Linking Producers to Consumers: Exploring Supply Chain Dynamics in Nepalese Sugar Industry

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ABSTRACT

Purpose: *This study aims to investigate the relationships between key drivers of sustainable supply chain management (SSCM) and their impact on the performance of the Nepalese sugar sector.*

Design/Methodology/Approach: *A survey was conducted with primarily from retail stores, to gather insights into the current state of SCM practices.Co-relation and regression were done to conform association based of framework to assess the hypothesis.*

Findings/Results: *The findings reveal that delivery reliability, flexibility, and cost control are significant factors influencing the effectiveness of supply chain management in Nepal's sugar industry. Multiple regression analysis indicates that the independent variables account for 38.3% of the variability in supply chain management practices. The study highlights the importance of enhancing delivery reliability, fostering flexibility, and optimizing cost control to improve the sustainability and competitiveness of the sugar supply chain in Nepal. Addressing challenges related to infrastructure, information sharing, and stakeholder collaboration is essential for implementing effective SSCM strategies.*

Originality/Value: *The findings of this research provide valuable insights for policymakers to manage subsidies for optimal production of sugarcane by reducing farmer's pain.*

Keywords: Supply chain management, sugarcane industry, sustainability, delivery reliability, flexibility, cost control.

1. INTRODUCTION :

Sugarcane (*Saccharumofficinarum*) is a globally significant crop known for its high sucrose content, making it a vital source of sugar for various industries (Khan et al. 2016)[1]. The domestication of sugarcane has a long history, with its origins believed to be in the Polynesian islands of the South Pacific, where it is thought to have existed around 2000 BC (Hannah and Spence 1996)[2].

According to FAO (2021)[3] statistics, global sugar crop production saw a slight increase between 2020 and 2021, with sugarcane being the primary source. The cultivation area for sugarcane is reported to be approximately 26.9 million hectares, yielding an average of 70.9 tons per hectare (t/ha). The total global production of sugarcane is around 1.9 billion tons, significantly higher than the 270 million tons produced from sugar beet in 2021. Sugarcane not only serves as the main source for sugar production but also plays a crucial role in energy production and the creation of byproducts like ethanol and fibers (Morais et al. 2015)[4].

As the largest crop commodity in terms of total production, sugarcane is cultivated in about 100 countries worldwide. Its growth is primarily concentrated in tropical and subtropical regions, where adequate water supply is available for more than six to seven months each year, either from rainfall or irrigation. Approximately 80% of the world's sugarcane is produced in 120 countries, covering around 27 million hectares and yielding between 1.8 to 2 billion tons annually (Food, 2022)[5]. These signify sugar impact on human livelihood [6].

In Nepal, sugarcane is the third major commercial cash crop, contributing 1.2% to the agricultural GDP. The country ranks 41st in suger production, with an output of 2.93 million tons, and occupies the 35th

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position in harvested area (64,483 ha) and 67th in yield (45.4 t/ha) (P. R. Neupane, Maraseni, and Köhl 2017)[7]. Commercial production is primarily focused on 14 districts, particularly after the establishment of Morang Sugar Mill Limited in 1947. However, the overall production and cultivation area have been declining since 2015/16, leading to a significant trade deficit in the sugarcane industry. Currently, out of 31 existing industries, only 10 sugar mills are operational (P. R. Neupane, Maraseni, and Köhl 2017)[7]. We must convert agriculture into product to create value (Mishra, Nepal and Aithal, 2022)[8] that is why converting sugarcane into sugar is important along with supply of sugar to consumer.

2. STATEMENT OF PROBLEMS :

Supply Chain Management (SCM) plays a crucial role in efficiently moving goods through the supply chain, particularly in the context of Nepal's sugar industry. It encompasses the management of material flows, from manufacturers and suppliers to transporters and retailers, ultimately delivering products to consumers. The primary objective of SCM is to maximize the overall value generated throughout this network (Islam, 2013)[9].Despite the increasing recognition of SCM's importance in both practical and academic fields, the sugar industry in Nepal faces significant challenges that hinder its potential. Operating costs continue to rise, and the sector struggles to adapt to the complexities of modern supply chain dynamics. Accordingto the Nepal Labour Force Survey of 2018, 60.4% of the population was engaged in agriculture, but this figure dropped to 50.4% by 2021(Kafle, L., 2023)[10].The government's limited investment in the agricultural sector, with only NPR 58.98 billion allocated for FY 2023/24, further exacerbates these issues. Despite Nepal ranking 41st globally in sugar production, the industry fulfills only 71% of the domestic sugar demand, highlighting inefficiencies within the supply chain. This study aims to investigate the relationship between key SCM variables—cost control, flexibility, and delivery reliability—and their impact on the performance of the sugar supply chain in Nepal. By addressing these factors, the research seeks to identify strategies that can enhance the efficiency and sustainability of sugarcane production, ultimately contributing to the growth of the industry and improving the livelihoods of those involved. Understanding these dynamics is essential for developing effective SCM practices that can navigate the challenges faced by the Nepalese sugar sector.

3. OBJECTIVES :

The general objective of this study is to assess the relationship between cost controls, flexibility and delivery reliability with supply chain performance of sugar in Nepal.

4. LITERATURE REVIEW :

The sustainable management of sugarcane supply chains in Nepal is increasingly recognized as a vital component of the country's agricultural sector. Sugarcane (Saccharumofficinarum) is the largest commercial cash crop in Nepal, particularly thriving in the southern regions where the climate is favorable for its cultivation.

4.1 Drivers for Sustainable Supply Chain Management and Performance

This literature review examines the key drivers of sustainable supply chain management (SSCM) in the context of Nepal's sugar industry, emphasizing the integration of environmental, social, and economic considerations.

Risk and Uncertainty

The sugar supply chain in Nepal faces various risks, including climate change, market fluctuations, and resource scarcity. These risks can disrupt production and affect the livelihoods of farmers who depend on sugar production. The increasing vulnerability of supply chains to external shocks necessitates a comprehensive approach to risk management that incorporates environmental sustainability and social responsibility (Neupane et al., 2017)[7]. For instance, climate-related risks have been shown to impact production yields, making it essential for stakeholders to develop adaptive strategies to mitigate these effects. Addressing these risks within an environmental, social, and economic context is a critical challenge for sustainable supply chain management (Meixner, 2009) [11].

Law and Regulation

The regulatory environment in Nepal significantly influences the sugar supply chain. Environmental regulations aimed at reducing the ecological footprint of agricultural practices are becoming more

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stringent. Compliance with these regulations is crucial for the sustainability of sugar production, as non-compliance can lead to penalties and loss of market access (Bhat, 2008)[12]. The government's commitment to sustainable agriculture necessitates that sugar producers adhere to environmental standards while also navigating the complexities of varying regulations across different regions (Nidumolu, 2009)[13].

Innovation and Knowledge

Innovation plays a critical role in enhancing the sustainability of sugar supply chains in Nepal. The adoption of new agricultural technologies and practices can lead to improved yield and resource efficiency. For example, the introduction of drought-resistant sugar varieties and precision farming techniques can help farmers adapt to changing climatic conditions (Hales, 2009)[14]. Furthermore, knowledge-sharing among farmers, researchers, and industry stakeholders is essential for fostering innovation and improving overall supply chain performance (Christian, 2008)[15].

Integration and Efficiency

The integration of supply chain operations is vital for enhancing efficiency and sustainability in Nepal's sugar industry. Effective communication and collaboration among stakeholders, including farmers, processors, and distributors, can lead to better resource management and reduced waste (Ahumada, 2009)[16]. Information technology plays a significant role in facilitating this integration, allowing for real-time data sharing and improved decision-making throughout the supply chain (Jayaratne, 2011)[17].

Strategy

Developing a comprehensive strategy for sustainable sugar production is essential for addressing the unique challenges faced by the industry in Nepal. This includes setting clear objectives for environmental performance, social equity, and economic viability. Establishing shared key performance indicators among stakeholders can enhance accountability and drive improvements in sustainability (Der, 2000)[18]. Moreover, integrating sustainability considerations into strategic planning can help align the goals of various supply chain partners.

Relationships and Collaboration

Strong relationships among supply chain partners are crucial for the sustainability of Nepal's sugar industry. Collaborative efforts can enhance trust and facilitate knowledge exchange, ultimately leading to improved practices and outcomes (Lambert, 2017)[19]. For instance, partnerships between farmers and sugar mills can foster better resource sharing and support for sustainable farming practices, contributing to the overall resilience of the supply chain.By focusing on these key drivers, stakeholders in Nepal's sugar industry can work towards a more sustainable and efficient supply chain that benefits all participants, from producers to consumers.

4.2 The Evolution of Sustainability Concepts

The modern concept of sustainability, particularly the Triple Bottom Line (TBL) approach, has gained prominence since the publication of the "Our Common Future" report by the World Commission on Environment and Development in 1987. Sustainability is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The TBL framework emphasizes three critical pillars: environmental integrity, economic viability, and social equity (Vachon, 2008)[20]. This comprehensive understanding of sustainability is particularly relevant in the context of suger production in Nepal, where the interplay of these three dimensions is crucial for the long-term viability of the industry. The limited definition of sustainable development from the Brundtland Report has been expanded to define sustainability as a requirement for current generations to manage resources in a manner that ensures an acceptable quality of life can be shared by future generations (Asheim, 1994)[21]. This broader perspective connects the ability of current generations to experience social well-being, enjoy economic prosperity, and maintain a healthy environment without jeopardizing the prospects of future generations. The modern definition of sustainability incorporates the implications of the TBL framework, which identifies economic, social, and environmental aspects as key pillars of sustainable development (Parris, 2003)[22].Achieving sustainability requires the integration of these three dimensions, as illustrated in various models that demonstrate the intersection of environmental, social, and economic performance in sustainable supply chain management (Carter, 2008)[23]. In the context of Nepal's sugarcane industry, this integration is vital for addressing the challenges posed by climate change, market volatility, and resource

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scarcity.Sustainable Supply Chain Management in Nepal's Sugarcane Industry

Sustainable supply chain management (SSCM) is increasingly recognized as essential for enhancing the performance of supply chains, particularly in agriculture. The relationship between competitive strategy and supply chain strategy is significant, as companies must adapt their operations to align with sustainability goals while responding to external business environments and market demands (Pettit, 2010). In Nepal, the sugarcane industry faces unique challenges that necessitate a robust SSCM approach.

4.3 The Framework

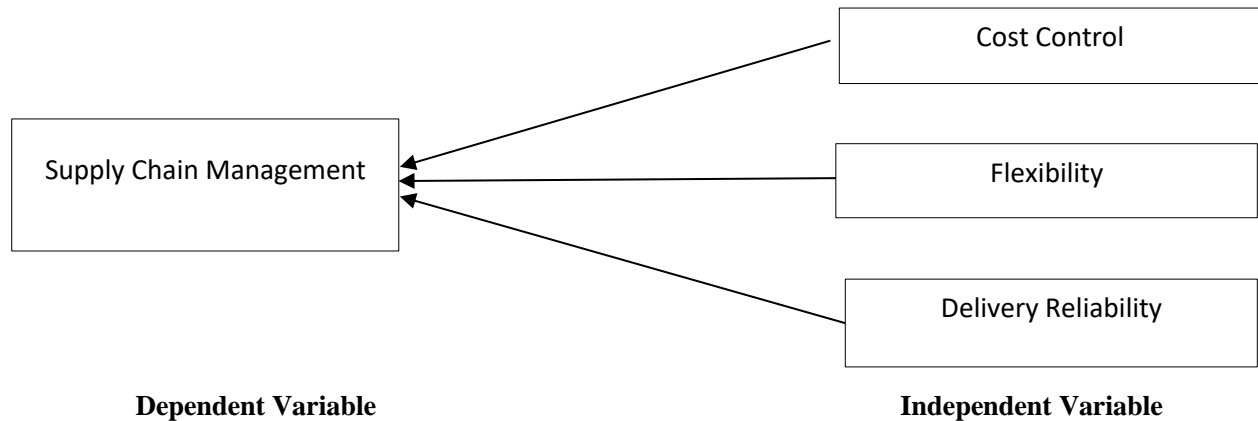The framework for this study is presented in the figure 1.

Fig 1: Theoretical Framework

Cost Control

Cost control is a critical factor in ensuring financial efficiency within supply chain management. Accurately measuring financial results can be challenging, especially in a dynamic business environment. However, collecting accurate and adequate information on costs is a key element in the management process, both at the individual company level and across the entire supply chain. As managers increasingly recognize the importance of cost effectiveness as a source of competitive advantage, they are striving to improve and develop methods of analyzing and managing costs and processes. One area where significant cost savings can be achieved is in the supply chain (Carter &Ferrin, 1995)[25].

Flexibility

Flexibility in supply chain management reflects the ability of a system to change or react with minimal penalties in terms of time, effort, cost, or performance. Flexibility in supply chains enables companies to respond to short-term changes in demand or supply situations, as well as external disruptions, while also adapting to strategic and structural shifts in the supply chain environment. Flexibility combines agility and adaptability (Lee, 2004)[26]. High-speed and low-cost supply chains have been important drivers for companies, as they work well in stable conditions where the entire supply chain focuses on economies of scale and delivering quick supply at the least cost. However, these supply chains may struggle to react to sudden changes in demand. Changing market demand, varying supplier lead times, product quality issues, and information delays are sources of uncertainty that create a need for building 'flexible' supply chains that can deal with these changes better than their rivals, thereby achieving a competitive advantage (Kopecka, 2003)[27].

Delivery Reliability

Delivery reliability is measured by perfect order fulfillment and demonstrates the degree to which a supplier can serve its customers within the promised delivery time. Reliability is essential in implementing an effective supply chain management strategy, as it enhances productivity and reduces costs. The flexibility demanded of producing companies often conflicts with the required delivery reliability. In this context, the reasons for a lack of delivery reliability are often rooted in the missing, incorrect, or insufficient exchange of information between a company's own business processes and with the customer. Reliability ensures that inventory is delivered to customers on time. On-time,

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consistent performance is frequently attributed to effective shipper/carrier collaboration (Alvarado, 2001).

5. METHODOLOGY :

This study employed a mixed-methods approach to investigate the relationships between key drivers of sustainable supply chain management (SSCM) and their impact on the performance of Nepal's sugar industry. The research design involved a combination of quantitative and qualitative techniques to gather comprehensive insights into the current state of SCM practices.

5.1 Sampling and Data Collection

A survey was conducted with 200 respondents, primarily from retail stores (54%), while wholesalers and chain stores accounted for 24% and 22%, respectively. The focus on retail outlets in the Parsa district is significant, as these stores are crucial for directly engaging with customers and maximizing sugar sales across various outlets. The study aimed to include a diverse range of retail stores to ensure comprehensive insights into the industry's SCM practices. The selection criteria for respondents included a minimum of one year of experience in the sugar industry, ensuring that participants possessed adequate knowledge of SCM practices. To gather data, a structured questionnaire was developed, consisting of both closed-ended and open-ended questions. The questionnaire was divided into two parts: the first part focused on gathering general background information from respondents, while the second part employed a Likert scale to assess the importance and agreement levels concerning the independent variables (cost control, flexibility, and delivery reliability) and their relationship with the dependent variable (supply chain management).

5.2 Data Analysis

The collected data were analyzed using both descriptive and inferential statistical techniques. Descriptive analysis was performed to calculate measures such as mean and standard deviation for the independent and dependent variables. This analysis provided insights into the relative importance of each variable within the context of Nepal's sugar supply chain. To examine the relationships between the variables, Pearson correlation analysis was conducted. The correlation results were used to test the research hypotheses and determine the strength and direction of the associations between the independent variables (cost control, flexibility, and delivery reliability) and the dependent variable (supply chain management).Furthermore, multiple regression analysis was employed to assess the combined effect of the independent variables on the dependent variable. This analysis helped identify the relative contribution of each independent variable in explaining the variability in supply chain management practices within the Nepalese sugar industry.

5.3 Qualitative Data Collection and Analysis

In addition to the quantitative survey, qualitative data were collected through semi-structured interviews with key informants, including industry experts, policymakers, and representatives from sugar mills and farmer associations. The interviews aimed to gather in-depth insights into the challenges, opportunities, and best practices in SSCM within the Nepalese context. The qualitative data were analyzed using thematic analysis, which involved identifying recurring themes and patterns in the interview transcripts. The themes were then used to corroborate and contextualize the findings from the quantitative analysis, providing a more comprehensive understanding of the factors influencing supply chain management in Nepal's sugar industry.

5.4 Ethical Considerations

The study adhered to ethical research principles throughout the data collection and analysis process. Informed consent was obtained from all participants, and confidentiality was maintained by ensuring anonymity in the data reporting. The research protocol was reviewed and approved by the institutional review board to ensure compliance with ethical standards. By employing a mixed-methods approach, this study aimed to provide a robust and multifaceted understanding of the factors influencing sustainable supply chain management in Nepal's sugar industry. The combination of quantitative and qualitative techniques allowed for the triangulation of findings, enhancing the validity and reliability of the research outcomes.

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6. RESULTS AND DISCUSSION :

6.1 Descriptive Analysis

The data are taken from survey and descriptive analysis was done followed by following inferential analysis. Subsequent to presenting the demographic profile, a descriptive analysis was conducted on independent variables—cost control, flexibility, and delivery reliability—and their relationship with the dependent variable, supply chain management. The analysis revealed that delivery reliability had the highest mean score of 4.114, followed closely by flexibility at 3.986. Cost control, however, scored lower at 3.876, indicating that while it is essential, it may not be prioritized as highly as the other two variables in the context of sugarcane marketing.

The standard deviations for these variables were also noteworthy, with delivery reliability showing the highest standard deviation (0.872), suggesting a greater variability in perceptions of reliability among respondents. This variability underscores the challenges faced in achieving consistent delivery performance within the sugarcane supply chain.

6.2 Correlation Analysis

Pearson's correlation analysis is carried out to know to what extent variables under study are correlated to each other. A positive correlation reveals that the direction of the relationship is positive with one increasing in reaction to the other's increase. Meanwhile a negative correlation reveals that an inverse of the above which is increase in one variable when there decrease in other.

Table 1: Correlation Analysis

		Cost Control	Flexibility	Delivery Reliability	Supply Chain
Cost control	Pearson Correlation	1	.487**	.284**	.369**
	Sig. (2-tailed)		.000	.000	.000
	N	200	200	200	200
Flexibility	Pearson Correlation	.487**	1	.552**	.524**
	Sig. (2-tailed)	.000		.000	.000
	N	200	200	200	200
Delivery reliability	Pearson Correlation	.284**	.552**	1	.556**
	Sig. (2-tailed)	.000	.000		.000
	N	200	200	200	200
Supply chain	Pearson Correlation	.369**	.524**	.556**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	200	200	200	200
**. Correlation is significant at the 0.01 level (2-tailed).					

Table 1 shows the relationship between dependent and independent variables. The relationship between Supply Chain Management and other four independent variables.i.e., Cost Control, Flexibility and Delivery Reliability.

Delivery Reliability Variable and Supply Chain Management

The correlation analysis between Cost Control and Supply Chain Management. Since, the P value is less than alpha i.e., 0.00<0.05, the correlation is significant between variables. From this, it can be understood that Cost Control plays a significant role in SCM.

Further, with the correlation coefficient value of 0.369, it can be said that there is positive relationship between the two variables. Hence, there is significant relationship between delivery reliability and supply chain management.

Flexibility Variable and Supply Chain Management

The correlation analysis between Flexibility and Supply Chain Management. Since, the P value is less than alpha i.e., 0.00<0.05, the correlation is significant between variables. Form this, it can be understood that flexibility plays a significant role in SCM.

Further, with the correlation coefficient value of 0.524, it can be said that there is positive relationship between the two variables. Hence, there is significant relationship between flexibility and supply chain management.

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Delivery Reliability Variable and Supply Chain Management

The correlation analysis between Delivery Reliability and Supply Chain Management. Since, the P value is less than alpha i.e., 0.00<0.05, the correlation is significant between the variables. Form this, it can be understood that Delivery Reliability plays a significant role in SCM.

Further, with the correlation coefficient value of 0.556, it can be said that there is positive relationship between the two variables.

Hence, there is significant relatio   nship between Delivery Reliability and Supply Chain Management.

6.3 Regression Analysis

This section determines which independent variables explain variability in the outcome, how much variability in dependent variables is explain by independent variables and dependent variable, and which variables are significant (over other variables) in explaining the variability of the dependent variable. Linear regressions were used to explore the impact of independent variables.

A multiple regression model was applied to determine the form of relationship between the variables of Supply Chain Management. The equation for Impact of independent variables is expressed in the following equation:

$$Y = \alpha + \beta_1 X_1 + \beta 2 X_2 + \beta 3 X_3 + ei$$

Where,

   Y = Supply Chain Management (Dependent Variable)

   X_1 = Delivery Reliability

X2 = Cost control

X3 = Flexibility

α = Constant

β1, β2…...β8 = Regression coefficients of Factor 1 to Factor 3 respectively

ei = Error term

Table 2: Model Summary

R	R Square	Adjusted R Square	Sig.F
.626[a]	.392	.383	.000

Adjusted R2 is called the coefficient of determine and tell us how the Supply Chain Management in Nepalese Sugarcane Industry (Dependent Variable) varied with Delivery Reliability, Flexibility, Cost Control (Independent Variable). Form the regression model summary above, the value of adjusted R2 is 0.383. This means that the independent variables accounted for up to 38.3% of Supply Chain Management in Nepalese Sugarcane Industry (Dependent Variable).

The remaining 61.7% can therefore be achieved through other factors outside the three variables. Similarly, ANOVA was used to establish the appropriate of the regression model in giving reliable results. The regression model is seemed appropriate when the confidence level is 95% and above.

Table 3: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	25.088	3	8.363	42.147	.000[b]
Residual	38.889	196	.198		
Total	63.977	199			

a. Dependent Variable: supply chain

b. Predictors: (Constant), delivery reliability, cost control, flexibility

Table 3 above shows the F-significance value of p<0.05. This means that the regression model has a less than 0.05 likelihood (probability) of giving a wrong prediction. Hence, the regression model has a confidence level of above 95% which confirms that our regression model was appropriate and the results reliable.

The results for the coefficient results have presented in the table 4 below.

Table 4: Model Summary

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	Std. Error	Beta			VIF
1 (Constant)	1.049	.284		3.691	.000	
Cost Control	.152	.068	.142	2.226	.027	1.311

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Flexibility	.239	.071	.245	3.347	.001	1.735
Delivery Reliability	.356	.063	.380	5.684	.000	1.439

Dependent Variable: SCM

Looking at the significance levels, the study established that there is a significant relationship between delivery reliability. This means that this dimension account for the greatest contributions on the attainment of the supply chain management. Therefore, individual suppliers need to follow this dimension to achieve effective supply chain management.

6.4 Hypothesis Testing

Hypothesis testing is an act in statistics whereby an analyst tests an assumption regarding a population parameter. The methodology employed by the analyst depends in the nature of the data used and the reason for the analysis. Hypothesis testing is used to infer the result of a hypothesis performed in sample data from a larger population. The test tells the analyst whether his primary hypothesis is true. Statistical analysts test a hypothesis by measuring and examining a random sample of the population being analysed. Since that is often impractical, researchers typically examine a random sample from the population. If sample data are not consistent with the statistical hypothesis, the hypothesis is rejected. Each hypothesis is tested and analysed individually, and the analysis is done with a system designed for statistical analyses (SPSS).

Hypothesis I

Ho1:   There is significant relationship between cost control and supply chain management.

From the Regression analysis the p value of cost control, is less than 0.05(0.027<0.05), Null hypothesis is fail to be rejected at 5% level of significance. Thus, Cost control has significant effect on supply chain management in Nepalese Sugarcane industry.

Hypothesis II

Ho2:   There is significant relationship between flexibility and supply chain management.

From the Regression analysis the p value of flexibility, is less than 0.05(0.001<0.05), Null hypothesis is fail to be rejected 5% level of significance. Thus, flexibility has significant effect on supply chain management in Nepalese Sugar supply chain.

Hypothesis III

Ho3:   There is significant relationship between delivery reliability and supply chain management.

From the Regression analysis the p value of delivery reliability, is less than 0.05(0.00<0.05), Null hypothesis is fail to be rejected at 5% level of significance. Thus, flexibility has significant effect on supply chain management in Nepalese Sugar supply chain.

The effective management of supply chains is critical for achieving competitive advantage in today's dynamic business environment. Three pivotal factors—cost control, flexibility, and delivery reliability—play a significant role in enhancing the performance and sustainability of supply chains. This discussion examines the interplay between these factors and their implications for supply chain management, particularly in the context of industries such as sugarproduction.

Cost Control: A Foundation for Financial Efficiency

Cost control is fundamental to ensuring financial efficiency within supply chains. Despite the straightforward nature of financial calculations, accurately determining financial results can be complex, particularly in rapidly changing business environments. The collection of precise and comprehensive cost information is essential for effective management, both at the organizational level and across inter-organizational networks. As highlighted by Carter and Ferrin (1995)[25], achieving cost savings within the supply chain can significantly enhance a company's competitive position. In the context of the sugarcane industry, where profit margins can be thin due to fluctuating market prices and operational costs, effective cost control measures are vital. Companies must develop robust analytical methods to monitor and manage costs throughout the supply chain, from raw material procurement to production and distribution. By leveraging technology and data analytics, organizations can identify inefficiencies and implement strategies to optimize resource allocation, ultimately leading to improved financial performance.Bialas (2014)[29] emphasized that accurate cost information is essential for effective management, both within individual companies and across the supply chain. In the context of

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Nepal's sugarcane industry, understanding cost dynamics can lead to improved supply chain management and enhanced competitiveness.

Flexibility: Adapting to Market Dynamics

Flexibility is increasingly recognized as a critical attribute of successful supply chains. It reflects the ability of a system to respond swiftly to changes in demand or supply conditions with minimal penalties in terms of time, cost, and performance. As Lee (2004)[26] notes, flexibility combines agility and adaptability, allowing firms to navigate the uncertainties inherent in supply chain operations.In the sugarcane sector, flexibility is particularly important due to the seasonal nature of production and the variability in market demand. High-speed and low-cost supply chains, while effective under stable conditions, may struggle to adapt to sudden shifts in consumer preferences or external disruptions, such as climate-related events. Therefore, building flexible supply chains that can respond effectively to these changes is essential for maintaining competitiveness. Companies that invest in flexible production processes and adaptive logistics systems can better manage uncertainties, thereby achieving a sustainable competitive advantage (Kopecka, 2003)[27]. Lee (1995)[26] noted that flexibility in supply chains allows for rapid responses to external disruptions and strategic shifts. In Nepal's sugarcane industry, fostering flexibility can enhance the overall effectiveness of supply chain management.

Delivery Reliability: Ensuring Customer Satisfaction

Delivery reliability is a crucial component of supply chain performance, as it directly impacts customer satisfaction and operational efficiency. Measured by perfect order fulfillment, delivery reliability reflects a supplier's ability to meet promised delivery times. As Alvarado (2001)[28] emphasizes, reliable delivery enhances productivity and reduces costs, making it a cornerstone of effective supply chain management. However, the pursuit of flexibility can sometimes conflict with the need for delivery reliability. In many cases, the reasons for unreliable deliveries stem from inadequate communication and information exchange between supply chain partners. For instance, delays in information sharing can lead to misalignment between production schedules and customer demand, resulting in missed delivery deadlines. To mitigate these issues, companies must foster strong collaboration between shippers and carriers, ensuring that all parties are aligned in their operational objectives and can respond swiftly to changing circumstances.According to Pourhejazy (2016)[30], reliability not only enhances customer satisfaction but also ensures that inventory is delivered on time. In the sugarcane industry, timely delivery is crucial for maintaining customer relationships and ensuring repeat business. The data collected from the respondents indicated a strong emphasis on delivery reliability, highlighting its significance in achieving a successful supply chain cycle. The supply chain of all agricultural products should enhanced through agriculture act as soon as possible by incorporating the recommendations from Mishra, A.K., Nepal, A.,&Aithal, P.S.,(2022): Chaudhary, K.K.,& Mishra, A.K.,(2021): Mishra,S.K., Shrestha, S., Jha, S.K. et al.,(2023): Mishra,S., ShresthaS.,Mishra,A.k., Jha, M., et al.,(2023) and Mishra,A.K.,(2024)[9,31,32,33&34].During informal discussions with NARC scientists, it was found that sugarcane production in Nepal could potentially be tripled by bridging the gap between current yields and achievable potential. This could be facilitated by providing targeted subsidies and promoting the formation of specialized farmer groups (Mishra,2024).

Targeted Subsidies for Farmers

Currently, government subsidies channeled through sugar mills are not directly reaching farmers during plantation or harvesting, when the need is highest. By providing these subsidies directly to farmers, productivity could be significantly increased. However, there are concerns that this approach may reduce farmers' motivation to work hard or lead to misuse through fake documentation.

Promoting Specialized Farmer Groups

An alternative approach is to develop specific farmer groups focused on specialized tasks such as seed production, equipment/machinery operation, and post-harvest management. These groups would receive subsidies in the form of custom hiring services, which could create opportunities for producing jaggery (unrefined sugar) as well. This would result in a more competitive market with greater options for consumers.

Jaggery is known for its health benefits compared to refined sugar, which may attract health-conscious consumers. By adopting these strategies of targeted subsidies and farmer specialization, Nepal can harness the full potential of its sugarcane production, benefiting both farmers and consumers.

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7. CONCLUSION :

This research study aimed to investigate the production processes and overall supply chain practices within Nepal's sugar industry. The sugar supply network involves various production processes and material flows, engaging multiple stakeholders to deliver a valuable product to consumers. Effective supply chain management (SCM) necessitates addressing issues that arise from social, environmental, and economic dimensions, as these factors are interconnected and have long-term implications for the industry.The primary objective of the study was to explore the relationships between independent and dependent variables within the context of sugar outlet supply chain management in Nepal. The SCM approach has been in practice for an extended period, resulting in significant growth and development in the sector. The rapid increase in the number of sugar outlets indicates a growing entrepreneurial spirit, with many individuals eager to establish their businesses. This trend highlights the need for effective competition strategies, where cost minimization emerges as a critical factor for success. Therefore, enhancing the effectiveness of SCM is essential for the growth and sustainability of the sugar industry in Nepal.The study identified several barriers faced by suppliers, including inadequate infrastructure, delayed price information, and other industry-specific challenges. Timely and accurate pricing information is crucial for effective decision-making within the supply chain. The findings suggest that improving access to basic infrastructure and maintaining healthy relationships among stakeholders throughout the supply chain can significantly enhance overall performance. The research highlights the critical role of delivery reliability, flexibility, and cost control in enhancing supply chain management within Nepal's sugarcane industry. The findings underscore the importance of prioritizing these factors to improve operational efficiency and customer satisfaction. As the sugarcane sector continues to evolve, implementing effective SCM practices will be essential for navigating the challenges posed by market dynamics and ensuring sustainable growth. Future research should explore additional factors influencing supply chain performance and investigate the long-term impacts of these practices on the industry. The agriculture act is most even for identifying farmers legally and managing subsidies for them to enhance productivity for achieving nation sugarcane production.

8. IMPLICATION :

The results of this study are significant for retailers, wholesalers, chain stores, and suppliers, as they provide insights into the evolving trends in sugar supply chain management. The findings will benefit those involved in sugar production and marketing in Nepal by identifying key nodes within the supply chain and effective distribution channels to reach targeted customers with the right products at the right time.It is crucial for importers in the sugar industry to understand and satisfy the needs of wholesalers, retailers, and chain stores, as these stakeholders directly influence consumer purchasing behavior. By addressing their requirements, the sugar industry can enhance sales and contribute to long-term growth. It will reduce sugarcane farmers pain by providing options as subsides will strengthen them.

9. ACKNOLEDGEMENT :

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