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The antecedents of supply chain performance of apples in Uttarakhand: Scale Development

Aanchal Sharma Lamba[1], Ajay Sharma[2], Rajesh Kumar Upadhyay[3], Deepak Kholiya[4], Dr. Amit Kumar Uniyal[5]

[1,2,3]School of Management
[4]School of Agriculture
Graphic Era Hill University
Dehradun, Uttarakhand, India
[5]Graphic Era Deemed to be University, Dehraudn

ABSTRACT

Purpose: This study aims to develop and provide a reliable scale which can assess the supply chain performance of apples in Uttarakhand.

Research Design/Methodology: A detailed review of literature has been conducted by the authors to identify the critical factors that can have a significant and positive impact on the SCP of apples in Uttarakhand. After that, an instrument has been developed from a group of items. The instrument was then purified and refined by pre-testing, pilot-testing, reliability and validity tests. The questionnaire was distributed and filled to the respondents and by the respondents respectively (apple growers of Uttarakhand) by visiting them in person. Random sampling technique was used in this study. Out of total 450 responses collected; 409 responses were used for the process of analysis (exploratory factor analysis thriugh SPSS 23). To confirm unidimensionality, EFA was performed. Principal component method with Varimax rotation has been used to establish certain dimensions.

Outcomes: The outcome of this study reveals that the authors performed EFA on 35 items and observed that 27 items have factor loading above the threshold value of 0.5, so, they were considered significantly.

Research Limitations / Implications: This research study covered only one type of a fruit i.e. apple. Also, only Uttarakhand has been considered as a study area in this study.

Practical Implications: Empirical validation amongst the constructs of the study offers wide-ranging knowhow to experts, researchers and supply chain stakeholders. The researchers have been able to provide in-depth knowledge for decision making related to performance measurement system for apple SC.

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Originality/value: The current study will be able to justify the requirement apple supply chain in Uttarkhand by providing a validated and reliable instrument (questionniare) for the overall enhancement of the SCP of apples.

Keywords: Supply chain performance, Information & communication Technology, Post-harvest management, Intermediaries, Uttarakhand, Instrument development.

INTRODUCTION

Food sector is one of the significant contributors to the World economy, with rising populace and an ever-transforming way of life. Food supply chain incorporates a network of stakeholders whose prime objective is to have good quality food produce (Van der Vorst et al., 2009). Supply chain (SC) aims at value creation which further enhances the overall supply chain performance (SCP). Globalization has forced all types of supply chains to unleash their potential, cover fresh markets and make on-time delivery of good quality agriculture produce, it is important to be well informed about the factors that can affect the SCP in a significant and positive manner. Consequently, it has said that improving SCP has been even more tricky due to greater uncertainities, stiff competition, complex distribution system and globalization of markets (Rao & Goldsby, 2009). This type of complication may adversely affect the performance of a supply chain system. Identification of factors that may affect the SCP is challenging as there are a lot of constraints like shelf life, seasonal production, sensory properties, and quality assurance etc. In order to satisfy the needs of the end consumers, SCP needs to be improved at regular intervals. If identified appropriately, the stakeholders will get an idea as to where to focus more. Various exertions have been made to study several factors that affect the SCP of various products in different locations in different contexts, but no study has been conducted that study the factors affecting the SCP of fresh fruits like apples specifically in Uttarakhand. Therefore, a gap exists in terms of identification of factors and association of these factors with one another. This paper intends to include the factors that can have an impact on the SCP of apples in the region of Uttarakhand.

Literature Review

2.1 Supply Chain Performance

Supply Chain Council developed a model named Supply Chain Operations Reference. This model discussed the various types of factors that can be used by decision makers to develop a balanced approach towards SCP measurement. The indicators are reliability, cost, responsiveness and asset utilization. Beamon (1999a, b) suggested a 3 dimension system for performance measurement: resources (operations efficiency), output (customer gratification) and flexibility (responsiveness to changing environment).

Performance measurement of any SC is a herculean task as there exists a lot of constraints like shelf life, seasonality in production, sensory properties and temperature-controlled transportation. To the best of the author's knowhow, no integrated model exists in fruit supply chains that combine various factors to measure the performance especially after post-harvest stage. Van der Spiegel (2004) suggested that factors that define product and process quality aspects are required to included in PMS in the context of agriculture.

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The concept of SCP dates back to 90s therefore, in pursuit of SCP, there is a requirement to develop an integrated model that integrates various critical factors that impact the performance of SC operations. Previous studies which date back to 90s have demonstrated that agricultural SCs lack accurate critical performance factors for assessment, standardization and sound decision making. Beamon (1999a, b) determined that performance measurement systems of various supply chains are not up to the mark as they consider the use of costs as the only critical factor, which is still the case with most of the SCs. Aramyan et al, (2006) developed an integrated model for SC performance measurement specifically for agricultural SCs which included efficiency, flexibility, responsiveness and quality attributes as the critical factors. It has also been noted that the critical factors for measuring performance of agricultural supply chains are assessed in some links, while the same are not assessed in others (Aramyan et al, 2007).

Qualitative as well as quantitative measures that affect the agriculture supply chain performance has been studied and analyzed by various researchers. Bunte et al.(1998) suggested SC efficiency and SC effectiveness as the major benchmarks for measuring SCP of any commodity. Bowersox and Closs, (1996) suggested that SCP can be enhanced by information sharing, which could be done by adopting information & communication technology. Trienekens et al (2008) suggested that efficiency, responsiveness, quality and flexibility collectively have an essential part to play in the concept of SCP. Faranak et al, (2013), suggested quality, safety, flexibility, post -harvest management and intermediaries as some of the important indicators of supply chain performance. Higher the level of collaboration through ICT , lower the food loss (Sufiyan et al, 2019). A few performance indicators like storage, transportation, packaging which constitute post-harvest management, on-time delivery, information integration, reduced lead time have been presented for enhancing the supply chain performance (Neely et al, 1995). Many researchers focused on cost as one of factors that affect the supply chain performance, as it was easy to comprehend **(**Ballou et al, 2000; Ellram, 2002).

2.2 Information & communication technology

Basically, ICT is an extended term of IT. It implies to all the techs. which knobs telecom, intellectual factory/house supervision systems, broadcast systems including network-based monitory and control. Dependence on ICT can lead to faster communications, processing of data (Singh et al, 2020). ICT is deemed to be crucial to agriculture supply chain supposedly and as it has an ability to handle the flow of information across the SC (Sundaram et al., 2020). It has also been argued that users' considerations in terms of technology acceptance as well as their demographic attributes like age, experience, gender, and qualification appear to be imperative (Fakhoury and Aubert, 2017**;** Sarrayrih and Sriram, 2015). ICT is potent enough to assist agriculturists in proper utilization of resources (Fakhoury & Aubert, 2017). It has been studied that various problems related to adoption of ICT include lack of consciousness and ease of use at the level of users (Ishengoma et al, 2019). Also, the low level of application can be ascribed to how users realize the implication of ICT Tools (Olaolu et al,2018). Conversely, several findings indicate that ICT knowledge is a one of the critical factors for ausers to attain better performance in their corresponding disciplines (Rorissa and Demissie, 2010). However, it has been observed that ICT skillsets are not the only reason for the proper application of ICT Tools, other factors like ICT supply and ICT infrastructure aid also have a vital role to play (Ziemba et al, 2013). Fresh produce like fruits get easily spoiled with high

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temperature and moisture; thereby they need proper monitoring on a real-time basis (Schanes et al, 2018, Tingman et al, 2010). Fresh produce supply chains require on -time delivery, which is possible through the implementation of ICT Tools (Bosona & Gebresenbet**,** 2013). Therefore, adoption of ICT Tools has the capability to create a responsive and flexible SC (Han et al, 2017).

Mkwizu & Sichone (2019) conducted a qualitative study to test the moderation effect of technology between User's attributes and Information system success in Tanzania , the findings reveal that technology does act as a moderator between user's attributes and success of information system. Previous literature has also emphasized the importance of ICT in SCP. This indicates that there is a possibility that ICT could moderate the relationship between PHM and SCP. There is , however, no evidence based on our knowledge that ICT has a moderating role to play between PHM and SCP. Additionally, there is scanty research on ICT, PHM and SCP in the form of an integrated model. These arguments provide the basis for this research study to be done. A study was carried out in Kenya to examine whether ICT acts as a moderator between financial flow risks and performance among manufacturing firms or not, it was further found that ICT was a moderator between financial flow risks and firm performance (Thogori et al, 2017).

The significance of ICT with context to different industries has been well documented; however, scanty research has been conducted on the moderating role of ICT between post-harvest management and supply chain performance in agriculture context. Thus based on Technology Adoption Model, we propose that ICT can moderate between PHM and SCP.

2.3 Post-harvest management

Several researchers have studied and defined post-harvest management in detail. Negi & Anand, (2015) described post-harvest management (PHM) as a process which includes washing/cleaning, cooling, handling &, processing, packing, transportation of the fresh produce which is perishable in nature from one place to another. The basic role of post-harvest management is to delay the expiration of the produce as long as possible. In order to delay the expiration, horticultural managers need to be professional enough. The optimum PHM of the fresh produce is not similar for all types of fresh produce (Jobling, 2002). Gardas et al, (2018) identified packaging, storage, transportation as major factors for reducing damage after harvest and improving SCP using DEMATEL approach and found that an efficient and robust PHM system ensures on-time delivery of the harvested produce without comprising on their quality and safety. In postharvest, harvested fresh produce is basically an isolated system that is small scale. Studies relating to post -harvest management seeks to comprehend the quality of these small scale systems (Ramady et al, 2015). PHM may have a sweeping impact on SCP by maintaining the quality attributes and shelf life of the harvested produce (Arah et al, 2016). PHM operations of apples include cleaning, sorting& grading, packaging, storage & transportation. These operations remove elements that are detrimental and improve the appearance and quality of the produce at the same time assuring that the produce conforms well-established quality standards for the produce. PHM practices also include the management and control of factors like temperature and relative humidity, selection of packaging material (FAO, 2009). It has been observed that 20-30 % of fresh produce is damaged just post harvest which has substantial economic and social relevance (Dhatt and Mahanjan, 2007). To avoid post-harvest losses, the horticultural produce needs proper handling at every stage. Therefore, these

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operations are of vital relevance, therefore it is imperative to understand the appropriate post-harvest management practices.

2.3.1 Cleaning/Washing

For all the apple growers, proper hygiene must be the prerequisite as apples are not only prone to post-harvest diseases, thebut can also transmit food-borne illness to the end consumers. Unfortunately, in some parts of developing nations like India, cleaning or washing apples just after the process of harvestation is not a common procedure. This can be ascribed to either the portable water unavailability or sheer lack of knowledge of the procedure by apple growers. However, in places where water is not a constraint, practice of proper cleaning and use of disinfectants can help the apple growers maintain the quality of apples.

2.3.2 Sorting & Grading

Sorting & Grading of fruits like apples is believed to be significant as it can fetch remunerative prices to the apple growers. It further improves packaging, handling other post-harvest functions. Sorting & grading is generally separating the apples in various homogenous attributes like size, shape, color and quality. In most of the parts of developing nations like India, sorting and grading is done manually. This process is expensive and gets affected due to the unavailability of labors during the peak season (Mizushima et al, 2013).

2.3.3 Packaging

One of the major aspects to consider in post-harvest management activities of apples is packaging. Definition of packaging differs from being simple and functionally focused to more extensive. It can be defined as an extrinsic component of the product and a characteristic that is related to a product (Olson & Jacoby, 1972). Packaging is basically done to enclose the fresh produce like apples to safeguard them form mechanical damages and adulteration from different sources (Prasad & Kochhar, 2014). Crates made up of wooden material, boxes made up of cardboard and plastic, sacks are some common packaging materials used in India and not using appropriate and quality packaging material can lead to damage of the fruit (Idah et al, 2007). It has been noted that the undesirable compressive jerks and forces bring about internal injuries which affect the quality of the fruit. Poor quality packaging material that impedes ventilation and affects the overall SCP adversely (Olayemi et al, 2010). It could be seen from the associated extant literature that scholars have focused on defining the term packaging and the functions of packaging. Limited studies have been undertaken on relevance of packaging as a component of post-harvest management in the context of SCP enhancement of apples in Uttarakhand.

2.3.4 Storage

After harvesting, apples are transported to plainer regions for the purpose of storage. Various techniques and methods like refrigeration and controlled atmosphere are used to improve the shelf life of apples. It has been observed that farmers of Uttarakhand pay exorbitant prices for these kinds of facilities which add to the overall transaction cost (Sharma et al, 2015). A study revealed that19.3% respondents stated that adequate and proper storage facilities are one of the factors that can help improve the supply chain performance (Kasso & Bekele, 2016).

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In today's scenario, agricultural supply chains face issues related to storage . These issues further affect the supply chain activities adversely and lead to bad SCP. These supply chains need to perform well in order to survive in the market and compete with their rivals (Nadeem et al, 2018). Several researchers have investigated the role of storage/warehousing in different types of supply chains (Haseeb et al., 2019), nevertheless, the associated previous studies are not represented sufficiently w.r.t. storage/warehousing in the context of various SCs. Therefore, it becomes important to assess the effect of storage/warehousing on the supply chain performance of agricultural produce. Additionally, ICT has been taken as a moderating variable between PHM and SCP.

2.3.5 Transportation

The crucial and fundamental role of transportation is undeniable. Crum (2015) stated that the magnitude of transportation service will continue to have a significant role in supply chain management. Also, the quality of transportation service still continue to affect the level of customer satisfaction, order fulfillment time which constitutes SCP by and large. On-time delivery is one of the major aspects of enhanced SCP which determines how perfectly the delivery has been done (Gunasekaran et al , 2001).

Kasso & Bekele (2016) assessed the root causes of post-harvest losses (PHLs) and degradation of horticultural crops in terms of quality in Dire Dawa Administration, they observed that transportation is a major factor that can have an impact on SCP of horticultural crops. 19.3% respondents also stated that rudimentary transportation practices lead to quality deterioration which further adds negatively to the SCP.

2.4 Intermediaries

Intermediaries are basically individuals who buy produce from the producers and further sell them to those who want it (Kotler, 2015). It has been observed that intermediaries have a significant and positive relevance in SC of any kind of a commodity and that of fruits in particular. They have a remarkable impact on the farmer's and the trader's livelihood and form an integral component of food SC which adds values to raw produce, acts as a provision of market information related to transportation, storage, production and planning (Chopra et al, 2007). The presence of intermediaries may lower transaction costs pertaining to market related information as it can be obtained submissively during interactions or keenly from stakeholders who are familiar with each other. The impact of less as well more number of intermediaries is still a matter of debate. It has been noted in some previous studies that less number of intermediaries leads to better access to market related information as compared to more number of intermediaries in the network, thereby improving the overall performance (Burt, 2000). Several studies have been documented pertaining to SC of vegetables in Tanzania which strongly focused on SC analysis, linkage between SC stakeholders (Eaton et al, 2007). However, scanty research studies have been documented about the role and impact of intermediaries on horticulture supply chains (Mwagike, 2015).

Therefore, it can be implied that literature gap exists in terms of not including post-harvest management, intermediaries and information & communication technology as the critical factors that can have an impact on SCP of agriculture produce like apples.

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Research Methodology

The current study aims at developing and validating an instrument that measures the SCP of apples in Uttarakhand State of India. After an extensive review of associated literature and a systematic process, a holistic performance measurement model has been proposed. This model is in sync with the previous performance measurement model and operational definitions of SCP. There is a dire need to corroborate the proposed framework through the process of empirical analysis. Punniyamoorthy et al 2013 suggested an empirical verification method and this study basically adopts the same. Furthermore, the same method has already been used for the purpose of development of an instrument in case of different industries **(**Cao et al, 2010; Prakash et al, 2017). Firstly, with the help of extant literature, four constructs of the study have been studied thoroughly. Secondly, SCP is growing manifold, several instruments have been developed in various nations for various types of industries. A substantial pool of items have been created under the pre-mentioned four constructs with the help of literature. A tentative questionnaire has been developed further pre-tested and pilot tested for the process of refinement. The detail of the empirical verification method has been represented below in Figure 1.

3.1 Pre-testing

Pre testing addresses issues like outline, length, presentation, sequences and responses, quality of question statements and queries of respondents. This step helps in removing errors (Bryman, 2013). This study included academicians, industry experts (Horticultural experts) and actual respondents (Forza, 2002) for pre-testing. The authors approached 2 acadmecians, 2 horticultural experts who have their expertise in research methodology, and SC of fruits respectively. Numerous reviews, remarks and recommendations have been obtained and were taken into consideration.

3.2 Pilot - testing

Pilot testing was done and the same respondents (apple growers) were considered who will be a part of the main study. Pilot testing ensured that the instructions, questions and scale are clear and comprehensive (Pallant, 2011). This step highlighted the misinterpretations, flaws in the questionnaire (Neuman,2014). This comprised of a small portion of respondents from the substantial pool (Flynn et al, 1990). Therefore, data were gathered, reviewed, analyzed and considered very profoundly from 41 respondents.

3.3.Questionnaire

The questionnaire included two components: The first component was about descriptive info which included demographic details like age, gender, educational qualification and work experience in apple cultivation. The second part included questions pertaining to the constructs ICT, PHM, Intermediaries and SCP. The five-point Likert scale was used ; the details about the scale are below in table 1:

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Table 1 : Scaling of the questionnaire used.

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3.4 Sample selection and Data collection

Paper and online questionnaires were distributed among 450 respondents (apple growers) of Uttarakhand State of India. Each questionnaire was translated into Hindi (local language) before circulation and retranslated into English after fetching replies. For the process of translation, help of bilinguals was taken. Questionnaires were given to apple growers to mark their perception on SCP, information & communication technology, post-harvest management and intermediaries on a Five-point Likert Scale. All apple growers were assured of anonymity and confidentiality of the whole process.

Total 409 responses from apple growers were received, which were then screened and missing values and outliers. These responses were then finalized for the process of statistical analysis. More responses were fetched from male apple growers (97.31%) with an average age of 50 years, experience in apple cultivation of 6-10 years and a high school degree.

Data Analysis

4.1 Data screening

Data screening is the primary step of data analysis as it offers fundamental comprehension of the research study undertaken (Hair et al, 2014). It encompasses data cleaning, outliers, normality, linearity and homoscedasticity (Chen, 2012). The purpose of data screening is to confirm the precision of data being entered (Rasi et al, 2014). Pallant (2011**)** suggested the data screening method and the current study follows the same.

4.2 Linearity

Linearity basically tells the association amongst independent variables i.e. the degree to which the variation in one variable is related to the variation in other variables involved in the study (Hair et al, 2014). The correlation among independent variables was produced to interpret the direction and strength of the association (Abdullah et al, 2016).

4.3 Multicollinearity

Multicollinearity basically emphasizes the extent to which two or more independent variables are associated with one another (Saunders et al, 2016). Several issues like difficulty in interpretation may occur due to multicollinearity (Hayes, 2013; Cao et al, 2008). Tolerance and Variance inflation factor are the two values that have been calculated to find out the presence of multicollinearity. It has been revealed that tolerance values are greater than 0.1 and VIF are less than 5 which justifies no issue of multicollinearity in the dataset.

4.4.Instrument Reliability and Validity

4.4.1 Unidimensionality

Unidimensionality refers to a group of items that can be explained by only one parent construct. The concept of unidimensionality ensures that every item is essentially related to its respective parent construct (Chen & Paulraj, 2004**).** This can be ascertained by exploratory factor analysis (EFA) or confirmatory factor analysis (CFA) (Squire et al, 2009). Therefore, the authors carried out exploratory factor analysis to discover new constructs for the study.

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For the purpose of checking the sample adequacy, Kaiser -Myer-Olkin (KMO) test and Bartlett's test for sphericity were performed to determine the adequate sample size needed for factor analysis (Qrunfleh, 2010; Udbye, 2014). The KMO value below 0.5 is unacceptable whereas the KMO value above 0.90 is considered excellent (Leech et al, 2005Flynn The present study has KMO value 0.78 which is quite good.

To confirm unidimensionality, EFA was performed. Principal component method with Varimax rotation has been used to establish certain dimensions (Okuduba, 2016). The Varimax rotation method was an effective analytical attempt for orthogonal rotation of factors (Hair, 2014). The threshold value for factor loading needs to be more than 0.5. If an item does not load under a particular construct or is cross load, then that particular item was deleted (Hair, et al, 2014). The authors performed EFA on 35 items and observed that 27 items have factor loading above the threshold value of 0.5, so, they were considered significantly. Meanwhile, the rest 4 items had factor loading below 0.5 and the other 4 had cross loadings under more than one specific construct. Therefore, those 8 items were deleted.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.962
Bartlett's Test of Sphericity	Approx. Chi Square	9949.730
	df	351
	Sig.	.000

Table 2. Sample adequacy test through KMO and Bartlett's Test

4.4.2 Reliability

Reliability describes the internal consistency of an instrument. It determines the power of the instrument to measure the same thing every time. Several methods are there to measure the internal consistency of responses fetched from respondents, Coefficient alpha (Cronbach's alpha) is one of them and has been used in the study. This method shows how well the indicators are positively correlated with one another (Hair et al, 2014). The threshold value of Cronbach's alpha is 0.7 (Hair et al, 2014). The table below shows that all estimates are above the threshold score, therefore, the data used in the study is internally consistent.

Construct	Items	Factor Loading	Reliability and Validity
Information & communication technology	ICT provides platform for interaction among supply chain partners	0.851	Alpha=0.97 AVE= 0.81 CR= 0.97
	We use the up-to-date ICT Tools like personal computers, WhatsApp, telecommunication devices, GIS, GPS, Personal Digital Assistance, web portals	0.917	
	We face challenges in putting the	0.872	

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	Information communication & technology into practice		
	GIS have enabled us to map the natural environmental conditions with regards to agricultural production, correct usage of fertilizers and other agrochemicals	0.917	
	We receive training support from Government on how to use these modern ICT Tools	0.905	
	We have adequate technological infrastructure in terms of internet connectivity	0.931	
	ICT enables tracking and traceability of the entire supply chain so that information could be put to use for improving the cultivation practices	0.897	
	ICT enables us to process the orders fast which reduces the lead time	0.901	
	With the help of ICT, we can use the farm inputs	0.916	
Post-harvest management	We need to build a greater number of cold chain facilities in the hilly regions	0.872	Alpha= 0.93 AVE= 0.60 CR=0.93
	We have proper access to different modes of transportation for the movement of apples from one point to another	0.841	
	Inspecting the storage structure at regular intervals help us identify the infected, bruised, and rotten apples form the clear ones	0.736	
	We have round the clock availability of packaging material for apples	0.856	
	We adhere to packaging standards (like WHO, ISO and APEDA) for the packaging of apples	0.875	
	Our packaging of apples communicates the complete details of the fresh produce apples	0.839	
	We sort, and grade apples based on variety colour size and spoilage	0.744	
	Our packages of apples are easy to open and empty, fit in storage spaces and contains the appropriate amount	0.745	

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	Cost of refrigerated transportation in the hilly regions is very high as the price they get from wholesalers hardly covers the cost they incur in refrigerated transportation	0.866	
Intermediaries	Intermediaries buy the produce from us at a very reasonable price from us and later hoard the produce to create artificial scarcity	0.79	Alpha=0.81 AVE= 0.64 CR=0.84
	Intermediaries helps us in facilitating the transfer of fresh produce (apples) from farm gate to wholesalers and retailers	0.83	
	Disintermediation of intermediaries will lead to remunerative prices to the customers	0.80	
Supply chain performance	We fill the orders of our buyers on time	0.808	Alpha=0.89 AVE=0.62 CR=0.89
	We have an ability to respond to revised customer order	0.820	
	We use organic manure, chemical fertilizers, and toxicants to avoid pathogens	0.785	
	We adhere to WHO and ISO standards and treat them as mandatory practices	0.738	
	We reduce waste by converting into value-added products like jam, jelly, pickle, squash	0.729	
	We avail high profit margins due to the production of best quality apples	0.745	

Table 3: Reliability and validity

4.4.3 Descriptive and correlation analysis

Researchers carried out the descriptive analysis over the variables to compute the values of mean, correlation, and standard deviation. Table 2 represents the values of descriptive analysis of the study variables.

N=409	Mean (SD)	Correlation			
		ICT	PHM	INT	SCP
ICT	2.93 (1.86)	1			
PHM	2.02 (1.27)	0.039**	1		
INT	2.91 (1.59)	0.074**	0.272	1	
SCP	2.83 (1.53)	0.026**	0.385**	0.681**	1

Table 4: Correlation is significant at 0.01 level (2-tailed).

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4.4.4 Composite Reliability (Construct Reliability)

Composite reliability measures internal consistency in scale indicators, like Cronbach's alpha (Netemeyer, 2003). It measures the total reliability of a group of items loaded on a latent variable. The threshold value ranges between 0 and 1, more the threshold value, more the reliability. If the threshold limit is above 0.70, then it is considered very good. Internal consistency is denoted if the value of CR is below 0.60 (Hair et al, 2014).

4.4.5 Average Variance Extracted (AVE)

Average variance extracted is considered as a complimentary measure of construct validity (Krush, 2009). It is the grand mean value of the squared loadings of the items associated with parent (Hair et al, 2014). The value of AVE equal to or higher than 0.50 denotes that the parent construct describes more than half of the variance of its items. While the value of AVE less than 0.50 implies that more error remains in the items than the variance explained by the parent construct (Hair et al, 2014). It has been noted that the values of AVE are considerable as shown in (Table 1) which also validates various concepts like unidimensionality, internal consistency and reliability of the scale (Wang et al, 2014).

4.4.6 Convergent Validity

Convergent validity means that various items of a particular parent construct are alike. For convergent validity, the value of AVE should be 0.5 or greater (Hair et al, 2008). When various items relate with each other and behave similar, then the condition of convergent validity is satisfied (Neuman, 2014). If the correlation is high among the items in a parent construct, it shows that the scale is measuring what it intended to measure (Hair et al, 2014). Higher the values of factor loadings, higher the convergence for a latent construct. Standardized loadings are required to be atleast 0.5 and loadings higher than 0.7 are considered acceptable. Therefore, values in Table 1 show the results of convergent validity.

4.4.7 Discriminant Validity

The concept of discriminant validity is just the opposite of convergent validity. It is a kind of measurement validity for several items based on the idea that items of distinct constructs diverge (Neuman, 2014). No cross loadings of factors satisfy the condition for discriminant validity (Hair et al, 2014). It demonstrates that the items of one parent construct congregates/converges, and are negatively associated with contrasting constructs (Saunders et al, 2016). In order to support the concept of discriminant validity, all the constructs present in the study need to be different from one another in terms of correlation importantly (Hair et al, 2014). No cross loadings have been found in the rotated component matrix. Therefore, values in Table 1 satisfies the condition of discriminant validity.

Discussion

The one and only objective of this research paper study is to develop an instrument after a proper empirical validation of the constructs present in the study. A structured questionnaire has been developed from a group of items collected from the associated extant literature. Those collected items have been pre-tested and pilot-tested by the authors. Then, the final questionnaire was distributed to apple growers and then gathered data were empirically tested analyzed by performing

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EFA. It has been observed that 27 items were retained out of the initial 35 items for the current study. The outcomes of this study is in tandem with previous studies.

Implications

The current study delivers a holistic and comprehensive view to the experts and researchers about performance measurement model for apple SC. A systematic approach is required to be considered to identify and enhance the SCP of apples. Empirical validation amongst the constructs of the study offers wide-ranging knowhow to experts, researchers and supply chain stakeholders. The researchers have been able to provide in-depth knowledge for decision making related to performance measurement system for apple SC.

Conclusion

SCP is a vital thing for every industry. Poor performance not only dislocates operations but correspondingly disrupts the entire SC system . Therefore, it becomes domineering to develop a proper performance measurement system which would further enhance the supply chain performance. In this study, the researchers have developed a reliable instrument for developing a performance system model and recognizing the critical factors that can impact the SCP of apples. The process of development involves an exhaustive literature review that identifies the critical factors like post-harvest management, information & communication technology and intermediaries that can impact the performance of apple SC. A group of items have been created from studies conducted previously and the same has been pre-tested and pilot-tested. After this process, the structured questionnaire was constructed and distributed to apple growers. Responses from 450 apple growers were received after manual screening and data cleaning process. 409 responses were finalized for the analysis process. By using SPSS 23, the concept of unidimensionality, linearity, multicollinearity, reliability and validity have been evaluated. To conclude, as far as future scope of research is concerned, a few more variables can be added to the performance measurement model. The same proposed performance measurement model can be used in different location with different kind of fresh produce. Also, the researchers can assess and prioritize as in which variable to focus more in future.

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