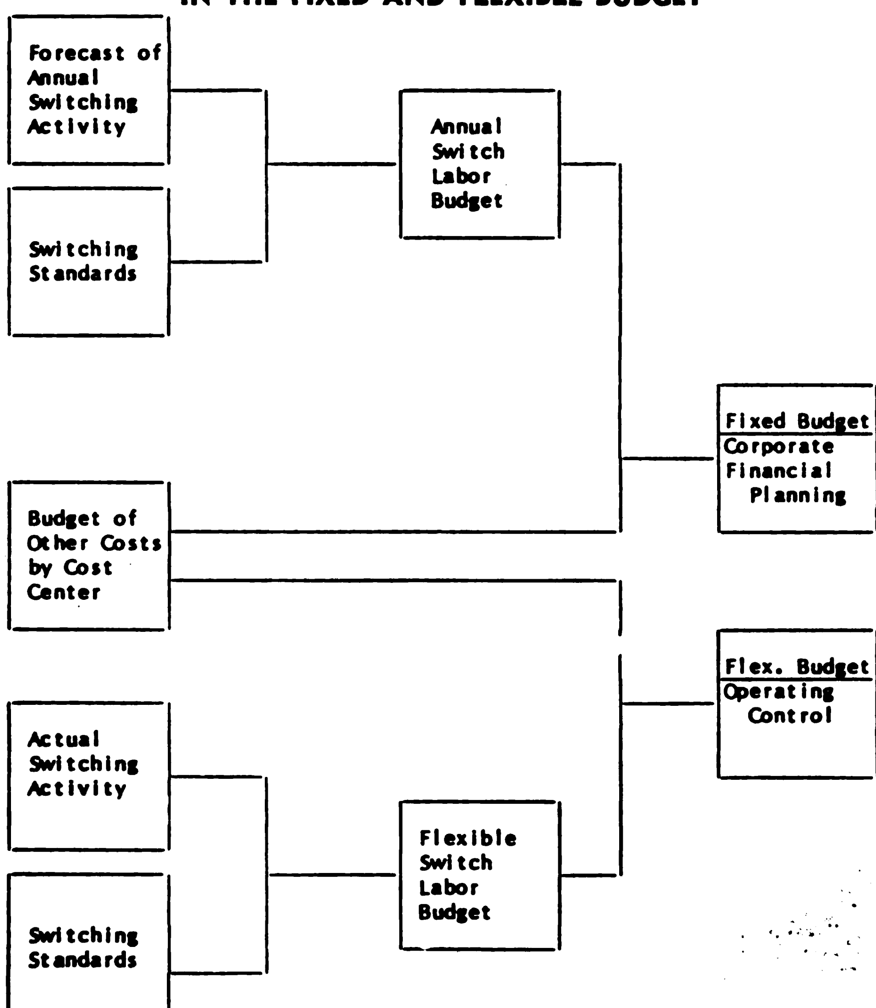

FIGURE 3

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407
Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0
Digitized by Google
Original from UNIVERSITY OF MICHIGAN

DAILY SWITCHING PERFORMANCE REPORT

Date ....

Terminal **Springfield**

This Date Switch Crew Hours					
Actual	Standard	Better (worse)	% Efficiency	Cost Center & Activity	(1) Activity Count
	(2)			Crew #123	
	10.8			Spotted, Ind C	11
	2.0			Pulled, Ind C	7
	1.6			Trips, Ind C	2
	6.7			Spotted TOFC	12
	0.3			Trips TOFC	2
	2.6			Repair	4
	5.5			Std. Crew Allowance	
32.0	29.5	(2.5)	91.5%		
(4)	(3)	(5)	(6)		

Note: The activity count (1) is multiplied by the standard per unit to determine the standard (2). The standard total (3) is compared to actual time worked (4) to determine efficiency (5) and (6).

FIGURE 4

YARD STATUS DETAIL REPORT

Cars on Hand Over 36 — Hours as of Midnight 9/06/79

YARD EDEERFIEL MA — TERMINAL SUPT. EAST DEERFIELD

CAR INIT	CAR NUMBER	L E	MECH DEST	TONS	COMMODITY	CONSIGNEE	DESTINATION CITY	ST	ARRIVAL TRAIN	ARRIVAL TIME	ARRIVAL MO	ARRIVAL DAY	RATES PER DIEM	RATES INCEN.	MONEY PER DIEM	MONEY INCEN.
BM	984	E	A230	35					PLCA	1000	09	05	.26		9.62	
CNJ	6977	L	B105	80	PREP FEED	AGENT	EDEERFIEL	MA	PLCA	1000	09	05	.11	.03	4.95	1.35
BM	966	E	A230	30					PLCA	1000	09	05	.26		9.62	
CP	23054	L	B105	55	FLOUR	AGENT	EDEERFIEL	MA	PLCA	1000	09	05	.12	.04	5.40	1.80
BAR	4427	L	B106	69	PAPER	AGENT	EDEERFIEL	MA	PLCA	1000	09	05	.09	.02	3.42	.76
BMW	57	E		30		AGENT	EDEERFIEL	MA	PLCA	1000	09	05				
BMW	431	E		30		AGENT	EDEERFIEL	MA	PLCA	1000	09	05				
BMW	51	E		30		AGENT	EDEERFIEL	MA	PLCA	1000	09	05				
SOU	525931	L	A230	83	FIBRD	AGENT	EDEERFIEL	MA	PLCA	1000	09	05	.30		14.10	
CP	382010	L	L152	61	GRAIN MILL	AGENT	GREENFIEL	MA	PLCA	1000	09	05	.29		11.02	
PC	549807	E	G312	30		AGENT	SPRINGFIE	MA	PLCA	1000	09	05	.16	.05	6.08	1.90
RBOX	16430	L	B208	68	PULP	AGENT	TURFALLS	MA	PLCA	1000	09	05	.42		15.96	
						LOADED CARS	6		EMPTY CARS	6					80.17	5.81

FIGURE 5

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407
Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

YARD STATUS SUMMARY REPORT

PERIOD ENDING MIDNIGHT 09-03-79

YARD AYER .... MA

BLOCK	HOURS 0-12 LOAD	EMPTY	HOURS 13-24 LOAD	EMPTY	HOURS 25-36 LOAD	EMPTY	HOURS 37-48 LOAD	EMPTY	HOURS 49-60 LOAD	EMPTY	HOURS OVER 60 LOAD	EMPTY	TOTAL CARS LOAD	EMPTY	PER DIEM 24 HOURS
FITCHBURG MA											3		3		23.04
AYER MA							9				3	2	12	2	75.84
MCVILLE NY						2								2	14.64
BOSTON (MYSTIC)			1										1		5.70
WELLS RIVER VT					2								2		17.28
WORCESTER MA			12	1			2						14	1	67.96
ROTTERDAM NY						2								2	14.16
EAST DEERFIELD						1								1	9.60
AYER MA			13	1	2	5	11				6	2	32	8	
TOTAL HOURS				298		203		420				807		1728	922
TOTAL PER DIEM		.00		65.98		67.28		16.66		.00		419.04		568.96	228.22
TOTAL INCENTIVE		.00		26.10		25.52		2.34		.00		73.44		127.40	66.90

FIGURE 6

shown in Figure 6. The Yard Status Summary Report is prepared for each yard and lists the number of loads, empties and their costs for each destination block. This report informs terminal management how many cars have accumulated for each destination and their hire costs. It also reports which blocks have incurred the greatest delay.

The information contained in these reports assists B&M terminal management in directing its resources to moving those cars which have been delayed the longest and incurred the greatest hire cost. It also assists management in making run vs. wait decisions by showing the car hire cost consequences of those decisions.

Although not a feature of the Boston and Maine's present system, the Integrated Terminal Management System includes car hire expenses in the fixed and flexible budgets of the Cost Accounting System for Yards and Terminals described earlier. Car hire costs for the fixed budget are based on forecasted traffic volumes. Car hire costs for the flexible budget are based on actual traffic volumes.

In this manner, management can anticipate car hire costs through the fixed budget and measure performance through the flexible budget. The flexible budget sets standards of costs, including car hire costs, with which actual performance can be compared.

Training

The final piece of ITMS is a training package to assure the best use is made of the system. The training is at two levels—operator and manager. The creation of an information system can be difficult. Training is usually limited to the operator on the input side of the system.

Railroads need more comprehensive training from the manager's point of view. It has been our experience in designing information systems that managers often do not know how to respond to reports. The process of using information systems requires an understanding of various skill levels to assure competent use of the system.

INTEGRATED TERMINAL MANAGEMENT SYSTEM

The Integrated Terminal Management System provides railroad management a structure which corresponds with the evolutionary consolidation and centralization process which has occurred in the industry. It is a management process whereby service considerations and the cost of operations can be balanced, both at the terminal level and at the management level of a railroad. At the same time, it sets up a reporting and control mechanism which parallels the management process.

The system will permit terminal managers to ask "What if" type questions. For example, "What is the impact of delaying the departure of an outbound train one hour to wait for an inbound connection?" The Integrated Terminal Management System would have the capability (through TSS) of cascading the effect of that delay back on all of the

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407
Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0
Digitized by Google
Original from UNIVERSITY OF MICHIGAN

cars waiting to be classified and the trains waiting to be dispatched. The cost of that delay would be calculated through the use of the Car Hire Costing System.

In summary, the railroads have, in place, the most costly requirement for ITMS—a data base consisting of waybill and operating information. ITMS is designed to permit railroads, at low cost relative to the investment expense of the equipment being managed, to control their operations in such a way as to significantly improve their financial leverage.

FOOTNOTES

1 "Potential Economies and Improvements in Performance Resulting from Improvements in Railroad Terminal Operations," Federal Railroad Administration, (FRA-OPPD-78-4), November 1977.

2 Marcia M. Allen and William J. Rennicke, Terminal Sequencing System, Transportation Research Forum, 1977.

3 "A Costing Methodology for Yards and Terminals—The Conceptual Design of a Cost Information System," developed by Deloitte Haskins & Sells under contract to the Federal Railroad Administration, DOT-FR-65135, 1977.

4 This system was developed by and implemented on the Boston and Maine.

Generated at University of Minnesota on 2021-10-21 16:21 GMT / https://hdl.handle.net/2027/mdp.39015035374407
Creative Commons Attribution-NonCommercial-NoDerivatives / http://www.hathitrust.org/access_use#cc-by-nc-nd-4.0

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN