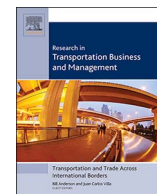




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Economics of cargo airships for food transport to remote northern communities

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1. Introduction

About 70% Canada's landmass lacks access to all-season road infrastructure. As a result, northern Canada must depend on transportation systems that are high-cost, unreliable, and with service levels that vary seasonally. The lack of low-cost, reliable freight transport service year-round imposes myriad negative impacts on the residents of these regions. For example, the cost of food in the remote communities is 2.5 to 3 times higher than the cost of food in the urban areas of Canada. Airships have been advanced as a potential solution to the high cost of transporting food and the general food insecurity of aboriginal communities in northern Canada (Council of Canadian Academies, 2014).

This paper assesses the potential for a transport airship to reduce the costs of food transportation to isolated communities in northern Manitoba and northwestern Ontario. The analysis is based on the operations of the North West Company's (NWC) grocery distribution system. The logistics costs for a proposed 50-t lift transport airship are compared to the costs of using ice road trucking and small airplanes to deliver food and general merchandise.

The analysis begins with a description of the study region and the NWC shipping data. Subsequently, a brief background on the food retailer (NWC) is presented with data that describes current freight movements and associated costs. The third section presents the results based on the North West Company's freight shipments versus the cost for a transport airship that was developed based on estimates provided by the developer and expert opinion.

2. Study area description

The NWC was founded in the 17th century to compete with the Hudson's Bay Company in the Canadian fur trade (Keith, 2001). The NWC has evolved into a food and general merchandise retailer that specializes in serving remote communities in northern Canada, Alaska, and island communities in the Caribbean and Guam (The North West

Company, 2013). The company's annual sales average 1.2 billion.¹ Approximately 69% of these sales revenues are earned through the company's Canadian operations.

Within Canada, the NWC operates six branded retail chains and a wide range of wholesale companies that trade in food products, financial and medical services, and fur and Inuit art. Among the retail store brands operated by the NWC, the most extensive is their Northern Store chain. The NWC operates 123 Northern Store outlets in seven provinces and three territories across Canada. These stores are mainly located in small, remote northern communities, and as a consequence the NWC has a complex and unique logistics network in comparison with retail chains operating in major urban centres across southern Canada.

3. The dataset

In co-operation with the University of Manitoba, the NWC provided freight transportation data for their entire network of stores across Canada for the period April 2010–March 2011. The dataset describes freight origins, destinations, quantities, modes, freight types (food or general merchandise (GM)), and costs for air and truck transport. The objects in the dataset are carrier invoices that have been transcribed into a spreadsheet. This information is of extreme value because no comprehensive dataset that describes freight movements in northern Canada is publicly available.

Although this dataset is invaluable, its limitations should be noted. One potential limitation is that this dataset may not describe all NWC's freight movements. This could be due simply to transcription errors. Secondly, dimensional data are not described in the dataset therefore it is only possible to discuss freight shipments in terms of tonnage and not volume. Third, indirect logistics costs, such as inventory holding costs, are not described in the dataset. Finally, descriptions of subsidized freight flows are incomplete and therefore excluded in this analysis.² This dataset does, however, describe actual freight flows and actual

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E-mail addresses: barry.prentice@umanitoba.ca (B.E. Prentice), matt.adaman@gmail.com (M. Adaman).¹ All values in this report are quoted in Canadian dollars.² This refers to Nutrition North (Nutrition North Canada, 2012) or Food Mail (Aboriginal Affairs and Northern Development Canada, 2010) freight flows. In addition to these flows not wholly being described in the dataset, the issue of subsidized freight rates is unique. Transport airship freight rates would likely be subsidized to the same degree as existing modes of transport making comparison unnecessary.



Fig. 1. Map of ESLW and NWON regions in Canada.

Modified from: Canada [computer file]. (no date). St. Catharines, Ontario: Brock University Map Library. Brock University provides this and other maps for free use by the public. Available: Brock University Library Controlled Access http://www.brocku.ca/maplibrary/maps/outline/North_America/canada.pdf.

transportation costs in regions that have received very little research attention previously (Adaman, 2013).

4. Selection of cases

Fig. 1 presents a map of the case study regions. The formulation of case regions is based on a set of selection criteria meant to ensure cross-case comparison. The selection criteria are as follows:

1. The regions must possess a relatively large number of communities and a relatively large population.
2. The regions must have no all-season roads or other surface infrastructure.
3. The regions must be relatively different from one another in terms of average distances, modal availability and split, and quantities of freight.

The first two criteria ensure a sufficient amount of transportation activity in each region. The third criterion is included in order to

enhance the generalizability of the findings from these analyses. Two regions that meet these criteria are as follows: The east-side of Lake Winnipeg (ESLW) in Manitoba and northwestern Ontario (NWON). Summary statistics shown in Fig. 2 describes how each region differs in terms of geographic size, the number of communities and population, average air and ice road transport distances, and freight quantities.

5. Transport airship operating cost model

Several transport airship developers were contacted to provide operating cost data, but only one provided useful information for calculating transport airship trip costs. The transport airship is a rigid design in its early stages of development. Consequently, the operating cost model should be viewed as a best available estimate rather than actual transport airship operating costs. Further development and prototype testing will reveal the accuracy of these estimates.

The received cost data have been modified for this research to provide a more conservative estimate of the transport airship's performance. First, the cruising speed was reduced to approximate the speeds

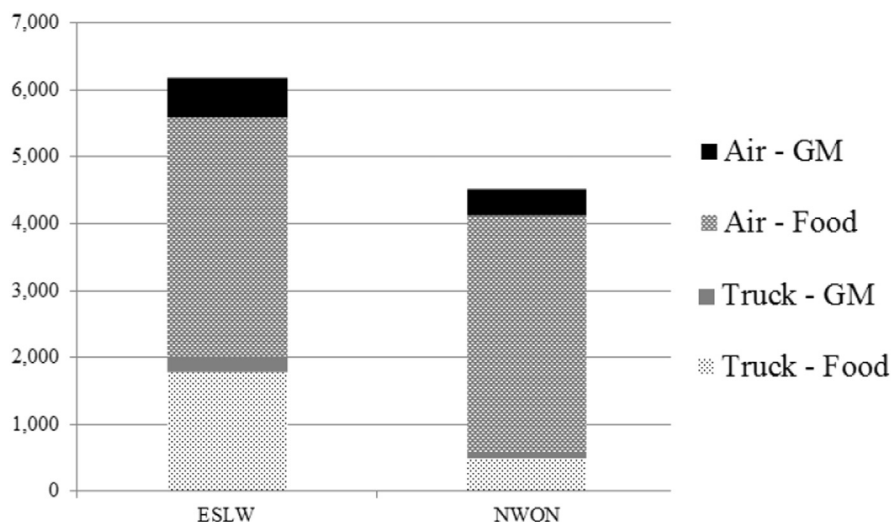


Fig. 2. Summary statistics for the North West Company case study regions. km²: Land area of region in square kilometers. Comm.: Number of communities in each region. Pop.: Population of each region. Ice Road: Average ice road kilometers, weighted by total ice road trucking MTK. Air: Average air kilometers, weighted by total air transport MTK. Air/ST: Modal split between air and surface transport in. t: Total quantity of freight shipped to the region's stores in metric tonnes. T/C: Total freight quantity per capita, April 2010–March 2011. These regions vary significantly in terms of land area, population density and modal split. Population density for the ESLW is 0.33 while the NWON is only 0.07 persons per square-kilometer. On a per capita basis, the ESLW received 0.49 t freight and the NWON received 0.55 t. A lower population density means greater distances must be overcome for freight re-supply. This is reflected in the average ice road distances in the NWON that are a third greater than the ESLW. Although the NWON has more kilometers of ice roads, these communities are more dependent on air transport than the ESLW communities (87% for NWON versus 68% for ESLW).

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