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A Reflection On Impact Of Implementation Of Information & Communication Technology On Supply Chain Performance Of Apples In Uttarakhand: An Approach To Sustainability

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Abstract

The present study was conducted in Uttarakhand State of India to examine the impact of implementation Information & communication technology (ICT) on supply chain performance (SCP) of apples. A survey was conducted covering 450 respondents (apple growers) associated with apple supply chain in Uttarakhand. The study employed a cross-sectional research design. The researchers analyzed primary data by using descriptive analysis, exploratory factor analysis, correlation, and simple linear regression. Exploratory factor analysis was first employed to reduce the number of factors to be considered in the complete process of research analysis without losing the significance of the explanatory power of all the variables present in the study. Correlation and simple linear regression analysis was conducted to comprehend the relationship between a dependent variable (supply chain performance) and an independent variable (implementation of information & communication technology). The end results reveal that show that the implementation of ICT significantly affects the SCP of apples in Uttarakhand. In the end, the authors have also discussed the theoretical and practical implications of the study.

Keywords: Apples, Information & Communication Technology, ICT tools, Supply Chain Performance, Uttarakhand

Introduction

Supply chain performance (SCP) is a logical and orderly process that measures the efficiency and the effectiveness of the overall supply chain (SC) [1]. SCP is an aggregate of the performance of each firm/stakeholder/partner functioning in the supply chain system [2]. The whole supply

chain gets disrupted if there occurs a problem in any one of the firms/stakeholders/partners in the supply chain. SCP is an overall measure of performance that hangs on the performance of each supply chain stage [3].

Information & communication technology (ICT) has a pivotal role to play in achieving better supply chain performance. It comprises 3 main technologies namely computer technology, communication technology and information management. ICT is basically a stretched term of IT. Reliance on ICT can lead to fast communications, processing of data and market intelligence [4]. ICT is deemed to be essential to agriculture supply chain both theoretically and practically as it has a potential to handle the flow of real-time information through the supply chain [1]. Implementation of ICT in agricultural SC is considered as one of the prerequisites as it has the potential to provide updated information in terms of cultivation practices, credit facility availability, government schemes, seed selection, use of fertilizers, demand and supply trends, taste, and preference of the customer [5].

Government of Himachal Pradesh has offered financial aid in the form of subsidy to their apple growers under "Horticulture Technology Mission" on various elements like area expansion, training and development of apple growers, organic farming, promotion of agriculture machineries [6]. Accessibility to market information, soil management, harvest and post-harvest management are the positive consequences of ICT adoption and implementation which have already aided the apple growers of States like Himachal Pradesh (HP) and Jammu & Kashmir (J&K) to fetch lucrative prices. Northern States like HP and J&K have showcased market extension through the implementation of ICT tools at the right time. This target has been achieved on account of creation of high level of awareness via online portals and advertisements. Different studies have been done on the relevance of ICT in agriculture supply chains of HP and J&K specifically.

The current study evaluates the impact of ICT on SCP of apples in Uttarakhand, in particular. However, trivial study has been carried out on the impact of ICT on the SCP of apples in Uttarakhand. Therefore, this study has been conducted in Uttarakhand specifically as the State is a major producer of apples and has a great potential to develop its economy and provide employment opportunities to its population through ICT driven supply chain.

Literature Review

Performance measurement of agricultural supply chains is a herculean task as compared to other types of supply chains as there are many features like constraints in terms of shelf-life, seasonal production, sensory properties and temperature-controlled transportation. The idea of supply chain performance dates to 90s therefore, in pursuit of supply chain performance improvement, there is a requirement to develop a supply chain that is robust and efficient which could only be possible with the use of contemporary ICT tools [7]. Beamon (1999, b) determined that performance of a variety of supply chains are not up to the mark as they consider "cost" as the only critical factor and neglect other factors like ICT [8].

Consequently, ICT acts as a significant support system for agriculture extension. In this rapidly changing world, it has come up as an indispensable mechanism for delivering information and recommendations on resources required for promoting contemporary farming culture [9]. Previous literature has also emphasized the importance of ICT in SCP.

ICT improvement and advancement can be utilized to provide accurate, reliable, timely and relevant services to the growers/farmers therefore leading to more remunerative agribusiness [10]. It has been found that the farming community is inclined towards the application of ICT but there is a tremendous lack of ICT knowledge which refrains them from using ICT Tools frequently [11]. A study included interview of 192 farmers in Oyo State, Nigeria, the results revealed that no professional trainings have been given to marginal farmers which is why those farmers know old conventional tools like radio and television for the process of communication [12]. With ICT implementation and transparent communication systems, the famers of developed nations have been able to reduce their transaction costs to a greater extent [13]. As study examined the level of understanding and admittance adoption of ICT among cassava farmers based in Nigeria, the consequences show video recorder, an audio cassette, GSM, and computer remained as the vastly used ICT tools for the purpose of stem selection of cassava, selection and land preparation, planting time of cassava and marketing of cassava produce [14]. It has been observed that aquaculture farms are difficult to reach as they are scattered, hence, this leads to the application of contemporary ICT tools like Global information systems (GIS) , remote sensing technology and interactive voice response systems for thorough access to prevailing market information [15]. In the year 2016, a study was undertaken at Vasai and Naigaon by taking the viewpoint of 60 farmers regarding the benefits of ICT. They found that 91.80 per cent of them were using ICT for crop cultivation and maintenance of records and this improved their productivity and supply chain performance [16]. In the year 2010, descriptive and correlation were performed to study the level of information sharing, quality and SCP. They were found significantly correlated with one another [17]. A study included interpersonal in - depth interview and found that effective utilization of ICT has an ability to provide remunerative prices to apple growers and lead to enhanced SCP. A study was carried out using multiple regression analysis to identify which factor affects the SCP of fruits and vegetables [18]. The results indicate that the supply chains that were using ICT were more likely to obtain enhanced economic and SCP [19]. Various studies have pointed out that supply chains running with the implementation of ICT Tools got their competitive edge weathered and their matter of survival is only ICT [18]. Evidence of various empirical studies revealed that there exists a positive association between ICT implementation and SC productivity [20].

ICT has the potential to aid agriculturalists in utilizing resources optimally [21]. It has been found that most of the difficulties related to ICT implementation include lack of mindfulness and resistance to use technology at the level of farmers [22]. Additionally, the low level of application can be attributed to how users realize the application of ICT Tools [23] Conversely, several findings indicate that ICT expertise is a one of the critical factors for users to attain better performance in their subsequent disciplines [24]. However, it has been noted that ICT competence is not the only reason for the proper application of ICT Tools, other elements like

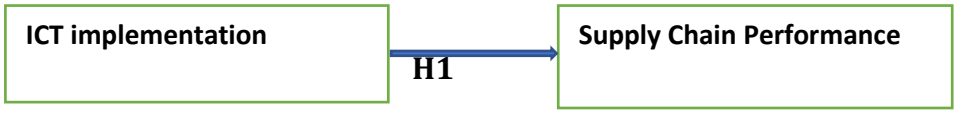
ICT supply and ICT infrastructure aid also have a crucial part to play [25]. Fresh produce like fruits get easily degraded with temperature; therefore, they need to be scrutinized and regulated on a real-time basis which can be done effectively with ICT implementation [26][27]. Supply chains of fresh produce require on -time delivery which is feasible through ICT [28]. Therefore, the ICT implementation is believed to prepare a SC capable of instant response and enhanced performance [29].

Materials and Methods

Conceptual Framework

The conceptual model of the study highlighting the relationship between the identified dependent (SCP) and independent variables (ICT Tools) has been represented in figure 2.

Figure.1 Conceptual Framework of the study.



The following hypothesis has been proposed by the researchers for the empirical analysis in this study.

Hypothesis 1: ICT Implementation impacts the SCP of apples in Uttarakhand significantly.

Sample Technique, Sampling Selection and Data Collection

To get a representative sample, random sampling technique was adopted to estimate the characteristics of the whole population (farmers growing apples). The total number of 450 respondents (apple growers of Uttarakhand) out of 450 responses, 409 responses were usable. The researchers collected the primary data with the help of the questionnaire using five-point Likert scale ranging from 1-5. Semi-structured interviews were also conducted to have an in-depth knowledge about the attitude of apple growers towards the implementation of ICT for the apple supply chain in Uttarakhand.

Demographics of the respondents

The present study includes respondents (apple growers) from Uttarakhand State of India. The authors gathered primary data with the help of a structured questionnaire. A comprehensive review of the extant literature was navigated to design structured questionnaire to cover all the items. The survey questionnaire consists of four sections viz.

1. Demographic details of the respondents
2. Information & communication technology

The demographic profile of respondents included gender, age, experience, and qualification. The questionnaire included closed-ended questions, where the respondents were required to fill the questionnaire. The dimension of the scale includes (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree and 5=Strongly agree).

Data Collection

A structured questionnaire that was self-administered was put in use to gather data for the process of analysis. The data was obtained from the respondents of Uttarakhand State of India.

Table 1: Demographic Profile (Frequency Analysis)

		Frequency	Percentage
Gender	Male	398	97.31
	Female	11	2.69
Age	18-25 years	80	19.5
	26-35 years	73	17.8
	36- 45 years	62	15.1
	46-55 years	62	15.1
	Above 55 years	132	32.2
Experience	1-5 years	15	3.6
	6-10 years	178	43.5
	11-15 years	97	23.7
	16-20 years	84	20.5
	Above 20 years	35	8.5
Education	Less than elementary	131	7.57
	High School	157	38.3
	Intermediate	45	11.0
	Graduation	49	11.9
	Post-Graduation and above	27	6.6

Source: Primary Data

To select the respondents, the researchers used a simple random sampling method. Further, the respondents were assured about the confidentiality of their responses. Out of 450, 409 responses were used in the analysis.

Descriptive Analysis

Descriptive analysis was carried over the variables to compute the values of mean, correlation, and standard deviation. Table 2 represents a descriptive analysis of the study variables. The standard deviation of variables lies between 1.53 to 1.86. The mean value of variables found between 2.83 to 2.93.

Table 2: Descriptive analysis

	Mean	**St. deviation**
Information & communication Technology	2.93	1.86
Supply chain performance	2.83	1.53

Source: Primary Data

Reliability Analysis

The reliability analysis for the factor demonstrates that the threshold limit for the alpha value ranges from 0.7 to 0.9. Reliability scores above 0.7 should be retained in the scale [30]. Therefore, the value of Cronbach Alpha was 0.975 for Implementation of ICT Tools and 0.898 for Supply chain performance.

Measure of Sampling Adequacy

Bartlett's test of sphericity and the Kiaser- Meyer-Olkin (KMO) test of adequacy of sample were originally performed on the data and confirmed appropriateness of conducting Principal Component Analysis (PCA) [31]. The value of KMO test for our set of predetermined variables reached the value 0.711.

Results

To estimate the values of mean, correlation, and standard deviation, descriptive analysis was carried over the variables. Exploratory factor analysis (EFA) was performed employing SPSS to obtain the items of ICT with values above 0.7. Using the principal component method, factor analysis of 12 ICT and 9 SCP items was conducted. 9 ICT items and 6 SCP items were extracted based on threshold value of factor loadings. The decisive factor for the number of factors to be extracted was that the eigen value of every factor had to be equal or greater than one. The obtained factors were further rotated by the varimax method. Therefore, included items for analysis have more than recommended value of 0.7 at least. The following table exhibits the results of EFA.

Table 3: Post-factor analysis results of factor loading

Constructs	Items	Statements	Cronbach alpha	Factor loading
ICT	ICT1	Platform for interaction among supply chain partners is being provided by ICT	0.975	0.714
	ICT2	ICT Tools like personal computers, WhatsApp, telecommunication devices, GIS, GPS, Personal Digital Assistance, web portals are being used by us to a greater extent		0.848

	ICT3	Various challenges are being faced in using ICT as a tool		0.799
	ICT4	GIS has enabled us to map the natural environmental conditions with regards to agricultural production, correct usage of fertilizers and other agrochemicals		0.722
	ICT5	Government provides us proper training on how to use these modern ICT Tools is		0.856
	ICT6	We have proper internet connectivity at our end all the time		0.848
	ICT7	Tracking and traceability of the entire supply chain takes place smoothly which results into advanced cultivation practices		0.807
	ICT8	ICT enables us to process the orders fast with reduces the lead time		0.851
	ICT9	We utilize farm resources optimally all because of ICT		0.813
SCP	SCP1	We fill the orders of our buyers on time	0.898	0.819
	SCP2	Instant response to revised customer orders is one of our strengths		0.817
	SCP3	Organic manure, chemical fertilizers, and toxicants are being used by us to avoid pathogens		0.817
	SCP4	Adherence to WHO and ISO standards is one of the guidelines		0.822
	SCP5	Waste is reduced by converting the residuals into value-added products		0.785

		like jam, jelly, pickle, squash		
	SCP6	High profit margins are being availed due to the production of the best quality apples		0.781

Source: Primary Data

Correlation

A correlation coefficient of zero represents there exists no linear relationship between two variables whereas a correlation coefficient of -1 or +1 indicates a perfect linear relationship. Here, the correlation value 0.722 reveals a moderate association between implementation of ICT and supply chain performance.

Table 4: Results of correlation analysis

N=409	Information &Communication Technology	Supply Chain Performance
Information &Communication Technology	1	.722**
Supply Chain Performance	.722**	1

Source: Primary Data; **Correlation is significant at the 0.01 level (2-tailed);

Hypothesis Testing

To investigate if ICT implementation has a significant impact on supply chain performance.

Hypothesis:

H1: ICT implementation significantly impacts SCP.

The hypothesis stated that ICT implementation impacts SCP of apples significantly and positively. Therefore, the hypothesis is accepted according to the results of the model summary in the below mentioned table 5.

Table 5: Summary of Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.722[a]	.521	.520	.86209

Source: Primary Data; a. Predictors: (Constant), ICT

In the above case, with the coefficient as 0.722, the mean response value for supply chain performance increases by 0.722 for every one unit change in the implementation of ICT. The value of r^2 for the association between ICT implementation and SCP is 0.520.

Discussion

This section discusses outcomes of the study based on primary and secondary research conducted. Secondary data discusses that ICT has a relevance in the overall improvement of any supply chain. Several States of India including Uttarakhand, face challenges as farmers lack in depth knowledge pertaining to the use of ICT in supply chains. However, some States are doing good in terms of ICT adoption which has helped the farmers to streamline their supply chain operations to a greater extent.

The current study has two relevant variables naming implementation of information & communication technology, and supply chain performance. The nested association between implementation of ICT and SCP is our prime objective. Amidst the association between implementation of ICT and SCP, ICT is an independent variable while SCP is a dependent variable. The study has tried to find the association between both.

Implications of the study

Theoretical Implications

Resource-based view theory (RBV) justifies the importance of new resources in ICT, knowledge, and relationships [32]. From the viewpoint of SCM, performance can be improved by implementing ICT optimally. For the attainment of enhanced performance by RBV, the resources are required to valuable, rare, have high imitation cost [33]. The above nuance has been studied in several sectors and different situations. The results shows that implementation of ICT has a significant and positive association with SCP. The result could be used as a basis for other future investigations.

Practical Implications

Largely, it can be stated that it is necessary to focus on the factors affecting the SCP of apples. The exhibit study uncovers that implementation of ICT has a significant role to play in the overall supply chain performance. Potential cultivators of apples must include the implementation of ICT in the post-harvest practices to improve SCP. Further, training aids must be given to them to increase the awareness amongst them. The study statistically inferred that ICT has a significant association with SCP. Hence, measures must be adopted by agriculturalists to enhance the SCP.

Limitations and Future Scope of Research

The current investigation has boundaries and further extent of developments. The results of our study are confined to analysis of the relationship between two variables (Implementation of ICT and SCP) in the SC of apples in Uttarakhand only, more in depth examination in this sector, as well as other sectors, is needed to mark the results globally acceptable. Likewise, the nature of the collected data was cross-sectional in nature, hence, have some constraints like common method bias (CMB), causal relation. Though this study requires longitudinal study to result into causal link between the variables. Furthermore, the size of the sample, sampling method and empirical tools may affect the results. Consequently, forthcoming studies must cross-check the outcomes. The study was undertaken by using the above stated variables, forthcoming studies may be carried out by adding up other variables. Moreover, primary data has been gathered by using with the self-reported questionnaire which might have a probability of Common Method Bias.

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