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Demand chain management in the container shipping service industry

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ABSTRACT

The growing service sector in the global economy signifies the need for applying service science to study the interdisciplinary nature of services. In particular, container shipping service is considered a key enabler of international trade and global economic development. To strengthen the role of shipping in supporting global seaborne trade, it is highly desirable to identify the determinants that influence the total capacity of the shipping industry, explain how the related business activities (e.g., demand for shipping service, vessel price, fleet size, etc.) are linked to the demand for container shipping service, and empirically verify the findings. This study builds on the demand chain management paradigm to analyze the service capacity of the container shipping industry. We establish a path-analytic model to explain how shipping demand affects such shipping-related variables as vessel price and to evaluate their effects on the service capacity of the industry. The empirically-tested model provides managers and researchers with insights on how to enhance the coordination and integration of a series of shipping-related variables from shipping demand to capacity management in the container shipping service industry.

1. Introduction

As the global service sector continues to grow, service science has evolved as an important academic discipline. Service science is a new interdisciplinary research area that emphasizes quality and productivity improvements in service management (Spohrer and Maglio, 2008). Supply chain management (SCM) is an approach to satisfy customer needs for products and services by integrating the business activities of firms across their entire value chains (Gunasekaran et al., 2008; Wong et al., 2009). In recent years, demand chain management (DCM) has received similar attention as SCM with a focus on strategy development (Francis et al., 2008). DCM is considered broader in scope than SCM because the former emphasizes understanding customer demand, as well as improving organizational ability in product and service development to better meet market needs (Canever et al., 2008). Despite the potential of DCM as a potent strategic management approach, there are still many unanswered questions about its application in practice, particularly in a specific service industry such as shipping (Frohlich and Westbrook, 2002). This omission in the literature is undesirable in view of the fact that container shipping service, which facilitates economic exchange and so international trade, is an important contributor to global economic development. The different shipping-related variables that determine the service capacity of container shipping service providers can affect global economic development. Considering the importance of container shipping as a service science discipline, we empirically develop and test in this paper a container shipping model built on the DCM paradigm.

Container shipping service is a key enabler of international trade and global economic development (Lun et al., 2009, 2011). When demand for shipping capacity is uncertain and significant lead times are required for expanding service capacity, managers of shipping firms need to carefully plan and decide on their firms' capacity (Lun and Browne, 2009). However, postponing the expansion decision increases the risk of capacity shortage when shipping demand is expected to grow (Ryan, 2004). Such issues of service capacity management have been widely reported in the SCM and operations management literature. For instance, Nickell (1977) establishes a model with uncertain timings of future changes in shipping demand. Smith (1979) develops an algorithm for solving the problem with deterministic exponential demand growth and discrete facilities. Maglaras and Zeevi (2003) examine pricing and capacity sizing for systems with shared resources. Wang et al. (2007) study capacity decisions and supply price games with the flexibility of backward integration. While these service capacity management studies are useful for solving well-structured problems using such approaches as mathematical modeling and optimization techniques, empirical studies that provide managerial insights on issues related to service capacity

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and pricing in the container shipping industry from the DCM perspective are seriously lacking (Scudder and Hill, 1998).

According to Maglio et al. (2006), service science aims at explaining the origins and growth of service systems, and solving fundamental problems such as how to invest optimally to improve service productivity. Service provision is an economic activity where the buyer does not obtain exclusive ownership of the thing being purchased. With the development of global trade, service depends on customer participation and input through providing information via organizational value chains (Sampson and Froehle, 2006). Maglio and Spohrer (2008) define service systems as "dynamic value co-creation configuration of resources". Service science is the study of service systems with an aim to "categorize and explain the many types of service systems that exist as well as how service systems interact and evolve to co-create value". Providing container shipping service means taking an interdisciplinary effort that incorporates the determination of price and shipping service levels to match market demand. In container shipping, the demand for shipping service is derived from trade. Shipping lines provide service to customers by carrying cargoes from ports of loading to ports of discharge. If shippers need more shipping service, price will rise. To meet higher demand, ship owners need to order new ships from ship builders in the new building vessel market. Ship owners can also adjust their shipping capacity by buying and selling ships in the second-hand market. This service system illustrates (1) how customers and service providers must interact to establish a unique service system and (2) how organizations come together to create value across the system (Maglio and Spohrer, 2008). Service science is useful for categorizing and explaining the service systems that exist and how they interact. Another goal of service science is to apply scientific understanding to advance the ability to design, improve, and scale service systems for such business purposes as efficiency, effectiveness, and sustainability enhancements.

This study aims at developing an empirical model for examining the container transport service system, which is a key element of the transport sector. Specifically, this study develops and tests a container shipping service model of the factors that determine the capacity of container transport service. We begin with the DCM paradigm that puts an "emphasis on the importance of the marketplace and designing the chain to satisfy the needs" (Heikkila, 2002). In this research we adopt the demand for container shipping as the starting point for studying the business activities of the container shipping industry on the basis of DCM. We identify the factors that affect the total service capacity in container shipping and develop a container shipping service model to explain the relationships among the factors and assess their effects on the service capacity of the container shipping industry. Using path analysis of the structural equation modeling technique, we test the container shipping model comprising the determinants of shipping capacity based on the DCM paradigm.

2. Foundation of DCM theory

DCM originates from various academic disciplines. In operations management, DCM is linked with logistics involving strategy spanning the whole value chain and is closely related to supply chain studies (Williams et al., 2002). Traditional SCM focuses on managing flows of products to consumers. Recently, SCM also pays attention to consumer demand and regards it as the core of a value chain's business strategy, highlighting DCM as an important branch of SCM. Key objectives of DCM include understanding and managing consumer demand throughout the whole value chain with a reorientation from managing the supply chain to a focus on the demand for products and services. The concept of DCM is also closely related to the market orientation perspective that emphasizes market intelligence generation, market information dissemination, and market responsiveness (Narver and Slater, 1990; Kohli and Jaworski, 1990; Lai, 2003).

According to the market mechanism, the performance of the container shipping market depends on both the demand for, and the supply of, container shipping service, as well as the industry structure that governs the competition (Brooks, 2000). Industry structure affects the characteristics of an industry, particularly the number and size of shipping service providers, the extent of concentration among the service providers, and the degree of homogeneity of their offerings. With respect to industry structure, the container shipping industry can be considered as an oligopoly (Harlaftis and Theotokas, 2002). There are several characteristics that make the container shipping business different from other service sectors, which include the following: (1) high fixed cost, (2) little difference in the services offered, and (3) a few operators account for the majority of the total shipping supply (Lun et al., 2010a). In the shipping industry, the market consists of four separate but inter-related segments, namely (i) the new building market that trades new ships, (ii) the sale and purchase market that trades second-hand ships, (iii) the demolition market that deals with scrap ships, and (iv) the freight market that trades sea transport. These four key shipping market segments are considered as different markets (Stopford, 2004).

3. Proposition development

Industry structure affects a shipping firm's conduct in the shipping market (Bain, 1968). Conduct governs organizational choice of key decision variables such as capacity. The basic conditions of demand and supply in the container shipping market influence the market structure, which in turn affects the combined actions of the firms in the marketplace. One characteristic of the shipping market is that it brings buyers and sellers together in determining the freight rate (i.e., price) and the fleet size (i.e., quantity or shipping capacity). International trade volume, as a key determinant of the demand for container shipping service, affects the freight rate. Furthermore, freight rate influences ship owners' decisions to adjust the capacity of their fleets.

Other than the freight market, the industry structure of container shipping service is composed of other related business activities. According to Adland et al. (2006), the shipping market can be categorized into the real and auxiliary markets. The real market for ships consists of new building vessels and the demolition market. More orders for new building vessels reflect an increase in the industry's service capacity, while more scrapping of ships means a decrease in the total service capacity of the freight market. On the other hand, the auxiliary market involves the freight market that trades sea transport services, as well as the sale and purchase market for second-hand ships.

3.1. Demand for shipping service

International trade of general cargo is a key factor affecting the demand for container shipping service. World output growth plays a decisive role in determining the volume of seaborne trade (Branch, 1998). Shipping and international trade are inter-related. Ships serve to transport cargo, whereas seaborne trade without ships will come to a halt (Farthing and Brownrigg, 1997). A change in seaborne trade indicates a change in demand for shipping service as the demand for sea transport is a derived