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Problems of Indian Sugar Supply Chain at the Distribution Level : An IT-enabled Solutions

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ABSTRACT

This study aims to identify various issues at distribution level via secondary sources and panel discussion for developing an appropriate relationship to facilitate IT applications in order towards processing and market demand at distribution level. A field survey was conducted with 30 sugar mills (located in states of Uttar Pradesh and Uttarakhand) in an unstructured way to avail information about distributors like brokers, wholesalers and retailers. To check the extent of IT enabled applications for recognized issues, 220 responses were randomly collected from 149 distributors (80 brokers, 54 wholesalers and 15 retailers) and 60 employees of IT companies who provided supply chain solutions, and 11 employees of companies with large-scale sugar consumption. The outcomes were measurably noteworthy and related to one another, which revealed that mean all identified issues were developing positive relationships among them. This study proposes few suggestive IT-based solutions, which can improve the distribution system.

Keywords: Supply chain management, IT-applications, sugar industy, distributors, multivariate methods

INTRODUCTION

Sugar is one of the most important used item in our daily life. The region of Uttar Pradesh in India is the biggest producer as well as the consumer of sugar in India (Word Press, 2010; Word Press, 2011). Therefore, U.P. is identified to comprehend the sugar supply chain framework (Yagyasena, et al. 2013).

The sugarcane producers; logistics/transporters; mill-proprietors; distributors, agents, traders and merchants; and purchasers are the significant players of supply chain in sugar industry. In the process, sugarcane is transported to millers for the manufacture of sugar and other by-products and then further distribution of sugar and by-products at the end consumers in different methods (Amu, et al. 2013; Kadwa and Bezuidenhout, 2015). The sugar is produced from sugarcane in four phases, for example, accepting of cane from producers, cane crushing, sugar manufacturing, lastly packaging of sugar, i.e. SML (stands for the small medium large). The mill warehouses store sugar in different pack sizes and distributed afterwards to the wholesalers as requested by intermediaries or private operators. The wholesalers store the sugar for additional dispersing to their territory retailers and lastly offered to the customers. Most buyers (circuitous client) like PDS (Public Distribution System) and BPL (Below Poverty Line), military, institutional clients (aircrafts, shopping centers, railroads, food organizations, etc.) and different nations request sugar straightforward to the mills and additionally from wholesalers (Kumar, et al. 2012). Close to 60% backhanded clients, request sugar straight forward to wholesalers. (Kansal, 1998). In the sugar factories supply network works through the distribution of sugar bags from millers to the retailer ends. The mills pack their sugar into two types of bags i.e. 100 Kg and 50 kg per bag. These bags are generally stored in the mill godowns and some of

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them distributed to the brokers according to the order released by the Government of India.

The prime aim of the study was is to expedite the applications of IT based solutions to solve the recognized issues at distribution level in the sugar factories supply chain. The objectives were: to find appropriate issues at distribution level and to identify the effect of IT on sugar industry supply chain at distribution level.

The first part of study involved with the documentation of appropriate factors/issues at distribution level through data gathering from primary (distributors) and literature. The second part deals with the application of methods. The analysis of the factors method used for surrounding the model to encourage IT application. The Regression Method applied for developing relationship and ANOVA was used for testing the hypothesis. The third part included reasonable IT solutions for the issues, which provided optimum profits for distributors involved in distributing and selling sugar.

Supply chain management principles are in greater demand at the distribution level to ensure a regular availability of commodity to all at affordable price and to offer enough nutrition. Unfortunately, as reported by Harwood (2001), not many literature are available in the distribution aspect of an agro-food supply chain. In particular, the areas such as poultry, wine, dairy and sugar distribution are neglected in supply chain management.

Very few studies were carried out related to the supply chain framework of sugar industry in Australia, Brazil, Greece and China. The scholastic writing for the Indian sugar sector is scanty. Studies led in different nations provided a restricted significant knowledge at the distribution level.

Higgins and Muchow (2003), studied the benefits of marketing of sugar, in supply chain arrangements in Australia. Different marketing strategies add significant value in maintaining the international competitiveness for the industry at the distribution level. The deployed tasks investigate strategies to cause exceptional to notice the results of various sugar costs and expenses; and outcomes of inconstancy year to year. Ekawati et al. (2019) minimized the bullwhip effect that exists in the supply chain of refined sugar in Indonesia by using Support vector regression method. This method yielded a high degree of accuracy. Solomon et al. (2020) studied the impact of the present ongoing COVID-19 pandemic crisis on the Indian sugar industry. They explained that the sugar industry is at a crossroad and undergoing different changes. The impact may not last forever, but strategies like mechanization in the fields and ethanol blending are going strengthen the sugar industry.

Bolling and Suarez (2001) have examined the sugar industry of Brazil and highlighted the recent changes in manufacturing, consumption, and trading of sugarcane, sugar and ethanol. It indicated that Brazil has the capability of producing either sugar and/or ethanol from cane. (Lüdtke, et al. 2020). This points out that there is no transparency among the supply chain partners those associated with the sugar market and prices. Claudino et al. (2018) identified the production mix decision of managers, which showed that mill adds value to the output characterized through flexibility and responsiveness while orienting the production of sugar and/or ethanol according to the market requirement.

Ioannou (2005) examined the supply chain reorganization process in HNI, one of the sugar industry in Greece. In their investigation, they announced that this industry has improved demand inclusion and spared very nearly one million US dollars by ideal arranging of bury nodal material exchanges. The supply chain studied, in this study and a model suggested, deriving optimal distribution practices at distribution after examining the customer needs and logistical costs. Banomyong et al. (2017) developed a framework that measures the sustainable performance of the supply chain by using a composite index in sugar industry in Thailand. Kusrini et al. (2019) used SCOR model to measure the supply chain performance of one sugar company. Mutenure et al. (2018) studied the sugar supply chain in South Africa and tried to find out the economic viability of integrated bio-ethanol. Pothongsangarun and Kumplanon, (2017) studied the factors affecting the logistics management and the processes to increase the efficiency of sugar industry (Wangkanai group) in Thailand. Aguilar-Rivera et al. (2019) analyzed the Mexican sugar industry that is plagued with certain challenges like lack of infrastructure for handling and

distribution of ethanol blends and an absence of the framework of sustainability analysis. Ruggeri and Corsi, (2019) analyzed the data of sugar cane producers and identified different clusters that show the similarities and patterns of different indicators between producer's organizations.

Price plays an important role in the supply chain of sugar factories. During the study in the region, it was observed that, no other partners (like cane producers, mills, and other shareholders) negotiate with sugar prices, but at distribution level, brokers, wholesalers and retailers are free to negotiate with the sugar prices among each other. It was observed that retailers never negotiate with the prices but the brokers and wholesalers are highly involved in price negotiation with the response rate of about 71.43 per cent and 78.95 percent (Kumar et al. 2013; Kumar et al. 2014). The response rate obtained for the brokers and wholesalers may vary accordingly with the location, region, or state. The data obtained from them can be slightly different on a large sample size.

Everingham et al. (2002) inspected the vulnerability with variable climatic conditions for sugarcane enterprises. This changeability has an effect over the supply chain including transportation, promotion, and so on. The IT application can truly help in building up the regular atmosphere figure frameworks particularly at distribution level. The distributors as wholesalers, brokers and retailers in India have limited or no use of IT applications in the distribution of product like sugar, as observed during the survey (Kumar et al. 2013; Kumar et al. 2014; Carrizosa et al. 2020).

Zhu and Cote (2004) studied a Chinese sugar complex, Guitang Group. Authors acknowledged that obstruction associated with communication and information dissemination were the main barriers for ensuring effective supply chain performance (Rights and Sterba 2020; Cremers et al. 2020). Rai and Mogens, (2010) suggested use of IT for co-creation for better fulfillment of customer needs. To achieve higher customer satisfaction same concepts can be extended to supply chain management. In another study Rai et al. (2011) suggested use of ICT innovation in India for better results. Ali and Kumar (2001) have suggested use of information management and modelling for internal supply chains. Fu et al. (2000) suggested synchronized supply chains with the help of multi-agent enabled integration and collaboration. Omondi, (2019) carried out a study in Kenya that showed the effect of Enterprise Resource Planning (ERP) software on the supply chain performance of a sugar producing company.

Infrastructural development is possible only when there is a strong usage of e-applications among the partners at distinct levels of the sugar factories supply chain. It observed that the current usage of e-applications at distribution levels partially implemented for addressing the various issues occurred with their respective response rates. Kumar et al. (2013, 2014) mentioned that there is no such use of e-applications for outbound logistics and smooth financial flow between sugar mills and distributors at distribution level.

MATERIALS AND METHOD

The methodology applied for the collection of the data included survey methods, i.e. both planned and unstructured manner. The data was collected from 149 distributors, 60 IT companies and 11 LSSCC.

The responds were collected from all three distributors i.e. brokers, wholesalers, and retailers; IT-companies and LSSCC is 220.

The reliability test was conducted with value of 0.788 (comes under acceptable range) for all the seven (D1 to D7) recognized issues.

The factor method to test the validity of identified issues: to ensure the rationality of the scales used, the validity factor analysis was done (Burton and Mazerolle 2011; Floyd and Widaman 1995; Kumar et al. 2013). This strategy utilized for creating legitimate relations among the number of issues and was diminished into a few (Hair et al. 1995). To validate the construct factor analysis employed in the present study, i.e. seven issues were taken from D1 to D7 at distribution level.

The distribution level primary data presentation was based on the 5-point Likert scale. The importance of this scale utilized to quantify the importance level for all issues, which encourage IT-applications at this level. The description for the issues (D1 to D7) was listed in

(Table 1). The mean and standard deviation measurements for different issues at distribution level was done (Gupta and Gupta, 2011). To test the measurable significance of these issues (D1 to D7), the Pearson relationship with significant two-tailed test was utilized. Correlation matrix for seven issues at distribution level was also calculated.

The overall significance level was tested using KMO and Bartlett's whose MSA value was 0.667 i.e. comes under acceptable range. Further, CHI-SQUARE value was 284.412 at 21 df i.e. degree of freedom at a significant level of 0.000 i.e. in the range of 95% of confidence interval. The output indicates high level of significance level and it was inter correlated to one

Table 1 : Description of issues at distribution level

Notations	Issues at Distribution Level	Description	References
D1	Order processing	Order processing refers to fulfilling customers' orders, a crucial distribution component. Therefore, poor order processing makes the distribution process inefficient.	(Kumar et al., 2014; Omondi, 2019; Zhu and Cote, 2004)
D2	Managing vendors/relations with vendors	Vendor management plays a vital role in effective distribution. Poor information sharing and lack of coordination with the vendors directly affect vendor management.	(Aguilar-Rivera et al., 2019; Cremers et al., 2022; Rai et al., 2011)
D3	Relations with customers	Relations with the customer is an essential component of effective distribution as it fosters long-term relationships with them. As a result, businesses employ different methods to engage with customers to improve the customer experience.	(Kumar et al., 2012, Banomyong et al., 2017; Rai and Mogens, 2010; Zhu and Cote, 2004)
D4	Managing the middleman for distribution	A middleman has an active role in performing critical tasks in selling and purchasing goods. In addition, middlemen act as intermediaries in distribution who facilitates the various parties involved in the transaction chain.	(Closs & Kefeng, 2000; Fu et al., 2000;Rights and Sterba, 2020)
D5	Managing the fluctuations in the prices of sugar	The fluctuations in the market lead to a rise and fall in commodity prices. This may be attributed to reasons like the demand and supply gap.	(Ali and Kumar, 2001; Kumar et al., 2013; Mutenure et al., 2018)
D6	Managing the market demand of products and by-products	Addressing the market demand is crucial as it affects the distribution process. Market demand management requires a sophisticated marketing information system. This system should be capable of collecting, analyzing, and proliferating the information across the decision-makers.	(Ekawati et al., 2019; Ioannou, 2005; Kumar et al., 2010; Kusrini et al., 2019; Pothongsangarun and Kumplanon, 2017)
D7	Brings transparency to the demand and supply of sugar market to benefit the consumers and farmers	Lack of transparency to the demand and supply in the market adversely affects the consumers and farmers alike. The market intelligence tools may bring visibility which is essential for the benefit of farmers and consumers.	(Carrizosa et al., 2020; Ruggeri and Corsi, 2019; Gurung, 2006; Kumar, 2020)

another which further helps in forming the reduced factors. Thus, seven issues at distribution level, i.e. from D1 to D7 were forming two reduced factors/ issues (Figure 1).

- Managing supply chain partners and their orders (FD1); and
- Managing market demand and prices of products and by-products (FD2)

Finally, a model framework for enabling IT-applications at distribution level with their factors loading pattern was planned (Figure 1).

Multiple regression model

This model was used to develop a relation among multiple independent factors/issues and a dependent one. The mean and SD value i.e. descriptive statistics for reduced issues evaluated. These indicated with their respective notations with the 'N' number of respondents i.e., 220. At distribution level, there were two issues used to perform the regression method by establishing a suitable relationship among them. During the analysis, the two identified issues sorted into two criteria i.e.,

- Dependent variable: Managing market demand and prices (FD2); and
- Independent variable: Managing supply chain partners and their orders (FD1)

The co-efficient of co-rrelation matrix was applied between FD1 and FD2 whose value is 0.446 i.e., statistically significant. The result showed a high level of correlation among each other and no evidence of multi-collinearity observed. This forms a suitable base to execute analysis using multiple regression analysis.

To examine the relationship between two issues FD1 and FD2, regression method was employed. The final regression equation as shown below:

$$FD2 = 2.839 + 0.360\ (FD1) \qquad \text{equation 1}$$

The value of R2 explains only 19.9% of the variance occurred in the management of demand and prices (FD2) is accounted by managing the supply chain partners (FD1). This R2 value is much smaller but the significance level of the construct is high. Therefore, the output is favored the construct.

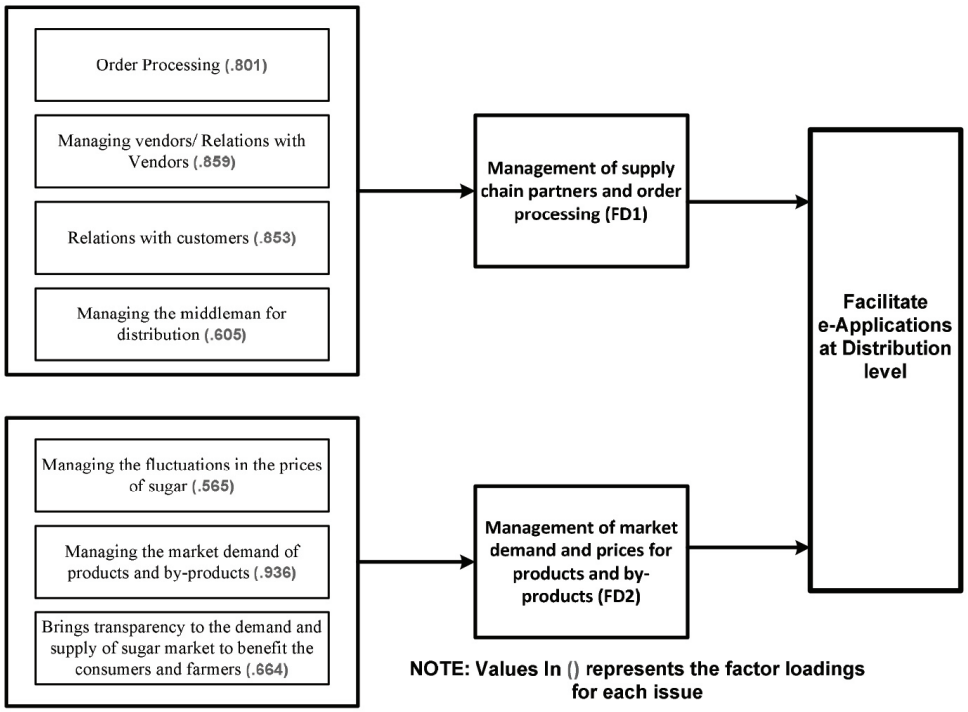

Figure 1 : A model for facilitating e-applications at distribution level

Hypothesis testing

The research hypothesis testing was conducted with the help one-way analysis of variance (ANOVA). The results of the hypothesis as shown here:

Hypothesis-1: There is no significant difference by using IT application in order processing and market demand at distribution level.

This hypothesis is verified by using ANOVA between the issues namely, order processing (FD1) and market demand (FD2), to check their significant differences. Hence, the null hypothesis is considered for testing the hypothesis.

ANOVA results showed that the F (14.286) calculated value for FD1 is larger than the critical value. Hence, the null hypothesis is rejected because the mean scores for these two issues, FD1 and FD2, have the values of 3.99 and 4.27, respectively are different. Also, from the regression equation (equation-1), the unstandardized coefficient of FD1 is 0.360.

Thus, it accepts the alternate hypothesis, i.e., creating significant differences among these factors/issues. Hence, the distribution level can be developed by overwhelming these issues like order processing and market demands with IT applications. This management is done only after managing the product's information, prices and market demand.

RESULTS AND DISCUSSION

The result proved that issues namely, managing the supply chain partners and their orders (FD1) and managing market demand and prices (FD2) were having positive relationship with facilitating IT applications at the distribution level. This showed the issue related to the management of market demand and prices (FD1) to be addressed by managing the supply chain partners and their orders (FD2) with IT applications at the distribution level. The results of statistical analysis for Hypothesis-1 also indicates that there was significant difference by using IT application in order processing and market demand at distribution level". This indicated that the alternate hypothesis was accepted after rejecting the null hypothesis. This showed that all these issues can be addressed with various IT enabled applications. The necessary IT solutions provided for the are listed herein.

Some advanced technology software like S2K distribution management software is very useful for processing order of sugar at distribution level. This type of software performs multiple functions such as creating order, managing order details, order status, account information, etc. It will be very useful for transferring the information of order electronically from mills to distributors and vice versa at distribution level. In India, no such software is in use. Another technology i.e., Logistics Operating Systems (LOS) is used for order processing (Closs and Kefeng 2000; Gurung 2006).

The computer system brings transparency at distribution level through which the proper management of supply chain partners like vendors and customers of sugar (brokers, wholesalers and retailers) is possible. This system helps in maintaining their information, records, order related data, order prices, etc.

S2K sales analysis software is a strategic approach for managing the inventory and sales. This helps in improving the relations with customers and vendors (based on the cost, volumes and profitability).

IT-enabled solutions are used for managing the market demand and prices of sugar or by-products. This brings transparency to the sugar market and controlled under the supervision of Government. Still the problem with the fluctuation in prices occurs. In addition, various types of taxes like excise, VAT, sales taxes, etc. on the product may further increase the sugar prices. Hence, an effective and advanced technology would be required to solve such problems. In this way, the sugar prices in the market will be same and there will be no or less fluctuation in the prices (Kumar et al. 2013). Hence, the facilitation of IT applications at distribution level is necessary for managing such issues.

IT enabled results helps in dealing with issues at distribution level. IT enabled solutions provide optimum profits to the distributors in certain ways in the supply chain network of sugar industry (Figure 2). Thus, IT helps the distributors in distributing and selling sugar among them and to consumers.

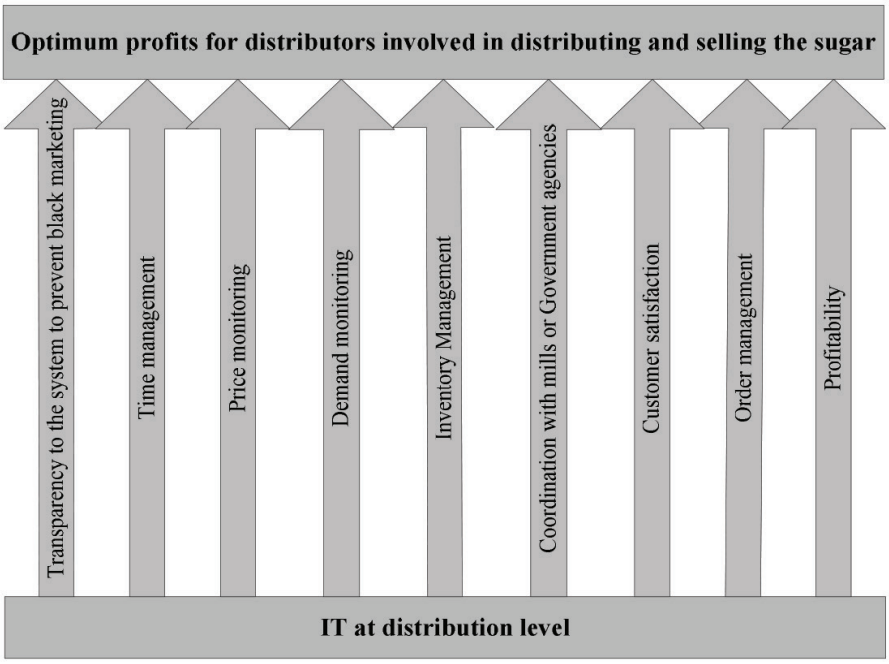

Figure 2 : Role of IT at distribution level

Table 2 : IT solutions for various issues at distribution level

S.No.	Issues	IT Solutions
1	• Order Processing	• S2K distribution management software • Logistics Operating Systems (LOS)
2	• Managing relations with customers, vendors and middleman	• Advance Computer System (LOS)
	• Managing inventory and sales	• EDI
	• Managing the market demand of products and by-products	• SAP
	• Managing the fluctuations in the prices of sugar	• ERP
	• Bringing transparency to the demand and supply of sugar market to benefit the consumers and farmers	• S2K sales analysis software

CONCLUSION

Information Technology plays an important role in improving supply chain systems. Besides providing visibility, IT-applications would help in the management of the flow of goods, money or funds and information. Based on the literature review and survey method the different issues identified by the distributors. Few IT enabled results indicated with the effective execution of information technology at the distribution level believed to help in distributing and selling the sugar in the transparent market with appropriate price as per customer demand. The result showed that distributors like, brokers, wholesalers and retailers are not frequently using IT application for performing the task and lacks in upgrading their technology.

Like any other industry, sugar industry also works in a way where all partners involved in the supply chain is enormously dependent to one another. Supply chain partners cannot work in an effective manner without evolving strong connections among them. In the present context, it concluded that the millers-distributors relationship is very crucial in order to make a better flow of product i.e., sugar and other by-products like mud, bagasse and molasses in the market. Hence, it

is prudent to create an IT application or a software that can provide the similar stage at both distributor and miller ends which creates transparency, visibility and finally improves their income.

The policy makers and various industry actors should facilitate in overcoming the various issues and assist partners such as sugarcane producers, mill owners, distributors, and other shareholders/investors of the sugar mill in achieving their undertakings. Deep participation of GOI can decrease the load of the supply chain partners, especially for cane producers and distributors. To provide provision of IT enabled application, new government policies should be drafted.

This study is limited to only two states of Uttarakhand and Uttar Pradesh, the northern part of India. Such states having a large geographical region as compared to other states, which may bring slightly deviation in the output. Many sugar producing countries like Brazil, Australia, South Africa, Cuba, etc., have different culture and geography, because of which the factors/ issues at the distribution level may vary.

In view of this examination, further studies, e-commerce architecture (Kumar, et al. 2010) should be created by featuring the handiness of IT at various levels. The sugar business may build its intensity in the near future when contrasted with different ventures by utilizing IT applications (Kumar et al. 2013, 2014). This type of study further should be conducted and analyzed by using R programming, time series analysis and structural equation modelling (SEM).

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