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Measuring Supply Chain Coordination in Milk and Dairy Industries: A Confirmatory Factor Model

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Abstract

Coordination within the supply chain is a strategic weapon to the problem that occurs due to lack of supply chain coordination. Since supply chain consists of various organizations, it can satisfy customers' needs, only when the whole of its partners becomes coordinated. To cope up and endure in a business environment where competition is high, firms should decrease the flow of interruption within upstream and downstream supply chain activities. This kind of endurance in such business environment can only be achieved by means of organized supply chain coordination. In this paper, we investigated empirically the major factors affecting supply chain coordination in milk and dairy industries. Based on an extensive literature review, the study created 15 measured variables and offered a comprehensive model to examine four key constructs. The data were collected from 330 milk suppliers, processors, and retailers in the central part of Ethiopia and the result were validated using rigorous statistical techniques. To approach this, an exploratory factor analysis (EFA) has been applied to classify factors for major constructs. And also, Structural Equation Modeling (SEM) was employed to assess the convergent validity through Confirmatory Factor Analysis (CFA) using AMOS version 4.

Keywords: Coordination; Supply chain management; Dairy industries; Structural equation modeling

Introduction

As it is clearly seen in the business environment nowadays, effective supply chain management seems to be considered as a crucial concern that has to be dealt with in global business context [1]. In the local activities of traditional business, those involving in supply chain have been doing such activities independently. But at present, it is not advised to perform business independently considering the ever growth of the competitive market [2]. Consequently, more developed and well-organized supply chain coordination is ideal for consistent success and profitability of any business. The more convincing reason for such claim is that the ever increasing competition that is constantly influenced by business globalization, product diversity and technological advancement motivated independent firms to work in unity in a supply chain that allows them to gain mutual benefits [3]. In today's business, competition is among integrated supply chains instead of individual organizations. Hence, a supply chain shall be well coordinated and that will play a huge role in making supply chain attainable to customer demands [4].

Coordination of different business activities among units become vital as organizations pay much attention to their core activities. Thus, their fruitfulness constantly relies on their capacity to coordinate their internal and external activities in the value chain outside their own boundaries [5]. The need for coordination is evident in supply chains, as companies forming a supply chain are dependent on the performance of other organizations. Supply chain coordination is achieved when a decision maker, acting rationally, makes decisions that are efficient for the supply chain as a whole [6].

Since a supply chain consists of various organizations, it can satisfy customers' needs, only when the whole of its partners become integrated and coordinated [1]. In this way, supply chain drivers ought to jointly create value and improve supply chain performance effectively and efficiently [7]. Even if the objectives and interests of different supply chain members are varied, the coordination among them becomes undeniably crucial to determine the supply chain performance as a whole [8].

In trying to elaborate the attributes of coordination, we can say that Coordination in a supply chain involves putting the existing interdependencies in order [9]. Supply chain coordination also involves cooperation between firms a sharing of important information with each other in the process of developing, producing and distributing goods and services to end marketplaces. Coordination can also be defined as structuring the efforts of a couple or more of supply chain drivers for the outcome of achieving effectiveness and be aware of each other's tasks while working independently to achieve their actual set of goals [8]. However, lack of coordination occurs in the supply chain, when each stage has incomplete information about the flow of products, information and, funds. Such causes will reduce the supply chain performance as a whole. Thus, supply chain coordination becomes vital to achieving the all level consensus, in which different members along a supply chain can respond to market requirements in proper ways [8,10]. With regard to Ethiopian dairy industries, the concept as well as the implementation of well coordinated and supervised product supply chain management is late developed. Although it applies to industry and agriculture lead economies, the need for institutionalized supply chain coordination is indispensable. Why, because the success of such initiative, among other things, depends on the level of supply chain coordination.

The objective of this study is to identify the major determinants of supply chain coordination in milk and dairy industry. It is argued that, to sustain in competitive business environment, firms must reduce the flow of interruption within upstream and downstream supply chain process. Here, the question is how to achieve the strategic fit in the supply chain, so that the tasks of each supply chain stage can be completed in a manner consistent with a mutual goal. The reason is that firms' supply chain profitability depends on how well all supply chain members work together. Thus, this paper aims at identifying

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mechanisms for milk and dairy industries to better coordinate their product, information, and financial flow to improve the match between upstream and downstream phases of their supply chains. The studies entirely focus on supply chain coordination among supplier, processors and retailers in milk and dairy industries. The paper is organized as follows: The next section reviews prior literature on the major determinants of supply chain coordination. A research frame work developed from the literature is presented in the succeeding section. Then, the research methodology used in conducting the study is described. After that, factor analysis and confirmatory model used in data analysis is presented. Finally, Concluding remarks are explained in the last section.

Quantity flexibility

Is one of the most widely discussed forms of non-price coordination. Quantity flexibilities allow the buyer to get a different quantity than the earlier estimate [11,12] and this can be provided in various ways, such as minimum purchase quantity agreement [13], backup agreements that allow a customer to purchase higher quantities than initial amounts they ordered [14]. Quantity flexibility also considered as a major form of supply chain agreement [15].

Some popular form of supply chain contracts in the literature includes *quantity discount* and flexibility [16,17]. Also suggested different form of coordination systems for instance price changes and quantity discounts [18]. In addition, *Flexibility, solidarity, mutual benefit, harmonization of conflict,* self-control in the use of power, a kind of reputation, and information sharing are some of the norms often discussed in the coordination Zenger [19-28]. These determinants play a key role in coordinating supply chains through team-based approaches.

It is true that there are various obstacles that hinder effective coordination in a supply chain. Behavioral obstacle, quantity discounts and price fluctuations: are among the major factors that can adversely affect supply chain coordination [10,29]. On the other way, coordination in each stage of the supply can be effective during cross-functional integration. Hence, Successful supply chain coordination requires cross-functional integration in various supply chain activities [30].

Information sharing: Coordination between different stages of supply is very important for success of the global business optimization, and it is only achieved if supply chain members share their information unambiguously. Previously, the value of information sharing within a supply chain has been extensively analyzed by different scholars. These studies have been used a simulation to assess the value of information sharing in the supply chain coordination [31-36].

Simatupang and Sridharan had conducted research on the knowledge of coordination for supply chain integration [37]. In their study, four different forms of coordination has been depicted namely: logistics synchronization, information sharing, incentive alignment, and collective learning. These coordination methods are imperative to help supply chain members and enhance sustainable supply chain profitability.

Sahin and Robinson identified centralized decision-making and decentralized decision making for better-utilizing supply chain coordination [38]. As opposed to centralized decision, decentralization decision-making is the best way for better supply chain coordination as well as for prompt customer order fulfillment. Coordination mechanisms can be also classified into price and non-price coordination. Price coordination includes quantity discount and non -price coordination incorporates quantity forcing, quantity flexibility, and service differentiation [14,15]. Haghighat suggested quantity discount as a method for coordinating the order quantity between a retailer and supplier. But the motivation for giving quantity discounts might be either based on price discrimination or order quantities. On the other way, the alliance also the way of supply chain coordination in which both buyers and sellers can be benefited by providing value to each others. According to Rice and Ronchi [39], if there is alliance in the supply chain, business partners can share some mutual interest, exchange value through buyer-seller activities, and also perform some coordination mechanisms.

Xu and Beamon had conducted research on Supply Chain Coordination and Cooperation Mechanisms. They suggested that Coordination within a supply chain is a strategic weapon to the problems that occurs from inter-organizational dependencies within the chain. Whang had also conducted research on taxonomy of coordination and he suggested cross-functional and inter-organizational team as different level of coordination mechanisms [40]. Collaboration is a recent trend in supply chain management that focuses on joint planning, coordination, and process integration between suppliers, customers and other partners in a supply chain [41]. Walter et al. observed that high performing collaboration relationship requires not only a focus on the direct value creating or buyer-supplier function but also an equal focus on the indirect relationship building and sustaining function [42]. The study conducted by [43] Christopher, also shows that companies are moving towards collaborative relationship in an attempt to make the supply chains more competitive (Figure 1). A research frame work of supply chain coordination

Methodology

Research design and scale development

The methodology of the paper is quantitative in nature. A survey research design was used to collect data for the scale development. Items were developed based on extensive literature review and consulting with supply chain professionals. The items were also measured by conducting a pilot test on some other milk industries and we have strongly discussed with supply chain practitioners and with those people who have engaged themselves in milk processing.

Study area and population

The survey would be conducted mainly on the supply of milk to the inhabitants of Addis Ababa from the nearby rural districts. The study concentrated on suppliers, local milk processing industries, and retailers. To this conclusion, for methodological reasons-hence in line with the objectives, the general population of this study includes all actors in the milk industry along the chain of market. Moreover, the target population of the study would be included milk producers, processors and retail markets at various stages along the supply chain.

Sampling and data collection

The sample was drawn from suppliers, processors and retailers in bishoftu, selale, and Addis Ababa cities, Ethiopia. The data collection instrument used was a questionnaire which was administered to the total sample size of 375 respondents. Of the 375 distributed items, 15 were returned due to an unwillingness of respondents. From the sample size of 360, 342 were received, resulting in a response rate of 95%. A total of 8 questionnaires was discarded because of incomplete data. Therefore, only 330 respondents were considered as valid and

the result represented an accurate response rate of 91.6%. Out of 330 respondents, the study included 225 (68%) milk suppliers, 75(23%) retailers and 30(9%) employees from 3 major milk processing plants (shola milk, mama and family dairy). A seven-point Likert scale with end points of "strongly disagree" and "strongly agree" was applied to measure the items. To approach this, purposive and stratified sampling technique has been employed.

Reliability analysis

The Cronbach's alpha was conducted to evaluate the reliability of each scale. Alpha values over 0.7 indicate that all scales can be regarded as reliable. As can be seen from Table 1, Cronbach's alpha value of coordination is 0.807 and the scale alpha values of the four factors were above the cutoff value, ranging from 0.963 to 0.979. These results imply that the theoretical constructs are good indicators of the model fit. Thus, we can state that the instrument is acceptable and used to measure 15 coordination variables.

Scale refinement

For each of the item scales, factor analysis was applied to reduce the total number of items in manageable factor. A principal component analysis is applied to extract factors with an eigenvalue greater than 1. Varimax rotation is employed to facilitate interpretation of the factor matrix. KMO (Kaiser-Meyer-Olkin) measure of sampling adequacy also examined to validate factor analysis. The KMO value was estimated around 0.819 which indicates sampling adequacy. The factor loading indicates four distinct constructs: non-price coordination (F1), relationship (F2), price coordination (F3), product development decision (F4) (Table 2).

Coordination Indicators	Theoretical background
harmonization of conflict	[19-24,26-28]
Alliance	[10]
quantity flexibility	[11-14,45]
behavioral obstacle	[10,29]
decentralized decision	[38,42]
Information sharing	[31-36,43]
Mutual benefit	[19-28]

Table 1: A brief description of reviewed papers on supply chain coordination indicators.

As we have seen in the above table, item-to-total correlation range 0.996 to 0.856 and the communality ranges above 0.5. The mean score value is 79.91 with 25.183 variance and 5.018 Std Deviation. And also, the total scale reliability alpha is 0.808, which is greater than 0.6 and confirmed reliability of the questionnaire (Table 3).

Non price coordination (F1): This factor covers five key coordination indicators (KCI). These are harmonization of conflict, alliance, behavioral obstacles, and quantity flexibility and decentralization decision. The factor loading ranges from 0.968 to 0.899 and the Cronbach's's alpha value is 0.978. Item- to- total correlation ranges from 0.873 to 0.975. Here, 92.472% of the division is explained and it covers 4.642 of the Eigenvalues.

Relationship (F2): The relationship factor covers four KCI. These are *information sharing, mutual benefit, incentives, collaboration relationship*, and *quantity discount*. The factor loading ranges from 0.948 to 0.903 and the Cronbach's's alpha value is 0.975. Item- to- total correlation ranges from 0.970 to 0.884. Here, 93.19% of the variance is explained and it covers 3.728 of the Eigenvalues.

Price coordination (F3): Three measured variables are identified in *price coordination* factor. These are quantity discount, organizational interdependencies, and price fluctuation. The factor loading ranges from 0.947 to 0.885 and the Cronbach's alpha value is 0.963. Item-to- total correlation ranges from 0.935 to 0.908. Here, 93.179% of the variance is explained and it covers 2.796 of the Eigen values.

Product development decision (F4): This factor covers three KCI. These are cross functional team, new product development, and trust. The factor loading ranges from 0.857 to 0.669 and the Cronbach's alpha value is 0.737. Corrected Item- to- total correlation ranges from 0.954 to 0.877. Here, 96.828% of the variance is explained and it covers 1.937 of the Eigen values.

			Corrected item-	Alpha if	communality	
Variables	Mean	S.Deviation	total correlation	item delated	Initial	Extracted
Harmonization of conflict	5.4	0.601	0.965	0.776	1	0.955
Quantity flexibility	5.41	0.624	0.996	0.777	1	0.945
Alliance	5.38	0.608	0.915	0.778	1	0.912
behavioral obstacle	5.41	0.623	0.975	0.776	1	0.949
Decentralized decision	5.37	0.681	0.873	0.782	1	0.828
Information sharing	5.28	0.69	0.97	0.789	1	0.97
Mutual benefit	5.26	0.709	0.938	0.791	1	0.933
Collaboration	5.24	0.724	0.884	0.795	1	0.87
Incentives	5.27	0.696	0.959	0.788	1	0.958
Quantity discount	5.25	0.503	0.947	0.807	1	0.955
Organizational interdependence	5.25	0.513	0.934	0.808	1	0.944
Price fluctuation	5.27	0.502	0.885	0.809	1	0.898
Cross functional team	5.37	0.762	0.937	0.818	1	0.969
New product development	5.39	0.749	0.937	0.816	1	0.968
trust	5.35	0.632	0.856	0.781	1	0.784

Scale Statistics :
Mean=79.91, Variance,25.183, Std. Deviation=5.018
No. of Variables =15, No. of cases =330,
Cronbach's alpha = 0.807

Table 2: Mean, SD, Corrected item-to-total correlation and Communality for key Coordination indicators.

		Factors			
No.	**Variables**	**Non price coordination (F1)**	**Relationship (F2)**	**Price coordination (F3)**	**Product development decision (F4)**
1	Harmonization conflict	0.968			
2	Behavioral obstacle	0.964			
3	Quantity flexibility	0.961			
4	Alliance	0.946			
5	Decentralized decision	0.899			
6	Information Sharing		0.948		
7	Mutual benefit		0.938		
8	Incentives		0.935		
9	Collaboration		0.903		
10	Quantity discount			0.935	
11	Organizational interdependence			0.924	
12	Price fluctuation			0.908	
13	Cross functional team				0.954
14	New product development				0.949
15	Trust				0.877
	Cronbach's alpha	**0.979**	**0.975**	**0.963**	**0.967**
	Egin value	4.642	3.728	2.796	1.937
	Percentage variance	92.472	93.19	93.179	96.828
	KMO (Kaiser-Meyer-Olkin) measure of sampling adequacy=0.819 Bartlett's Test of Sphericity (Chi-Square= 7829.503, Df=105, Sig = 0.00), mean=79.91				

Table 3: Factor analysis result for key co-ordination indicators.

Correlation between constructs and indicators								
Non price coordination	1							
Information and r/ship	0.504	1						
Price coordination	0.498	0.389	1					
Product development	-0.004	0.188	-0.08	1				
Summated 1	0.913	0.233	0.279	-0.018	1			
Summated 2	0.256	0.926	0.145	0.102	0	1		
Summated 3	0.251	0.228	0.922	-0.036	-0.009	0	1	
Summated 4	-0.004	0.118	-0.069	0.983	0	0	0	1

* Correlation is significant at the 0.01 level (2-tailed)

Table 4: Correlation.

The correlations between constructs and indicators (Table 4) show acceptable discriminant validity, as correlations between constructs (non-price coordination, relationship, price coordination and product development decision) and their defining indicators (summated1, 2, 3, and 4) are highly significant while correlations between indicators and the remaining constructs are low and insignificant.

Confirmatory factor analysis result

Confirmatory factor analysis is appropriate to analyze how well the measured variables/items clearly represent the latent construct [44]. In such instance, the confirmatory model loadings are illustrated with standardized and unstandardized results (Figures 1 and 2). This confirmatory model was estimated by maximum likelihood (ML) and the model fit results are discussed. The overall fit of the models was examined by various indices and the results for standardized and unstandardized model were x^2 =161.809, *Df*, 84, *P-value* =0.000

RMR (root mean square residual)

Lower RMR represent a better fit, but higher value indicates worse fits [44]. The RMR estimates for the present study was 0.008, meaning a reasonable fit.

RMSEA (root mean square error of approximation)

Is useful to adjust the complexity of models and to manage the tendency of the chi- square goodness of fit [44,45]. In this field, the RMSEA estimate is 0.047. GFI (goodness of fit index): the acceptable range of GFI value is between 0 to1 and the higher value indicates the better fit [45]. The GFI estimate for the current study is 0.943, which represent a good indicator of model fit.

NFI (normal fit index): ranges between 0 to 1 and a model approaching 1 represent the perfect fit [44]. In this study, the NFI value is 0.977, which is a significant and good indicator of model fit.

CFI (comparative fit index)

Is also widely used indices which help to compare the proposed model with baseline model and model values above 0.90 represents a good indicator of model fit [45]. In the present study, CFI value represents 0.989; this is another indicator of model fit (Figure 2).

Standardized confirmatory model

As indicated on the standardized confirmatory model (Figure 3), the four major constructs are non-price coordination, relationship, price coordination and product development decision. These factors are identified in the following section briefly;

Non price coordination: This construct consists of 5 (five) measured variables such as alliance (0.99), decentralized decision (0.98),

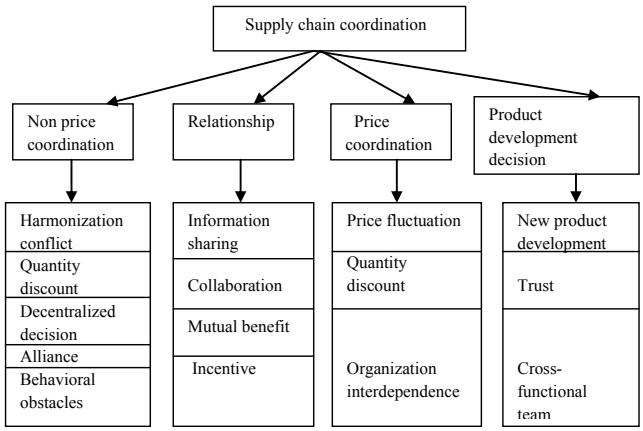

Figure 1: A research frame work of supply chain coordination.

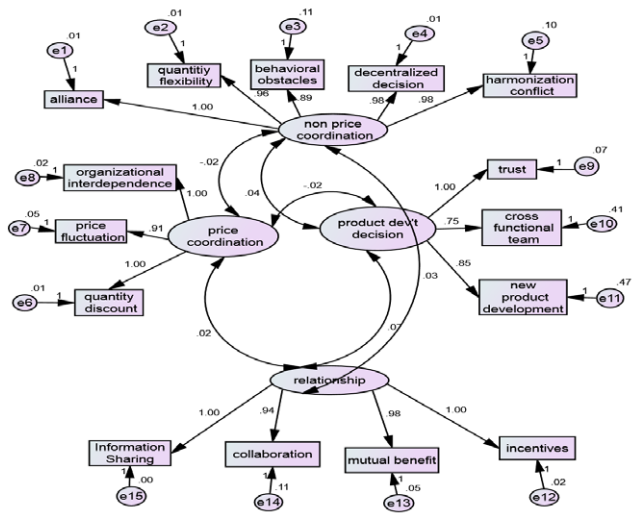

Figure 2: Confirmatory model: Unstandardized Result.

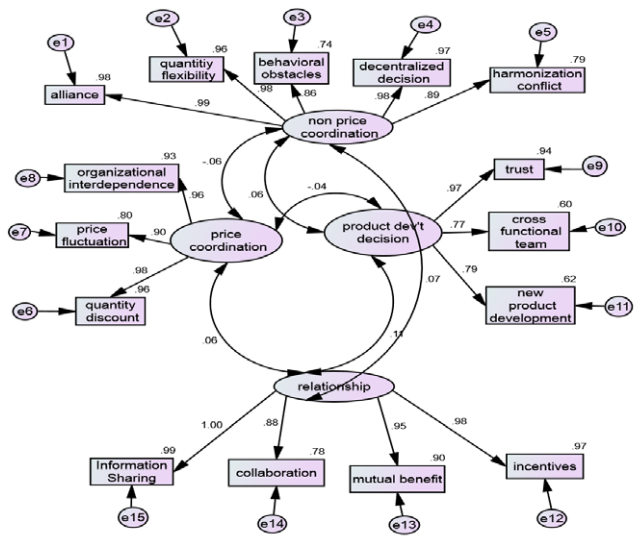

Figure 3: Confirmatory model: Standardized Result.

harmonization conflict (0.89), quantity flexibility (0.98) and behavioral obstacles (0.86). All the loading points were calculated within the range 0.86 to 0.99. This reveals that alliance, decentralized decision, and quantity flexibility play a key part for the betterment of supply chain coordination among firms 'procurement, production and distribution systems. These determinants also help to coordinate raw milk producers, processors, and retailers through team-based approaches. Hence, in supply chain coordination, suppliers and processors must have a smooth relationship with distributors/retailers that compete not only in monetary value, but also in non-price coordination manner.

Relationship: Here, the loading point of measured variables ranges from 0.88 to 1.00. In this case information sharing (1.00), incentives (0.98) and mutual benefit (0.95) are the major determinants of relationship coordination. The existence of collaboration (0.88) among producers, processors and retailers will also helpful for better supply chain coordination.

As we know that, nowadays, it is hard to do business independently in which there exist many competitors. Thus, well-organized supply chain coordination is more desirable for sustainable business profitable. In this regard, long term supply chain relationship is one of the keys to success.

Coordination: This section helps us to better understanding of financial flows within the supply chain stages through price coordination mechanism. As we have found out in the confirmatory model, the factor loading point of the quantity discount and organizational interdependencies were 0.98 and 0.96, respectively. On the other way, price fluctuation represents 0.90, meaning that all measured variables have a significant contribution to non-price coordination. In the case of milk and dairy supply chain, the volume of milk supply can be affected by seasonality of demand, shortages of supply and some other environmental elements. It is too true that price fluctuation and quantity discounts are among the major factors that can adversely affect supply chain coordination as a whole. Thus, firms' supply chain strategies should be supported by financial resource and this will create economic link and organizational interdependence between suppliers and local milk processing industries (Figure 3).

Product development decision

Here, 3 measured variables are explained under product development decision construct. As depicted in the model, the overall loading for each item range between 0.94 to 0.60 and the loading of trust was set on 0.94 and new product development as well as cross functional team explained about 0.62 and 0.60, respectively. New product development decision, trust and cross functional team activities need to be coordinated with supply chain management in a strategic level so that less competitiveness in the supply chain will be decrease (Table 5).

Concluding Remarks

In previous decades the main and crucial stages of the supply chain such as procurement, production and distribution seem to have been dominantly managed independently. But the accessibility of excess inventories, intense competition, and market globalization were forcing firms to enhance their supply chain capabilities that can promptly respond to consumer preferences [3]. To cope up and endure in a business environment where competition is high, firms should decrease the flow of interruption within upstream and downstream supply chain activities. This kind of endurance in such a business environment can only be achieved by means of organized supply chain coordination. Supply chain coordination practice attracts most firms, mainly those operating businesses independently. It is

		Fit indices for the Measurement Model	
Indices	**Unstandardized Result**	**Standardized Result**	**Recommended Values**
X^2	161.809	146.029	
Df	84	84	
X^2/df	1.92	1.73	<3.0
P- value	0.000	0.000	
RMR	0.008	0.008	<0.10
GFI	0.943	0.948	>0.90
AGFI	0.919	0.926	
NFI	0.977	0.978	
RFI	0.972	0.972	
IFI	0.989	0.990	
TLI	0.986	0.998	Values that approach to 1
CFI	0.989	0.990	>0.90
RMSEA	0.047	0.047	Between 0.03 and 0.08
AIC	233.809	218.029	< saturated and independence models
AIC saturated model	240	240	< saturated and independence models
AIC independent model	7139.849	6619.771	

Table 5: Model fit summary.

something that every firm needs for managing interdependent logistics activities in order to mitigate demand variability and unnecessary inventories. Giving consideration to these obvious reasons, this study was undertaken to identify the key determinants of coordination indicators in milk and dairy industries of Ethiopia. The study created 15 measured variables and offered a comprehensive model for examining supply chain coordination. Based on a scrutinized literature review, it conceptualized supply chain coordination as a major construct and 4 other latent constructs such as non-price coordination, relationship, price coordination, and product development decision. The instrument was tested using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), resulting good validity and scale reliability.

The first most important group of Key Coordination Indicators (KCI) categorized under *non-price coordination* metrics. This factor consists of 5 Key coordination variables. The other nodal point is the *relationship* construct. Supply chain relationships also play a pivotal role to create integration among each the supply chain stages. This relationship construct covered 4 Key coordination indicators, namely *Information Sharing*, collaboration, *mutual benefit, and incentive*. On the other way, we can see price coordination and this construct covered 3 key measured variables, namely *organizational interdependence, price fluctuation, and quantity discount*. Here, two measured variables relating to price coordination, such as, *sales promotion* and *price stability* were deleted from the final instrument due to unrealistic result. Therefore, price coordination construct did not include sales promotion and price stability variables. But further research shall be extended these variables by examining in a different perspective. In addition, the Product development decision presents the last nodal point for measuring SC coordination in dairy industries. *Trust, new product development*, and *cross-functional teams* were the major measured variables in product decision matrix. These outcomes can vitally be used in evaluating the major roles of milk processing industries and in identifying the gap in the problem area. This clearly indicates that the relative importance of each measured variable for improvement of supply chain coordination and it helps as imperative rules for sustainable supply chain profitability. The results can also be used as a strategic weapon to distinguish the main problem areas in which each and every change in betterment are required so that companies can easily implement their supply chain strategies in association with their business partners.

Competing Interests

The authors declared that they have no competing interests

Authors' Contributions

Habtamu. R, contributed to all data, modeling, and drafting the manuscript. Rajwinder. S also contributed to modeling and editing the manuscript. All authors have read and approved the final manuscript

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