Integrating Enablers of Sustainable Freight Transportation and Perishable Commodity Supply Chain

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ABSTRACT

Extant research has addressed the challenges pertaining to sustainable freight transportation and those associated with transportation of perishable commodities in disparate ways in that enablers of sustainable freight transportation have not been mapped with the considerations of transportation related to perishable commodities. This is characterized by short product life-cycles, retail demand uncertainties, traceability issues and so forth. In this backdrop, the authors’ research attempts to integrate the considerations related to sustainable freight transportation with that of perishability-related aspects. To this end, this research employs interpretive structural modelling (ISM) so that enablers related to both the problems can be fused and modeled in such a way that enablers related to independent, autonomous, dependent, and linkage attributes can be identified, and their interactions can be understood.

KEYWORDS

Benchmarking, Graph Theory, Interpretive Structural Modelling, Perishable Item Supply Chain, Supply Chain, Sustainable Freight Transportation

INTRODUCTION

The adverse impacts of greenhouse gases (GHG) on climate has already been extensively researched and well documented (Bouzon et al., 2015). Owing to the fact that core operations pertaining to transport sector contributes significantly towards greenhouse gas emissions (GHG), sustainable freight transportation from academic and practitioner’s perspective has received considerable attention in recent times (Pan et al., 2013). Sustainability in the freight operations entails management of triple bottom line (TBL) such that the three associated considerations i.e. economic, environmental, and social perspectives can be addressed simultaneously. From a tactical standpoint, reverse logistics, route optimization, technology driven processes, multi-modal freight transportation, carbon emission monitoring and sustainable performance measurement are some of the key practices adopted by transport companies (Mathivathanan et al., 2017 and Szeto et al., 2014). To meet the desired level

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of GHG reduction for sustainable transportation of freight from a sectoral standpoint, regulatory and policy interventions such as improving the fuel efficiency standards in logistics operations has often been advocated both at the level of private/public transportation and freight industry (Solis et al., 2013, Loo et al., 2012 and Nuzzolo et al., 2016). Transportation planning and network design considerations for composite transportation network that encapsulates facets such as optimal emission pricing and dynamic information exchange between vehicles has been demonstrated to be have a positive impact on the reduction of GHGs not only for private vehicles but also for multi-modal freight industry (Sharma et al., 2013). Adoption of environmental management standards, eco-management and audit schemes backed by green practices such as freight pooling etc. are also key enablers for GHG reduction in freight transportation resulting in macro and micro level improvements.

Addressing sustainability aspect however in freight transportation requires a nuanced approach depending upon the type of commodity being transported. Consider for example shipping iron ore through sea lanes or transporting through trains; in such case however because the product is non-perishable and certain level of product quality need not be maintained from origin to destination, from a practice point of view, transportation related complexities remains within a certain threshold. In case of perishable commodities such as fruits and vegetables however delivering them would be relatively complex in that other critical inputs need to be considered. Some of these inputs pertain to the fact that as opposed to unperishable commodities, fruit/vegetables are characterized by finite shelf life and certain demand pattern (Nahmias, 2011). The complexities associated with transporting perishable commodities are further compounded by refrigeration requirements during transportation. Table 1 enlists critical operational attributes that are required to be taken into consideration in context of a perishable supply chain.

It is to be noted that these key attributes have been populated based on the research carried out by Aung et al. (2014), Manzini et al. (2013), Yu et al. (2013), and Govindan et al. (2014).

Bridging the knowledge gap in terms of sustainability practices in context of perishable food supply chain is an important objective of this research. In this work, we intend to integrate sustainability practices (aimed at reducing GHG) with transportation of perishable goods. These explicit sustainability practices in terms of key enablers are populated in Table 2 employing relevant literature. The resultant enablers are listed in Table 2.

The objective of this work to abridge the extant gap between the supply chain and sustainability in freight transportation. There are several aspects to this gap however. First, the research gap exists primarily around integrating the enablers for sustainability in freight transportation with critical operational level attributes. This gap needs to be addressed owing to the fact that by considering sustainability aspects in freight transportation and critical operational parameters related to perishable supply chain in isolation, a coherent and effective framework that aims to deal with the larger issues (such as minimizing wastage during transportation, traceability in the supply chain) in perishable food

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Attribute Notation</th>
<th>Attribute Name</th>
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<tbody>
<tr>
<td>1</td>
<td>CA1</td>
<td>Short product life cycle</td>
</tr>
<tr>
<td>2</td>
<td>CA2</td>
<td>Retail demand uncertainty</td>
</tr>
<tr>
<td>3</td>
<td>CA3</td>
<td>Spoilage during transportation</td>
</tr>
<tr>
<td>4</td>
<td>CA4</td>
<td>Refrigeration requirements</td>
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<tr>
<td>5</td>
<td>CA5</td>
<td>Minimum service levels of wholesaler</td>
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<tr>
<td>6</td>
<td>CA6</td>
<td>Varying storage considerations</td>
</tr>
<tr>
<td>7</td>
<td>CA7</td>
<td>Traceability in supply chain</td>
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