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A Brief Intermodal Rail Network (IRN) Scale: Establishing Validity and Reliability

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Abstract

An Intermodal Rail Network (IRN) Scale was created for the purpose of measuring consumer perceptions about their experiences with airport intermodal rail travel. Some previous research has focused on intermodal rail in other arenas, but to date, no paper that we know of has developed a valid and reliable scale to measure consumer perceptions of airport intermodal rail travel. The indirect purpose of this scale is to aid in measuring the factors that would influence the use of an IRN, wherein the greater the usage, the greater the efficiency, and therefore reduce the number of vehicles around the airport that produce greenhouse emissions. In this paper, we outline the methodology used to develop our scale. A total of 365 participants were solicited to help generate items for the scale, narrow down the list of items to those most relevant to a positive experience with intermodal rail, and test the final scale for validity and reliability. A factor analysis using the principle components and varimax rotation loaded strongly on one factor, providing evidence for validity. Reliability was tested via Cronbach's Alpha and Guttmann's Split-half tests, indicating high consistency and reliability.

Keywords: airport transportation, high-speed rail, intermodal rail, scale, valid, rail stations, airport rail, reliable

1. Introduction

Aviation growth includes airport infrastructures that extend far beyond the limits of airport sites reaching large-scale real estate, transport and economic development at the metropolitan level (Halpern 2014). A key focus for infrastructure is in passenger transportation to airports, which plays a crucial role in the flow of passengers. This has major implications on sustainability and aviation's carbon footprint on a metropolitan scale, all the while ensuring that the passengers' needs are met with regards to time and convenience. Despite airplanes being the swiftest mode of transportation on earth, airplanes likely can't land at your home or place of employment (Shank 1999). The purpose of this study is to create a scientifically valid and reliable Intermodal Rail Network (IRN) Scale that can be used by the industry, specifically commercial service airports, to be able to receive passenger ratings on different aspects of satisfaction and importance as it relates to the intermodal rail service. A secondary purpose of this scale is to aid in measuring the factors that would influence the use of an IRN, wherein the greater the usage, the greater the efficiency, and therefore reduce the number of vehicles around the airport that produce greenhouse emissions.

This study seeks to analyze IRN from the eyes of the consumer, by creating a valid and reliable scale that can be used by airport managers to evaluate its service from the passenger's perspective. The end outcome of any airport management team is to provide a traveler's experience that is satisfying and pleasing. Airport managers can gauge item efficiency from an operational standpoint, but true passenger feedback is needed to provide an added perspective that enables the airport team to understand what is of most importance to the passengers. Travelers' perspectives provide managers with the knowledge to develop an idea of item prioritization. When analyzing items that need attention, and in turn funding for improvement or even upkeep, this scale may prove to be an asset that allows airports to focus on issues that are of greater importance to passengers, or on areas that the passengers believe need improvement.

Due to the high requirement of space that an airport of high volume demands, many airports are located in remote areas, many miles away from the heart of a city. This creates a scenario where the travel to the airport is as much of a consideration and part of the trip as the actual flight itself. To a passenger travelling through any major commercial airport, time is of the utmost importance. All too often passengers miss flights along with

affiliated transportation services although only airport facilities receive the blame. The trend within the aviation industry has been to integrate different forms of transportation in order to improve connectivity between the airport and the surrounding cities. This has been with an eye towards creating a system of passenger flow into and out of the airport that is more convenient and efficient. The literature review section discusses the topics of airport congestion, history of IRN, airport rail travelers, high-speed rail, and sustainability through IRN as these topics relate to the IRN Scale research.

1.1 Literature Review

1.1.1 Airport Congestion

Roadway congestion around airports has been an issue that has plagued the aviation community for several decades (Clewlow, Sussman & Balakrishnan 2012). This has become a major problem since airports were predominantly designed with a majority focus on the airfield, with an almost neglectful look at the landside transportation network that feeds the airport. The issue has been exaggerated in recent times due to the exponential increase in the number of vehicles on the road. For instance, Fox and Tallon (2013) identified congestion as a key economic, environmental and management issue from research performed on the amount of vehicles in China resulting in congestion. Urban transport policies were implemented to assist with traffic congestion in Beijing and suggestions to upgrade Beijing's public transport networks to meet future population demands due to continued economic growth. In England, research suggests that environmental conditions would deteriorate as a rise in car ownership and traffic increased as well as the levels of noise and pollution increased (Bianconi & Tewdwr-Jones 2013; Gunn 2011). Similar to other research, the findings suggest that new types of traffic and urban management are needed to address the negative impacts of congestion. While the amount of vehicles has been beneficial to airports in terms of increased revenue from parking fees, it has developed into a significant issue in terms of customer dissatisfaction with the congestion and the time delays created as a result. Several larger airports around the country have invested heavily in providing alternatives to solve this problem.

The most popular solution to airport congestion involves the implementation of a rail line that connects the airport to the existing public transportation rail service of the corresponding city (Shank 1999). However, this solution is heavily dependent on the city's original metro rail/subway system being efficient and widely used by the public for it to be of any viable help to airport roadway congestion. The concept behind this system is for passengers to use the existing regular service rail to a designated station, and then have a passenger board a special dedicated rail service leading directly to the airport. Once at the airport rail station, the passenger would simply walk across and directly into the airport terminal avoiding the hassle, need, and most of all congestion of using the roadway network to be dropped off at the terminal. These automated people movers have since been implemented at airports such as New York's JFK Airport, Miami International Airport, and several others across the country. These ideas were proposed much in the late 1990s, and began to see fruition during the early 2000s. This rail service to airports is a relatively new idea, and has the potential to be an asset to any major airport challenged by congestion. The solution however, is applicable and limited only to airports located in cities with preexisting metro rail/subway systems. This system is being termed as an IRN that connects the passenger to the various modes of transportation. An IRN would provide a passenger access to the terminal, the city through the existing metro rail/subway, the airport parking garages, and even the rental car centers attached to the airport. The next section discusses the history of intermodal research.

1.1.2 History of Intermodal Rail Network

The field of airport intermodal rail is fairly under-researched, and deserves more focus within the aviation community, as it is much needed as discussed in the airport congestion section. Intermodal research is an emerging research field that has evolved since the early 1990s yet there have been limited studies conducted in the past (Bontekoning, Macharis and Trip 2004). The scientific community has portrayed a fair overview of the situation as prior research stated that the concept of intermodal rail or "people movers" was significantly more popular in Europe than the United States. However, as discussed in the airport congestion section, this again could be attributed to the larger percentage of European cities already having rail/subway services as IRN is useful when working together with preexisting metro rail/subway services. Coogan (1995) additionally stated that due to this preexisting culture of rail transport, Europeans could be twice as likely to use rail services to reach their final destinations as compared to Americans. Harvey (1986) conducted research by way of attempting to identify the contributing factors in people's choice of mode of transport to access the airport. The research cemented the foundation that the largest factors behind the decisions were travel time and travel cost. Mandalapu and Sproule (1995) examined the most cost beneficial scenarios that would warrant rail access to airports. Their findings stated

that rail implementation was cost beneficial at airports with greater business travel passengers due to the value placed by business travelers on time sensitivity and time saved.

Bontekoning, Macharis and Trip (2004) conducted a review of ninety-two publications in order to identify the characteristics of the intermodal research community and scientific knowledge base. The research suggests that North American researchers dominate the rail research in drayage, mode choice and pricing, and rail haul operational management, and that European research dominate the research in rail haul in terms of the strategic and tactical level, as well as the category transshipment. Morlok et al. (1995), Morlok and Spasovic (1994), Spasovic and Morlok (1993), H€oltgen (1996), Fowkes et al. (1991) and Niérat (1997) researched how high drayage costs affect profitability of intermodal services and limits the competitiveness of intermodal services in comparison to road transport. Walker (1992) and Spasovic and Morlok (see Morlok et al., 1995; Morlok and Spasovic, 1994; Spasovic and Morlok, 1993) developed tools to study drayage operations behavior with findings that suggest that substantial cost savings could be achieved through a centrally planned operation where trips can be combined in a more efficient manner so there are less empty hauls. As for mode choice and pricing, Harper and Evers (1993), Evers et al. (1996), Murphy and Daley (1998), Ludvigsen (1999) and Tsamboulas and Kapros (2000) assessed shippers' perceptions of different cost-quality determinants of intermodal rail–truck service along with other transport modes. The research suggests that the overall perception for all modes ranks timeliness and availability of highest importance. Bontekoning, Macharis and Trip (2004) identified that intermodal policies do not effectively measure or support policy objectives such as reducing congestion and pollution, and improving safety. Furthermore, these policies do not adequately address spatial and economic objectives and infrastructure planning. Clarke et al. (1996) research suggests that that Americans will benefit in socio-economic terms from a shift from truck transport to intermodal transport from a safety perspective as intermodal transportation reduces fatal highway accidents by about 1%. Fonger (1993) and Engel (1996) suggest that the European society is better using road transport due to the societal costs of intermodal rail–truck, truck, and rail transport in Germany. However, Jensen (1990) shows the opposite from his design of a rail–truck intermodal system that competes with long-haul domestic road transport on heavy transport links in Sweden, both for private costs, quality aspects and external costs. As for spatial and economic policy objectives in Europe, it is common that evaluation of a new intermodal terminal is on business economic merits and its contribution to regional economic development (Bontekoning, Macharis and Trip 2004). Whereas in the USA, new intermodal terminals are evaluated strictly on business economics merits so Slack (1995), and Barton et al. (1999) suggests that the planning practice in America should incorporate regional economic development objectives. Stank and Roath (1998) suggest that a scale be developed to survey manufacturers and shippers/consignees prior to building intermodal terminals to assess their perceptions regarding the potential development on such facilities. This section leads into the Airport Rail Travelers to further understand the perceived benefits by travelers in enhanced transport to airports.

1.1.3 Airport Rail Travelers

Now that we have discussed airport congestion and the IRN history, we will look at the impact to the airport rail traveler. Cao (2013) research findings suggest that rail transit positively influences satisfaction with life (SWL) through enhanced access to different activities, and through improved transit service, enhanced accessibility, and their impacts on traveler's satisfaction with travel. This study focused on the connections between transit and SWL using the Hiawatha line in Minneapolis as the basis for the research. Cao's (2013) research along with the research by Litman (2005) and Cervero et al. (2004) is in alignment with the livability principles of the 2009 US Interagency (Department of Housing and Urban Development-Department of Transportation-Environmental Protection Agency) Partnership for Sustainable Communities which includes identifying transportation choices that decrease household transportation costs and nation's dependence on foreign oil while improving air quality and amount of green-house gas emissions. Previous research conducted by Ettema et al. (2010) and Delbosc and Currie (2011) suggests that travel allows individuals to carry out the activities that contribute to an individuals' SWL and that transportation-disadvantaged people tend to have a low level of SWL because of social exclusion.

Lythgoe and Wardman (2002) performed an analysis of inter-urban rail demand to and from Manchester and Stansted Airports, in England. It was the first detailed analysis of aggregate rail flows to and from airports in Britain. This research expands upon previous research conducted by Lythgoe (1999), Wardman (1994, 1997) and Wardman, Toner and Whelan (1997). The study investigated the sensitivity of the market segment to growth in air traffic along with the cost and service quality of rail services for airport travelers. The importance of the study laid in identifying factors impacting demand for airport rail, as train operators sought revenue opportunities in this market segment, and local authorities and airports had an interest in increasing the amount of airport rail users. Lythgoe and Wardman (2002) used the term outward traveler to denote a British resident and inward traveler to denote an overseas resident. Time and headway largely impacted outward travelers' demand for the

rail while only the number of interchanges largely impacted inward traveler's demand. The amount of time awaiting a connection over the amount of time as the rail trip itself impacted demand by both outward and inward travelers. The addition of an interchange negatively impacted demand by 40% for outward travelers and 37% for inward travelers. With each addition of an interchange, demand for the airport rail decreased. The study findings are applicable not only to Britain, but also to airports and other organizations around the world that are interested in the improvement of public transport to and from airports. There are many positive impacts to the airport traveler in using a rail system. The next section discusses how rails can become integrated with the airport traveler's travel.

1.1.4 High-Speed Rail

Many positive benefits exist in travelers using a rail system as discussed in the previous section, this section discusses ways to integrate rails into the airport traveler's travel. Chiambaretto and Decker (2012) identified a taxonomy of Air and high-speed rail (HSR) integration. Keeping in mind that not all rail systems have to be a HSR system. However, this taxonomy only looks at Air and HSR integration. HSR services for airports do not necessarily involve airline integration, as the lack of integration or degree of integration depends on commercial agreements and on practical arrangements between any partners involved (Dobruszkes and Givoni 2014). In the taxonomy created, four different categories were defined: none as in no integration, low integration, medium integration and high integration. None is defined as a rail being used to only service an airport where passengers purchase separate tickets and assume all risks affiliated with travel delays. Low integration is defined as the rail tickets being received from the airline possibly at an extra fee depending on the airline and the class of travel. Medium integration is defined as one booking with one ticket where pre-check-in occurs at the railway station but luggage handling is not included. High integration is defined as having train schedules optimized with airline schedules and including online check-in or check-in at the rail station and luggage handling between rail and air. HSR is generally about three times more expensive than the cost to build a conventional rail in industrial countries (Chuang, M.Y. & Johnson, W.H.A. 2011). This cost structure has been evident from the costs incurred by countries such as France, Spain, and Japan. However, the World Bank suggest that the cost of Chinese HSR is only 20-30 percent higher than conventional rail cost due to less costly labor and state-owned land.

Clewlow, Sussman and Balakrishnan (2012) studied the role of cooperation between HSR and aviation in improving the aviation system planning process. The research focus was in four areas consisting of identifying how airports, airlines, and rail operators cooperated to enable airport–HSR connectivity, service characteristics of airport–HSR connectivity, challenges associated with airport–HSR connectivity and the demand for air transportation evolved in the presence of airport–HSR connectivity. Their findings suggest that there are specific key factors that appear to contribute to a successful airport–HSR connection. The first factor is infrastructure consisting of feeder or transfer service between HSR and air transportation necessitates that the rail station be located at the airport. The second factor is schedule and frequency consisting of rail operators and airlines both needing to have the same goal of optimizing their networks through coordinating timetables to ensure that rail service meets passengers' connecting flights. The third factor is market characteristics of the airport such as airports with HSR links being dominant international hubs for a country. The fourth factor is in having HSR lines as feeder service for international flights. For the purposes of the present study, the IRN doesn't consist of a HSR but it is of importance to understand different integration levels and successful airport-HSR connection. The IRN in the present study would be provided as a free airport service similar to shuttle buses and monorails services for airline passengers. This section provides ways of integrating rail into an airport system but now we will discuss how rail systems also have environmental benefits as discussed in the next section.

1.1.5 Sustainability through Intermodal Rail Network

Rails can provide benefits to airport travelers and be integrated with airports which reduces airport congestion. This section discusses the environmental impacts of IRN. There here has been a paradigm shift from using road transportation to using rail to address sustainable mobility. The implementation of such mechanisms allow for the reduction in automobile transportation and therefore reduce CO_2 emissions and non-renewable resource use (Hull, 2007). The use of intermodal rail to transport passengers from areas nearby the airport can reduce CO_2 emissions through the reduction in the number of moving vehicles on the road around the airport as well as a major reduction in congestion. This practice is used widely in the European Union. For example, in a study conducted in Sweden by Akerman and Hojer (2011) the reduction of carbon emissions by switching from car to rail was approximated to be 50%. Wang (2010) identified Chinese cities as having urban transport challenges to include congestion, air pollution, energy shortage and global climate change fostering a need for efficient and equitable urban transport policies for China's sustainable development. The research explored whether modeling policies from other countries would perform well in China. Sustainability is a world-wide challenge in need of much research.

Despite the need for sustainability throughout the world, it is important to realize some key numbers and constraints of moving toward sustainable transportation. For example, the overall level of emissions in London is approximately 44 $MtCO_2$ (million tonnes of carbon dioxide). To reduce such a large amount of carbon emissions and maintain economic growth and quality of life is a difficult challenge (Hickman, Ashiru, & Banister, 2010). Regan (2014) studied Europe's conflicting objectives of air transport liberalization and environmental sustainability. The study addressed the need for a global agreement and some type of re-regulation in order to achieve environmental sustainability due to increasing CO2 emissions and the need to address congested hub airports.

The first step, however, is to include the public in achieving such a task. In order to include the public, the public must first be willing to use this form of public transportation method such as intermodal rail to reduce the number of fuel driven vehicles on the road. The present study's purpose is to design a scale that will measure the aspects that the consumer's consider as important to the efficiency of a rail system. This will allow planners and airport managers to investigate whether the public will use it. It is the first step toward sustainability. A great example of the sustainable prospect of using intermodal rail is Miami International's people mover. It is estimated that 16,000 people use the system daily to be transported from various parking locations and terminals to reach their intended point of interest. It has been estimated that the CO_2 emissions have been reduced by 157,000 tons due to the reduction of 1400 shuttle trips (Miami-airport.com).

Overall, airports look at ways to generate revenue through maximizing profits and stimulating airport growth (Graham 2011). Improving airport operational efficiency is key to revenue generation and is necessary in attracting more business (Ahn and Min, 2014). As Regan (2014) suggests, there are 'irreconcilable differences' among competing needs on economic and social benefits derived from a competitive aviation marketplace without environmental sustainability being compromised. IRN is one solution the authors pursued in conquering the balance of economic and social benefits and environmental sustainability. The focus of the IRN present study explores an IRN Scale for commercial service airports to acquire passenger satisfaction ratings on features of intermodal rail service. This research also provides a means to measure factors influencing IRN use to ultimately result in reduced vehicles around the airport that produce greenhouse emissions.

2. Methodology

This study was conducted using a four-step process. At each stage, consumers were used as the participants in order to generate the final scale. This was done in order to achieve construct validity since the developed scales would eventually be filled out consumers themselves. This study used a methodology similar to that of previous studies that developed valid and reliable scales (Rice, Mehta**,** Steelman, & Winter, 2014; Rice, Mehta, & Winter, in press). Additionally, this methodology is consistent with Hinkin's (1998) scale development process.

2.1 Stage 1: Item Generation

The goal of Study 1 was to begin generating items for the scale. Many scales are developed primarily through solicitation of items from content experts; in addition to this, we also solicited items from actual and potential consumers. The researchers' reasoning behind this decision was that it would be consumers themselves who will be asked to respond to the finalized scale items.

2.1.1 Participants

Eighty-two (thirty-six females) participants from the United States took part in the study. The mean age was 33.02 (*SD* = 11.14). Participants were recruited via a convenience sample using Amazon's ® Mechanical Turk ® (MTurk). MTurk is an online source of participants who are paid compensation for participation in studies. Previous research has shown that MTurk data is as reliable as laboratory data (Buhrmester, Kwang, & Gosling, 2011; Germine, et al., 2012). All participants were identified as being airline consumers who spoke English as a native language, as was the case for each following the study. Additional aviation experts were recruited from the [name of Institute] community.

2.1.2 Materials and Stimuli

Participants first gave electronic consent via SurveyMonkey ® and were presented with the following scenario: "*An airport intermodal rail system consists of a train or rail connection between the existing parts of the airport parking lot, rental car lot, public transportation and terminals. The airport intermodal rail system is outside of the airport and is prior to entering the TSA security. This does NOT include the rail system that commonly connects terminals to each other, which is inside the airport and beyond the security checkpoint. In the context of an airport intermodal rail system, please identify 6 characteristics of the airport intermodal rail system that you associate with having a positive experience. Please input single words (e.g. comfortable) or short phrases (e.g.*

easy to navigate)." After providing the list of six words or phrases, participants were debriefed and dismissed.

The study generated a total of three hundred and twelve unique words or phrases (e.g. efficient, handicap accessible, etc.). All items were reviewed for correct spelling and all words were de-capitalized for equal saliency in the following steps.

2.2 Stage 2: Nominal Paring

The goal of Study 2 was to pare down the initial list of items by eliminating words or phrases that were not perceived by participants as being sufficiently important to a positive experience with intermodal rail.

2.2.1 Participants

Twenty (ten females) participants from the United States took part in the study. The mean age was 32.50 (*SD* = 13.44). As with the previous study, participants were recruited via a convenience sample using MTurk.

2.2.2 Materials and Stimuli

The three-hundred and twelve words generated in the first study were presented to participants with the following statement, "*An airport intermodal rail system consists of a train or rail connection between the existing parts of the airport parking lot, rental car lot, public transportation and terminals. The airport intermodal rail system is outside of the airport and is prior to entering the TSA security. This does NOT include the rail system that commonly connects terminals to each other, which is inside the airport and beyond the security checkpoint. In the context of an airport intermodal rail system, please rate whether each word or phrase below is or is not an important characteristic of an intermodal rail system that creates a positive experience.*" Thirty-three words were judged to be an important characteristic of an intermodal rail system that creates a positive experience by at least 75% of participants, and were included in the next study.

2.3 Stage 3: Likert-scale Paring

The goal of Study 3 was to continue narrowing down the list of items. At this stage, a more sensitive measure of the relationship between the items and the construct was being identified. A Likert-type scale was used to provide data on the importance of each item.

2.3.1 Participants

Fifty-one (twenty-two females) participants from the United States took part in the study. The mean age was 34.33 (*SD* = 12.41). Participants were recruited via a convenience sample using MTurk.

2.3.2 Materials and Stimuli

In this study, the thirty-three words carried over from Study 2 were presented to participants with the following statement, "*An airport intermodal rail system consists of a train or rail connection between the existing parts of the airport parking lot, rental car lot, public transportation and terminals. The airport intermodal rail system is outside of the airport and is prior to entering the TSA security. This does NOT include the rail system that commonly connects terminals to each other, which is inside the airport and beyond the security checkpoint. In the context of an airport intermodal rail system, please rate how important each word or phrase below is as a characteristic of an intermodal rail system that creates a positive experience.*" Participants were asked to respond on a Likert-type scale from "Not at all important" (0) to "Extremely important" (+3). An average score across participants was calculated for each item; words that averaged 2.5 or higher (equivalent to the average participant saying that this item was *at least* "quite important") were retained for the next study. This resulted in six words being carried over to Study 4.

2.4 Stage 4: Scenario-based Testing

The first three studies in this research were designed to help generate and narrow down items that were viewed as important for having a positive experience with an intermodal rail. The purpose of Study 4 was to begin to collect evidence about the validity and reliability of the newly created measure.

2.4.1 Participants

Two hundred and twelve (ninety-eight females) participants from the United States took part in the study. The mean age was 32.81 (*SD* = 10.57). Participants were recruited via a convenience sample using MTurk. Importantly, a logic rule in the survey was set-up such that participants were first asked if they had used an intermodal rail system in the past five years. Those who answered "yes" were forwarded to the survey below. Those who answered "no" were debriefed and paid.

2.4.2 Materials and Stimuli

In this stage, participants were given the following scenario: "*An airport intermodal rail system consists of a train or rail connection between the existing parts of the airport parking lot, rental car lot, public transportation and terminals. The airport intermodal rail system is outside of the airport and is prior to entering the TSA security. This does NOT include the rail system that commonly connects terminals to each other, which is inside the airport and beyond the security checkpoint. Please think back to the last time you used an intermodal train/rail at any airport. Then please respond below to how strongly you agree or disagree with the following statements.*" Participants were then given the questionnaire (see Appendix A; note that past tense was used for this scenario) and asked to provide statements of agreement or disagreement on a 5-point Likert-type scale (coded from -2 to +2).

2.4.3 Scale Development.

A factor analysis using the principle components and varimax rotation resulted in all items loading strongly on one factor. The purpose of the principle components analysis was to analyze the data structure in terms of variance, while the varimax rotation increases the interpretability of the factors, and supporting the findings that all the items loaded on one factor (Field, A., 2009). The overall purpose of the factor analysis was to show the validity of the developed scale, and since all the times of the scale loaded on one factor, that they were all measuring the same area. To measure the internal consistency and reliability of the developed scale, two tests were conducted, namely a Cronbach's Alpha test, and Guttmann split-half test. The Cronbach's alpha test measures the correlation between the variance of a single item from a scale to the variance of the whole scale (Cronbach, 1951). A Cronbach's alpha is defined as coefficient of internal consistency (Schweizer, 2011), and internal consistency is said to exist if the Cronbach Alpha's test is greater than 0.7. The Cronbach's Alpha test resulted in a value of 0.80, indicating high internal consistency. A Guttmann split-half test divides a scale into two random halves and measures the correlation between the two halves (Guttman, 1945). A higher correlation between the halves indicates good reliability of the developed scale. The Guttmann split-half test generated a coefficient of 0.79, indicating good reliability.

3. Discussion

The research purpose is in the development of a valid and reliable scale of consumers' experiences with intermodal rail. Through this scale, it can be evaluated what salient aspects are required to have a successful intermodal rail system which will in turn reduce the level of emissions around an airport. The research began with three hundred and twelve "satisfaction" items being identified by customers as associated with positive experiences with intermodal rail. The research resulted with those three hundred and twelve "satisfaction" items being reduced to six items. These six items identified by consumers were clear directions, efficient, on time, reliable, safe and secure. A scale which is located in Appendix A was developed that could be used to measure consumer satisfaction with intermodal rail service. This scale will be useful to airport management in identifying areas of strength and weakness affiliated with the intermodal rail. Areas of weakness would become areas that are monitored, measured and improved. It is important to airports that passengers have satisfaction with their use of the intermodal rail as consumer loyalty can be impacted by negative experiences. Metro rail and subway services are valuable not only in terms of economic validity but also in meeting airport passengers' travel needs and enhancing their overall travel experience (Schank 1999).

It is important to discuss that the final scale has only positive items associated with an intermodal rail. Harrison and McLaughlin (1991) suggest, reverse-scored items "…can have detrimental effect on psychometric properties of a measure…" when the items are randomly placed within the scale. Therefore, it would be preferable to have items on only one end of the scale (Hinkin, 1998). Although arguments can be made for scales that include both positive and negative items, the approach was to avoid cognitive confusion of consumers when having to switch between positive and negative items.

3.1 Validity

For a scientific scale to be useful, it must have validity associated with it. In order to ensure construct validity, two processes were followed. First, consumers were allowed to choose the items that belonged in the scale, with additional items added from other sources. This process was followed because it is these consumers who will be using the final scale in real-world situations. While items generated by experts may be useful, experts often fail to pick up on nuances of consumer perception due to being too close to the issue. Not only were consumers allowed to have large control in the item generation, but also it was potential consumers who were responsible for narrowing the item list down from three hundred and twelve to six items. Second, a factor analysis on the dataset was conducted suggesting that all items strongly loaded on one factor. These two pieces of evidence

pointed strongly to a final scale with good validity.

3.2 Reliability

A useful scale must have good validity and reliability. The final six items in the scale were tested for reliability. The Cronbach's Alpha test indicated high internal consistency among the items. The Guttman Split-half test added further evidence to high reliability for the final scale items.

3.3 Practical Applications

The practical applications of the research lie in the scale being useful to airport managers in the design and development of IRN for airport customers. The identified six items affiliated with consumer satisfaction present a framework to use of important items that need to be present for new IRN's. Therefore, designers and developers will want to build the IRN around the customer's needs for clear directions, efficiency, on-time service, reliability, safety and security. While it is important to define these terms, consumers have generated these items and so the research may only infer as to their definitions and context of this setting. These items are believed to refer to the following definitions. Clear directions refer to the ease of use and understanding of the signage and audible instructions. Efficiency refers to the actual ease of use and benefit of using the rail network. On-time service refers to the punctuality of the rail network. Reliability refers to the faith that the service will operate at the times and in the manner as expected and as previously experienced. Safety refers to the overall safety of the network within the control of the system without external influences, so as to say that the system itself is inherently safe to use. Security refers to the aspect of safety to prevent against malicious intent or dangerous activities of external influences. These items indicate the main aspects that will increase the usage of the IRN by the passengers. By doing so this will reduce the number of vehicles congested around a terminal of an airport and increase the efficiency of traffic. This reduction in traffic will result in a greater reduction in CO_2 around the airport, increasing the air quality and overall sustainability of the airport. It will also be a useful tool to evaluate consumer experiences and areas that need to be targeted for improvement in the operations and maintenance of an IRN. Providing greater customer satisfaction with IRN could enhance business at an airport and affiliated airlines.

3.4 Limitations

There are undoubtedly certain limitations associated with the research. The study only benefits those cities with a preexisting metro rail and subway services, and therefore are the only ones that can utilize the developed scale. Furthermore, the scale developed doesn't currently define the six terms, clear directions, efficiency, on-time service, reliability, safety and security as additional research will identify the depth of meaning for each term.

3.5 Future Research

There are future research areas that have been identified to better study this are more in depth. The first future research area is for the six terms identified by consumers as necessary for satisfaction to be defined. Surveying consumers to identify the depth and scope of each term should be conducted to further enhance the developed scale. A second area of future research is for the scale to be tested in cities with a preexisting metro rail and/or subway service so that any modifications necessary to the scale may be incorporated. Different studies of rail systems using simulators could be another potential area of further research. The use of simulators will better facilitate the understanding of passenger flow and allow for a more well rounded perspective on the overall nature of passenger movement. Additionally, simulators could be a method of testing new functions that have arisen out of analysis of the responses of passengers that used the developed scale. Once areas for improvement have been identified by the use of this scale, their effectiveness can be tested using simulators. This will in turn provide evidence to suggest that the developed scale is in fact of practical significance and is of use to the industry. Future research could be conducted for simulators of a railway control center for operations and monitoring, similar to studies conducted of air traffic control centers. These studies could seek to understand the threat and error in the system to include the cognitive load carried by the staff of the control center. The study outcome could help to support a positive safety culture within city rail systems.

A third area of study is for scales to be developed and tested to use on railway control center personnel to assess threat and error in the system and human performance data. Furthermore, researchers may choose to focus on running another simulation to study emergency exercises needed in potentially hazardous situations requiring evacuations. The simulator could have an additional use in training of emergency personnel in carrying out emergency exercises. Surveys to identify public perceptions of rail safety could be conducted to understand any misconceptions that do exist and need to be corrected. This will help to build trust and confidence leading to public support of increased rail design and development within airport cities. A final recommendation for future

research involves the generation of additional scales to assess the emergency preparedness level of the shuttle and tunnel.

3.6 Conclusion

The end goal of this research endeavor was to build a valid and reliable scale that could measure consumer satisfaction with an airport's IRN. The goals of the research were achieved through the execution of a multi-study approach and a consumer centric generation of a valid and reliable IRN scale. The value in the developed scales lies in its ability to aid airport management teams to better understand their consumers, and also allow for more focused airport development specifically in the area of IRN. Additionally, designers and developers at airports without existing networks will want to build the IRN around the six items that have been deemed important for customer satisfaction which are clear directions, efficiency, on-time service, reliability, safety and security. This scale will prove to be useful as an evaluation tool for measuring consumer experiences and areas that need to be targeted for improvement in the operations and maintenance of an IRN. IRN should be considered and more heavily integrated as research suggests that it would result in less highway fatalities and contribute to individual's SWL (Cao 2013; Clarke et al. 1996; Delbosc and Currie 2011; Ettema et al. 2014). An indirect benefit of increased consumer satisfaction with the use of the IRN, lies in the reduction of CO2 emissions around the airport, which improve the sustainability of the entire operation from an environmental perspective.

References

Ahn, Y. H., & Min, H. (2014). Evaluating the multi-period operating efficiency of international airports using data envelopment analysis and the Malmquist productivity index. *Journal of Air Transport Management, 39*, 12-22. http://dx.doi.org.portal.lib.fit.edu/10.1016/j.jairtraman.2014.03.005

Akerman, J., & Hojer, M. (2005). How much transport can the climate stand? – Sweden on a sustainable path in 2050. *Energy Policy, 34,* 1944-1957. http://dx.doi.org/10.1016/j.enpol.2005.02.009

Barton, J. E., Selness, C. L., Anderson, R. J., Lindberg, D. L., & Foster, N. S. J. (1999). Developing a proposal for a multiuser intermodal freight terminal as a public-private partnership. *Transportation Research Record, 1659*, 145-151. http://dx.doi.org/10.3141/1659-18

Bianconi, M., & Tewdwr-Jones, M. (2013). The form and organisation of urban areas: Colin buchanan and traffic in towns 50 years on. *The Town Planning Review, 84*(3), 313-336. Retrieved from http://search.proquest.com/docview/1366370249?accountid=27313

Bontekoning, Y. M., Macharis, C., & Trip, J. J. (2004). Is a new applied transportation research field emerging?––A review of intermodal rail–truck freight transport literature. *Transportation Research Part A, 38,* 1-34. http://dx.doi.org/10.1016/j.tra.2003.06.001

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality data? *Perspectives on Psychological Science, 6*(3), 3-5.

Cao, J. (2013). The association between light rail transit and satisfactions with travel and life: Evidence from twin cities. *Transportation, 40*(5), 921-933. http://dx.doi.org/10.1007/s11116-013-9455-8

Cervero, R., Murphy, S., Ferrell, C., Goguts, N., Tsai, Y.-H., Arrington, G. B., … McKay, S. (2004). Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. *Transportation Research Board*, Washington, DC.

Chiambaretto, P., & Decker, C. (2012). Air rail intermodal agreements: Balancing the competition and environmental effects. *Journal of Air Transport Management, 23*, 36-40.

Chuang, M. Y., & Johnson, W. H. A. (2011). Hop on board: the importation and future development of high # speed rail (HSR) in China. *Journal of Technology Management in China, 6*(3), 232-241.

Clarke, D. B., Chatterjee, A., Rutner, S. M., & Sink, H. L. (1996). Intermodal freight transportation and highway safety. *Transportation Quaterly, 50*(2), 97-110.

Clewlow, R. R. L., Sussman, J. M., & Balakrishnan, H. (2012). Interaction of High-Speed Rail and Aviation Exploring Air–Rail Connectivity. Transportation Research Record: Journal of the Transportation Research Board, No. 2266, Transportation Research Board of the National Academies, Washington, D.C., 2012, pp. 1–10. http://dx.doi.org/10.3141/2266-01

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *psychometrika, 16*(3), 297-334.

Delbosc, A., & Currie, G. (2011). Transport problems that matter – social and psychological links to transport dis-advantage. *Journal of Transport Geography, 19*(1), 170-178.

Dobruszkes, F., & Givoni, M. (2014). Competition, Integration, Substitution: Myths and Realities Concerning the Relationship between High-Speed Rail and Air Transport in Europe. *Sustainable Aviation Futures, 4,*

175-197. http://dx.doi.org/10.1108/S2044-9941(2013)0000004008

Engel, M. (1996). Modal-Split-Ver€anderungen im G€uterfernverkehr: Analyse und Bewertung der Kosten—und Qualittseffkete einer Verkehrsverlagerung Straße/Schiene. Deutscher Verkehrs-Verlag, Hamburg.

Ettema, D., Garling, T., Olsson, L. E., & Friman, M. (2010). Out-of-home activities, daily travel, and subjective well-being. *Transportation Research Part A: Policy and Practice, 44*(9), 723-732.

Field, A. (2009). *Discovering statistics using SPSS*. Sage publications.

Fonger, M. (1993). Gesamtwirtschaftlicher Effizienzvergleich alternativer Transportketten: eine Analyse unter besonderer Ber€ucksichtigung des multimodalen Verkehrs Schiene/Strasse. Vandenhoeck & Ruprecht, G€ottingen.

Fowkes, A. S., Nash, C. A., & Tweddle, G. (1991). Investigating the market for inter-modal freight technologies. *Transportation Research A, 25*(4), 161-172. http://dx.doi.org/10.1016/0191-2607(91)90002-8

Fox, M., & Tallon, A. (2013). Traffic congestion in beijing: Issues and policies. *Geography, 98*, 43-49. Retrieved from http://search.proquest.com/docview/1460135914?accountid=27313

Germine, L., Nakayama, K., Duchaine, B. C., Chabris, C. F., Chatterjee, G., & Wilmer, J. B. (2012). Is the web as good as the lab? Comparable performance from web and lab in cognitive/perceptual experiments. *Psychonomic Bulletin & Review, 19*(5), 847-857. http://dx.doi.org/10.3758/s13423-012-0296-9

Graham, A. (2011). The objectives and outcomes of airport privatisation. *Research in Transportation Business & Management, 1*, 3-14. http://dx.doi.org/10.1016/j.rtbm.2011.05.004

Gunn, S. (2011). The Buchanan Report, environment and the problem of traffic in 1960s Britain, *Twentieth Century British History, 22*, 521-542. http://dx.doi.org/10.1093/tcbh/hwq063

Guttman, L. (1945). A basis for analyzing test-retest reliability. *Psychometrika*, *10*(4), 255-282.

H€oltgen, D. (1996). Terminal, intermodal logistics centres and European infrastructure policy (Ph.D. Thesis). University of Cambridge, Cambridge.

Halpern, C. (2014) Airport Companies as Silent Partners: The Complex Interplay between Public and Private Ownership. *Sustainable Aviation Futures, 4*, 131-154.

Harrison, D. A., & McLaughlin, M. E. (1991). Exploring the cognitive processes underlying responses to self-report instruments: Effects of item content on work attitude measures. *Proceedings of the 1991 Academy of Management annual meetings,* 310-314. http://dx.doi.org/10.5465/ambpp.1991.4977169

Harrison, D. A., & McLaughlin, M. E. (1993). Cognitive processes in self-report responses: Tests of item context effects in work attitude measures. *Journal of Applied Psychology, 78,* 129-140.

Hickman, R., Ashiru, O., & Banister, D. (2010). Transport and climate change: Simulating the options for carbon reduction in London. *Transport Policy, 17*(2), 110-125. http://dx.doi.org/10.1016/j.tranpol.2009.12.002

Hinkin, T. R. (1998). A brief tutorial on the development of measures for use in survey questionnaires. *Organizational research methods*, *1*(1), 104-121. http://dx.doi.org/10.1177/109442819800100106

Hull, A. (2007). Policy integration: What will it take to achieve more sustainable transport solutions in cities? *Transport Policy, 15,* 94-103. http://dx.doi.org/10.1016/j.tranpol.2007.10.004

Jensen, A. (1990). *Combined Transport: Systems, Economics and Strategies.* Swedish Transport Research Board, Stockholm.

Kulick, B. (2013). Simulation for Planning Passenger and Freight Transportation System Projects. Symposium on Simulation for Architecture and Urban Design (SimAUD 2013). San Diego, California, USA, 1-4.

Litman, T. (2005). Impacts of rail transit on the performance of a transportation system. *Journal of the Transportation Research Board, 1930*, 21-29. http://dx.doi.org/10.3141/1930-03

Lythgoe, W. F. (1999). Airport Rail Access (Master's Thesis). Institute for Transport Studies, University of Leeds.

Lythgoe, W. F., & Wardman, M. (2002). Demand for rail travel to and from airports. *Transportation, 29*(2), 125-143. Retrieved from http://search.proquest.com/docview/212426808?accountid=27313

Miami International Airport: Miami Central Station (MCS), Miami-Dade County. (n.d.). Retrieved April 21, 2015, from http://www.miami-airport.com/cip_miami_central_station.asp

Morlok, E. K., & Spasovic, L. N. (1994). Redesigning rail–truck intermodal drayage operations for enhanced service and cost performance. *Journal of Transportation Research Forum, 34*(1), 16-31.

Morlok, E. K., Sammon, J. P., Spasovic, L. N., & Nozick, L. K. (1995). Improving productivity in intermodal rail–truck transportation. In P. Harker (Ed.), *The Service Productivity and Quality Challenge* (pp. 407-434).

Niérat, P. (1997). Market area of rail–truck terminal: pertinence of the spatial theory. *Transportation Research A, 31*(2), 109-127. http://dx.doi.org/10.1016/s0965-8564(96)00015-8

Partnership for Sustainable Communities. (2009). *Livability Principles.* Retrieved from http://www.sustainablecommunities.gov/aboutUs.html

Regan, P. (2014). Open skies or closed airports? europe's dilemma for a sustainable aviation strategy. *Journal of Management and Sustainability, 4*(2), 106-110. Retrieved from http://search.proquest.com/docview/1540086311?accountid=27313

Rice, S., Mehta, R., & Winter, S. R. (in press). A Trustworthiness of Commercial Airline Pilots (T-CAP) Scale for American Consumers. *Journal of Aviation Technology and Engineering.*

Rice, S., Mehta, R., Steelman, L., & Winter, S. R. (2014). A trustworthiness of commercial airline pilots (T-CAP) scale for Indian consumers. *International Journal of Aviation, Aeronautics, and Aerospace, 1*(3). Retrieved from http://commons.erau.edu/ijaaa/vol1/iss3/3

Schank, J. (1999). *Airport access via rail transit: what works and what doesn't* (Master's Thesis). Retrieved from http://hdl.handle.net/1721.1/9382

Schweizer, K. (2011). On the changing role of Cronbach's α in the evaluation of the quality of a measure.

Slack, B. (1995). Along different paths: intermodal rail terminals in North America and Europe. Proceedings from 7th World Congress on Transportation Research, Sydney, Australia, 4, 123-131.

Spasovic, L. N., & Morlok, E. K. (1993). Using marginal costs to evaluate drayage rates in rail–truck intermodal service. *Transportation Research Record, 1383*, 8-16.

Sproule, W. (2002). Planes, Trains and People Movers. Designing, Constructing, Maintaining, and Financing Today's Airport Projects, 1-9. http://dx.doi.org/10.1061/40646(2003)34

Stank, T. P., & Roath, A. S. (1998). Some propositions on intermodal transportation and logistics facility development: shippers' perspectives. *Transportation Journal, 37*(3), 13-24.

United States Department of Housing and Urban Development. (2008). *Indiana income limits [Data file]*. Retrieved from http://www.huduser.org/Datasets/IL/IL08/in_fy2008.pdf

Walker, W. T. (1992). Network economics of scale in short haul truckload operations. *Journal of Transportation Economics and Policy, XXVI*(1), 3-17.

Wang, R. (2010). Shaping urban transport policies in China: will copying foreign policies work?. *Transport Policy, 17*, 147-152. http://dx.doi.org/10.1016/j.tranpol.2010.01.001

Wardman, M. (1994). Forecasting the impact of service quality changes on the demand for inter-urban rail travel. *Journal of Transport Economics and Policy, 28*, 287-306.

Wardman, M. (1997). Inter-urban rail demand elasticities and competition in Great Britain: Evidence from direct demand models. *Transportation Research E, 33*, 15-28. http://dx.doi.org/10.1016/S1366-5545(97)83195-X

Wardman, M., Toner, J. P., & Whelan, G. (1997). Interactions between rail and car in the inter-urban leisure travel market in Great Britain. *Journal of Transport Economics and Policy, 31*, 163-181.

Appendix A

Please respond how strongly you agree or disagree with the following statements.

1. The train system has clear directions.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. The train system is efficient.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. The train is on time.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. The train is reliable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. The train is safe.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. The train is secure.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree