Chapter 7
Findings and Discussion

7. Findings and Discussion

7.1 Key findings and discussion w.r.t. Objective 1

The results of the analysis of objective 1 have been described in Chapter 5 of the thesis. The key findings from fulfillment of objective 1 are provided in this sub-section. Objective 1 comprised of an exploratory study involving identification of criteria and sub criteria for port ranking exercise of the key inland water ports in Assam. Key findings in this regard are summarized below:

- The study identified seven inland water ports of prominence on the Brahmaputra (NW2) namely Dhubri, Jogighopa, Pandu, Biswanath, Silghat, Nematighat and Dibrugarh. While for Barak (NW16), three ports Karimgamj, Badarpur and Silchar have been identified. This is based on information available in policy documents and secondary data accessed from IWAI and IWT.
- The systematic literature review has yielded five criteria and twenty sub criteria for ranking the key inland water ports. The five identified criteria- port geographical location, port physical conditions, port infrastructure, port costs and port efficiency and performance have been validated through expert opinion. The first three criteria are corresponding to the hard factors concerning physical evidence while the remaining two are a measure of the soft factors which indicates overall efficiency and effectiveness.
- In terms of port geographical location, proximity to import/export and closeness to highways/railroads emerge as major factors with weightages of 47.4% and 38.9% respectively. Majority of the inland water ports selected for the study are well connected by highways/railroads. The results have accurately validated that accessibility is a major factor determining the prospect of any business entity. In this regard, proximity to dry ports also plays a significant role, however, due to the presence of a single dry port at Amingaon, the impact of the same is not substantial (9%).
- Considering port physical conditions, water depth is the forerunner with a weightage of 71.8% and rightly so, water depth is an important parameter for determining vessel operations. Dyck and Ismael (2015) had substantiated the significance of water depth among other factors. The importance of water depth is also evident from the significant expense undertaken every year from the public exchequer on dredging

activities. To address this significant factor, the ministry of Ports, Shipping and Waterways GoI has launched ‘Sagar Samriddhi’- an online Dredging monitoring system. For the major ports in India, the annual maintenance dredging is around 100 million cubic meters at an expenditure of approximately Rs. 1000 crores each year (PIB Release dtd. 09.06.2023). Apart from water depth, operating weather condition with a weightage of 21.3% plays an important role in determination of the operational seasons for the inland water port. Apart from Dhubri, Jogighopa and Pandu, none of the other ports are operational throughout the year. For business continuity, it is pertinent to have yearlong operations.

- In context of port infrastructure, port equipment and terminal size emerge as significant factors with weightages of 32.8% and 29.1% respectively. Although container ships and containerization have revolutionized the global shipping industry, yet none of the inland water ports in Assam are presently equipped to handle container transport effectively. Port equipment is of utmost importance for enabling efficient port operations and turnover. As the volume of trade increases, the space required for loading, unloading and storage shall substantially increase and there shall be an imminent need for terminals of larger sizes. It was observed that the terminal sizes at Pandu, Dhubri and Karimganj are relatively substantial.
- With reference to the criteria of port costs, the major factor has been found to be the docking cost with a weightage of 43.5% while the sub-criteria have secured almost equal weightages. Although the docking cost is regulated and notified by government agencies on a uniform basis, yet this can be a major decision factor for the shipping companies.
- Concerning port efficiency and performance, loading/unloading efficiency with a weightage of 60.6% has emerged as a prime factor and this rightly emphasizes the requirement of mechanized loading unloading facilities. Barge waiting time weightage is 23.8% which is largely determined by the effectiveness of the operational processes and longer wait times can be a major deterrent for vessels considering to dock.
- Results of the pairwise comparison of the major criteria have yielded port geographical condition and port physical conditions with weightages of 43.4% and 29.8% as the major determinants of the port ranking exercise.

- In terms of the global weights of sub-criteria, water depth, proximity to import/export and closeness to highways/railroads have emerged as the top three factors with overall weightages of 21.44%, 20.56% and 16.86% respectively. There are eight other sub criteria which have weightages in the range of 2-7% while the remaining nine have weightages less than 1%.
- The top three inland water ports in Assam are found to be Jogighopa and Pandu on Brahmaputra (NW2) and Karimganj on Barak (NW16). This ranking has been arrived at considering the *as-is* scenario during the data collection period. The research outcome can be very well substantiated by the fact that Jogighopa has been selected to be developed as the country's first international multimodal logistics park. A budget of Rs. 693.97 crore has been earmarked for the mega project. Pandu port is also as one of the most important inland water ports in Assam and has been allocated Rs. 72.6 crore for development of a ship repair facility. Additionally, along the Barak river, substantial investment has gone into modernizing and developing the Karimganj port terminal.

7.2 Key findings and discussion w.r.t. Objective 2 and Objective 3

The results of the analysis of objective 2 and 3 have been described in Chapter 6 of the thesis. The key findings from fulfillment of the objectives are provided in this sub-section. Objectives 2 and 3 comprised of identification of prospective dry port locations and optimization of the overall port network infrastructure. Key findings in this regard are summarized below:

- The preliminary region-specific study identified four prospective dry port locations one each at Jogighopa, Tezpur, Dibrugarh in the Brahmaputra valley and Badarpur in the Barak valley.
- Prospective dry port locations have been identified at Jogighopa, Amingaon, Jagiroad, Tezpur, Jorhat, Dibrugarh, Tinsukia, Rangia, Bongaigaon, Badarpur and Karimganj. All these locations fulfill the criterion for selection of dry ports.
- The existing one hub network model leads to higher cumulative distance and associated costs. The cumulative distance from the 10 feeder ports is 2506 kms while waterway specific, the cumulative distance is 1576 kms.
- For the best-case scenario of the two-hub network system, the cumulative distance from the 10 feeder ports is 1461 kms. This leads to 41.69% minimization in cumulative distance over the one hub network.

- The best-case configuration of the three-hub network system yields a cumulative distance of 1014 kms. The optimal configuration leads to a distance saving of 30.59% over the two-hub network.
- The optimal dry port locations have been identified as Amingaon, Tezpur and Badarpur for the inland water port infrastructure system of Brahmaputra and Barak.
- The optimal arrangement of dry ports has been found to be waterway specific.

7.3 Implication of the study

The research is an attempt to explore the untapped inland waterways potential of the northeastern region which is naturally endowed with rivers and waterways. The research objectives were addressed to bridge the gap between existing level of research as well as on the implementation front as well. The findings of the study have been able to draw conclusive evidence regarding the inland water infrastructure of the region. The study has been able to connect the ground realities in terms of the existing waterway infrastructure with the proposed investments in the domain. The inland water port ranking exercise has provided substantial evidence for policymakers to consider the significant parameters in their decision making. The study has been able to highlight the gaps in as-is process with the proposed to-be process through the optimized hub and spoke network. The implications have been discussed in terms of academic and managerial domains.

7.3.1 Academic and Research Implication

- The study has provided a fresh new perspective to draw attention of researchers to the domain of water transportation which is greener and cheaper as well. A lack of awareness among stakeholders exist which may be addressed through academic interventions.
- The research has attempted to fill the academic and research void in the domain of inland water transportation for the northeastern states and Assam.
- The methodology review of multi criterion decision making techniques as highlighted through the research provide context for utility and application of the same to specific scenarios.
- The blend of qualitative and quantitative techniques adopted for research work has been a novel approach in investigating the logistics infrastructure system.

- The methodology of Analytic Hierarchy Process for inland water port ranking has far sighted academic implications in terms of adaptation of the model for other regions and major waterways.
- There lies a great opportunity in exploring the dry port infrastructure network of the entire country as no significant research evidence has been found regarding the same
- The criteria and sub criteria identified for port ranking exercise provides scope for the research community to adapt the key attributes for their work.
- The conceptual framework from the optimization exercise can be adapted for similar port network system optimization.
- The global weights of sub criteria substantiate the need of focusing on priority areas such as port physical conditions and geographical attributes in determining the effectiveness of inland water ports.

7.3.2 Managerial and Policy Implication

- The findings from the study provide ample insights for policy makers to consider while planning for public infrastructure investment decisions in the domain of water transportation.
- The identification of key inland water ports and dry port network through the research work provides opportunity of development for those regions.
- The fundamental inputs for decision support systems for managers in shipping organizations can be derived from the calculated global weights of the sub criteria.
- Policy makers may use the final ranks of the sub criterion to identify high impact domains for improving overall port competitiveness. Water depth is one such attribute for which already governments are incurring high expenditure.
- In a similar note, availability of equipment for effective material handling is limited at ports which brings in opportunity for organisations to cater to that need through their service offerings.
- The significance of dry ports and the importance of locating dry ports in appropriate locations has been highlighted through the research findings. A similar approach may be undertaken by decision makers for initiating DPR preparations for the shortlisted sites.
- Policy makers have envisaged huge investments under varied schemes of the government and this research work provides impetus to carry out a cost benefit analysis of the investments.

7.4 Recommendations

Recommendations from the research work have been broadly classified into two categories- one which is derived directly from research findings and those from general observations during the research work.

7.4.1 Recommendations from research findings

The following recommendations may be directly attributed from the research findings:

- The AHP ranking exercise has identified Jogighopa, Pandu and Karimganj as among the top ranked inland water port locations. Policymakers and government organizations may prioritise public infrastructure development for the top ranked ports on an immediate basis while for the lower ranked ports, DPR studies can be initiated for fulfillment of long term goals.
- From the findings of objective 1, it has been found that multimodal connectivity is an important factor for port ranking. Proximity to import/export and closeness to high/railroads have secured highest priorities and thus, there should be a continued thrust in these areas for building appropriate infrastructure for the linkages.
- Water depth has emerged as a challenge for most inland water ports and even the top ranked ports are facing immense operational problems due to the same. Karimganj despite being a top ranked port is operational for eight months in a year due to water depth. Although dredging is a major recurring activity for the port administrators, scientific studies must be carried out to find out alternatives that can help in reducing the accessibility challenges.
- Dry ports play an important role in effective utilization of water transportation. In the state of Assam, there is only one dry port. From results of objective 2 and 3, it has been established that a 3-Hub network shall be the most optimal configuration in terms of minimizing the total distance. Although proposed investments have been made for augmenting dry port infrastructure in the country, yet the northeastern region has not been allocated additional dry ports apart from the existing one. Policy makers may consider this and initiate feasibility studies for establishment of additional dry ports in the region.
- The hub and spoke network model may be directly adopted by transporters for string planning of goods and supplies. The identified hub locations can be appropriate for establishment of distribution centres from the perspective of optimal distribution costs

- The extensive literature review has yielded a dearth of awareness about the domain of water transportation and its benefits. Despite being a greener and cheaper mode of transport, this mode is yet to get traction. Policymakers, educators and researchers may consider the exploratory findings of the study and create awareness on leveraging the benefits of the inland waterway transport.

7.4.2 Recommendations from observation

On the basis of observation and interaction with stakeholders during field visits, the following recommendations have been made:

- The areas in the immediate vicinity of the inland water port locations require developmental initiatives. This is observed even more for the ports on the Barak River. The overall attractiveness of an inland water port shall also depend on the surroundings and thus, this requires immediate intervention.
- The linkages of the port network with the local markets are something which needs to be explored to leverage the benefits of both. The local community is an important stakeholder and can play a pivotal role. Government organisations may consider building on these linkages to establish markets/*haats* in the vicinity of the inland water ports.
- The significance of containerization is not realized for the river ports and thus, none of the inland water ports in the region can handle container transport. Lack of equipment is a major deterrent and the lower ranked ports have a dearth of proper equipment for material handling. This gap may be bridged by proper provision of equipment through infrastructure funding.
- There is an imminent need of involving the local community in understanding the significance of developing the port infrastructure. Encroachments on port land has been observed which requires immediate intervention by the authorities.
- Although a lot of digital transformations have been made in the domain of inland water transport, yet the ground realities at some of the ports are different. Conventional and repetitive means of data collection and reporting are still being in use for few of the lower ranked ports.
- Capacity building measures can be initiated by ministry and departments to include water transport-oriented courses with traditional courses.
- Governments need to incentivize this mode of transport through different schemes so that transporters may feel the urge to shift to this greener mode of transport.

- Entrepreneurial ventures in the domain of inland water transport should be encouraged so that there is a spurt in service providers for the domain in the region.
- An effective awareness campaign on the opportunities of inland water transport needs to be undertaken so that all stakeholders may be benefitted.

7.5 Conclusion

Water transport is the global need of the hour and for a developing nation like India, the benefits of this greener and cheaper mode of transport is immense. In pursuit of the country's developmental goals, this untapped domain necessarily needs to be explored and fully developed. For the region of Northeast, there lies a huge potential in connecting to the Southeast Asian economies through the river network. The research work has attempted to explore key antecedents impacting the inland waterway transport network and provide fundamental inputs for developing a decision support system for government organizations, shippers and other stakeholders. The AHP model findings have demonstrated the need for stakeholders to provide to key areas such as export connectivity, multimodal facilities development, river dredging and so on. The optimisation model for the river network through a hub and spoke model has identified prospective locations for dry port development.

7.5.1 Contribution of the study

Contribution of any research is measurable through its contribution to existing knowledge as well as its impact to practice. As discussed in earlier sections, the contribution of the present work has been enumerated through its contribution to body of knowledge and practice.

7.5.1.1 Contribution to body of knowledge

Fulfillment of objectives 1 and 2 has directly provided key inputs to existing research on MCDM methodologies and the significant contribution has been highlighted through the following points:

- The key contribution of the study lies in application of quantitative multi criterion decision making techniques such as analytic hierarchy process for inland water port ranking.
- Although MCDM techniques have been leveraged for sea port optimization in other countries, it has not been carried out in the Indian context.

- The exploratory study of the inland water ports on Brahmaputra and Barak holds significance considering the documentation of the port specific details. It adds on to the body of knowledge in specific embodiments.
- The study substantiates the previous largely qualitative work in the domain by providing conclusive evidence through the port level parameter specific data.
- The Hub and Spoke network model have not been previously attempted in context of river ports and the theoretical framework is original contribution.

7.5.1.2 Contribution to practice

In addition to contribution to theory, the thesis has distinctive contribution towards practice and provides key inputs for practitioners and policymakers.

- The research work provides direction for researchers and policymakers in terms of identifying data sources and data capturing tools pertaining to the inland water transport domain.
- The self-developed AHP on Microsoft Excel provides for a convenient way to calculate the weightages of the AHP model as well as check for consistency.
- The key findings from the objectives provide priority inputs for decision makers in terms of public infrastructure funding for waterway infrastructure development
- The hub and spoke optimized scenario model provide key inputs for prioritizing hub location selection

7.5.2 Scope for future study

Considering the significance of waterway transport as well as envisioning the goals India Inc. has set for itself in terms of GDP, there lies a great opportunity in expanding the research work. The following points highlight few of the areas wherein this present research work can be worked upon further:

- This study has been like the tip of the iceberg and there lies an opportunity to further take research direction for this domain of water transportation.
- The study can be expanded to include other major waterways of the country. A pan India exercise can be undertaken for the riverway ports through adaptation of the AHP model.
- The direct linkages to market factors can be explored and this can yield substantive inputs for policymakers.

- An attempt may be made on the further drilldown of the sub criteria in context of other environmental parameters.
- The results of the AHP model can be tested by extending the range of stakeholders to include local communities and environmental groups.
- Application of hub and spoke model can be attempted to optimize other modes of transport.
- Cost benefit analysis pertaining to the infrastructure investment in comparison to the trade volumes may be undertaken.
- Studies involving sensitivity analysis to understand the impact of different scenarios and assumptions can be undertaken.
- Other MCDM techniques such as ISM, MICMAC, fuzzy AHP may be explored in context of decision prioritization for inland water infrastructure decision making.
- Transport mode optimization studies which leverage multiple modes of transport can be a future research direction.
- Environmental impact and sustainability studies related to inland water infrastructure development can be undertaken