The Importance of Advanced Information Technology and Green Vehicles in Supply Chain Management

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Abstract. This research explores the impact of advanced technology and green vehicles on supply chain performance in the perspective of Mexican manufacturing firms. The study used 153 firms’ data to test hypothesis. The study adopted simultaneous regression statistical method, while the findings show that advanced information technology plays an important role in supply chain improvement through greater-level of information sharing with supply chain partners, reducing the discrepancies and errors on different levels such as forecasting and scheduling. On the other hand, green transportation and vehicles reduce the supply chain cost and improve environmental performance with building strong competitive advantage through more usage of renewable energy, greater level of customer satisfaction and trust, positive image and reputation.

Introduction

During twenty-first century, Governmental bodies, corporate sectors and consumers started to realize the importance of ecological supply chain and/or environmental friendly supply chain management [1]. Because polluted/traditional supply chain is heavily dependent on fossil fuel and energy consumptions, while no integration and coordination between different supply chain partners due to scarcity of technology development and every firm and/or department working in silos, not just discrepancies/errors on different stages of supply chain occur including planning, forecasting and production, warehousing, dispatching etc. [2].

For the UPC (Universal Product Code), RFID has been become a feasible and viable replacement in various industries, since last couple of years, a numbers of firms have implemented RFIDs and different kind of sensors in their supply chain for efficient and effective tracking, storage, and delivery of products. In addition, cloud computing plays a vital role in supply chain and information sharing easily may be shared with supply chain partners for consensus development and improvement. The best examples of implementing modern technologies are P&G (Procter & Gamble), Wal-Mart, and Unilever. Figure 1, illustrates the usage of RFIDs and different Sensors in Vehicles.

The RFID is mainly based on three parts including, readers, antennas, and tags, which has been illustrated in Figure 1. RFID tags are categorized by its power including “Active Tag”, “Semi Active or Semi Passive”, “passive Tag”. The device is majorly used in transportation and warehousing for tracking and tracing. RFID passive tag its own has no battery and is used by the incoming waves, which is broadcast by a reader; RFID active tag has their own battery; RFID semi-passive tag has its own battery system to emit signals and is use for limited range of operations.

The key objective of this research is to explore the importance and role of green vehicles and usage of modern technology in supply chain operations for reduction cost and harmful effects on environmental sustainability in terms of worst air quality and carbon emissions. The rest of the paper is structured as follows: literature review and hypothesis development are presented in Section 2. Data source, Research model and methodology of current research are elucidated in Section 3. Section 4 displays analysis, results and discussions. Finally conclusion is drawn in section 5.
Literature Review

According to the Khan and Dong [3], green information systems and usage of modern technologies in supply chain improve the integration and coordination between supply chain partners in terms of greater information sharing and reduction of discrepancies in production scheduling and forecasting. Liu et al. [4] and Khan et al. [5] conducted a research and found that the adoption of RFID and modern technologies are essential in today’s global supply chain for better coordination among supply chain partners, while usage of RFIDs and sensors also provide real-time information, which may control and/or mitigate the disruption of supply chain.

Khan et al. [6] highlighted that unnecessary usage of technologies can become a burden and may create pressure on organizational performance in terms of huge cost and need to provide training to employees. Sanders [7] and Khan et al. [8] information technology has a positive effect on firms’ environmental, economic and operational performance, but usage of right technology for right operation totally depend on management decision and intelligence. Another wise, technology will only incur huge cost in the systems without any major value addition. A number of researchers emphasized the importance of technology in different operations of supply chain including, logistics and transportation, distribution and warehousing, manufacturing and scheduling etc. Dao et al. [9]; Benitez and Walczuch [10] firms may build competitive advantage through adopting right technology at right time, while green technology in vehicles and manufacturing functions may reduce pollution and improve environmental performance with better image and reputation (Khan et al. [5]).

Information system denotes the backbone for better information sharing and integration of different processes with supply chain partners. RFIDs and cloud computing technologies as used for tracking and tracing goods and vehicles. However, these technologies are also adopted for cost reduction and protection of vehicles and valuable goods from thieves. This research study is conducted to recognize the role and effects of green vehicles, internal environmental management, and usage of different modern information technology on supply chain management performance. Undeniably, we have cited and discussed few research papers in literature review section due to restriction of pages and author guide provided by conference organizing committee. However, on the basis of above cited research papers, we develop the following hypothesis:
H1: Information technology improves the supply chain performance.
H2: Green vehicles in logistical operations enhance supply chain performance.
H3: Internal environmental management plays an important role in improving supply chain management performance.

Data Source and Methodology
This research used the primary data collected from manufacturing firms based in Mexican territory. We developed a questionnaire on Likert-scale and distributed in 208 manufacturing firms, while the total returned foams received was 178, in which 25 foams were not filled properly and missing data. We have excluded the 25 foams from our dataset. The remaining 153 filled questionnaire were used for data analysis. However, the response rate was 74% approximately, which was satisfactory for testing study hypothesis through simultaneous regression statistical technique. Figure 2. displays the research model.

Data Analysis and Results
This research employed reliability, exploratory factor analysis, and simultaneous regression for testing research hypothesis. The EFA was conducted to determine the underlying structure for the 23 items of the questionnaire. According to the model shown in figure 1, 4 factors were requested. The items were designed to index 4 constructs; “supply chain performance”, which was an exogenous variable in this study. On the other side, explanatory variables were included, “Internal environmental management”, “Green vehicles and transportation”, “Advanced information technology”. The value of KMO measures of sampling adequacy (0.714) shows that the sample have fulfilled the requirement to proceed further analysis. However, a significant result of Bartlett’s test (p < 0.05) indicates that matrix is not an identify matrix. Further, we run EFA (Exploratory Factor Analysis), which accounts for 15.17, 19.15, 21.12, and 23.29 percent of the variance respectively. However, these 4 components explain 78.73% cumulative total variance, while all these 23 items are loaded onto their own components in the rotated solution and have no cross-loadings too. In addition, constructs validity and discriminant have already been ensured.

The simultaneous regression results are displayed in table 1. The combination of variance significantly is predicted 38.1% of the total variance in predicting supply chain performance (F = 31.14, p < 0.001), with only 3 exogenous variables which significantly predict supply chain
performance. The coefficient of parameter estimates suggest that ‘Advanced information technology (0.121, \( p < 0.05 \))’, ‘Green vehicles & transportation’ (0.153, \( p < 0.001 \)), and ‘Internal environmental management’ (0.139, \( p < 0.05 \)) reflect a significantly and positively effect on supply chain performance. Therefore, all hypothesis (H1, H2, and H3) are supported respectively.

### Table 1. Regression Estimations.

| Hyp. | Unstandardized Coefficients |
|------|----------------------------|
|      | B  | Std. Error | t    | Sig.  | Remarks |
| (Constant) | 9.076 | 1.509 | 5.742 | 0.000 |
| H1 Advanced information technology | 0.121 | 0.054 | 2.171 | 0.031  | Supported |
| H2 Green vehicles & transportation | 0.153 | 0.029 | 4.421 | 0.000  | Supported |
| H3 Internal environmental management | 0.139 | 0.049 | 2.412 | 0.001  | Supported |

* Dependent variable: Supply chain performance (\( F = 31.14, < 0.001; \text{Adjusted R-Square} 38.1\% \))
*** indicate significant on 1%; ** and * indicate significant on 5% and 10% respectively.

### Discussion and Conclusion

The findings show that ‘internal environmental management’, advanced information technology and green vehicle have positive and significant effect in improving supply chain performance. Similarly, Daugherty et al., [11] and Khan et al., [8] highlighted that internal management take serious actions and strategic decision for betterment of supply chain performance. There is no doubt that supply chain is a backbone of any manufacturing firm. Khan and Dong, [5] they found that senior leadership role is very important in all strategic decision of supply chain and ethical leadership can easily implement different strategic and techniques such as lean, JIT, TQM and green practices, which reduce the end-to-end supply chain cost with better performance outcome. The results also indicate that ‘advanced information technology’ and ‘green vehicles’ have positive effects on supply chain performance. Advanced technology facilitates greater level of information sharing with supply chain partners, integration and coordination, and reduces the discrepancies and disruption of supply chain [4, 8]. On the other hand, green vehicles help to build positive image of firms with cost reduction through renewable energy sources [6]. The usage of green vehicles and transportation reduce the carbon emissions and improve the supply chain performance. The findings are also supported by [5, 7]. In addition, the usage of green transportation and vehicles builds competitive advantage for the firms [7], and meanwhile customer satisfaction and trust are also improved [4-5].

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