A SWOT Analysis of Intelligent Products Enabled Complex Adaptive Logistics Systems

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1. INTRODUCTION

It is increasingly emphasized that effective alliance partnerships and new forms of communication and information technologies for the growing number of distribution logistics issues must be grounded in a non-reductionist paradigm focused on understanding relationships and applying flexible problem-solving. To address these needs, key principles of *complex adaptive systems* (CAS) theory are being applied to logistic planning and research, called *complex adaptive logistics systems* (CALS).

The conventional approach to logistics systems has been to treat them as predictable and controllable. However, nowadays, logistics is a complex dynamic network, exhibiting a self-organizing adaptive behavior similar to a CAS. In other words, it is important not to look at logistics as mere dynamic flow networks with a relatively stable structure but as dynamic systems whose structures evolve and change (Surya Dev Pathak, Dilts, & Biswas, 2004). Towards this trend, it should lead to radically different approach to management of logistics systems that places much emphasis on enabling self-organization, learning and adaptation. In the light of the situation, this study has attempted to draw upon insights by using a strength, weakness, opportunity, and threat (SWOT) tool to examine the relevance and usefulness of the concept of CAS as an approach to better understanding views of logistic systems in which new communication and information technologies' interventions could be introduced and sustained.

The remainder of this article is organized as below. Subsequent to the introduction in Section 1, the background of logistics systems and complex adaptive logistics system is briefed in Section 2. The research methodology employed in this article was explained in Section 3 which is followed by the formulation of research questions in Section 4. Then Section 5 gives the key findings found in this study and the relevant recommendations are also presented at the end of this section. Next, Section 6 highlights the future research directions. Finally, the conclusion drawn in Section 7 closes this article.

2. BACKGROUND

2.1. Logistics Systems

Logistic systems are a complex network with a huge number of interactions and inter-dependencies among different entities including suppliers, customers and business partners, activities and resources. From another perspective it can be viewed as a complex information processing system in which the useful information needs to be stored, processed and transmitted.

2.2. Complex Adaptive Logistics Systems

The logistics systems is highly nonlinear, shows complex multi-scale behavior and evolves self-organizes through a complex interplay of its structure and func-

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tion. As a consequence, it makes difficult to manage and control. One of the key to successful factors is to attain theoretical advance and a rich set of tools and techniques to model and analyze the complexity of the whole logistic system. Based on that statement, (Choi, Dooley, & Rungtusanatham, 2001) emphasized that the concept of complex adaptive systems (CAS) can help one to understand how logistic systems as living systems co-evolve with the rugged and dynamic environment. In other words, they pointed out that CAS can be used as a new building block for the logistics systems. Generally speaking, CALS was introduced in 2008 (Wycisk, McKelvey, & Hülsmann, 2008), but the similar viewpoint has been presented earlier by many researchers. For example, in (Choi et al., 2001), the authors pointed out that supply networks should be recognized as a CAS and demonstrated how to manage that. Similarly in (Surana, Kumara, Greaves, & Raghavan, 2005), the authors emphasized that it is critical to understand the nature of the interconnection patterns between the structure and functioning. In (Surya D. Pathak, Day, Nair, Sawaya, & Kristal, 2007), the authors provided a framework of CAS view to the real-world supply networks. Furthermore, in (Li, Yang, Sun, Ji, & Feng, 2010), the authors presented that in order to better understand and manage CALS, there is a need to examine its complex nature from an evolutionary perspective. That means, to investigate how does a CALS emerge, adapt and evolve over time?

Nowadays, growing international competition has increased the need to develop more robustness and effective communication system in which the entire logistic systems can share the accurate and timely information by all members. In the light of this statement, a key feature of CALS is that they consist of smart parts. The term "smart parts" describes logistics entities, which possess the capabilities of interaction and autonomous decision-making through the usage of modern communication and information technologies (Kiritsis, Bufardi, & Xirouchakis, 2003). In addition, their smartness lies in the ability of the parts to autonomously decide about their optimum behavior regarding their given individual goals (e.g., time, quality, costs). So far, CALS exhibits complex adaptive behavior at many different domains of analysis: multiple-level dynamical networks, collaboration mechanism, transshipment bidding, environmental adaptation, and so forth. We believe this diversity of levels gives logistics systems a broad intellectual and adaptable scope.

3. RESEARCH METHODOLOGY

The key tool used in this article for strategically planning of CALS (i.e., assessing the feasibility of treating logistics systems from a complex adaptive perspective) is a SWOT analysis approach. Briefly, SWOT analysis was popularized by Andrews (1965) and as a strategic tool which has been widely used in business management applications. The main advantage of SWOT is allow companies to use long range planning approach based on qualitative analysis rather than quantitative forecast (Barca, 2005).

In theory, SWOT analysis presents a mechanism for identifying the linkage among company's internal factors (i.e., strengths and weaknesses), and external factors (i.e., threats and opportunities) in the marketplace. Based on that, four types of strategies, namely SO (strengths-opportunities) strategies, WO (weaknesses-opportunities) strategies, ST (strengths-threats) strategies, and WT (weaknesses-threats) strategies of the business venture or project can be judged. In other words, *SWOT matrix* transforms weaknesses into strengths and threats into opportunities (Arslan & Er, 2008). For example, the SO strategies use a firm's internal strengths to take advantage of external opportunities; the WO strategies improve internal weaknesses by taking advantage of external opportunities; the ST strategies use a firm's strengths to avoid or reduce the impact of external threats; and the WT strategies are defensive tactics directed at reducing internal weaknesses and avoiding environmental threats (Weihrich, 1982).

In the literature, there are many successful cases of applying SWOT analysis to the strategic level decision making. For instance, by using SWOT analysis, Halla (2007) conducted a strategic urban development planning based on the case of Dares Salaam city in Tanzania and concluded that the method is stronger than the procedural or master-planning approach in planning cities. Caruana et al. (2010) addressed a strategic development model that focusing on higher education of the healthcare issue by using SWOT methodology. They proposed a two-step process: one first drew a SWOT matrix and then used the identified SWOT results to develop the strategic development model. In a similar vein, the SWOT methodology has been used extensively in other higher education and healthcare domain (Christiansen, 2002a; 2002b; Dyson, 2004). Furthermore, in the discipline of waste

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