Evaluation of Factors of Service Quality for Intermodal Terminals

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Abstract

Intermodal transportation has revolutionized the movement of goods in domestic and international trade. A vital role is played by inland intermodal terminals in hinterland connectivity of containerized intermodal movement. This study is aimed at identifying and examining various factors which define service quality and customer satisfaction for users of intermodal terminals. The stakeholders aim to understand these factors within limited resources and time. Therefore, ranking the factors is indispensable to increase the customer satisfaction at the inland intermodal terminals. In the present paper, the factors are graded by applying one of the multi-criterion decision-making (MCDM) practices recognized as the Best Worst Method (BWM). This study intends towards addressing the research gap in service quality for intermodal terminals and suggest focus areas to improve service quality for the industry players.

Keywords

Intermodal Terminals, Dry Ports, Service Quality, Customer Satisfaction, BWM

1. Introduction

In the modern history, advent of containerization became revolution in international logistics. It brought safety, lesser handling, economy and unitization to the cargo which were earlier moving in loose condition and so were prone to handling and cargo safety issues leading to inefficiencies. Invented in USA in 1960s, following decades witnessed large scale adoption of containerization across supply chain and transportation modes. Shipping vessels, railcars, trucks and ports were standardized to enable seamless and smoother containerized transport of goods. Till date, many economies have seen unsurpassable surge in market share of containerized transport against bulk cargo. Today, share of intermodal railcars in total railcars originated in USA market is at all-time high, exceeding beyond 45% (American Association of Railroads, 2022).

In India, the surge in market share for intermodal wagons (container wagons in Indian context) over total rail wagon has been meagre in comparison to other economies. Container wagons accounted for about 5.12% of the total tonnes originating on the state-owned Indian railways’ freight operations in FY2020-21(Indian Railways Yearbook, 2021). Indian railways joined the containerization revolution by institutionalizing the container business by incorporating Container Corporation of India or the CONCOR in year 1988(Indian Railways Yearbook, 2021). Indian railways also took many other initiatives like allowing private participation in container train operations through concessionaire arrangement, opening many commodities for container movement, so on and so forth. With such initiatives, many public sector undertakings, Indian private players and multinational logistics services providers invested in intermodal infrastructure like inland intermodal terminals (called the Inland Container Depots, ICD in India), container trains and ancillary services(Gangwar, et al., 2010). Based on our survey of current market, there are about 14 public and private container train
concessionaires delivering services for international and domestic container movement. Development of ICDs is also on the rise, with around 113 rail linked ICDs already operational and 32 ICDs under development across the country. With increasing competitive landscape in Indian intermodal terminal marketplace, service quality will play a vital role in business sustainability. While many detailed studies have been done in diverse industries to understand factors of customer satisfaction, the current study shall focus on identifying and evaluating factors of customer satisfaction for users of intermodal terminals in Delhi NCR market of India. Thus, as per above discussion, objectives of research are established as below:

- To find the factors for ranking and valuation from literature review and business experts.
- To classify the factors by means of the MCDM method.

To accomplish the established research objectives, a two-step procedure covering identification of the factors followed by prioritization using BWM approach is used. The paper is organized such as Section 2 confers the literature review, Section 3 embodies the research methodology while Section 4 covers the data validation. Further, Section 5 discusses results and conclusion of the article is presented in section 6.

2. Literature Review

2.1 Service Quality and Customer Satisfaction

Service quality can be regarded as the center of buying behavior of the customer (Rabin, 1983). Service quality is defined as the holistic experience of the user of comparative superiority (or inferiority) of the services and the organization providing these services(Bittner, et al., 1990). As quality of service is different from that a physical product due to intangibility i.e., non-measurability (Bateson, 1977); heterogeneity i.e., variance in services (Booms, et al., 1981) and inseparability i.e. production and consumption are not separate (Gronroos, 1982). When a service provider understands how the consumer will assess the service, the service provider can accordingly propose innovative service designs and features to deliver desired customer experience(Gronroos, 1982). However, service quality is such an obscure construct that it is complex to describe and assess,(Parasuraman, et al., 1985). Therefore, the service quality quantification also has different mechanisms from that of product quality. There have been two prominent approaches for measuring service quality i.e., the American approach and the Nordic approach. The American notion basically is based on comparison made by consumer between expectation and actual experience of delivered service (Parasuraman, et al., 1985) whereas the Nordic notion believes only in the concept of perceived or experienced service quality by the consumer during the consumption of service (Gronroos, 1982). Initially, various studies on service quality recommended that service quality is a measure of match between the services delivered with expectations from customer. Thus, quality of service is directly proportional to customer expectation compliance. Therefore, a model based on gap analysis between expected and perceived service was initially proposed, named as service quality model which suggested 10 service quality determinants (Parasuraman, et al., 1985). However, in later studies, this model was renamed as the famous SERVQUAL model which compressed the earlier stated 10 determinants into 5 dimensions of service quality termed as tangibility, empathy, responsiveness, reliability and assurance. The SERVQUAL model has been increasingly used to calculate qualified rank of five dimensions in inducing customer’s complete quality perception. Numerous studies have used this model in various industries i.e., online banking (Han, et al., 2004); telecommunication services; higher education; tourism. SERVQUAL model also seems to be a proven and preferred choice of researchers in logistics industry. Researchers used SERVQUAL model for refrigerated transport (Teresa, et al., 2015), seaports (Shanaki, et al., 2011), container terminals of India (Hemalatha, et al., 2018), Nigeria (Ugboma, et al., 2007), Croatia (Kolanovic, et al., 2011), Iran (Sayareh, et al., 2016), Denmark (Safaie, 2003).

2.2 Intermodal Terminals

Intermodality is a distinctive feature of a transport system where a load unit is used to hold the goods, and this load unit or shipping container itself is handled (loaded or unloaded) on various transport modes to form an end-to-end supply chain. This enables reducing handling on the cargo itself (Commission of the European Communities, 1997). Another definition suggests a dry port as an inland terminal which connects the seaports to hinterland with a high-capacity transport mode(Roso, et al.). Few researches address the service quality in dry ports. For South Indian dry ports, user’s perception was studied through self-administered questionnaires and was found that the service quality variables for dry ports can be bundled into quick response, track service, distribution service, infrastructure, reputation, good operations, and equipment & facilities (Hemalatha, et al., 2017). Another study conducted in Ethiopia on two regional dry ports used SERVQUAL model (Gudisa, 2016) for service quality assessment. The European commission in its IQ report (2000) analyzed the quality of intermodal transport in two components viz. quality of terminals (internal quality) and the quality of the networks (external quality). In another study, the quality of service is considered as a key parameter in the design and operation of intermodal freight terminals (Ballis, et al., 2002). However, the SERVQUAL model needs customization as per application and service industry (Finn, et al., 1991). Therefore, it can be seen that
extant research on intermodal terminals’ service quality has not been done for India’s National Capital Region. Despite of growing importance of dry ports, there are few studies on service quality for them.

3. Methodology
Identification and evaluation of factors and consequences of customer satisfaction for intermodal terminals is explained in the following steps:

3.1 Identification of Factors
Based on our literature review, the factors for customer satisfaction are proposed and shown in Table 1.

Table 1. Factors of Customer satisfaction

<table>
<thead>
<tr>
<th>S No</th>
<th>Factors</th>
<th>Description</th>
<th>Reference</th>
<th>Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Accuracy in Records &amp; Billing</td>
<td>Incorrect record keeping and billing information creates hassle for the customer as information on Bills and Records are used for many references. Therefore, accuracy in keeping correct records and billing is an important criterion for the users of Dry Ports.</td>
<td>(Kolanovic, et al., 2011)</td>
<td>ARB</td>
</tr>
<tr>
<td>2</td>
<td>Terminal Infrastructure &amp; Equipment</td>
<td>Use of technology in processes and Equipment for efficiently and safely handle containers and cargo.</td>
<td>(Lu, et al., 2011)</td>
<td>TIE</td>
</tr>
<tr>
<td>3</td>
<td>Cargo Safety &amp; Information Security</td>
<td>Assurance to the safety of cargo under ICD's Custody in terms of preventing damages during handling, abstain pilferage. Securing information of shipper, consignee, shipment etc shared by customer to ICD during processing of shipment.</td>
<td>Newly introduced variable</td>
<td>CSIS</td>
</tr>
<tr>
<td>4</td>
<td>Cargo Tracking &amp; Regular Updates</td>
<td>Providing regular information to the customer in appropriate language regarding shipment status, location, delays, departure and arrival.</td>
<td>(Kolanovic, et al., 2011)</td>
<td>CTRU</td>
</tr>
<tr>
<td>5</td>
<td>Competitive Pricing</td>
<td>Pricing of the Intermodal Terminal for its services to customer is very important variant in a competitive market.</td>
<td>(Lu, et al., 2011)</td>
<td>CP</td>
</tr>
<tr>
<td>6</td>
<td>Services Availability</td>
<td>Suitable business hours, Location, Value-Added Services, Queing Time etc.</td>
<td>(Andersson, et al., 2016); (Lu, et al., 2011)</td>
<td>SA</td>
</tr>
<tr>
<td>7</td>
<td>Staff Behaviour &amp; Complaint Resolution</td>
<td>Staff Friendliness and service ability to effectively deal with customer. Timely resolution of customer complaints and claims by the ICD.</td>
<td>(Lu, et al., 2011); (Yeo, et al., 2015); (Kolanovic, et al., 2011)</td>
<td>SBCR</td>
</tr>
<tr>
<td>8</td>
<td>Terminal Image</td>
<td>Terminal's reputation in market, past record, Professionalism influences the customer satisfaction for users of Intermodal terminal. Good relationship with other stakeholders like Railways, Road Transporters, Shipping Lines and Ports&amp; Social Responsibility.</td>
<td>(Yeo, et al., 2015); (Kolanovic, et al., 2011)</td>
<td>TI</td>
</tr>
<tr>
<td>9</td>
<td>Service Punctuality</td>
<td>Waiting time has significant influence on customer loyalty in service industries. Services provided by the Intermodal Terminal operator to be delivered efficiently, accurately, consistently and as promised.</td>
<td>(Bielen, et al., 2007); (Kolanovic, et al., 2011)</td>
<td>SP</td>
</tr>
</tbody>
</table>
3.2 Best Worst Method (BWM)

MCDM problem is made of some alternatives & multiple criteria and each alternative has a score with respect to each criterion. The main purpose of an MCDM problem is to find the best alternative with the best overall score. There are many different methods to calculate the overall score for each alternative and the simplest way is to use an additive weighted value function (Keeney, et al., 1993). We use best-worst method (BWM) to determine the weight of each criterion. Since we have the score of each alternative, the overall score can easily be obtained. Based on BWM we need to track the following steps to calculate the vector (Rezaei, 2015):

Step 1. Define a set of criteria. In this step the decision-maker should define a set of criteria that is used to make a decision about alternatives.

Step 2. Define the best and the worst criterion. At this point, we ask the decision-maker to determine the best and the worst criterion regarded to their importance.

Step 3. Define the preferences of the best criterion over the other criteria. In this step the decision-maker determines a vector called Best-to-Other (BO). The resulting vector of “Best-to-Others” is:

\[ V_B = (v_{B1}, v_{B2}, \ldots, v_{Bn}) \]

Where \( v_{Bi} \) denotes the numerical importance of the best criteria \( B \) over \( i \)th attribute and \( v_{BB} = 1 \).

Step 4. Define the preferences of all criteria \( (j) \) over the worst criterion \( W \). In this step, the decision-maker determines a vector called Other-to-Worst (OW). The consequential vector of “Worst-to-Others” stands:

\[ V_W = (v_{1W}, v_{2W}, \ldots, v_{nW})^T \]

Where \( v_{iW} \) gives the preference of the \( i \)th criteria over worst criteria \( W \) and \( v_{WW} = 1 \).

Step 5. Search for the optimal solution. In this step we must find the optimal weights of the criteria (vector \( W \)). To do this, we must find a solution, which minimizes the maximum gaps between obtained weights and the opinion of decisionmaker. The purpose of this stage is to estimate the optimal weighting vector \( \left( x_1^*, x_2^*, \ldots, x_n^* \right) \) of the criteria.

The ideal weight of \( i \)th criteria is the one which addresses the mentioned criteria:

\[ \frac{x_i^*}{x_i} = v_{Bi} \quad \text{and} \quad \frac{x_i^*}{x_W} = v_{iW}. \]

In order to meet these criteria, the maximum absolute difference needs to be minimized for all criteria.

\[ \left| \frac{x_i - v_{Bi}}{x_i} \right| \quad \text{and} \quad \left| \frac{x_i - v_{iW}}{x_W} \right| \]

Therefore, the optimal weights for criteria can be calculated through the following programming problem (Rezaei, 2015):

\[
\begin{align*}
\min & \quad \max_i \left\{ \left| \frac{x_B - v_{Bi}}{x_i}, \frac{x_W - v_{iW}}{x_W} \right| \right\} \\
\text{Subject to} & \quad \sum^n x_i = 1 \\
& \quad x_i \geq 0 \quad \forall i = 1, 2, \ldots, n;
\end{align*}
\]

Problem (P2) is corresponding to the subsequent linear programming formulation (P3):

\[
\min \phi
\]

Subject to
Above problem (P3) is linear in nature and has an exclusive ideal result. On solving problem (P3), the value of \( \phi^* \) and optimal weights \((x_1^*, x_2^*, ..., x_n^*)\) are determined.

### Step 6: Checking the reliability of solution.

The nearer the consistency ratio to zero is, the more compatible the decision makers strategy is. By calculating a consistency ratio, we verify the consistency of the solution:

\[
\text{Consistency Ratio} = \frac{\phi^*}{\text{Consistency Index}}
\]

Table 2 is used to get the value of the consistency index (Rezaei, 2015).

#### Table 2. Consistency Index Table for BWM

<table>
<thead>
<tr>
<th>( v_{Bi} )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency index (max)</td>
<td>0.00</td>
<td>0.44</td>
<td>1.00</td>
<td>1.63</td>
<td>2.30</td>
<td>3.00</td>
<td>3.73</td>
<td>4.47</td>
<td>5.23</td>
</tr>
</tbody>
</table>

The consistency ratio value nearer to 0 is more consistent, while values nearer to 1 are less consistent. The consistency ratio not equal to zero (0) means that we don’t have full consistency in the pair comparison matrix but multiple optimality.

### 4. Data Validation

**Ranking Factors using Best-Worst Method:**

We conducted a survey with 6 industry experts and freight services users to rank the top and the least preferred criteria (the Factors) from the above identified 10 Factors. The respondents are industry experts, dry ports service providers and dry port service users. Four out of six decision makers selected CP as best factor and remaining two selected SP as the best alternative responsible for service quality of intermodal terminals. On the other hand, SA was chosen as the worst alternative by DMs. Using step 3 and 4 from section 3.2, the best to other and others to worst preferences were calculated and the ranks for all identified factors of customer satisfaction along with respective weights were determined using step 5. The optimal solution is determined by solving the linear programming problem (P3) using Lingo software. Prioritization of all the factors is then evaluated by ranking them according to their respective weights as shown in Table 3.

#### Table 3. Ranking of Factors using BWM method

<table>
<thead>
<tr>
<th>Notation</th>
<th>Factors</th>
<th>Weights</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>Competitive Pricing</td>
<td>0.19</td>
<td>1</td>
</tr>
<tr>
<td>SP</td>
<td>Service Punctuality</td>
<td>0.189</td>
<td>2</td>
</tr>
<tr>
<td>CTRU</td>
<td>Cargo Tracking &amp; Regular Updates</td>
<td>0.173</td>
<td>3</td>
</tr>
<tr>
<td>CSIS</td>
<td>Cargo Safety &amp; Information Security</td>
<td>0.126</td>
<td>4</td>
</tr>
<tr>
<td>ARB</td>
<td>Accuracy in Records &amp; Billing</td>
<td>0.083</td>
<td>5</td>
</tr>
<tr>
<td>SBCR</td>
<td>Staff Behaviour</td>
<td>0.064</td>
<td>6</td>
</tr>
<tr>
<td>TA</td>
<td>Technology &amp; Automation</td>
<td>0.052</td>
<td>7</td>
</tr>
<tr>
<td>TI</td>
<td>Terminal Image</td>
<td>0.043</td>
<td>8</td>
</tr>
<tr>
<td>TIE</td>
<td>Terminal Infra &amp; Equipment</td>
<td>0.029</td>
<td>9</td>
</tr>
<tr>
<td>SA</td>
<td>Service Availability</td>
<td>0.026</td>
<td>10</td>
</tr>
</tbody>
</table>
5. Result

The key aim of this research is to recognize and classify most significant factors which define service quality for intermodal terminal users leading to customer satisfaction. Based on previous theoretical frameworks from the logistics and cargo terminal establishments, the study firstly identified 10 factors of customer satisfaction as per Table 1. To rank the factors based on customer priority, BWM method was used and the weight of different factors was obtained. Table 3 suggests respective weights of the factors as per replies received in the survey.

As per the calculated weights, respondents have selected competitive pricing as the most important factor followed by service punctuality. Cargo tracking & regular updates is the third closely followed by cargo safety & information security, and last in top 5 ranked factor is accuracy in billing &records. It is also important to note the consistency index as consistency of the comparisons is represented by it. If values of consistency ratio are very close to zero, it represents high consistency of the comparisons, and thus high reliability of the results (Figure 1).

6. Conclusion

As competition from other modes of transport and within the intermodal terminal industry deepens, service providers are willing to increase the overall service quality delivered to the customers to achieve high customer satisfaction. This study concludes that the management of intermodal terminals should focus on 10 identified factors for achieving service quality and creating the favourable and memorable experiences for the customers. However, the management may not often deliver all factors at the same time due to constraint of adequate available resources. Therefore, they may consider the top ranked factors as priority areas to allocate its resources to deliver high quality services and customer satisfaction. It is also suggested that the intermodal services should be designed to ensure timely delivery of services at highest value for money for the customer. Customer gain confidence if they are given visibility of service delivery through regular updates and access to tools for tracking shipment as and when needed. As an inherent property of intermodal transport, custody of shipment is changed many times thus making it vulnerable to pilferages and damages. Also, customer shares lot of important and confidential information with the service provider, and thus expects Safety of cargo and security of information. Accuracy in billing and records is the 5th most important factor where customer expects the intermodal terminal staff to maintain sanctity in record keeping and billing processes. It is recommended that further studies should include more factors which effect the customer satisfaction and also other MCDM tools can be used to confirm model of this study.

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