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INTERMODAL INNOVATION, SEVICE QUALITY, AND MODAL CHOICE

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I. INTRODUCTION

Intermodal innovation, service quality, and modal choice have perennially been important topics for transportation and logistics practitioners and researchers. In the aftermath of deregulation of the transportation modes, these topics may have even further increased in importance for a number of different reasons. First, deregulation itself creates more competition amongst carriers which in turn results in a heightened customer service focus and a variety of new technological and price-service innovations and opportunities to be evaluated by shippers (Ditmeyer 1987; Gellman 1986). Secondly, a number of recent and visible trends would also require closer scrutiny of modal and carrier service offerings and performance. These trends include movement to just-in-time (JIT) production systems which require a narrowing of the carrier "service performance window"; reductions in the number of carrier suppliers; the advent of carrier-shipper partnerships and "strategic alliances" (Bowersox, et al., 1989); increased use of single-sourcing and out-sourcing of transportation services; and the EDI information revolution (Morash 1990).

A majority of prior empirical research on the determinants of modal and carrier selection have emphasized motor carrier services and a tacit assumption has frequently been made that the findings are applicable to railroads (McGinnis 1990). Similarly, the importance of various selection criteria has usually been evaluated in the context of presently existing services rather than in terms of new technology and carrier service innovations (Grimm and Smith 1986; Gellman 1986). Finally, deregulation itself may have also changed the relative importance of various selection factors.

The present research attempts to overcome these limitations by specifically focusing on the importance of selection criteria for railroad services in general. Next, the importance of various selection factors for a "new" rail technology and service innovation--the RoadRailer--are evaluated. The RoadRailer is a dual-mode vehicle that can travel on either highways or rails. Barriers to adoption of RoadRailer technology are also investigated (Gellman 1986; Detmold 1986).

The next section of this paper will briefly review prior research on modal and carrier selection with particular attention to selection variables of transportation price, service quality, and situation-specific factors. This will be followed by a brief account of current RoadRailer technology and the specific research questions addressed in this study. Next, the Methodology employed to answer this study's research questions will be explicated. After presenting the results of the study's analyses, conclusions and implications for carrier management, shippers, government policymakers, and researchers will be set forth.

A. Determinants of Modal Selection

Although a large number of possible and potential modal selection criteria have been put forth in the literature, McGinnis has attempted to reduce the number of determinants through cluster and logit analysis (1981) and qualitative analysis (1989) to a limited and more manageable number of categories. These categories can be discussed under the major selection headings of transportation price, service quality, and situation-specific variables. Each will be briefly elaborated upon in turn.

Transportation Rates

Price has always been an important selection determinant for transportation services. However, it has usually lagged service quality in relative importance (Stock and LaLonde 1977). Similarly, McGinnis (1989, p. 39) has likened the modal and carrier selection process to a "constrained optimization problem" where users will attempt to minimize transportation costs subject to a number of service constraints. Thus, the "cheapest" transportation carrier will not necessarily be chosen if that carrier does not at least meet the user's service standards and service expectations. In the early years after transportation deregulation, price appears to have increased in importance as a selection variable; however, service quality remains the number one service factor for the selection decision (McGinnis 1990, p. 17).

Service Quality

Transportation service quality variables such as on-time delivery, reliability, and safe delivery without loss or damage have usually been identified by a majority of studies as particularly important selection criteria (e.g., Grimm and Smith 1986; Chow and Poist 1984; Stock and LaLonde 1977; Gilmour 1976). This is so because they affect the non-transportation costs (NTC) of a user's or entire channel's logistics system. Thus, two modes of transportation such as motor (M) and rail (R) will not be evaluated solely on transportation costs (TC) but rather on the total cost of their service offering including NTC (Roberts 1970). For example, in a situation of relative indifference between modes:

$$TC_M + NTC_M = TC_R + NTC_R$$

The crucial nature of NTC for modal choice and maximum transportation rates can thereby be deduced, ceteris paribus.

NTC can consist of a number of logistical costs such as customer service costs, inventory costs, production costs, packaging costs, etc. However, a number of researchers have stressed an "inventory-theoretic" approach to modal selection since many of the NTC involve inventory costs (e.g., more inventory held in the transportation "pipeline") and many other NTC can be "buffered" by holding extra safety stock inventory (Sheffi, Eskandari, and Koutsopoulos 1988; Das 1974; Baumol and Vinod 1970). Transportation service quality from modal choice can therefore have a major impact on inventory costs and other NTC of the shipper, consignee, and indeed the entire supply chain (Morash 1990). Because of the importance of transportation service quality such as reliability, loss and damage, and customer service flexibility as selection criteria, each will be briefly discussed in turn in the context of modal selection.

1. Reliability and On-time Delivery

Transportation service reliability has frequently been suggested as the most important modal selection determinant and conventional rail is sometimes thought to have a relative disadvantage on this score to motor carriage (Levin 1978; Boyer 1977). However, technological advances such as RoadRailer are intended to overcome this relative disadvantage when it exists (Ditmeyer 1987).

Reliability can be thought of as adherence to schedules; or low variability in pickup times, delivery times, and transit times. In fact, for many customer segments, it is frequently more important that transportation

service be reliable and consistent rather than fast (Morash 1990; Stock and LaLonde 1977, p. 55). The reasons for this preference are many since unreliable transportation performance directly affects the costs (i.e., the "NTC" discussed previously) and therefore the profits of the customer. Three dimensions of this reliability and resultant NTC will be elaborated upon next.

First, customers depend on reliable transportation for their own production and sales efforts. Inconsistent carrier performance can raise production costs, for example, by shutting down the line, or engender lost sales through stockout conditions (Morash 1990). To reduce production and stockout costs resulting form poor distribution performance, a customer may decide to add buffer or safety stocks (Sheffi et al. 1988, p. 145; Baumol and Vinod 1970). However, as alluded to earlier, the increased safety stocks raise inventory carrying costs including increased capital requirements.

Second, reliable transportation performance is important because customers have systematized their own distribution operations. Irregular shipments may cause congestion, confusion, and poor production sequencing at a customer's receiving docks. The results may be loss and damage, inefficient production and sales force efforts, and overtime or extra labor to handle the irregularities. For these reasons, early shipments may sometimes be even worse than late deliveries, especially for JIT systems. In fact, RoadRailer as an example has been partly marketed and targeted to the JIT market segment (Callari 1987).

Third, inconsistent transportation performance raises the ordering costs of customers. Management time must be devoted to tracking late or lost shipments rather than devoting time to other important matters. The cost of these efforts therefore represents the opportunity cost of their lost time as well as the psychic and nuisance costs involved.

2. Absence of Loss and Damage

In addition to carrier reliability, safe delivery without loss and damage is also an important selection variable. Although the direct cost to customers of shipment replacement for loss and damage can be high, the indirect costs can be much higher. The indirect costs consist of such things as customer lost sales, production down-time, reordering costs, personnel time spent in processing claims, and labor time in inspecting and disposing of damaged shipments. Loss and damage performance is therefore a significant issue to be considered during the modal and carrier selection decision processes.

3. Customer Service Flexibility

In certain nonrecurring situations, shippers and consignees may also require expedited and rush shipments. Such shipments may be needed for a customer's sales commitments to key clients, for special promotions, for stockouts and replacement items, or simply to keep production running. Customer service flexibility may also be required for special pickup and delivery situations, individualized requests or instructions, rerouting, or rescheduling (Grimm and Smith 1986, p. 62; Stock and LaLonde 1977). In total, failure of a transportation company to perform with the reliability, safety, and flexibility required can raise a customer's inventory carrying costs, ordering costs, cost of lost sales, and production costs. For these reasons, modal and carrier selection are important user activities for achieving optimal transportation service quality.

Situation-Specific Selection Variables

Situation-specific conditions include commodity characteristics, market characteristics, channel of distribution requirements, and carrier characteristics (McGinnis 1989, pp. 39-42; Slater 1982, pp. 74, 82-83; McGinnis, Corsi, and Roberts 1981). These conditions are captured in such situation-specific service variables as availability, accessibility, and capability. Although not given as much attention in the modal selection literature as price and service quality, recent literature reviews have called

for their increased study (McGinnis 1989; Slater 1982).

Such situation-specific selection variables may also be particularly important for rail selection decisions since modal use, facility use, and location patterns may be of a more fixed and enduring nature and involve a longer-term decision horizon. As aptly stated some time ago, "Having committed themselves to a particular factory design, inventory policy, and marketing pattern, shippers and consignees may feel themselves committed to one mode...Thus, important determinants of modal split and intermodal competition remain obscured in the idiosyncratic needs of shippers and consignees." (Morton 1972, p. 366). Additionally, modal selection decisions involving commitments to new technology such as RoadRailer may also initially require greater attention to such situation-specific variables as availability, assessibility, and capability.

B. Brief Account of RoadRailer Technology and Service Quality

RoadRailer has been advanced by some railroads as a means to recapture manufacturing traffic lost to motor carriage over the last several decades (Ditmeyer 1987; Morash, Hille, and Bruning 1977). It has also been "positioned" for JIT type freight (Callari 1987, Shaffer 1986). The RoadRailer is a multimodal and "car-less" service innovation that has both rail and highway wheels so that it can travel on either highways or the rail right-of-way. Although the concept has been around for some time, the most recent version of RoadRailer (Mark V) has detachable rail wheels in the form of a "bogie" (Kaufman et al. 1990, pp. 5c, 14c; Keefe 1989, p. 30). These rail wheels can be removed to permit greater highway payloads and easier vehicle maneuverability.

RoadRailer would appear to allow railroads to compete more closely with motor carriers for shorter distances (200-700 miles) than is true of traditional piggyback (800 miles or more) (Kaufman et al. 1990, p. 5c; Keefe 1989 p. 31; Morash, Hille, and Bruning, 1977, p. 43). However, one past disadvantage of RoadRailer is that it cannot usually be mixed with other types of rail cars unless added to the end of a train for intermediate drop-off. Consequently, current applications of RoadRailer find it used as either a "dedicated service" or unit train (e.g., Norfolk Southern's "Triple Crown" Service), as a feeder service for double-stack trains (e.g., Burlington Northern), or tacked on to the end of a train (e.g. Amtrak considering for mail carriage) (BN, Amtrak 1990; Keefe 1989). Recent adaptions have also been enthusiastically embraced in Australia where RoadRailer technology has received a major transportation award (Stove 1990).

In terms of modal selection criteria, it is generally thought that such an intermodal service innovation as RoadRailer could better compete with motor carriers on the previously discussed service quality dimensions of reliability, loss and damage, customer service flexibility, as well as situation-specific service requirements. Consequently, the relevancy of these selection criteria and other determinants of new technology adoption would appear to be of particular interest to carrier management, shippers and consignees, and governmental policymakers. Furthermore, an empirical investigation of the importance of modal selection criteria in the context of new rail technology has apparently not been reported on before in the research-oriented transportation literature.

C. Research Questions

In light of the previous literature review, the specific research questions addressed by this study were:

1. What is the current relevancy and relative importance of modal selection criteria for railroad services in general? (i.e., price, service quality, situation-specific variables, and transportation operations).

2. What is the relative importance of selection criteria for "new" technology adoption?

3. Do importance rankings for new technology selection criteria differ from general modal choice rankings?

4. What are the barriers to new RoadRailer technology adoption?

5. How do modal selection criteria differ for RoadRailer users versus non-users?

6. Are there any situational factors that predict RoadRailer use?

The next section of this paper will briefly discuss the methodology used to answer these research questions.

II. METHODOLOGY

To address this study's research questions, a multi-part shipper questionnaire was developed with separate sections on selection of rail services in general, adoption of RoadRailer technology, barriers to RoadRailer adoption, and respondent's situational and industry structural factors. The survey instrument was first pretested with the C.E.O.'s of several shipper firms, ranking Traffic Managers, and Railroad Vice Presidents for survey item validation over several organizational levels. For survey mailings, two separate lists of RoadRailer adopters and non-adopters were obtained. The list of RoadRailer adopters was primarily from customer and strong prospect lists of participating railroads and was labeled the "User" group. The list of non-adopters was obtained from an industrial directory which reflected addresses, contact phones, and commodities. With the assistance of cooperating railroad executives, the list was pared to those manufacturing type firms which could conceivably make use of RoadRailer services, but which were not presently using it. This group was labeled the "Non-users". To identify the senior ranking Traffic Manager or Transportation Department Head that would make modal selection decisions, the industrial firms in the "Non-user" group were called to obtain the name of the targeted person.

The questionnaire instrument was sent to 500 randomly chosen manufacturing firms from the two unstratified lists. The questionnaire included visual pictures of RoadRailer traveling on both highways and rail and a brief description of its technical features which had been pretested with engineers. One hundred twenty eight (128) firms responded for an effective response rate of approximately 26%. An analysis of firm size, location, and business sector showed no pattern differentiating respondents from non-respondent firms, so it was not deemed necessary to further investigate potential non-response bias.

III. RESULTS

A. Relative Importance of Railroad Modal Selection Criteria in General

Table 1 shows the relative importance of different selection criteria for choosing railroad transportation services in general. As shown in Table 1, the three service quality variables were rated most highly in importance by the Traffic Managers. As indicated in the Introduction, these Quality variables especially influence the level of inventory carrying costs throughout the supply chain or "channel of distribution". Thus, On-time Delivery (mean = 4.17), Reliability (mean = 4.09), and no Loss or Damage (mean = 4.04) were all rated particularly high and approximately equal in importance. This result is consistent with prior research on modal and carrier selection in terms of the greater importance of these service quality variables.

What is somewhat surprising in Table 1 is the relative closeness in importance of the next three "situation specific" variables to the previous

service quality variables. Thus, Availability (mean = 3.97), Accessibility (mean - 3.90), and Capability (mean = 3.83) were also rated highly in importance by Traffic Managers and their scores are not that "far behind" the previous service quality variables. In contrast to the service quality variables, these situation and shipper specific variables have not been given as much attention in previous modal choice studies if their presence has even been included at all. In the present research, the importance of these "situation specific" variables is attributed at least partly to the study's focus on railroads and the study results may also imply that it is not entirely appropriate to simply extend selection criteria findings from another mode to rail.

The pricing variables of Transportation Rates (mean = 3.58) and Minimum Shipment Weights (mean = 3.17) were indicated to be somewhat less importance by Traffic Managers. Finally, the transportation "operations" variables--

TABLE 1

Relative Importance of Selection Criteria for Modal Selection of Railroad Services in General (in rank-order)*

Selection Criteria *	Type of Service Variable	Mean
1. On-time Delivery	Service Quality	4.17
2. Reliability	Service Quality	4.09
3. No Loss or Damage	Service Quality	4.04
4. Availability	Situation Specific	3.97
5. Accessibility	Situation Specific	3.90
6. Capability	Situation Specific	3.83
7. Transportation Rates	Pricing	3.58
8. Loading Facilities	Operations	3.31
9. Unloading Facilities	Operations	3.29
10. Minimum Shipment Weights	Pricing	3.17
11. Packaging Requirements	Operations	2.86
12. Intermodal Requirements	Operations	2.86
13. Special Handling and Requests	Customer Service Flexibility	2.67

*Each of the selection criteria were rated on a five point Likert-type scale ranging from 1 = not at all important to 5 = very important.

Loading Facilities, Unloading Facilities, Packaging Requirements, and Intermodal Requirements were found to be of relatively low importance. These latter results for "pricing" and "operations" variables are reasonably consistent with most prior research on modal and carrier selection in general. However, the least important variable in Table 1 is the customer service flexibility variable as measured by "Special Handling and Requests". (mean = 2.67). This result may indicate that such customer service flexibility is not as important for railroad modal choice as for motor and air carrier selection; and would again caution against simply generalizing results from other modes to railroads.

B. RoadRailer Service Improvements

Table 2 shows the degree to which RoadRailer technology would provide a service increase over conventional TOFC (trailer-on-flatcar) or piggyback services. The results in Table 2 are somewhat disappointing for RoadRailer in that all of the service attributes exhibit average scores below the midpoint of 3.0 which would mean that these scores reflect "little improvement" in service. Thus, for the sample as a whole, Traffic Managers and Transportation Department Heads did not rate RoadRailer as being a particularly impressive service innovation. However, it should be pointed out at this juncture that there was quite a bit of variation in the service attribute rankings by Traffic Managers as will subsequently become apparent with the statistically

significant breakdowns between users and non-users.

In terms of the relative rankings in Table 2, the results are somewhat similar to those found for general railroad selection criteria in Table 1. In Table 2, the RoadRailer attribute displaying the greatest service improvement over TOFC is the Capability measure (mean = 2.53, Table 2). This "situation specific" variable is closely followed by the three service quality variables and then by the remaining two situation specific variables; Availability and Accessibility. Finally, pricing, operations, and customer service flexibility variables follow next in the service improvement rankings.

TABLE 2

Degree to Which RoadRailer Provides a Service Improvement Over Conventional TOFC or Piggyback Services*

	Attribute*	Type of Service Variable	Mean
1.	Capability	Situation Specific	2.53
2.	On-time Delivery	Service Quality	2.52
3.	No Loss or Damage	Service Quality	2.52
4.	Reliability	Service Quality	2.51
5.	Availability	Situation Specific	2.48
6.	Accessibility	Situation Specific	2.45
7.	Transportation Rates	Pricing	2.37
8.	Intermodal Requirements	Operations	2.37
9.	Unloading Facilities	Operations	2.35
10.	Loading Facilities	Operations	2.25
11.	Special Handling and Requests	Customer Service Flexibility	2.07
12.	Minimum Shipment Weights	Pricing	2.05
13.	Packaging Requirements	Operations	1.98

*Each attribute was rated on a five point Likert-type scale ranging from 1 = service not improved at all to 5 = service improved to a great extent.

C. Importance of Selection Criteria in Adopting "New" Technology

Table 3 shows the relative importance of selection criteria in adopting RoadRailer technology as measured by perceived service improvements by users and non-users. The results in Table 3 are quite gratifying for RoadRailer enthusiasts in that they indicate the pronounced favorable assessment of RoadRailer for the user segment compared to the unfavorable evaluation of the non-user segment. All of the selection criteria means for the user group are significantly greater than the selection criteria means for the non-user group and the majority (ten out of thirteen) are significant at the .001 level or better. This indicates the strong differences of opinion between the user and non-user groups. Unlike the earlier results for the entire sample of respondents in Table 2, the users in Table 3 rate most of the selection criteria as at least showing some improvement in service performance while the non-user group views these selection criteria as exhibiting little improvement or no improvement. These differences may again reflect situational disparities between different shipper groups and their different channels of distribution.

In terms of relative rankings, users again rank the three service quality measures most highly (No Loss or Damage, Reliability, and On-time Delivery). However they are even more closely followed by the three situation-specific variables--Capability, Availability, and Assessibility--than for the earlier results involving railroad services in general. In total, these variables in Table 3 represent the top six selection criteria in importance for new technology adoption closely followed by Transportation Rates as seventh and then transportation operations measures and finally the customer service flexibility variable.

Although the importance of "Quality" and "Price" variables were as expected from prior transportation and logistics literature, what are most

surprising in Table 3 are the relatively high importance of the "situation-specific" selection variables and the low importance of the customer service flexibility variable. These results might be interpreted as reflecting the special nature of selection criteria for "new" rail technology possibly involving long-term commitments and relative fixity of decisions and operations. Furthermore, rail services in general might be characterized as requiring a longer-term decision horizon involving fixed assets and user requirements that would justify more attention to selection criteria of capability, availability, and assessibility when compared to other modes. Once again, these results suggest that selection criteria findings should not be simply extrapolated from one mode to another.

TABLE 3

RELATIVE IMPORTANCE OF SELECTION CRITERIA*
IN ADOPTING ROADRAILER TECHNOLOGY--USERS Versus NON-USERS
(t-Tests for Differences Between the Means)

Selection Criteria: (Rank-Ordered by User Mean)*	Users (n = 43) Mean	Non-Users (n = 85) Mean	t	(Sig.) α
1. No Loss or Damage	3.55	2.03	4.93	.0001
2. Reliability	3.50	2.06	5.12	.0000
3. Capability	3.39	2.11	2.04	.0250
4. Availability	3.37	2.07	4.46	.0001
5. On-time Delivery	3.35	2.13	3.87	.0003
6. Accessibility	3.26	2.08	4.18	.0001
7. Transportation Rates	3.25	1.97	4.82	.0000
8. Intermodal Requirements	3.21	2.02	3.90	.0003
9. Unloading Facilities	3.03	2.03	3.38	.0013
10. Loading Facilities	2.87	1.97	3.02	.0040
11. Packaging Requirements	2.77	1.61	3.96	.0003
12. Special Handling and Requests	2.77	1.74	3.56	.0009
13. Minimum Shipment Weights	2.51	1.83	2.52	.0150

*The importance of each of the selection criteria were measured by perceived service improvement on a five point scale where 1 = no service improvement and 5 = greatly improved service.

D. Situational Factors that Distinguish RoadRailer Users from Non-Users

The next phase of the research tested respondents' industry situational or structural factors in order to distinguish RoadRailer adopters from non-adopters. These industry situational variables included industry concentration, product price competition, stability of market demand, rate of technological change, access to inter-firm technical information, trade-association communications, etc. However, only two situational variables were statistically significant in distinguishing users from non-users; and they are indicated in Table 4.

The first variable that was significantly greater for users than for non-users was the "importance of logistics for a company's competitiveness". Although the statistically significant difference was only moderately high (α = .0433), this particular result may imply that RoadRailer users require a premium transportation service to remain competitive in their industry. They may also be more likely to use logistics as a strategic "competitive weapon".

The second significant variable was the "importance of intermodal transportation to your company" which displayed an even stronger relationship in distinguishing RoadRailer users from non-users (α = .007). This suggests that RoadRailer users are particularly attracted to railroads that offer intermodal transportation solutions and are "sold" on the intermodal concept. The practical implication of this finding to railroad management is that this variable can be useful for discriminating between potential future users and unlikely future

users; whereas the other variables previously mentioned did not achieve statistical significance. Thus, in total, with the exception of these "logistical competitiveness" and "intermodal solutions" variables, the other industry situational variables were not found to be useful "discriminators" even though they might be characteristic of users.

TABLE 4

SIGNIFICANT SITUATIONAL FACTORS THAT DISTINGUISH USERS FROM NON-USERS
(Only significant t-Tests for Mean Differences are shown)

Industry Structural and Situational Variables:	Users (n = 43) Mean	Non-Users (n = 85) Mean	t	(Sig.) α
1. Importance of Logistics for our Company to be competitive in our Industry	3.69	3.37	2.05	.0433
2. Importance of Intermodal Transportation to our Company	3.44	2.59	2.78	.0070

*All variables were rated on a five point Likert-type scale ranging from 1 = not at all important to 5 = very important.

E. Existence of Barriers to RoadRailer Adoption--Users versus Non-users

The final phase of the research tested for the existence of barriers (or lack thereof) to RoadRailer adoption for users and non-users. The barriers which did not achieve statistical significance and therefore which did not separate users from non-users included new investment requirements, worker training, and a need for technical information. Somewhat surprisingly, these three potential barriers did not distinguish adopters from non-adopters.

However, three barrier variables were statistically significant in distinguishing users from non-users and are shown in Table 5. These significant relationships show that users are more likely than non-users to report: (1) the ease of adaptability of RoadRailer to their current transportation needs, (2) RoadRailer's compatibility with their company's current use of transportation modes, and (3) RoadRailer's compatibility with their company's existing facilities. All three variables are highly significant at the .0001 level. Essentially, these relationships suggest the importance of low situation-specific barriers of a systemic and facility network nature. This may ensure ease of RoadRailer adoption and facilitate a good "fit" between RoadRailer technology and a shipper(s)' distribution system and channel of distribution requirements.

TABLE 5

EXISTENCE OF BARRIERS TO ADOPTION OF ROADRAILER TECHNOLOGY--
USERS vs NON-USERS
(only significant t-Tests for Mean Differences are shown)

Variables--Absence of Barriers to Adoption:*	Users (n = 43) Mean	Non-Users (n = 85) Mean	t	(Sig.) α
1. Ease of Adaptability of RoadRailer to our current transportation needs.	3.97	2.23	6.35	.0001
2. Favorable compatibility of RoadRailer with our current use of transportation modes.	3.99	2.45	5.37	.0001
3. Favorable compatibility of RoadRailer with our existing facilities.	3.68	2.39	4.46	.0001

*Each variable was coded on a five point Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree.

IV. CONCLUSIONS

Service innovation, service quality, and modal choice are of strategic concern to carriers, users, and government. Considering the present study's findings, it is possible to sketch the profile of the adopter of new technology such as RoadRailer as a shipper who integrates the innovation with their firm's overall product strategy and logistics system. Specifically, the new technology adopters view logistics as a strategic component of their competitive product offering and "intermodal" as an integral part of that competitive advantage. This helps to explain the relative importance of the situation-specific modal selection criteria of capability, availability, and assessibility. These variables tap into the "fit" between RoadRailer technology and a firm's logistics system and network configuration in the serving of their customers. Furthermore, after deregulation, the continued primacy of service quality variables such as reliability, on-time delivery, and absence of loss and damage are also directly related to customer requisites. Finally, the significant "absence of barriers" for RoadRailer adopters as manifest in RoadRailer adaptability to their current transportation needs, to their current modal use, and to their existing facilities probably best mirrors the adopter's profile as one who achieves a good "fit" between the new technology and the firm's product strategy and logistical network structure.

The overall implication of these findings for carrier management to achieve new technology adoption is to identify, understand, and market to those market segments where the service innovation best "fits" with a producer's existing logistical configurations and product/customer strategy. In turn, the implication for producers in a deregulated and competitive environment is to be alert to the possibilities of carrier logistics innovations and technological opportunities that could potentially be leveraged for competitive advantage through their harmonious adaptation to the user's current channel of distribution strategy and facility-network structure. The early evidence for government policymakers is that deregulation appears to encourage potential service innovations by allowing market forces to both germinate and determine the viability of such technological partnerships between carriers and shippers. Finally, researchers in the transportation and logistics arena have much to do in exploring the relatively untapped area of transportation technology innovation particularly as it relates to service quality, modal choice, and competitive outcomes.

(REFERENCES AVAILABLE UPON REQUEST)