A

Dissertation Report

On

Investigation of Supply Chain Quality Issues in Agri-fresh Produce Supply Chain

Dissertation submitted in fulfillment of the requirements for the Degree of

MASTER OF TECHNOLOGY

by

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CERTIFICATE

This is to certify that the dissertation entitled **"Investigation of Supply Chain Quality issues in Agri-fresh produce Supply Chain"** being submitted by **Suresh Sharma (2013PIE5086)** is a bonafide work carried out by him under my supervision and guidance, and hence approved for submission to the **Department of Mechanical Engineering, Malaviya National Institute of Technology Jaipur** in partial fulfillment of the requirements for the award of the degree of **Master of Technology (M.Tech.) in Industrial Engineering**. The matter embodied in this dissertation report has not been submitted anywhere else for award of any other degree or diploma.

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Dated: June 2015

CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in this dissertation entitled **"Investigation of Supply Chain Quality issues in Agri-fresh produce Supply Chain"** in partial fulfillment of the requirements for the award of the degree of **Master of Technology (M.Tech.)** in **Industrial Engineering**, and submitted to the **Department of Mechanical Engineering, Malaviya National Institute of Technology Jaipur** is an authentic record of my own work carried out by me during a period of one year from July 2014 to June 2015 under the guidance and supervision of **Dr. Gunjan Soni** of the Department of Mechanical Engineering, Malaviya National Institute of Technology Jaipur.

The matter presented in this dissertation embodies the results of my own work and has not been submitted anywhere else for award of any other degree or diploma.

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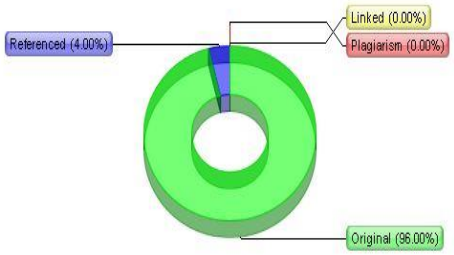

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- Suresh Sharma

ABSTRACT

Food supply chain (FSC) that is agri-fresh supply chain in today's global market is facing a particular problem concerning timely accurate order commitment. The problem is mostly attributed to the lack of coordinated decision-making of order quantities. Moreover, owing to the limited shelf life of agri-fresh products, these decisions are further complicated due to the additional problem of perishability of products. Short shelf life products pose unique challenges for individual members of the chain due to certain demand and short selling period. The supply chain management is almost 30 years older. But there is not a single study carried out by researcher which prescribes the standard quality constructs (issues/constructs) for agri-fresh supply chain. This conclusion is arrived on the basis of review of 115 research papers from 36 journals. From these articles total 60 constructs are extracted in which most of the constructs are without repetition. This exhibits that there is no standard dominant constructs for agri-fresh supply chain. Thus, in order to establish standard constructs and factors of agri-fresh supply chain quality, an empirical investigation is carried out in Indian Agri-fresh food supply chain. A survey questionnaire was used for collection of the responses from the different entities of supply chain. Questionnaire is made on the basis of the constructs extracted from the literature review. The variables used in survey were subjected to principal component analysis to find out factors (principal components) of Agri-fresh supply chain quality (AFSCQ). As a result of PCA, agri-fresh supply chain quality found to be having 7 factors for farmer, 8 factors for wholesaler, 8 factors for retailer and 5 factors for customer. Then this study is followed with reliability analysis for evaluation of reliability of factors. Then quality factors of agri-fresh supply chain quality going through examine the construct convergent validity. The seven factors obtained after PCA having 26 constructs for supplier/farmer, 30 for wholesaler, 29 for retailer, and 14 for customer. The final Croncach's alpha values for these seven factors ranged from 0.71 to 0.97 for all elements, which is considered to be good indicator of reliability scale. The examination of convergent validity and discriminant validity forms agri-fresh supply chain quality. This supply chain quality is developed using the SPSS 18.0 and AMOS 18.0 platform.

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ABBREVIATIONS

SCM = Supply Chain Management

CLM = Council for Logistics Managements

AFSC = Agri-fresh food supply chain management

AFSCQ = Agri-fresh food supply chain quality

PCA = Principal component analysis

QM = Quality Management

RFID = Radio frequency identification

SEM = Structural equation modeling

HACCP = Hazard Analysis and critical control points

QC = Quality Control

EFA =Exploratory factor analysis

CFA =Confirmatory factor analysis

ML =Maximum likelihood

GFI = goodness of fit index

AGFI =adjusted goodness of fit index

RMSEA =root mean square error of approximation

CFI =confirmatory fit index

RMSR =root mean square residual

CHAPTER 1: INTRODUCTION AND BACKGROUND

We have entered a new era in understanding the dynamics of competitive advantage and the role played by procurement. We no longer talk about suppliers and customers as though they are managed in isolation, each treated as an independent entity (Spekman et.al., 1994). More and more, we are witnessing a transformation in which suppliers and customers are inextricably linked throughout the entire sequence of events that bring raw material from its source of supply, through different value adding activities to the ultimate customer. Success is no longer measured by a single transaction; competition is, in many instances, evaluated as a network of co-operating companies competing with other firms along the entire supply chain (Spekman et.al., 1994, Spekman et al. 1998).

1.1 Supply Chain Management

The concept of SCM suggests that success of industrial business is dependent on the "interactions between flows of information, materials, manpower and capital equipment". But the term "supply chain" did not become popular until early 1980s.

Supply chain management (SCM) may be defined as:

A set of approaches utilized to efficiently integrate entities of chain including warehouses, and stores, so that product is produced and distributed at the right quantities, to the right locations, and in minimum time, in order to minimize system-wide costs while satisfying service level requirements (Simchi-Levi et al., 2008).

Over the years, the definitions have changed and broadened the scope of SCM, but, these definitions are still limited to manufactured products and services with little attention being paid to agri-fresh foods. For many products, a decision about supply chain strategy involves a choice between responsiveness and efficiency. The appropriate choice depends on how the product changes in value over the time interval between production and delivery to the customer. For any organization a supply chain consists of all stages involved tangibly or intangibly to fulfill the customer request (Harland, C.M., et. al. 2006). The supply chain includes not only manufacturers and suppliers but also the transporters, warehouses, retailers & even customers themselves. Within each organization such as manufacturer the supply chain includes all functions involved in receiving & filling customer request (Harland, C.M., et. al. 2006, Huang, S.H., et. al. 2002).

1.2 What is Agri-fresh produce?

Agri-fresh produce are products which are in perishable in nature. Agri-fresh produce use as end product for customer also use as raw material for for other products in industries so agri-produce constitutes a major part of the world economy. The research seems independent and oriented towards problem solving rather theory developing.

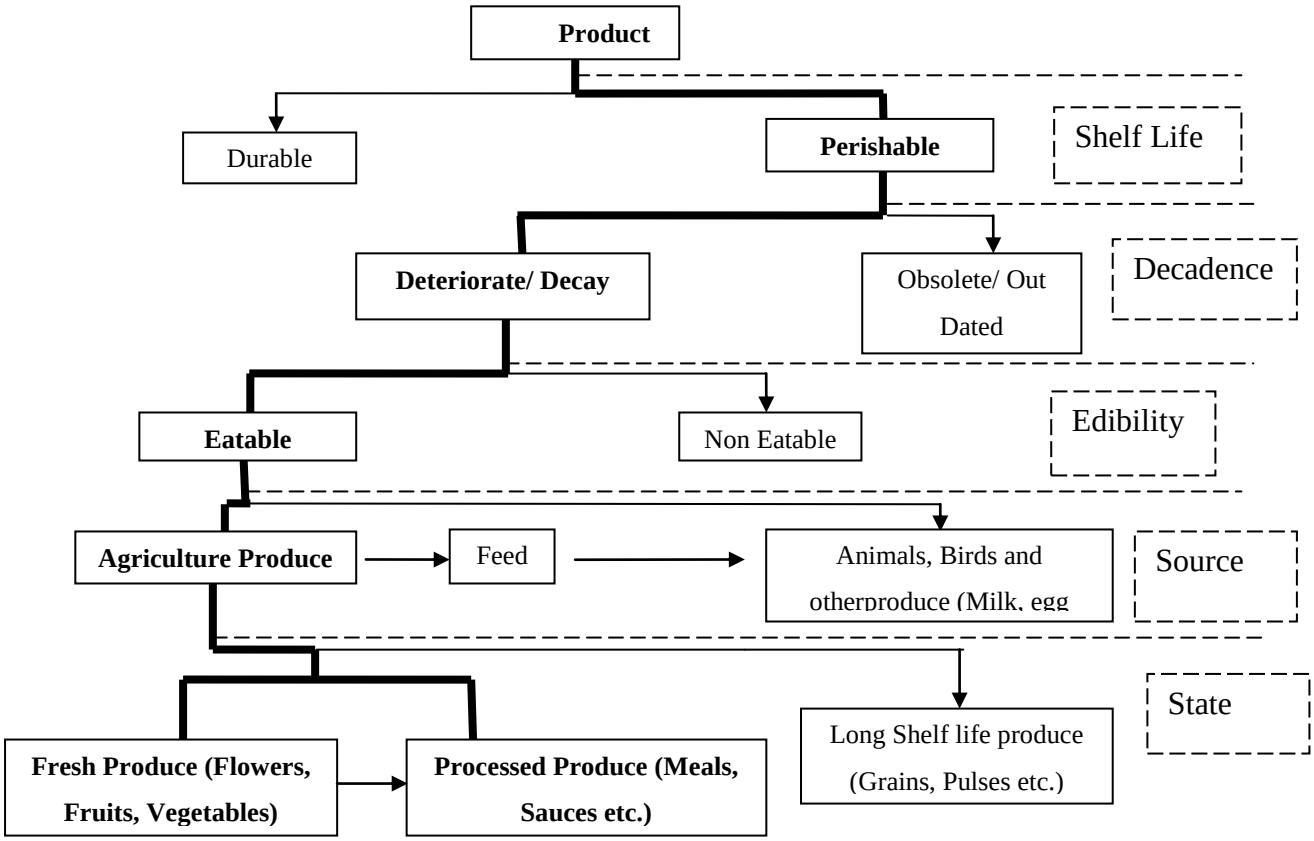

Figure 1: Agri-fresh Produce (Source: Manish shukla 2012)

Here define these as agri-fresh produce to clearly differentiate these from other agri-produce and non-agri produce. Figure 1 shows a detailed differentiation of various products to enhance the understanding of agri-fresh produce.

1.3 Agri-fresh produce supply chain

The term agri-fresh produce supply chains have been coined to describe the activities from production to distribution that bring agricultural products from the farmer to the customer (Aramyan et al., 2007).

An Agri-fresh produce supply chain is a network of food-related business enterprises through which food products move from production through consumption, including pre-production and post-consumption activities. Typical links in the supply chain are shown in Figure 2.

Agri-fresh supply chain is formed by the organizations responsible for production (farmers), distribution, processing, and marketing of agricultural products. The supply chain of agri-fresh, as any other supply chain, is a network of organizations working together in different processes and activities in order to bring products and services to the market, with the purpose of satisfying customers' demands. Agri-fresh supply chain management constitutes the processes from production to delivery of the agri-fresh produce, i.e. from the farmer to the customer. Farmers form the basis of the fresh produce supply chain and are usually organized in agricultural cooperatives. The role of the wholesaler in the fresh produce supply chain largely depends on the value added activities and services the cooperative offers to its members. When a cooperative offers to farmers-members integrated value added services such as

produce quality control, sorting, packing, and warehousing, the wholesaler can be bypassed and the retailer-customer can be approached through a third-party logistics provider that will ensure the arrival of produce to retailer's facilities in the correct time, quantity, price, and in the required quality.

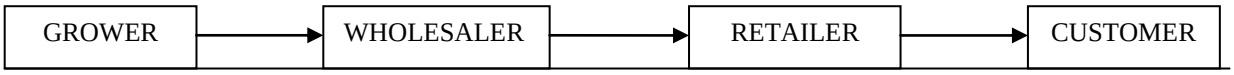

Figure 2: Agri-Fresh produce Supply Chain (Source: Aramyan H. L. (2007))

Agri-fresh supply chain is more complex than other supply chains. Agri-fresh supply chain is complex due to many issues i.e. perishable in nature, high fluctuations in demand and prices, increasing consumer concerns for food safety and so on. In agriculture produce, quality of supply chain is crucial which affect whole supply chain from producer to customer. There are many issues which are should be identified and rectified for improving quality of end product. As all know customer need fulfillment is aim of every supply chain with good quality and safety of product. The agri-fresh supply chain in India is very complex with numerous small stakeholders like farmer, wholesaler, retailer etc. They are not connected with proper information network. Each partner works in isolation. Indian products have low yields, which together with inadequate preservation increase the end product costs considerably with lack of suitable processing-grade varieties. There are number of inhibitors which not only affect the efficiency of supply chain but also influence one another significantly. It is therefore, important to understand their mutual relationship so that those inhibitors that are at the root of some more driving barriers and those which are most influenced by the others can be identified (Shukla and Jharkharia 2012).

1.4 Objective of research

- Identification of supply chain quality constructs;
- Development of a survey instrument;
- Principal component analysis (PCA) of constructs to find out underlying main factors of AFSCQ;
- Evaluating the reliability of established principal components or factors of AFSCQ
- Evaluating the validity of established principal components or factors of AFSCQ

1.5 Thesis Outline

The thesis has been broadly divided into six chapters. A brief outline of the remaining chapters is given as:

Chapter 2 is devoted to the understanding of supply chain and supply chain quality issues/constructs also called constructs. This chapter reviews the relevant literature on agri-fresh supply chain and issues/constructs.

Chapter 3 details out the methods used for supply chain quality construct. This chapter reviews the available research methodology use by researchers to addresses the supply chain quality constructs with different tools and methods.

Chapter 4 consists of survey design including method of doing survey with detail of parameters of survey design.

Chapter 5 is devoted to the analysis of the above survey and gets results with SPSS and check reliability of variables with cronbach's alfa and validity from CFA.

Chapter 6 concludes with summary of major research contributions. The implications for academia and practitioners as well as limitations of the study along with the scope for the future are also discussed.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

As the importance of Supply Chain Management is increased day by day in agri-fresh products so the attention towards the quality in supply chain it is also important. As the researchers are giving more attention towards agri-fresh supply chain still there is an absence of a journal with prime attention towards Quality Parameters of agri-fresh supply Chain. The key finding of this review is that investigation of different quality issues/constructs from the different case study carried by the researcher & findings the solution to make agri-fresh supply chain smoother than traditional Supply Chain. Lack of demand forecasting, demand and supply mismatch, lesser information sharing, etc. are the major causes of concerns.

The former authors are considering one or two issue of quality of supply chain for their case studies (Traceability, Information Sharing, Taste, etc.), may also consider more than one issue while carried out case study. Result shows the different issues in the agri-fresh produce which may further used for survey in different agri food industries and validate the issues. Most of the prior literature reviews are focused on a specific issue such as traceability, information sharing and ignore the broader perspective. This review fills this gap in the agri-fresh supply Chain literature. Meredith (1993) defined a literature review as a summary of the literature by focusing on issues and trends. Fink (1998) further modified the definition and defines a literature review as a "systematic, explicit, and reproducible design for identifying, evaluating, and interpreting the existing body of recorded documents". This definition has given emphasis to the review process as well as the desired results. Brewerton and Millward (2001) define a literature review as content analysis, where qualitative and quantitative techniques are used to find the structural and content criteria. Harland et al. (2006) argued that a literature review identifies the conceptual content of the domain and may even contribute to theory development. The critical analysis of the research papers reveals several un-noticed trends in the literature. But, the challenge is in analyzing the whole literature which keeps increasing with the development of the domain. Therefore, we have to put some delimiting criteria to make it possible to provide comprehensive reviews within the defined boundary (Shukla and Jharkharia (2012)).

The purpose of a literature review in this study is to find the issues/constructs from Literature from the different researchers. Agri-fresh produce supply chain includes the processes from the production to consumption of agri-fresh Products (Fruits, Vegetables, etc.). Literature review is done by systematically collecting the existing literature over a period of 20 years (1995-2014) and classifying it on the basis of structural attributes such as problem definition, Tools used, Quality Issues/constructs. The literature is also categorized according to the year of publication.

2.2 Methodology for critical review of literature

This section of chapter elaborates the methodology adopted for the purpose of providing a comprehensive and critical literature review of empirical research content in AFSCQ. The issues/constructs of time horizon of review, journal selection, article selection, article classification and analysis of articles will be discussed under literature review methodology. Methodology of literature is as follows.

- Time horizon for papers selection: The assessment period of articles is between 1994 and 2013 a 20 year time horizon.
- Selection of publications: The articles were collected from four major management science publishers' viz. Science Direct, Taylor and Francis, Emerald Online and Wiley Interscience as majority of well referred journals of industrial management are found in these databases.
- Journal selection: Exact phrase 'supply chain quality' was searched in articles titles of four databases and papers which addressing the agri-fresh produce and agri-fresh supply chain quality issues/constructs were considered.
- Empirical research article selection: selection of articles also based on methodology use in papers for research viz. Survey, case study, multiple case study, focus group etc.

2.3 Research segmentation and overview

The research papers that finally qualified the delimitation criteria were analyzed for the research outlets.

Table 1: List of journals reviewed and papers published by journal for the period 1994-2013

Name of Journals	No of papers published
Supply Chain Management: An International Journal	18
International Journal of Physical Distribution & Logistics Management	9
The International Journal of Logistics Management	6
International Journal of Retail & Distribution Management	5
International Journal of Production Economics	3
Journal of Manufacturing Technology Management	2
European Journal of Operational Research	3
Benchmarking: An International Journal	2
International Journal of Productivity & Performance Management	2
Sensors and Actuators	2
Journal of Small Business & Enterprise Development	2
Industrial Management and data system	1
Journal of Enterprise Information Management	1
International Journal of Quality & Reliability Management	1
Journal of Business & Industrial Marketing	1
Journal of Consumer Marketing	1
Competitiveness Review: An International Business Journal	1
Measuring Business Excellence	1
Logistic Information Management	1

Facilities	1
British Food Journal	31
Food Control	4
Journal of Food Engineering	3
Computers and Electronics in Agriculture	2
Bio system Engineering	2
Proceeding: Food Science	1
Food Policy	1
Agricultural Science in China	1
Journal of Rural Studies	1
Landscape and Urban Planning	1
China Agricultural Economic Review	2
Land Use Policy	1
Applied Mathematical Modeling	1
Chinese Management Studies	1
Ecological Economics	1
Omega	1

This exercise was performed to evaluate the effort of researchers and practitioners from various disciplines to shape the current status of agri-fresh supply chain literature.

Table 1 presents the list of the journals that published the research addressing the quality issues/constructs for agri-fresh supply chain in world.

Figure 3 shows the trend of agri-fresh food supply chain literature across the last 20 years. It presents the annual publication frequency of the total papers combining all the issues/constructs addressed. It is evident from Figure 3, that lately there is an increasing interest in addressing the issues in agri-fresh supply chain. As the graph is not linearly increasing over the years so this growth may not be fully credited to the increase in number of total publications every year. Moreover, the sudden increase in the number of papers from the year 2005 can be because of the global factors impacts on the total research in this field. More and more researchers are attracted towards this topic to do research and to find the quality issues in the agri-fresh supply chain. There is a factor such as the wastage of the agriculture foods due to logistic problems, temperature problems, product quality problems which comes in front of researcher and due to that research were increases after 2005.

Therefore, the increase in the number of research papers seems to be a reflection due to these critical factors. These factors did not seem significant in the period 1994-2004 as the maximum number of papers published in any given year is six which is quite less. It is interesting to note that though agri-fresh supply chain waste was always a major concern but only recently gained the attention of researchers. With the increasing population there is a high possibility that this issue will get more attention in future.

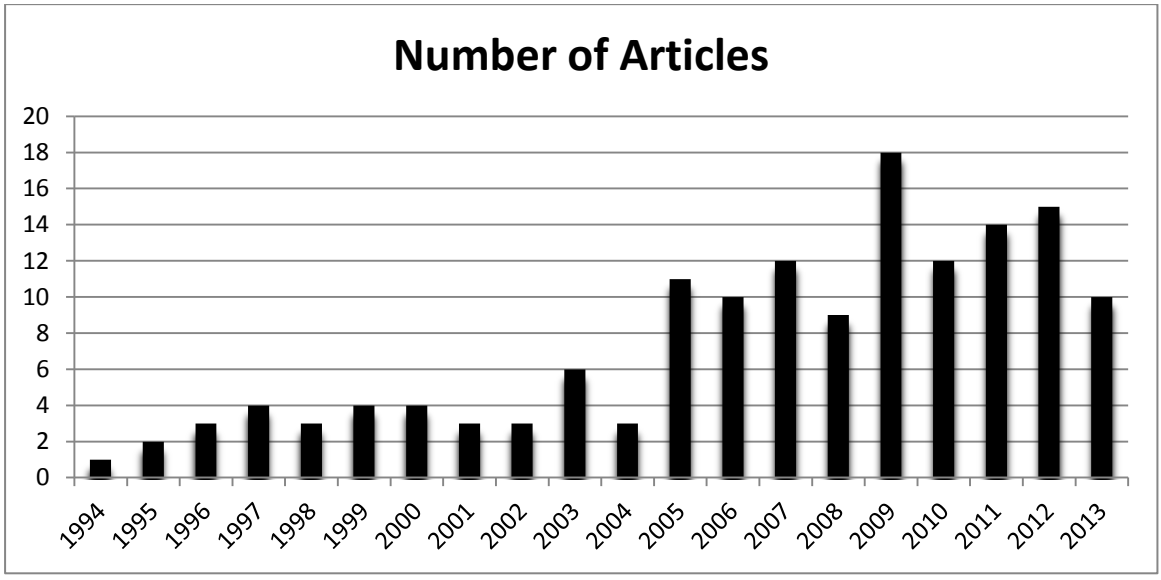

Figure 3: Trend of agri-fresh supply chain literature across the years

2.4 Issues/constructs Identification based on the literature

For the identification and collection of the issues/constructs there are several articles collected from the journals, conferences and the research thesis. This are the articles which are collected from the above 115 papers. For the collection of the issues/constructs we are going deeply through each paper and wrote the important part of the paper in excel sheet. These issues/constructs are strictly related with perishable foods and agri-fresh foods in different countries. The main aim behind the collection of these issues/constructs is to get the overall issues/constructs of the different agri-fresh food supply chain.

The agricultural sector is based mostly on agri products, which in turn depend upon a strong and dependable agri-fresh supply chain to survive and grow. India is the world's second largest producer of fruits and vegetables. The annual production of fruits is 46.8 MT while the annual production of vegetables is around 91 MT that accounts for 10 percent and 14 percent of the global production respectively (Viswanadham, 2006, Shukla and Jharkharia 2012). Estimates says around 35 percent to 40 percent of the total production of fresh fruits and vegetables, is wasted in India, which is about the total production of the Great Britain (Khan, 2005, Shukla and Jharkharia 2012). Even at current level of production, farm produce valued at Rs 70,000 million (US$1,400 m) is being wasted every year only because there is no adequate storage, transportation and other infrastructure supports (Viswanadham, 2006, Shukla and Jharkharia 2012).

The literature on agri-fresh supply chain management describes the reliance of strong and dependable supply chain on the characteristics of these factors, but the influence of interrelationships among the factors on the supply chain efficiency has been hardly taken into account in the literature. If not properly dealt with, these factors can be issues. The impact of these issues is a major point of concern that can result loss of quality, hygiene and overall efficiency of a supply chain. Literature review also reveals that especially in Indian context not much independent research has taken

place. Kumar (2008) identified commonalities and differences between the supermarket industry and its logistics capabilities in developed and developing economies. Maheshwar and Chanakwa (2006) have suggested solutions to post-harvest losses due to gaps in supply chain in India. Viswanadham (2006) and Khan (2005) elaborated food market in India. Sahay (2003) has talked about an inter-regional evaluation of dairy farming systems in India. Mahmood et al. (2005) and Wang and Li, (2012) gives that quality of fresh products can be considered as a dynamic state that decreases continuously until the point when it is unfit for consumption A large number of intermediaries supplement the lack of infrastructure, but add to the waste and increase the per unit consumption price. The other major operational cause is the lack of proper planning and management practices in the Fresh produce supply chain. This is because majority of the farmers are small land holders and share croppers and have little knowledge of technology, market demand, and financial incentives. According to Aksoy and Kaynak (2011), Hepner et al.(2004)), Ruben, R., Boselie (2007), Luai E. (2013), and Duffy (2008), the main obstacles that hinder the implementation of a quality system include: weak links between buyers and sellers; limited financial and human resources; inadequate expertise, training, and information sharing, and the lack of trust in food safety legislations and inspectors. Understanding the quality of supply chains requires analyzing the internal environment (e.g. country facilities and infrastructure, product quality and standards, exporter producer relationships and marketing research). The detrimental effects of demand amplification are well understood by Taylor, (2006) and include excess inventory, poor product availability, difficulties in resource planning and increased production and delivery costs.

Ahumada and Villalobos (2011) have differentiated the major issues/constructs for agri-fresh produce into strategic, tactical and operational issues/constructs. They defined that strategic issues/constructs includes decisions such as financial planning, supply network design, selection of capacity, and technology, etc. the tactical decisions cover harvest planning, scheduling of crops, selection of labor, capacity and crops, etc. The operational decisions include production scheduling activities, harvesting, storage, etc. Therefore there is a need to identify the inhibitors that are influencing the Indian supply chain's efficiency and dependability, and then to develop a generally applicable framework, which establishes interrelationships between these inhibitors.

Kathryn Anne-Marie Donnelly, Kine Mari Karlsen and Bent Dreyer (2011) were done his work on the five different products which mainly based on the traceability of different perishable products. He concluded that the traceability challenges identified in this study are mainly shown to be sector specific for instance, the apparent lack of need or regulation for identifying origin prior to mixing many deliveries of grain to gain a desired quality level.

Study of Tommi Tuominen (2009) is mainly concentrated on Benchmarking of the Russian and Finish Food Industry and finding the reasons for low productivity in Russian Food Industry. In this study researcher was took the number of non-structured interviews of the different Russian and Finish Industry peoples. And then

comparison is carried out with the SCM score card. Finally by this study researcher concludes that two factors standing out that are hindering the operational efficiency of food industry companies in Russia are road conditions and the low level of IT use. Study of Nga Mai et. al. (2010) is mainly relates with the findings of the issues in supply chain for Industries in the European Agriculture Industries. The main purpose of his research is what are the main issues in the traceability of the Agriculture Supply Chain? He concluded that improvement of supply chain management is expected as the most important benefit of traceability. Other benefits are increase of the ability to retain existing customers, product quality improvement, product differentiation, and reduction of customer complaints.

In order to manage the requirements for speed and flexibility, different supply chain parties need to have at least inter-firm collaboration at an operational level and unified supply chain support systems. However, this is a challenge for the companies along the supply chain. Organizations that are not open to sharing data or lack leading forecasting techniques have been identified as root causes of food waste between suppliers and retailers (Taylor and Fearne, 2009). In addition, performance indicators have been identified as one of the root causes of waste since they were focusing on cost, efficiency, and availability. In particular, it has been observed that availability is accorded greater importance than waste. Supply chain literature offers solutions on how to benefit from shared information. In the context of fresh foods, a limited number of writers consider the topic (Ketzenberg and Ferguson, 2008, Taylor and Fearne, 2009). The availability of data is no longer a problem, but the challenge still remains of how to best utilize the data to improve the performance of the chain. In his study, Fliedner (2003) examined several trade journals and reports and came up with a list of benefits resulting from sharing information. Both the retailer and manufacturer can expect to benefit from increased sales, lower product inventories, higher service levels or order fill rates, improved forecast accuracy, and lower system expenses. Other suggested benefits include reduced capacity requirements, faster order response times and faster cycle times, and a reduced number of stocking points, i.e. direct material flows.

Table 2: Quality issues/constructs from Literature Review

Author	Year	Methodology	Product	Quality issue
Hughes and Merton	1996	case study	Fruit	Freshness/ Taste
Manikas and Terry	2009	case study	fresh produce	logistic quality, performance measurement
Silpa Sagheer	2009	Focus group	food and drink	information quality
Talib, F., Rahman	2011	case study	vegetable	Collaboration
Zhang and Aramyan	2009	conceptual framework, case study	perishable	Integration
Zhang, Y. and Chen	2011	Empirical Study	Agri-food	Procurement quality

Rajkumar et al.	2010	case study	packaged food	Packaging quality, Quality standards of food
Manning L.	2013	case study	Perishable	Quality of Certification
Reardon, T.	2000	case study	processed food	manufacturer quality standard
Roberta de	2012	case study	vegetable	High competitiveness in Quality
Sebastian et al.	2010	case study	Nestle, Colgate Palmolive, Hindustan Lever	logistic quality
Shukla and Jharkharia	2012	literature review	Fruit and vegetable	operation
Bezuidenhout et al.	2012	case study	sugarcane	production and processing collaboration
Poppo L. Et al.	2002	Empirical Study	Perishable	supplier selection quality
Yang H.L.	2006	case study	mango, grapes	transactions between buyer and producer
Dorling et al.	2005	Mathematical Modeling	Agri-food	strategic management, Selection of supplier
Aramyan et al.	2007	conceptual framework, survey	Agri-food	Procurement quality
Choi T.Y. et al.	1999	conceptual framework	fresh produce	Transaction costs
Hepner et al.	2004	Mathematical modelling	Agriculture produce	information management
Cook	1999	Conceptual framework	Perishable	Raw material quality
Jensen et al.	2013	case study	Agriculture produce	Sustainability quality
Hobbs J.E at al.	2004	Mathematical modelling	agri-food	Coordination quality, Traceability
Cadilhon et al.	2005	case study	vegetable	Variety
Gyau and Spiller	2009	Empirical Study	fresh produce	Environmental issue
	2010	case study	Potato	Inter firm co-operation quality
Hamprecht et al.	2005	Empirical Study	Potato	Raw material quality
Mikkola M.	2008	case study	vegetable	Product quality
Bourlakis M.	2012	Empirical Study	Agri-food	Supplier quality, packaging quality
Beverland M.	2001	case Study	Fruit	brand quality
	2005	case study	perishable	biological quality
Taylor D. H.	2006	case study	agri-food	retailer's product quality, excess inventory, poor product availability, production and delivery costs
Taylor and Fearne	2009	case study	fresh produce	Product quality, Demand management
De Boer, K.	1997	Empirical Study	Agriculture produce	operational management
GENG Shul, REN	2007	case study	seafood	E- commerce
Dorling et al.	2006	Empirical Study	food	brand positioning

Petit C. et al. ,	2010	case study	agri-food	food quality, hygienic quality
Poppo L. Et al.	2002	Empirical Study	Short self-life product	logistic quality (bad delivery quality)
Hingley et al.	2008	case study	fruit, vegetable and salad	quality of final product
Faria-Fernandes et al.	2009	case study	Agri-food	Quality based payment system, cost
Folinas, D., Manikas	2007	conceptual framework	sensitive food	Traceability
Duffy	2008	case study	Agri-food	supplier quality
Bourlakis M.	2012	theoretical framework	frozen	Excess inventory
Fearne.	2005	case study	fruit	Quality index
Gomez-Limon et al.	2010	case study	Fresh-produce	Quality assurance
Harland	2006	case study	fresh produce	Quality standard, Information quality
Matopoulos A.	2010	case study	agri-food	Quality standard, Freshness quality
Ruben et al.	2007	case study	vegetable	Quality of human resources; inadequate expertise, training, Education
Lejars et al.	2007	case study	Sugarcane	Demanding quality, delivery quality
Mahmood, K..	2005	Empirical Study	agri-food	Quality variability in supply area, Quality information,
Ahumada and Villalobos	2011	literature review	agri-food	Strategic, Tactical and Operational issues/constructs
Kirezieva et al.	2008	focus group	fruit and vegetable	Logistic quality
Luai E.	2013	case study	agri-food	Lack of trust, Links between buyers and sellers,
Bevilacqua et al.	2008	case study	Vegetable	quality assurance
Zanoni and Zavanella	2009	case study	patato	quality regulation regarding the sale, High quality personnel
Alessandro Banterle R. L.	2012	theoretical framework	agri-food	Quality variation, Distribution quality
Thakur et al.	2010	case study	food grain	Traceability, Information quality.
Aksoy, S. et al.	2011	Empirical Study	vegetable	Quality factors of moisture
Salin V.	2008	focus group	agri-food	Land quality, Low quality vegetables, quality control system
Andrew Fearne et al.	1998	case study	vegetable	Document Quality
Khan et. al.	2005	case study	vegetable	environmental quality,
Thakur et al.	2013	Empirical Study	soybean	quality assurance,
Voss et al.	2010	focus group	fruit and vegetable	Quality performance
Wu, K.S et al.	2012	case study	fresh produce	food quality safety control

Maheshwar, C.	2006	Empirical Study	Mango	raw material quality, quality attributes
Wilding et al.	2010	case study	Apple	Collaboration, co-operation, co-ordination, trust
Wang., et al.	2012	case study	Banana	high variability in quality, material quality
Xiaoqiang Cai	2012	case study	Tomato	quality assurance, information quality
Petit C. et al. ,	2010	Theoretical framework	Fresh- Produce	Road Quality, Road traffic pollution

2.6Issues/constructs Classification based on problem context

After the issues/constructs are classified according to papers which are referred this 60issues/constructs are too big for next work to carry. For this sec of convenience of further research work the issues/constructs which are same aim of work had given the same name for example; Recalling, road traffic, transportation issues/constructs, RFID issue as the transportation quality issue. As the result of this issues/constructs are going lesser and the study is also quick and very respond able. Following table shows the entities of supply chain and number of issues/constructs in that entity of supply chain.

Table 3: Total Number of Issues/constructs after grouping of same issues/constructs

Sr.No.	Element of Supply Chain	Number of Issues/constructs
1.	Supplier	26
3.	Distributor/Wholesaler	30
4.	Retailer	29
5.	Consumer	14

2.7 Research Gap

Based on the insight gained from the literature about supply chain, agri-fresh supply chain, quality issues/constructs, quality performance etc. gaps are observed in the literature

- Deciding the quality constructs in the agri-fresh food supply chain.
- Deciding the supply chain element wise (supplier, wholesaler, retailer, and customer) dominant quality constructs.
- Formulate the factors of the agri-fresh food supply chain.
- Development of an effective integrated approach that could be used to address multiple problems of agri-fresh food supply chain is lacking.

To address all the above-mentioned problems, the proposed research work attempts to develop an integrated framework for agri-fresh food supply chains which

simultaneously addresses all the above issues confronted by individual members of AFSC.

2.8 Concluding Remarks

Review of literature introduces various aspects of food supply chain management, and presents a state of the art survey of relevant literature. By developing a quality for classification and codification, overall contribution of researchers in individual areas of food supply chain can be found out which helps the new researchers to identify relevant areas where work or research is significantly lacking. The value of the methodology presented lies in the fact that it can act as a guide for researchers to analyze the type amount of work that has already been done in the field of SCM.

CHAPTER 3: RESEARCH METHODOLOGY

An overview of research methodology adopted to achieve the overall objectives of the proposed research work is presented herein. The overall research plan, methodology for development of the integrated framework, and development of the various models used for analysis is discussed.

3.1 Introduction

Based on the review of the literature, it can be collected the number of issues/constructs which are presented in the agri-fresh food supply chain. Furthermore the issues/constructs are classified according to the entities of the supply chain for making the study more reliable and less complicated. Hence the proposed research work aims at develop factors which have capable of providing a comprehensive solution to the problems at each level of the supply chain.

The specific aim of the list of constructs is to represents the quality issues/constructs in agri-fresh supply chain and researcher who are carried different solution methods to overcome or to find out that problem; simultaneously facilitating decision making on appropriate tools used for each of the quality issue by the researcher.

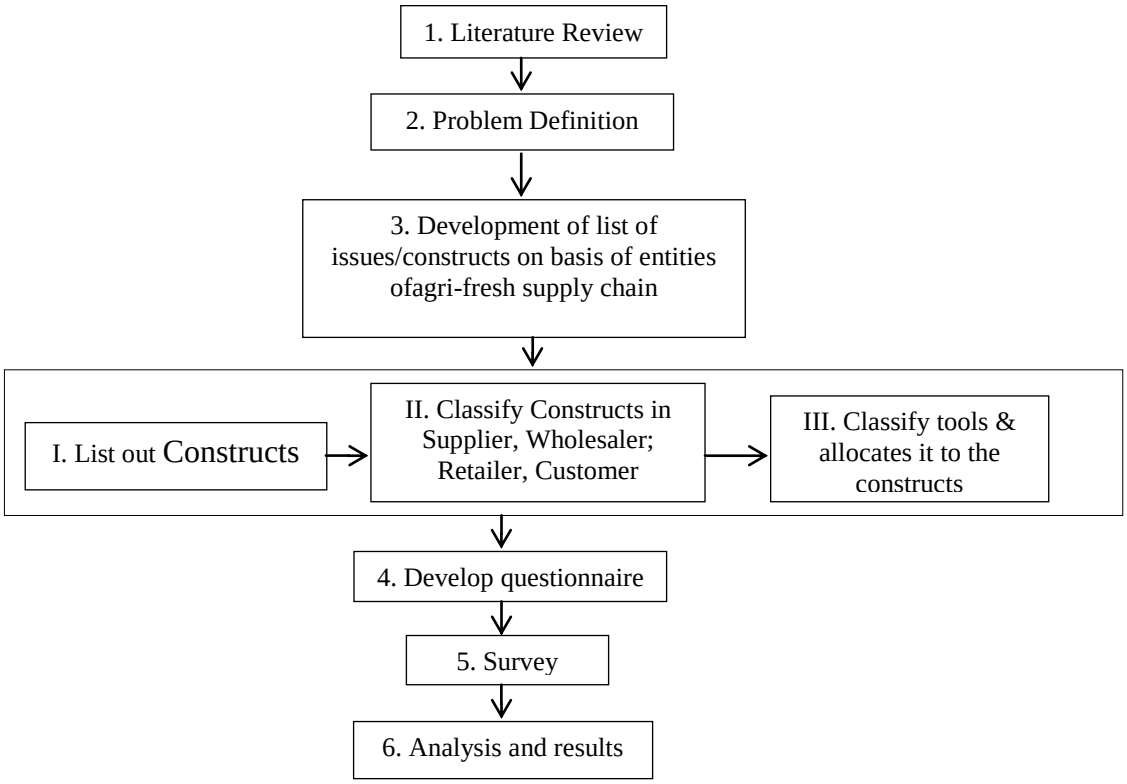

Figure 4: Research Design

Also the issues/constructs considered for individual members of the chain that deals with agri-fresh product, in a way that giving maximizing issues/constructs for that elements. For development of the theoretical model the issues/constructs which are collected in the literature are used. Each entity of supply chain has its own

issues/constructs. So that the techniques used by researcher to solve that issue is collected and the marked by that technique.

As the products are agri-fresh, the aim is to sell them before expiry. Hence the good techniques by researcher for each issue are proposed. Thus the overall objective of this stage is to investigate the total issues/constructs and number of tools assigned for individual issue by number of researcher. The complete research plan is summarized in Figure 4.

Phase 1: Literature Survey, Quality Issues/constructs Findings and Classification of Issues/constructs: In first Phase firstly papers are downloaded from the different sources such as Emerald Online, Science Direct, Springer and Taylor and Francis. These Papers are of three types 1 Survey Type 2 Literature type 3 Case Study type.

After downloading the Quality issues/constructs discussed, studied and found by the researcher. These issues/constructs are then coded. These issues/constructs may be qualitative or quantitative. Qualitative issues/constructs are those which are mainly not measurable units which express in form images, words, sounds etc. and Quantitative issues/constructs are those which are measurable in terms of numbers. Since Supply Chain has mainly based on five different elements which are Supplier, Wholesaler/ Distributor, Retailer, Consumer. The Issues/constructs which are collected from Literature Survey are classified according to these supply chain elements.

Phase 2: Develop Questionnaires for Survey: In this phase the issues/constructs which are classified used to make Questionnaires for case study. Each element has its own Questionnaires developed by taking reference of classified issues/constructs. Each question in Case study indicates one or more issues/constructs. The interview taking during case study is by Structured Questionnaire. Questions made will be of two type open questions and closed questions.

Phase 3: Survey: Case study will be for validation of the issues/constructs in the actual agri-fresh supply chain. The agri-fresh food is mainly had low shelf e.g. vegetables, fruit, grains etc.

One agri-fresh food will be choosing from above Agri-fresh food products and supply chain of that product will studied by going through on field study. The questionnaires made in first stage will be used for findings quality issues/constructs.

Phase 4: Analysis of Result: The results will be got by using the analysis software SPSS. The issues/constructs and there result getting from the asking question to subject in supply chain will put on software to develop result. SPSS analysis our issues/constructs and we conclude the dominant quality issues/constructs after analysis of results. We will get the dominant quality issues/constructs for specific agri-fresh food for specific supply chain.

Phase 5: Validation of factors: After validation if the dominant issues/constructs are same in same products with different manufacturer's issues/constructs will be correct. In this step, the solutions will be trying to find out to sorting out quality issues/constructs.

3.2 Development of list of constructs on basis of entities of Agri-fresh Supply Chain

The constructs are at each level of food supply chain related with information, transportation, and demand forecasting & inventory management. Hence to achieve the defined objective that getting the overall idea about the constructs in each supply chain element theoretical model is defined.

From the discussion carried out in the "Literature review" about the different constructs in food supply chain and analysis technique used by the researcher for resolving that constructs. At this point, it is important to clarify a terminology that is used interchangeably regarding elements, constructs, and factors.

Typically a "construct" is defined as "An idea or theory containing various conceptual elements, typically one considered to be subjective and not based on empirical evidence". The conceptual elements or constructs mean the same thing. However, if "factors" is used in the literature, it refers to the top most or generic element and it brings down construct to the second level. At the second level, the construct is less generic as compared to the factor. In this case pillar is considered to be at higher level than construct. Furthermore, several constructs together define a pillar. In subsequent part of this research, factors will be considered at higher level than constructs.

3.2.1. List of constructs for Supplier/Farmer

In table 5, 21 constructs are identified. As discussed in Literature Review section total 76 constructs are identified for the supplier element. But as there is repeatability in number of constructs we eliminate that repetitions by giving the name which having same meaning. But in order to empirically establish the factors and the respective constructs, one needs to consider all the constructs, irrespective of its repetition. For example, a construct like "information technology and information technology management should be treated as two different constructs so that the study is more error proof. After carrying out the empirical investigation, this particular construct may turn out to be constructing of certain pillar, while it is not necessary that a construct appearing several times in the literature will be a construct of empirically established pillar. In order to preserve the meaning of the each element, the phrase or the word has taken as it from the text and used in table 5.Only those constructs are clubbed together which either used the same word(s) or had the same meaning. For example, transportation strategy/RFID for transportation/ transportation routing/Logistic vehicle/ Logistic routing/ Logistic supply indicates same meaning as "transportation constructs". It does not indicate that all these 21 constructs are independent of each other. The majority of constructs can be found to be belonging to

the particular domain, and if a suitable PCA carried out, all the constructs can be observed to be falling under few independent constructs.

In Table 5, rows shows the number of constructs which are extracted from the literature survey. Column shows the T1, T2…… T12 values which are having meaning that the analysis method used by the researcher in his paper.

Following are the meaning of T1, T2…… T12;

T1 = Structural Equation Modeling (SEM)

T2 = Statistical Analysis

T3 = Conjoint Analysis

T4 = Conceptual Framework

T5 = Canonical Factor Analysis

T6 = Co-relation and Regression Analysis

T7 = Mathematical Modeling

T8 = Benchmarking

T9 =Delphi Method

T10 = Cluster Analysis

T11 =Fuzzy Technique

T12 =SCM Scorecard Model

Table 4: List of constructs for Supplier/Farmer

S.No	Constructs (Issues/constructs)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	Frequency
1.	Quality of use of raw material	1	0	2	0	1	0	1	0	0	1	0	06
2.	Hygiene quality in farming	1	2	0	0	0	0	0	2	0	0	1	06
3.	Life cycle quality	1	0	0	2	0	1	0	0	0	0	0	04
4.	Quality of packaging	0	0	0	0	0	0	0	0	1	0	0	01
5.	Quality of handling	0	0	0	1	0	2	0	0	0	2	0	05
6.	Delivery of fresh produce to wholesaler/retailer	2	0	0	0	1	0	1	0	0	1	0	05
7.	Personnel quality	1	3	0	1	0	2	0	0	0	0	0	07
8.	Training to labor	0	0	0	3	0	2	2	0	0	0	2	09
9.	Quality of communication or information	1	0	2	0	0	0	0	0	2	0	0	05
10.	Sales forecast	0	0	0	1	0	1	0	1	0	0	2	05
11.	Data accuracy	3	0	0	0	2	0	0	1	0	0	0	06
12.	Responsiveness	0	0	1	0	0	1	0	0	0	0	0	02
13.	Economic sustainability	0	0	2	0	0	0	0	2	0	0	0	04
14.	Quality assurance	0	0	0	0	0	0	0	0	1	0	0	01
15.	Volume flexibility in produce availability	0	2	0	0	0	2	0	0	0	1	0	10
16.	Quality of awareness about the produce	0	0	0	0	0	0	0	1	0	0	0	03
17.	Environmental quality	0	0	0	0	1	0	0	0	0	0	0	02
18.	Collaboration quality	1	0	0	0	0	0	0	0	0	0	1	06
19.	Commitment	0	0	2	0	0	1	0	0	0	0	0	04
20.	Payment according to quality of product	0	0	0	0	0	0	0	0	1	0	0	02
21.	Production cost	0	0	0	1	0	0	0	0	0	0	0	01
22.	Inventory cost	0	0	1	0	0	1	0	0	0	0	0	02
23.	Quality of transport medium	0	0	2	0	0	0	0	2	0	0	0	04
24.	Minimum pesticides residue	0	0	0	0	0	0	0	0	1	0	0	01
25.	Use of biotechnology	0	2	0	0	0	2	0	0	0	1	0	10
26.	Quality standards	0	0	1	0	0	1	0	0	0	0	0	02

As the frequency of the reliability construct is 5 that mean 5 different researchers are extracted the construct of food supply chain in their study. In the reliability row below T1, T2, T3… some values are written. For understanding this we take first matrix of 3 column 1 row which indicates value three. It indicated that out of 199 papers from which this constructs are extracted, 2 researchers are used structural equation modeling (SEM) to analysis the construct reliability.

Manikas and Terry (2009) is carried out research in food industry. In their study they extracted the construct of reliability for supplier. For analysis of this study they used the analysis technique structural equation modeling (SEM). As on the same basis the sample list of constructs for wholesaler, retailer and costumer are carried out. Like sample list of wholesaler, retailer and customer is given in appendix A.

CHAPTER 4: SURVEY DESIGN

4.1 Survey methods

A survey is a means of gathering information about a particular population by sampling some of its members, usually through a system of standardized questions. Surveys can be conducted by mail, telephone, personal interview, or Internet. They can be administered either to individuals or groups. The primary purpose of a survey is to elicit information which, after evaluation, results in a profile or statistical characterization of the population sampled. Questions may be related to behaviors, beliefs, attitudes, and/or characteristics of those who are surveyed.

The basic process of survey research can be outlined as follows:

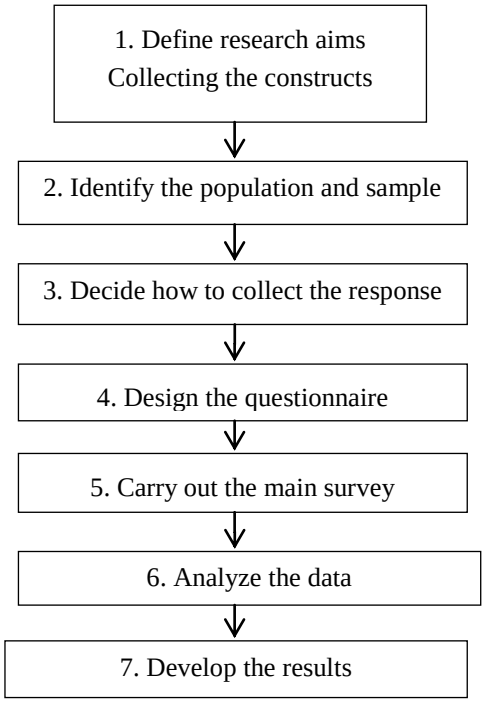

Figure 5: Steps of survey research

A crucial part of good research design concerns making sure that the questionnaire design addresses the needs of the research. To put this way; somehow we need to ensure that the questions asked are the right ones. To move from the research aims to deciding what the right questions to put on a questionnaire are is a key aspect that needs to be addressed by the researcher. This document makes some comments about this important area but does mainly concentrate on the mechanics of designing the questionnaire.

4.2 Defining the research aim

The aim behind carry out this total survey is;

- Validate the constructs that are collected from the literature actually with the agri-fresh food supply chain
- Extract the new constructs if present in agri-fresh food supply chain.

- Delete the unimportant constructs which are only present theoretically and not show any importance in agri-fresh food supply chain.

After completing the survey, result gives answer of above questions so that research aim is fulfill and aim also satisfied. The systematic approach of empirical research proposed by Flynn et. al. (1990) was followed to conduct the empirical study/investigation.

4.3 Identify the population and sample

The population is simply all the members of the group that you are interested in. A sample is a sub-set of the population that is usually chosen because to access all members of the population is prohibitive in time, money and other resources. A key issue in choosing the sample relates to whether the members you have chosen are representative of the population. Often the sample is chosen randomly from a list that contains all the members of the population; such a list is called a sampling frame. Some methods of selecting samples, e.g. quota sampling, do not require a sampling frame. As the study is totally concentrated on the agri-fresh foods so the survey is carried out with supply chain of agri-fresh food products. The population is selected from one of the agri-fresh food supply chain as indicated followed; there are several approaches to determining the sample size. These include using a census for small populations, imitating a sample size of similar studies, using published tables, and applying formulas to calculate a sample size.

Population	Margin of Error			Confidence Level		
	10%	5%	1%	90%	95%	99%
100	50	80	99	74	80	88
500	81	218	476	176	218	286
1,000	88	278	906	215	278	400
10,000	96	370	4,900	264	370	623
100,000	96	383	8,763	270	383	660
1,000,000+	97	384	9,513	271	384	664

Figure 6: Standard table for deciding sample size

As there is several approaches to calculate the sample size in this survey published standard tables are used. For any agri-fresh food supply chain as the element of supply chain are more so we have to consider population of total supply chain is more than 1000. For this survey ± 5 % as the precision level, confidence level is 95%, and the estimated proportion of an attribute that is present in the population p= 0.5.According to table sample size for confidence level 95%, population 1000,

precision level ± 5 %, p = 0.5 sample size is 278 i.e. we do survey for 275 samples. These samples are from different elements of the supply chain.

4.4 Deciding how to collect replies

In this stage decide whether the survey is to be completed by the respondent directly or through an interviewer, and design the questionnaire, and any other documents, accordingly. As the agri-fresh food supply contents different elements like supplier, Wholesaler/ retailer, and consumer data collected by face to face interview with giving them set of question on the sheet of paper. The advantage of this is High response rates; can clarify questions, if necessary; control over respondent selection; can use longer, more complex questionnaire; and easier to motivate the respondent.

4.5 Design the questionnaire

The heart of a survey is its questionnaire. Drawing a sample, hiring, and training interviewers and supervisors, programming computers and other preparatory work is all in service of the conversation that takes place between researchers and respondents. Survey results depend crucially on the questionnaire that scripts this conversation (irrespective of how the conversation is mediated, e.g., by an interviewer or a computer). To minimize response errors, questionnaires should be crafted in accordance with best practices.

Recommendations about best practices stem from experience and common lore, on the one hand, and methodological research, on the other. In this chapter, we first offer recommendations about optimal questionnaire design based on conventional wisdom (focusing mainly on the words used in questions), and then make further recommendations based on a review of the methodological research (focusing mainly on the structural features of questions).

Survey using questionnaire was used as the data collection method. One part of that questionnaire was meant for evaluation of reliability and validity of AFSC constructs to achieve quality in agri-fresh supply chain. While making the questionnaire, it was ensured that all the questions pertain to manufacturing industry only and not addressing any other domain like service industry. A thorough examination of questionnaire items revealed that deletion of constructs of those framework which addressed non-manufacturing industry used generic constructs. These generic constructs were equally applicable for manufacturing industry as well. Now, in order to check the content validity of the questionnaire items, it was sent to four practitioners in industry, one consultant and two academic.

While designing the questionnaire following points are to be considered;

- Use simple, familiar words (avoid technical terms, jargon, and slang);
- Use simple syntax;
- Avoid words with ambiguous meanings, i.e., aim for wording that all respondents will interpret in the same way;
- Strive for wording that is specific and concrete (as opposed to general and abstract);

- Make response options exhaustive and mutually exclusive;
- Avoid leading or loaded questions that push respondents toward an answer;
- Ask about one thing at a time (avoid double-barreled questions); and
- Avoid questions with single or double negations.

4.5.1 Open or Close questions

While designing this questionnaire the main thing on which focus should be more is which type of questions will be used in questionnaire. There are two types of questions i. Open type questions and closed questions. In order to analyze the answers to open questions, they must be grouped into a relatively small number of categories. This requires the development of a coding scheme; its application by more than one person; and the attainment of a high level of agreement between coders. The costs of these procedures, coupled with both the difficulties interviewers confront in recording open answers and the longer interview time taken by open questions, are responsible for the widespread use of closed questions. These practical disadvantages of open questions, however, do not apply to the measurement of quantities. The answer categories to open questions about amounts — for instance, number of doctor visits, hours devoted to housework, dollars spent for a good — are implicit in the question, so no coding is required, and no special burden is placed on interviewers. Moreover, offering respondents a set of closed quantity categories (e.g., less than 1 h, 1–3 h, and more than 3 h) can produce error. Evidence indicates that the way in which amounts are divided to form closed categories conveys information that may bias respondent answers. Thus, open questions are usually preferable to closed items for measuring quantities.

As the survey is based on to extract the construct so here questions are made of close type, which are having five options.

1: Extremely Important 2: Important 3: Neither important nor unimportant
4: Unimportant 5: Extremely unimportant

4.5.2 Rating Scale used

For rating the scale Likert scaling most often uses 5 points (Armayan, (2005)) because Likert scale is used for rating the scale as

- They are quick and economical to administer and score.
- They are easily adapted to most attitude measurement situations.
- They provide direct and reliable assessment of attitudes when scales are well constructed.
- They lend themselves well to item analysis procedures.

While taking this scale and using close ended questions have advantage that, no theoretical issues/constructs, scale is easy to translation, easily clarification of scale point meaning, uniformity of scale point meaning. After deciding this all pattern the constructs which are extracted from the literature are used to make the questions. Following are the some important note about these questions;

- Different questionnaire for different element of the supply chain.
- Number of questions also differs according to the element.
- Each question made on the basis of the constructs i.e. answer on the question indicates importance of that construct in the supply chain.
- So as literature review extracted 26 constructs so questions for survey of supplier is 26, similarly for Wholesaler/distributor, retailer and consumer.
- Observer should give their opinion on the 5-point scale basis.

Example of question: Supposed that one construct from the supplier is quality of communication, so the question formed is; for effective management and maximum productivity in agriculture produce, rate the importance of Quality of communication. The level of importance is on 1 to 5 scales:

1: Extremely Important; 2: Important; 3: Neither important nor unimportant;
4: Unimportant; 5: Extremely unimportant

The questionnaire designed in this section should be globalized that it is easily used for any of case of the food supply chain with minor changes of names.

4.6 Data Collection in survey

As the above discussed survey and survey instruments designed there is a need of the actual data collection through agri-fresh supply chain. For the collection of this data regarding the extraction of construct one special case is to be studied. The questionnaire designed in survey designed is used here for extraction of the constructs. As agri-fresh supply chain has low shelf life here that product is considered which is available anywhere easily and mostly used in the Indian scenario. By taking consideration into this factor agri-fresh food is the best perishable food which is available everywhere in India and which is having low shelf life.

Data is collected is going actually on the field to the different suppliers, wholesaler, retailers and customers. As total samples required for the study is around 250, sample size is distributed among all entities as 60 samples of supplier are taken, 80 samples of wholesaler are taken, 75 samples of retailer are taken, and 60 samples of consumers are collected. Samples are told to fill the questionnaire which is on sheet of paper by their own. Body of questionnaire consists of two parts, first part of questionnaire contain brief introduction of supply chain quality and information of respondents with scale of measured. Second part contains constructs of agri-fresh supply chain with questions. Questionnaire for supplier/farmer, wholesaler, retailer, and customer is included in Appendix B.

CHAPTER 5: DATA ANALYSIS AND RESULTS

5.1 Factor Analysis (EFA)

Factor analysis is interdependence technique whose primary purpose is to define the underlying structure among the variable in the analysis.

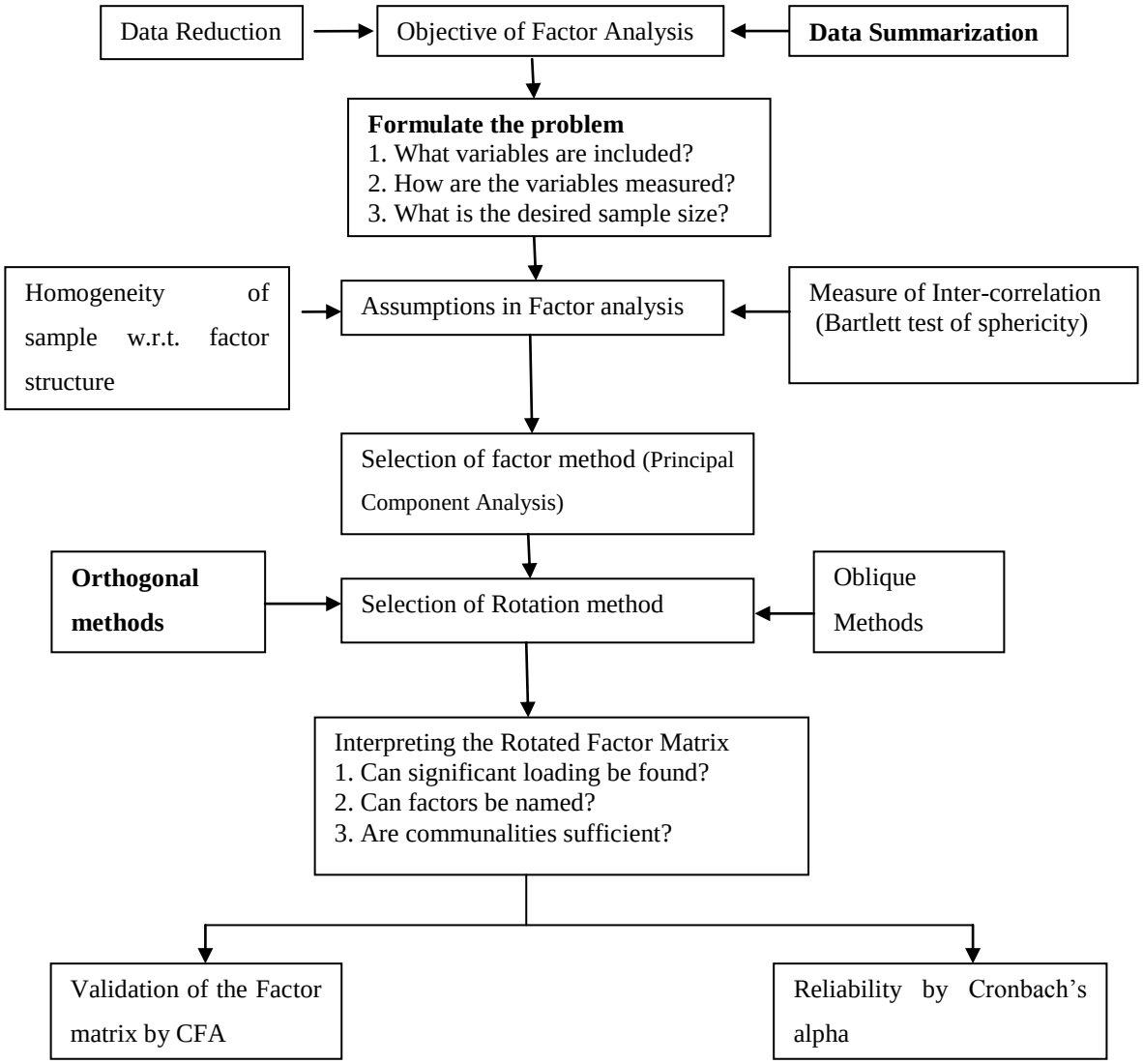

Figure 7: Steps in the Factor Analysis Decision

Objective of FA: - 1) data summarization, 2) Data reduction: - a) identifying representative variables from a much larger set of variables for use in subsequent multivariate analysis. b) Creating an entirely new set of variables, much smaller in number, to partially or completely replace the original set of variables. In both instances, the purpose is to retain the nature and character of the original variables. Factor analysis provides the tools for analyzing the structure of the interrelationships (correlation) among a large number of variables by defining sets of variable that

highly interrelated, known as factors. Steps are including in the factor analysis is shown Figure 7.

First, the data collected with the help of questionnaire are checked for its suitability in Principal Component Analysis (PCA). In order to find out the main factors of Agri-fresh supply chain quality (AFSCQ), PCA is carried out on the items of administrated questionnaire. Since the factors are not known prior, PCA method is used to find out underlying latent factors (or variables). The specific goals of PCA are to summarize patterns of correlations among observed variables, to reduce a large number of factors, to provide an operational definition (a regression equation) for an underlying process by using observed variables or to test a theory about the nature of underlying processes.

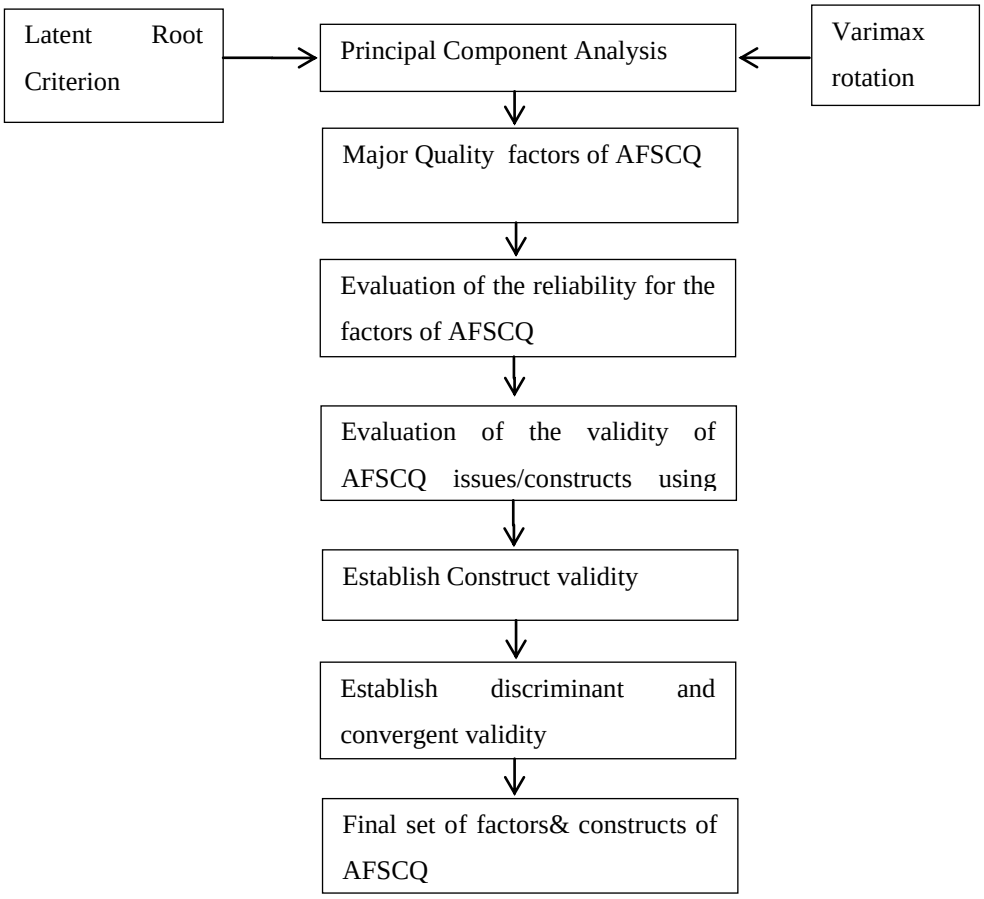

Figure 8: Steps included while doing data analysis

Once underlying latent factors (or variables) are established, the reliability of the scales is checked for internal consistency. In this process, make an attempt to maximize the reliability of the scales by removing some of the observed variables. Now if interpretability of the factors of AFSCQ is found to be adequate, the next step is to verify the factor structure by establishing the construct validity of the factors.

The researcher seeks to demonstrate the scores on latent variables vary with scores on other variables or that score on latent variables changes with experimental conditions as predicted by theory. Finally, the discriminate and convergent validity is established for the factor structure for which construct validity is found to be appropriate. This brief discussion on data analysis has given an outline of the work that will be carried out here forth. Detailed description of each data analysis technique is given in next section.

5.2 Principal Component Analysis (PCA)

The very first step to be considered before starting PCA is to check the suitability of data for analysis. Principal component analysis is appropriate when you have obtained measures on a number of observed variables and wish to develop a smaller number of artificial variables (called principal components) that will account for most of the variance in the observed variables. The principal components may then be used as predictor or criterion variables in subsequent analyses. Principal component analysis is a variable reduction procedure. It is useful when you have obtained data on a number of variables (possibly a large number of variables), and believe that there is some redundancy in those variables. In this case, redundancy means that some of the variables are correlated with one another, possibly because they are measuring the same construct. Because of this redundancy, you believe that it should be possible to reduce the observed variables into a smaller number of principal components (artificial variables) that will account for most of the variance in the observed variables.

In this case, it is very important to find out whether sample size is suitable for carrying out factor analysis with PCA method. There are many views regarding the suitability of sample size. Hutcheson and Sorfroniou,(1999) recommended at least 150-300 cases. While according to Comrey and lee (1992), a sample of 300 is considered fair. By reviewing several studies, Costello and Osborne (2005) reported that 14.7% of the studies they reviewed has subject to variable (STV) ration<2:1. In our case, it is 2.30:1 for the farmer, 2.6:1 for wholesaler, 2.62:1 for retailer and 4.5:1 for customer thus cannot be said to be exponentially small sample size. Thus on the basis of these arguments presented in the favor of the present sample size 60 for farmer, 75 for wholesaler, 80 for retailer, 60 for customer. PCA was performed in SPSS 17.0 using varimax rotation that generated following results.

5.2.1 Analysis for supplier/Farmer

For supplier varimax rotation generated 7 components on the basis of Eigen values (>1, Kaiser's criteria) given in Table 5. According to Hair (2006) Kaiser's criterion is considered to be good for the number of variables 20 and 50 in this study, the case number of variables 26. Latent Root Criterion is chosen to extract number of components. An eigenvalue represents the amount of variance associated with the factor. Hence, only factors with a variance greater than 1.0 are included. Factors with variance less than 1.0 are no better than a single variable, because, due to

standardization, each individual variable has variance of 1.0. It can be seen that only 7 distinct components (Eigenvalue>1.0) can be obtained and from Table 5 six components explain 76.95% of variance. For the appropriateness of factor analysis KMO measure of sample adequacy is used. KMO value should be greater than 0.6, in our case it is .650 which is acceptable. Thus it will not be very conservative to consider seven factors only. Once the extraction of factors has been completed, we examine the table of 'Communalities' which tells us how much of the variance in each of the original variables is explained by the extracted factors. The mean values of communalities were factors only. The mean value of communalities was 0.997, which is considered to be good indicator of the adequacy of the sample. If communalities are high, recovery of population factors in sample data is normally good, almost regardless of sample size, level of over determination or the presence of model error. Communalities shall all be greater than 0.6 or the mean level of communality to be at least 0.7. In our case, all communalities are greater than 0.6 and the mean also is higher than 0.7.

The factor loadings provided an indication of correlation of different original items (variables) with each factor and also extent of correlation. Variables with loadings above 0.50 were considered. Loadings in excess of 0.71 are considered excellent, 0.63 very good, 0.55 good, 0.45 fair, and 0.32 poor. Hence by going through all variables for a particular factor and by considering factor loading (from rotated component matrix) of items above 0.5, all the variables were assigned under one factor. It is important to specify here that all the cross loadings got removed by considering factor loadings above 0.50. The ultimate effect of rotating the factor matrix is to redistribute the variance from earlier to later one to achieve a simpler, theoretically more meaningful factor pattern.

Table 5: Result of PCA for supplier/farmer survey

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.999	19.228	19.228	4.999	19.228	19.228	3.773	16.510	16.510
2	4.138	15.914	35.141	4.138	15.914	35.141	2.934	14.284	30.794
3	3.168	12.183	47.324	3.168	12.183	47.324	2.880	13.077	43.871
4	2.632	10.124	57.448	2.632	10.124	57.448	2.712	11.433	55.304
5	2.066	7.946	65.394	2.066	9.946	66.394	2.703	10.397	66.701
6	1.745	6.710	72.104	1.745	9.710	76.104	2.119	9.151	76.104
7	1.318	5.068	77.172						
8	.958	4.876	82.048						
9	.950	4.039	86.087						
10	.929	3.688	89.775						
11	.698	2.685	92.459						
12	.613	2.357	94.816						
13	.519	1.996	96.812						
14	.348	1.339	98.151						
15	.210	.809	98.960						
16	.110	.424	99.384						
17	.104	.401	99.785						
18	.056	.215	100.000						
19	9.051E-16	3.481E-15	100.000						
20	4.077E-16	1.568E-15	100.000						
21	1.055E-16	4.057E-16	100.000						
22	-1.246E-16	-4.791E-16	100.000						
23	-4.595E-16	-1.767E-15	100.000						
24	-5.397E-16	-2.076E-15	100.000						
25	-8.230E-16	-3.165E-15	100.000						
26	-1.141E-15	-4.390E-15	100.000						

Extraction Method: Principal Component Analysis.

Table 6 shows the rotated factor loading in which factor loading for each variable is greater than 0.55.

Table 6: Component Matrix Table for supplier/Farmer

	1	2	3	4	5	6
Q20	.837	.019	-.008	.037	.095	-.166
Q16	.829	-.098	.198	.174	.114	-.195
Q22	-.807	.009	.058	.208	.150	.006
Q21	.800	-.323	.096	-.147	.237	.299
Q24	.792	.208	-.103	.123	-.040	.114
Q20	.771	-.147	-.135	.043	.238	.123
Q10	.700	-.123	.006	-.457	.247	.359
Q12	.692	.252	-.203	.123	-.340	.314
Q23	-.383	.985	-.178	.047	.405	-.430
Q19	-.350	.885	-.080	-.042	.330	-.250
Q18	.031	.856	.252	.036	.147	-.007
Q17	.083	-.152	.771	-.226	.085	-.391
Q13	.143	-.074	.618	.145	.101	.152
Q5	-.033	-.002	-.250	.908	.206	-.469
Q4	.423	.261	-.007	-.669	-.294	.238
Q2	-.263	.016	.119	.651	.029	-.090
Q7	-.434	-.208	.286	.580	.100	-.096
Q6	.527	.342	.170	.181	.800	.240
Q3	-.014	.125	.180	.419	.792	.150
Q1	.216	.315	.181	-.201	.700	.124
Q9	-.108	.059	-.110	-.031	.225	.924
Q11	-.050	-.030	.055	.042	-.039	.886

From Table 7, these seven factors (or main constructs of factors of supply chain quality) were identified as Product quality, Quality Performance, Quality in Logistic, Quality of Information, Relationship quality, Sustainability, Product safety and quality Assurance. Now, in order to find out underlying variables (or constructs) under each factor, the variables were arranged as per their loading with respect to each dimension (or factor).

Table 7: Constructs shrink to seven components for supplier/farmer

Group Name	Code	Quality issue	Communalities	Loading
Product Quality	Q1	Quality of raw material	.718	.800
	Q6	Delivery of fresh produce to wholesaler/retailer	.874	.792
	Q3	Life cycle quality	.867	.700
Product Safety	Q2	Hygienic quality in farming	.864	.551
	Q5	Quality of handling	.635	.908
	Q4	Quality of packaging	.725	-.669
	Q7	Quality of transport medium	.785	.867
Quality of Information	Q9	Quality of communication	.771	.886
	Q11	Data accuracy	.801	.924

Quality Performance	Q21	Production cost	.834	.800
	Q20	Payment according to quality of product	.711	.771
	Q22	Inventory cost	.590	-.807
	Q16	Quality of awareness about the produce	.788	.829
	Q24	Minimum pesticide residue	.898	.792
	Q10	Sales forecast	.857	.865
	Q12	Responsiveness	.754	.957
Relationship Quality	Q18	Collaboration quality	.784	.856
	Q19	Commitment	.844	.885
	Q23	Personnel Quality	.875	.794
Sustainability	Q17	Economic sustainability	.913	.924
	Q13	Environmental quality	.913	.900

Hence after performing PCA, seven factors/components of AFSCQ emerged, together they constitute a quality of AFSCQ in Agri-fresh supply chain. However, one needs to check reliability and validity before establishing the final set of factors and their constructs.

5.2.2 Analysis of Wholesaler

For wholesaler varimax rotation generated 7 components on the basis of Eigen values (>1, Kaiser's criteria) given in Table 8. According to Hair (2006) Kaiser's criterion is considered to be good for the number of variables 20 and 50 in this study, the case number of variables 30. Latent Root Criterion is chosen to extract number of components. An eigenvalue represents the amount of variance associated with the factor. Hence, only factors with a variance greater than 1.0 are included. Factors with variance less than 1.0 are no better than a single variable, because, due to standardization, each individual variable has variance of 1.0. It can be seen that only 8 distinct components (Eigenvalue>1.0) can be obtained and from Table 8 seven components explain 74.39% of variance. For the appropriateness of factor analysis KMO measure of sample adequacy is used. KMO value should be greater than 0.6, in our case it is .632 which is acceptable.

Thus it will not be very conservative to consider seven factors only. The mean values of communalities were factors only. The mean value of communalities was 0.997, which is considered to be good indicator of the adequacy of the sample. If communalities are high, recovery of population factors in sample data is normally good, almost regardless of sample size, level of over determination or the presence of model error. Communalities shall all be greater than 0.6 or the mean level of communality to be at least 0.7. In our case, all communalities are greater than 0.6 and the mean also is higher than 0.7.

Now, in order to find out underlying variables (or constructs) under each factor, the variables were arranged as per their loading with respect to each dimension (or factor). The factor loadings provided an indication of correlation of different original items (variables) with each factor and also extent of correlation. Variables with

loadings above 0.50 were considered. Comrey and Lee (1992) suggest that loadings in excess of 0.71 are considered excellent, 0.63 very good, 0.55 good, 0.45 fair, and 0.32 poor. Hence by going through all variables for a particular factor and by considering factor loading (from rotated component matrix) of items above 0.5, all the variables were assigned under one factor. It is important to specify here that all the cross loadings got removed by considering factor loadings above 0.50.Table 9 shows the rotated factor loading in which factor loading for each variable is greater than 0.55.

From Table 10, these seven factors (or main constructs of factors of supply chain quality) were identified as Product quality, Quality Performance, Quality in Logistic, Quality of Information, Relationship quality, Sustainability, Product safety and quality Assurance.

Table 8: PCA result for wholesaler survey

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.549	15.163	15.163	4.549	15.163	15.163	3.621	16.461	16.461
2	3.869	12.898	28.061	3.869	12.898	28.061	3.433	15.603	32.064
3	3.301	11.004	39.064	3.301	11.004	39.064	2.913	13.243	45.307
4	2.801	10.336	49.400	2.801	10.336	49.400	2.268	10.308	55.615
5	2.683	9.945	58.345	2.683	9.945	58.345	1.776	8.072	63.687
6	2.478	8.259	67.604	2.478	8.259	67.604	1.603	6.287	69.973
7	1.736	7.787	74.390	1.736	7.787	74.390	1.534	4.974	74.390
8	.974	5.246	76.637						
9	.936	5.119	81.756						
11	.762	3.405	89.035						
12	.755	2.517	91.553						
13	.696	2.320	93.872						
14	.559	1.862	95.734						
15	.423	1.410	97.145						
16	.299	.998	98.142						
17	.237	.789	98.931						
18	.182	.606	99.537						
19	.096	.320	99.857						
20	.043	.143	100.000						
21	7.107E-16	2.369E-15	100.000						
22	4.711E-16	1.570E-15	100.000						
23	4.188E-16	1.396E-15	100.000						
24	1.896E-16	6.320E-16	100.000						
25	-8.942E-17	-2.981E-16	100.000						
26	-1.706E-16	-5.687E-16	100.000						
27	-3.578E-16	-1.193E-15	100.000						
28	-3.753E-16	-1.251E-15	100.000						
29	-6.099E-16	-2.033E-15	100.000						
30	-6.934E-16	-2.311E-15	100.000						

Extraction Method: Principal Component Analysis.

Table 9: Component Matrix Table for Wholesaler

Component Matrix[a]							
	Component						
	1	2	3	4	5	6	7
Q7	.723	.025	.220	.250	.012	.135	-.139
Q1	.704	.023	-.153	-.014	.208	-.052	.141
Q25	.671	.079	.211	.032	-.378	-.096	-.124
Q2	.664	.219	.246	.286	-.015	.301	-.232
Q23	.491	.910	.149	-.267	.007	.289	.235
Q18	.375	.874	.166	-.158	.261	.236	-.096
Q22	.318	.724	-.200	.046	.225	-.027	.243
Q9	-.121	.720	-.123	-.072	-.011	.168	.302
Q21	.246	.622	.115	-.076	-.093	.112	-.155
Q10	.073	.610	.123	.063	.222	.072	.181
Q30	.169	-.093	.829	.371	.045	-.176	.051
Q29	.287	.062	-.807	.092	.045	-.153	-.006
Q27	-.067	-.041	-.070	.930	.047	.123	-.016
Q12	.311	.263	-.096	-.914	.063	.192	.216
Q16	.141	.246	.485	.910	.080	.018	.000
Q8	.272	.282	-.379	.879	-.038	.257	.067
Q24	.097	-.003	-.103	.823	.287	.120	.052
Q3	.016	.041	.294	.815	-.168	.066	.189
Q26	-.015	.008	.108	-.800	.143	-.014	.063
Q17	.038	.312	.191	.795	.063	.318	-.034
Q19	.409	-.013	-.084	.170	.944	-.047	.057
Q28	-.105	.351	-.078	.160	-.854	.109	-.065
Q20	.260	-.127	.147	.040	.843	.150	.087
Q11	.307	.109	-.007	.237	.068	.850	-.153
Q15	-.050	.174	.061	.036	.038	.845	.094
Q14	.057	-.043	-.147	.083	.113	-.821	-.020
Q13	.095	.049	.080	.469	-.018	.798	-.153
Q6	-.045	.152	.397	.058	-.049	.309	.837
Q4	-.013	.067	.067	.164	.336	-.091	.829
Q5	-.030	.184	.180	.283	.235	-.283	-.807
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.							
a. Rotation converged in 12 iterations.							

Hence after performing PCA, seven factors/components of AFSCQ emerged, together they constitute a quality of AFSCQ in Agri-fresh supply chain. However, one needs to check reliability and validity before establishing the final set of factors and their constructs.

Table 10: Constructs shrink seven factors for Wholesaler

Group Name	Code	Quality issue	Communalities	Loading
Product Quality	Q10	Appearance quality	.809	.671
	Q7	Delivery of fresh produce to Retailer	.904	.723
	Q1	Life cycle quality	.947	.704
	Q2	Quality of resources	.915	.664
Product Safety	Q6	Quality of transportation	.912	.837
	Q5	Quality of handling	.846	-.807

	Q4	Quality of packaging	..852	-.829
Quality of Information	Q11	Quality of communication	.722	.850
	Q13	Data accuracy	.745	.798
	Q14	Traceability within supply chain	.986	-.821
	Q15	E-commerce	.882	.845
Quality Performance	Q12	Sales forecast	.893	.-.914
	Q17	Responsiveness	.792	.795
	Q26	Inventory cost	.705	-.800
	Q8	Distribution Quality	.839	.879
	Q27	Minimum pesticide residue	.750	.930
	Q16	Volume flexibility in product availability	.708	.910
	Q3	Prompt Delivery	.995	.815
	Q24	Pricing according to quality of product	.730	.823
Relationship Quality	Q21	Collaboration quality	.940	.622
	Q22	Commitment	.766	.724
	Q9	Personnel Quality	.980	.720
	Q18	Profit	.868	.874
	Q10	Training to labour	.856	.610
	Q23	Quality of coordination	.844	.910
Marketing quality	Q27	Brand awareness	.996	.843
	Q25	Promotion activities	.910	.944
Quality Assurance	Q29	Quality standard	.903	-.807
	Q30	Quality assurance	.888	..829

5.2.3 Analysis for Retailer

For retailer varimax rotation generated 7 components on the basis of Eigen values (>1, Kaiser's criteria) given in Table 11. According to Hair (2006) Kaiser's criterion is considered to be good for the number of variables 20 and 50 in this study, the case number of variables 29. Latent Root Criterion is chosen to extract number of components. An eigenvalue represents the amount of variance associated with the factor. Hence, only factors with a variance greater than 1.0 are included. Factors with variance less than 1.0 are no better than a single variable, because, due to standardization, each individual variable has variance of 1.0. It can be seen that only 7 distinct components (Eigenvalue>1.0) can be obtained and from Table 11 seven components explain 92.54% of variance. For the appropriateness of factor analysis KMO measure of sample adequacy is used. KMO value should be greater than 0.6, in our case it is .750 which is acceptable.

Thus it will not be very conservative to consider seven factors only. The mean values of communalities were factors only. The mean value of communalities was 0.857, which is considered to be good indicator of the adequacy of the sample. If communalities are high, recovery of population factors in sample data is normally good, almost regardless of sample size, level of over determination or the presence of model error. Communalities shall all be greater than 0.6 or the mean level of communality to be at least 0.7. In our case, all communalities are greater than 0.6 and the mean also is higher than 0.7.

Table 11: Result of PCA for retailer survey

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.169	24.720	24.720	7.169	24.720	24.720	7.169	22.450	22.450
2	5.438	18.752	43.472	5.438	18.752	43.472	5.438	17.242	39.792
3	4.463	15.390	58.862	4.463	15.390	58.862	4.463	16.420	55.685
4	3.493	12.045	70.907	3.493	12.045	70.907	3.493	14.425	69.458
5	2.867	9.887	80.793	2.867	9.887	80.793	2.867	10.327	79.787
6	2.189	7.548	88.341	1.189	7.548	88.341	2.189	8.458	87.301
7	1.308	4.510	92.850	1.110	3.458	92.542	1.658	5.324	92.542
8	.992	2.110	94.960						
9	.882	1.040	95.650						
10	.772	.566	96.530						
11	.710	.458	97.400						
12	.620	.600	98.040						
13	.510	.201	98.950						
14	.204	.042	100.000						
15	.012	1.196E-15	100.000						
16	2.976E-16	1.026E-15	100.000						
17	2.553E-16	8.804E-16	100.000						
18	2.288E-16	7.890E-16	100.000						
19	1.054E-16	3.634E-16	100.000						
20	4.148E-18	1.430E-17	100.000						
21	-3.600E-17	-1.241E-16	100.000						
22	-7.758E-17	-2.675E-16	100.000						
23	-8.887E-17	-3.064E-16	100.000						
24	-1.959E-16	-6.754E-16	100.000						
25	-2.093E-16	-7.218E-16	100.000						
26	-2.554E-16	-8.808E-16	100.000						
27	-3.421E-16	-1.179E-15	100.000						
28	-4.455E-16	-1.536E-15	100.000						
29	-5.099E-16	-1.758E-15	100.000						

Extraction Method: Principal Component Analysis.

The factor loadings provided an indication of correlation of different original items (variables) with each factor and also extent of correlation. Variables with loadings above 0.50 were considered. Comrey and Lee (1992) suggest that loadings in excess of 0.71 are considered excellent, 0.63 very good, 0.55 good, 0.45 fair, and 0.32 poor.

Table 12: Component Matrix Table for retailer

Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
Q.12	-.903	-.014	.253	.214	.119	.099	-.172
Q.26	-.861	-.252	-.248	-.068	-.119	.244	-.231
Q.18	.834	-.283	.267	-.188	.288	-.100	.071
Q.15	-.814	-.057	-.060	-.072	-.215	-.400	.000
Q.16	.749	.026	.363	.098	-.432	.295	.172
Q.3	.697	.377	-.112	.131	-.200	.535	.308
Q.24	.677	.350	-.246	-.495	-.384	.222	.046
Q.8	.616	.214	.156	.119	-.119	-.172	.014
Q.27	.573	-.068	-.395	.185	-.211	.104	-.138
Q.14	.201	.938	.037	.383	-.335	.165	-.238
Q.11	.082	.831	-.424	-.429	.035	-.082	.264
Q.13	-.454	.749	.179	.268	.190	-.484	-.326
Q.6	-.066	.014	.967	-.026	-.088	.069	-.020
Q.2	.121	-.265	.888	-.011	.021	-.010	.209
Q.29	-.445	-.131	-.789	.556	.029	-.235	-.217
Q.1	.328	-.565	.774	-.057	-.246	-.101	-.388
Q.25	.154	.358	-.659	.923	.322	.181	-.012
Q.28	-.119	.346	-.671	.831	-.020	.042	-.040
Q.9	.366	-.061	-.159	-.747	.965	.014	.026
Q.7	.382	-.152	-.171	.548	.874	-.049	.040
Q.21	-.331	.379	.368	-.159	.765	-.420	-.185
Q.23	.019	-.069	.058	.165	.674	.174	.001
Q.10	.089	-.170	-.218	-.190	-.579	.301	-.156
Q.22	-.083	.075	-.399	-.031	.559	-.049	.097
Q.19	-.133	-.006	-.095	.002	-.197	-.882	-.153
Q.20	-.230	-.165	.327	.050	.363	.739	.040
Q.5	.425	.116	.206	.103	-.174	.287	.938
Q.7	.217	-.268	-.035	-.125	.000	.154	.793
Q.4	-.029	-.279	-.289	.349	.479	-.213	.732

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 18 iterations.

Hence by going through all variables for a particular factor and by considering factor loading (from rotated component matrix) of items above 0.5, all the variables were assigned under one factor. It is important to specify here that all the cross loadings got removed by considering factor loadings above 0.50.Table 12 shows the rotated factor loading in which factor loading for each variable is greater than 0.55.

From Table 13, these seven factors (or main constructs of factors of supply chain quality) were identified as Product quality, Quality Performance, Quality in Logistic, Quality of Information, Relationship quality, Quality of Logistic, Product safety and quality Assurance. Now, in order to find out underlying variables (or constructs) under each factor, the variables were arranged as per their loading with respect to each dimension (or factor).

Hence after performing PCA, seven factors/components of AFSCQ emerged, together they constitute a quality of AFSCQ in Agri-fresh supply chain. However, one needs to check reliability and validity before establishing the final set of factors and their constructs.

Table 13: Constructs shrink to four factors for retailer

Group Name	Code	Quality issue	Communalities	Loading
	Q6	Delivery of fresh produce to Retailer	.904	.967
	Q1	Life cycle quality	.905	.774
	Q2	Quality of resources	.952	.888
	Q28	Quality of product while competitiveness	.857	.671
	Q29	Appearance quality	.907	.789
Product Safety	Q7	Quality of transportation	.945	.793
	Q5	Quality of handling	.881	.938
	Q4	Quality of packaging	..934	.732
Quality of Information	Q11	Quality of communication	.696	.831
	Q13	Data accuracy	.918	.749
	Q14	Traceability within supply chain	.862	.938
Quality Performance	Q12	Sales forecast	.972	.903
	Q16	Responsiveness	.811	.749
	Q26	Inventory cost	.998	-.861
	Q15	Reliability in product supply	.839	.814
	Q18	Volume flexibility in product availability	.988	.834
	Q24	Pricing according to quality of product	.985	.677
Relationship Quality	Q21	Collaboration quality	.809	.765
	Q23	Commitment	.981	.674
	Q9	Personnel Quality	.973	.965
	Q17	Profit	.981	.874
	Q10	Training to labour	.997	.579
	Q22	Quality of coordination	.863	.559
Quality of logistic	Q3	Prompt delivery	.974	.739
	Q8	Distribution quality	.955	.882
Quality Assurance	Q27	Quality standard	.831	-.807
	Q25	Quality awareness`	.923	..829

5.2.4 Analysis for customer

For retailer varimax rotation generated 5 components on the basis of Eigen values (>1, Kaiser's criteria) given in Table 14. According to Hair (2006) Kaiser's criterion is considered to be good for the number of variables 20 and 50 in this study, the case number of variables 14. Latent Root Criterion is chosen to extract number of components. An eigenvalue represents the amount of variance associated with the factor. Hence, only factors with a variance greater than 1.0 are included. Factors with variance less than 1.0 are no better than a single variable, because, due to standardization, each individual variable has variance of 1.0. It can be seen that only 5 distinct components (Eigenvalue>1.0) can be obtained and from Table 14 seven components explain 76.54% of variance. For the appropriateness of factor analysis KMO measure of sample adequacy is used. KMO value should be greater than 0.6, in our case it is .714 which is acceptable.

Thus it will not be very conservative to consider seven factors only. The mean values of communalities were factors only. The mean value of communalities was 0.917, which is considered to be good indicator of the adequacy of the sample. If communalities are high, recovery of population factors in sample data is normally good, almost regardless of sample size, level of over determination or the presence of model error. Communalities shall all be greater than 0.6 or the mean level of communality to be at least 0.7. In our case, all communalities are greater than 0.6 and the mean also is higher than 0.7.

The factor loadings provided an indication of correlation of different original items (variables) with each factor and also extent of correlation. Variables with loadings above 0.50 were considered. Comrey and Lee (1992) suggest that loadings in excess of 0.71 are considered excellent, 0.63 very good, 0.55 good, 0.45 fair, and 0.32 poor. Hence by going through all variables for a particular factor and by considering factor loading (from rotated component matrix) of items above 0.5, all the variables were assigned under one factor. It is important to specify here that all the cross loadings got removed by considering factor loadings above 0.50.Table 15 shows the rotated factor loading in which factor loading for each variable is greater than 0.55.

From Table 16, these seven factors (or main constructs of factors of supply chain quality) were identified as Product quality, Quality Performance, Quality of Information, Relationship quality, and quality in logistic. Now, in order to find out underlying variables (or constructs) under each factor, the variables were arranged as per their loading with respect to each dimension (or factor).

Table 14: Result of PCA for customer survey

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.284	22.314	22.314	2.284	22.314	22.314	2.012	20.374	20.374
2	1.835	17.109	40.423	1.835	17.109	40.423	1.649	19.781	39.155
3	1.448	16.341	56.764	1.448	16.341	56.764	1.552	17.086	56.241
4	1.392	10.944	68.708	1.392	10.944	68.708	1.493	11.666	67.907
5	1.098	8.841	76.549	1.098	8.841	76.549	1.350	9.642	76.549
6	.981	7.008	64.557						
7	.938	6.700	71.257						
8	.880	6.284	77.541						
9	.746	5.326	82.867						
10	.687	4.909	87.776						
11	.507	3.620	91.397						
12	.475	3.393	94.790						
13	.402	2.873	97.663						
14	.327	2.337	100.000						

Extraction Method: Principal Component Analysis.

Table 15: Component Matrix Table for customer

Component Matrix[a]

	Component				
	1	2	3	4	5
Q6	.790	-.231	.119	.099	-.172
Q14	.713	.071	-.119	.244	-.231
Q9	.624	.000	.288	-.100	.071
Q13	.598	.172	-.215	-.400	.000
Q2	.154	.789	-.432	.295	.172
Q8	-.119	.697	-.200	.535	.308
Q3	.366	.576	-.384	.222	.046
Q7	.382	.253	.784	-.172	.014
Q5	-.331	-.248	.694	.104	-.138
Q4	.019	.267	.071	.758	-.119
Q1	.089	-.060	.000	-.578	.288
Q11	-.083	.363	.172	-.331	.875
Q12	.154	-.112	.308	.019	.511
Q10	-.119	-.246	.071	.089	.503

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

Hence after performing PCA, seven factors/components of AFSCQ emerged, together they constitute a quality of AFSCQ in Agri-fresh supply chain. However, one needs to check reliability and validity before establishing the final set of factors and their constructs.

Table 16: Constructs shrink to five factors for customer

Group Name	Code	Quality issue	Communalities	Loading
Product Quality	Q3	Delivery of fresh produce	.809	.576
	Q2	Product quality	.904	.789
	Q8	Reliability in product supply	.947	.697
Quality of Information	Q5	Quality of communication	.722	.694
	Q7	Responsiveness	.745	.784
Quality Performance	Q6	Volume flexibility of product	.893	.790
	Q13	Quality of customer satisfaction	.792	.598
	Q14	Brand awareness	.705	.713
	Q9	Pricing according to quality of product	.839	.624
Relationship Quality	Q10	Collaboration quality	.940	.587
	Q12	Commitment	.766	.589
	Q11	Quality of coordination	.844	.875
Quality of Logistic	Q1	Prompt delivery	.903	-.578
	Q4	Quality of facility location	.888	.758

5.3 Evaluation of reliability of the factors for internal consistency

Now, the internal consistency method was used to evaluate the reliability of each factor. Cronbach's alpha values were estimated for each pillar of each element using SPSS 17.0. Cronbach's alpha is based "internal consistency" of a test: the degree to which variables in the measurement set are homogeneous. Specifically, it is based on the average correlation of variables within a test. In exploratory research, items with Cronbach's alpha value higher than 0.6 are considered to exhibit internal consistency.

However in customer group 0.704, which are acceptable, but since there is large number of constructs present in the exploratory factor model, internal consistency of each factor was maximized which required dropping some items.

5.3.1 Reliability of survey of all entities of supply chain

For supplier survey as shown in table 17 gives internal consistency analysis for six pillars. Table 17 reports the original sets of the measurement items associated with the four pillars, the items deleted from the original sets to achieve maximum alpha and the reliability coefficients associated with the resulting scales. It shows, for example, that of the original 7 items in the quality performance group, the elimination of 2 items were necessary to achieve maximum alpha value 0.890, and the final alpha value ranges between 0.73 and 0.95, which indicates that the instrument considered reliable and internally consistent.

Table 17: Internal consistency analysis for six factors (for Supplier/Farmer)

Factor	Original no. of items	Original alpha	No. of items deleted	Final number of items	Final alpha
Product quality	3	0.931	0	6	0.931
Product safety	4	0.914	0	4	0.914
Quality of information	3	0.682	1	2	0.824
Quality performance	7	0.610	2	5	0.890
Sustainability	3	0.792	0	3	0.792
Relationship quality	5	0.812	1	4	0.905

For wholesaler survey as shown in Table 18 gives internal consistency analysis for seven factors.

Table 18: Internal consistency analysis for seven factors (for wholesaler)

Factor	Original no. of items	Original alpha	No. of items deleted	Final number of items	Final alpha
Product quality	4	0.852	0	4	0.852
Product safety	3	0.892	0	3	0.892
Quality of information	4	0.650	1	3	0.824
Quality performance	8	0.721	1	7	0.890
Marketing quality	2	0.942	0	2	0.942
Relationship quality	6	0.812	1	5	0.905
Quality assurance	2	0.792	0	2	0.792

For retailer survey as shown in Table 19 gives internal consistency analysis for seven factors.

Table 19: Internal consistency analysis for seven factors (for retailer)

Factor	Original no. of items	Original alpha	No. of items deleted	Final number of items	Final alpha
Product quality	5	0.789	0	5	0.789
Product safety	3	0.922	0	3	0.922
Quality of information	3	0.824	0	3	0.824
Quality performance	8	0.642	2	6	0.780
Quality of Logistic	2	0.958	0	2	0.958
Relationship quality	6	0.862	1	5	0.975
Quality assurance	2	0.852	0	2	0.852

For customer survey as shown in Table 20 gives internal consistency analysis for five factors.

Table 20: Internal consistency analysis for four factors (for Consumer)

Factor	Original no. of items	Original alpha	No. of items deleted	Final number of items	Final alpha
Product Quality	3	0.884	0	3	0.884
Quality Performance	4	0.903	0	4	0.903
Quality of Information	2	0.897	0	2	0.897
Relationship Quality	3	0.881	0	3	0.881
Quality in Logistic	2	0.794	0	2	0.794

5.4 Evaluation of validity of factors using confirmatory factor analysis

After carrying out exploratory factor analysis (EFA), the next step is to confirm and examine the details of an assumed factor structure obtained from EFA using confirmatory factor analysis (CFA). CFA is reckoned as a best-known statistical procedure for testing a hypothesis factor structure. It is performed to establish construct validity. In order to perform CFA, software package for AMOS 16.0, was used. The maximum likelihood (ML) estimation method was employed. A few assumptions need to be fulfilled in order to use the ML method.

- Reasonable sample size;
- The scales of observed variables should be continuous;
- The hypothesized model should be valid;
- The distribution of the observed variables should be multivariate normal.

The data for this research meet the first requirement as the sample size 275. In EFA, the size of the factor loadings, the number of variables and the size of the sample were important elements in obtaining a good factor model. The scale of the observed variables is continuous and the hypothesized model is developed from the literature, thus it is valid. Finally, for the normality of the observed variables, the rules of the

thumb given by west et. al. are followed, that is for a sample size of 400 or less, moderately non-normal data are acceptable. Recent research also shows that ML estimation method can be used for data with minor deviations from normality.

5.5 Construct Validity

One of the main advantages of CFA is its ability to assess the construct validity of proposed measurement theory. Construct validity is the extent to which a set of measured items actually reflects the theoretical latent construct (pillar in this case) those items are designed to measure. Hence, in order to establish construct validity, the analysis of proposed confirmatory factor model was carried out in multiple stages.

5.6 Evaluation of validity of factors of customer survey

For validity of factors construct validity is established by Confirmatory factor analysis in AMOS 18.0. Construct validity is the extent to which a set of measured items actually reflects the theoretical latent construct (factors in this case) those items are designed to measure. Hence, in order to establish construct validity, the analysis of proposed confirmatory factor model was carried out in multiple stages. Initially all 14 observed variables were considered. For five-factor model, the model fit indices were X^2 =140.57, degree of freedom (df) = 67, X^2/df = 2.09, goodness of fit index (GFI) = 0.893, adjusted goodness of fit index (AGFI) = 0.928, root mean square error of approximation (RMSEA) = 0..083, confirmatory fit index (CFI) = 0.928 and root mean square residual (RMSR) = 0.040.The final CFA models for customer with establish construct validity is given in 12.

5.6.1 Convergent Validity

To establish convergent validity, you need to show that measures that should be related are in reality related. Convergent validity is a measures of constructs that theoretically should be related to each other are, in fact, observed to be related to each other (that is, you should be able to show a correspondence or convergence between similar constructs) Further discussion is focused on elaborating quality for satisfying these conditions so as to establish Agri-fresh supply chain quality. Here is mentioned the interrelationships and directional interdependence between factors and constructs of each factor can only be established by carrying out path analysis. However certain relationships are hypothesized. For the convergent validity, CR > 0.7; CR > AVE and AVE > 0.5.

Table 21: Convergent validity of factors

Constructs		Factors	Estimate	AVE	CR
Q8	<---	PQ	0.809	0.712	0.95
Q3	<---	PQ	0.862	0.712	0.95
Q2	<---	PQ	0.870	0.712	0.95
Q5	<---	QOI	0.921	0.814	0.943
Q7	<---	QOI	0.884	0.814	0.943

Q4	<---	PS	0.812	0.812	0.901
Q1	<---	PS	0.812	0.812	0.901
Q13	<---	QP	0.768	0.705	0.892
Q14	<---	QP	0.892	0.705	0.892
Q9	<---	QP	0.849	0.705	0.892
Q6	<---	QP	0.847	0.705	0.892
Q12	<---	RQ	0.863	0.71	0.911
Q11	<---	RQ	0.835	0.71	0.911
Q10	<---	RQ	0.84	0.71	0.911

AVE = Avg. Variance Explained; CR = Composite Reliability; PQ = Product quality; QOI = Quality of information, PS = Product safety; QP= Quality of performance; RQ= Relationship quality;

5.6.2 Discriminant Validity

Discriminant validity is a measures of constructs that theoretically should not be related to each other are, in fact, observed to not be related to each other (that is, you should be able to discriminate between dissimilar constructs). To establish discriminant validity, it should to show that measures that should not be related are in reality not related. For discriminant validity MSV<AVE and ASV<AVE. AVE value for product quality is 0.446, quality of information is 0.572, product safety is 0.538, quality performance is .370 and relationship quality is .529. All value of ASV(Average shared square variance) is less than AVE (Avg. variance explained)

Table 22: Inter-constructs squared correlation (for customer)

			Estimate	MSV
Product Quality	<-->	Quality of Information	0.732	0.535
Quality of Information	<-->	Product Safety	0.832	0.692
Product Safety	<-->	Quality Performance	0.652	0.425
Quality Performance	<-->	Relationship Quality	0.649	0.421
Product Quality	<-->	Product Safety	0.712	0.506
Product Quality	<-->	Quality Performance	0.547	0.229
Product Quality	<-->	Relationship Quality	0.717	0.514
Quality of Information	<-->	Quality Performance	0.639	0.408
Quality of Information	<-->	Relationship Quality	0.824	0.651
Product Safety	<-->	Relationship Quality	0.743	0.532

MSV = Maximum shared squared variance

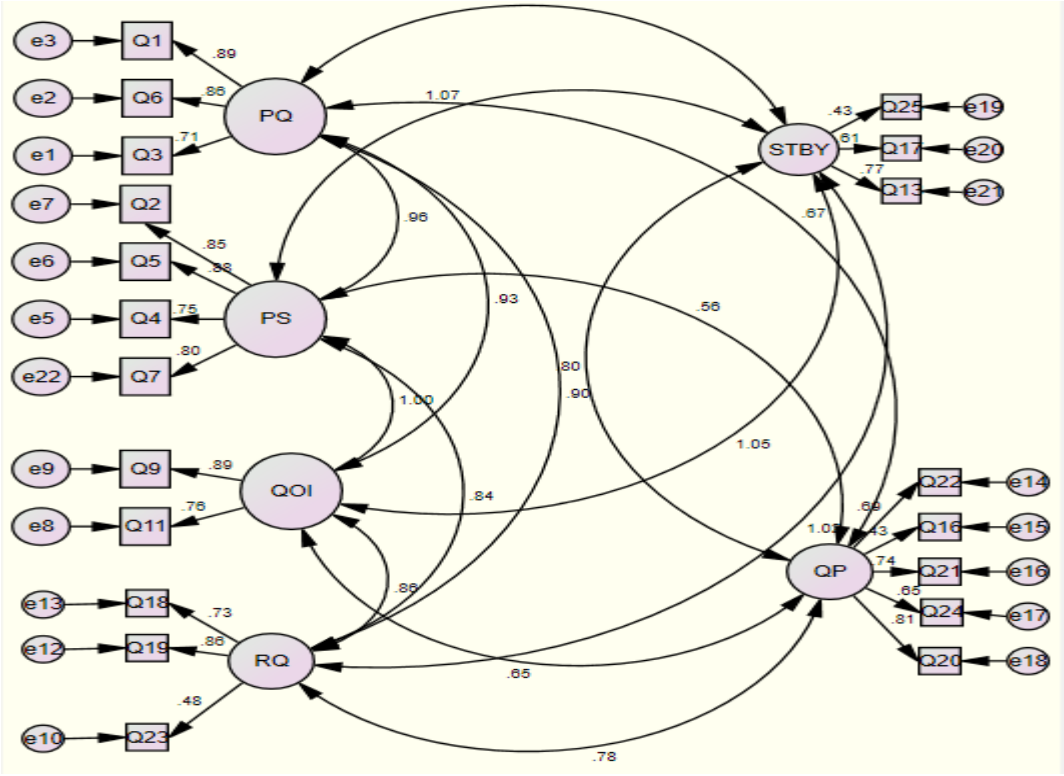

Figure 9: Confirmatory Factor Analysis for Supplier/ farmer Survey

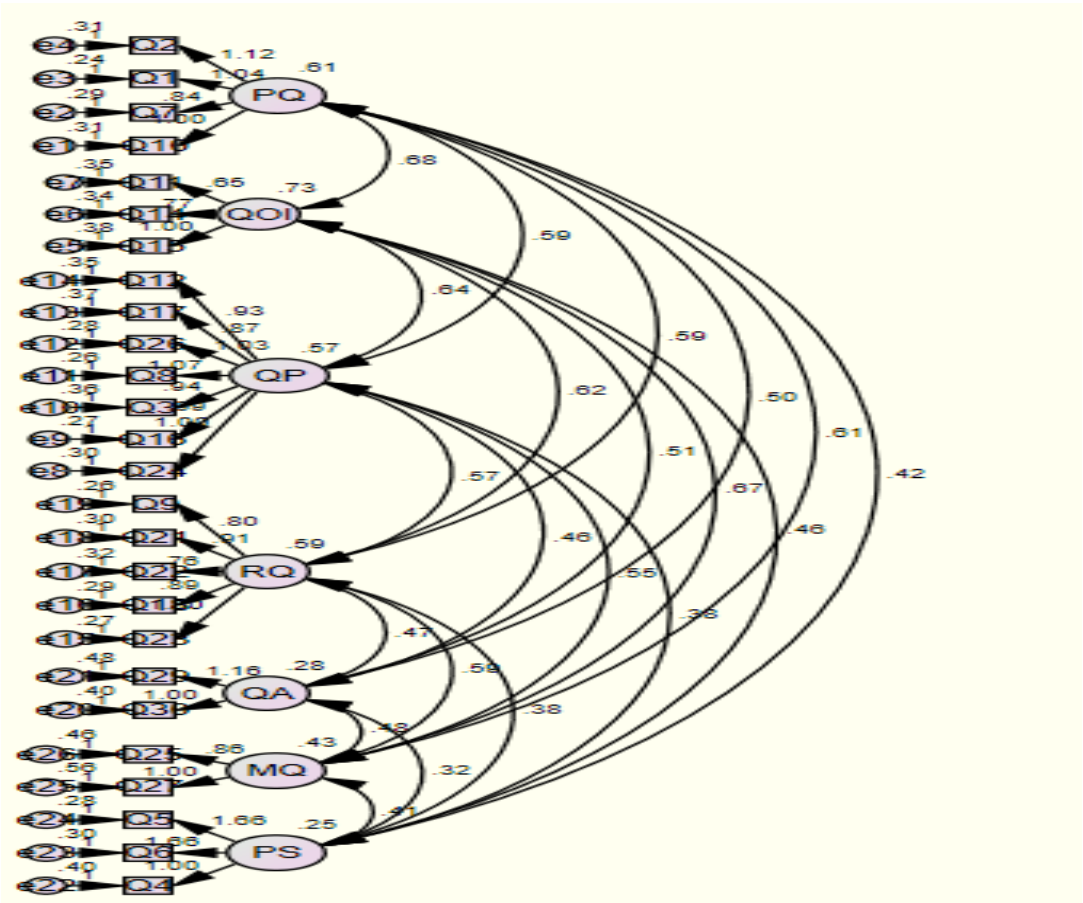

Figure 10: Confirmatory Factor Analysis for Wholesaler Survey

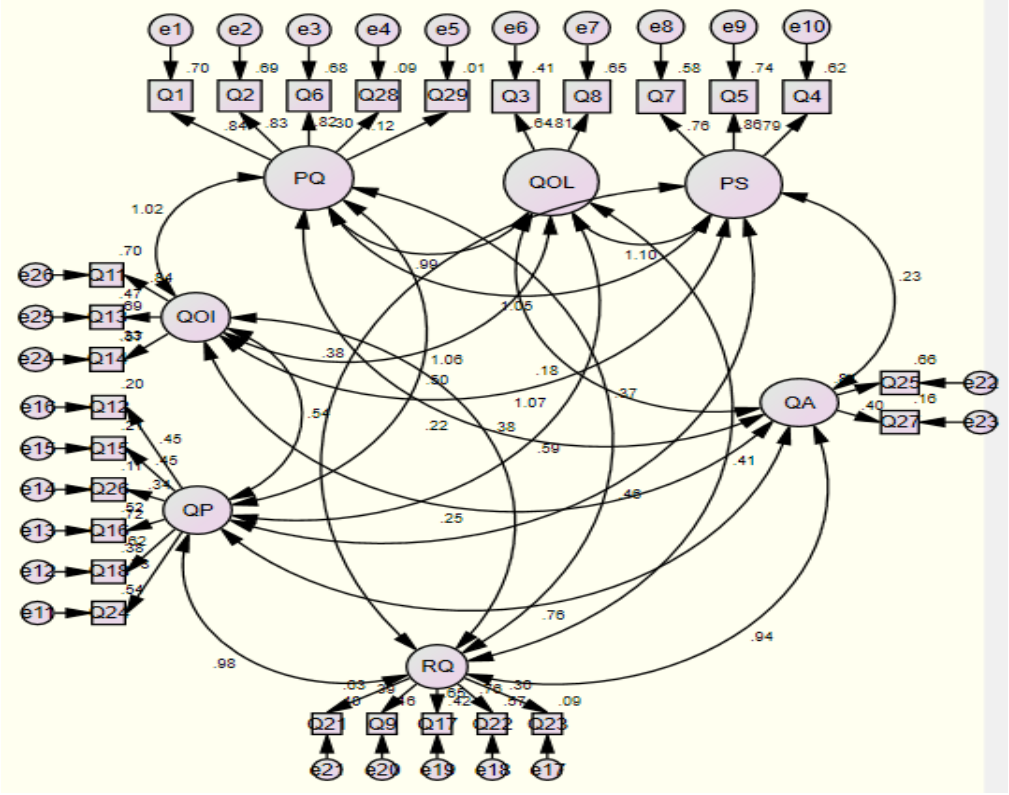

Figure 11: Confirmatory Factor Analysis for Retailer Survey

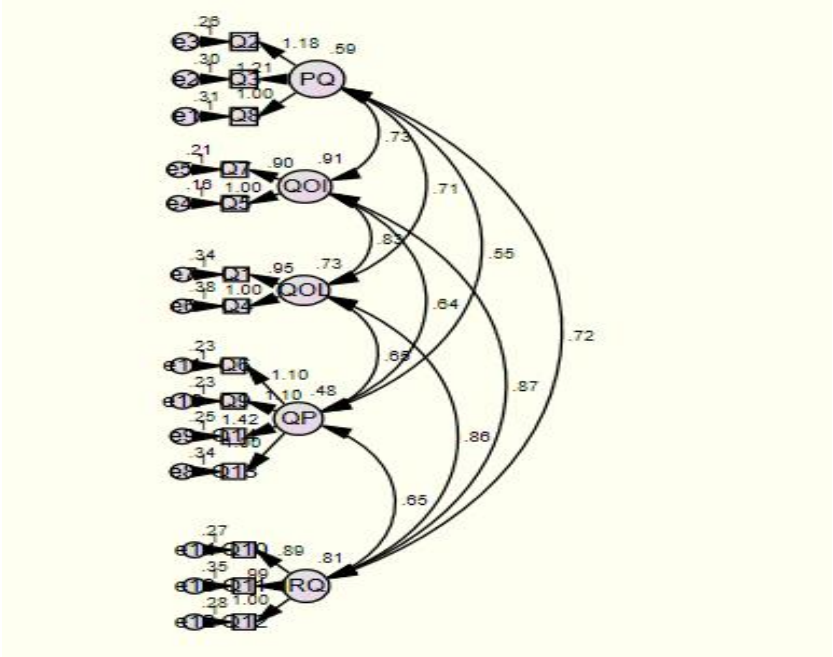

Figure 12: Confirmatory Factor Analysis for Customer Surve

QP = Quality Performance; QOI = Quality of Information; PQ = Product Quality;

PS = Product Safety; RQ = Relationship Quality; QOL = Quality of Logistic; STBY = Sustainability; MQ = Marketing Quality.

5.6 Factors of AFSCQ

The factors of AFSCQ established in the previous section have 21 in supplier, 26 in wholesaler, 26 in retailer and 14 in consumer are observed variables, hence there is need for further reflection on the final set of variables in a good way describe the factors or not.

Product quality: Product quality measures specification related to the product supplied between chain members, including quality of raw material, hygienic quality, quality of resources, appearance quality.

Product safety: Product safety means product does not exceed an acceptable level of risk, including freshness/taste, status of quality of most critical products etc.

Quality of information: is related to the information shared between the chain members, including sources, content, value and exchange method, including product information, communication, E-commerce and transparency etc.

Quality performance: Quality performance relates to supply chain performance which includes performance measurement, consumer's quality perception, customer satisfaction, and responsiveness, prompt delivery, production cost, and pesticide use, inventory cost etc.

Relationship quality: Relationship quality means collaboration quality between supply chain partners, including trust, consistent quality, reputation etc.

Sustainability: Sustainability relates to a factor which includes environmental quality, economic sustainability etc.

Quality assurance: Quality assurance is an ability of a supply chain member to direct supply chain process for better performance and business. It includes quality standard, quality attributes, auditing process, quality advancement, supporting quality claims, policy quality, quality of solution etc.

Quality in logistics: Quality of logistic refers to logistic operations quality as distribution quality, roads quality, service quality, availability etc.

Quality of marketing: Quality of marketing means marketing promotion activities to increase market share for product, including brand awareness, quality regulation regarding the sale.

CHAPTER 6: CONCLUSION AND FUTURE SCOPE

6.1 Conclusion Remark

This study mainly relates with evaluating reliability and validating of food supply chain in Indian agri-fresh food supply chain. Each step wise procedure analysis clarifies a group of factors which are made from extracted constructs in the process. A PCA of 99 constructs gives seven different factors principal components. These seven principal components are referred as factors. The factors were identified as product quality, product safety, quality of information, sustainability, quality assurance and relationship quality and quality performance.

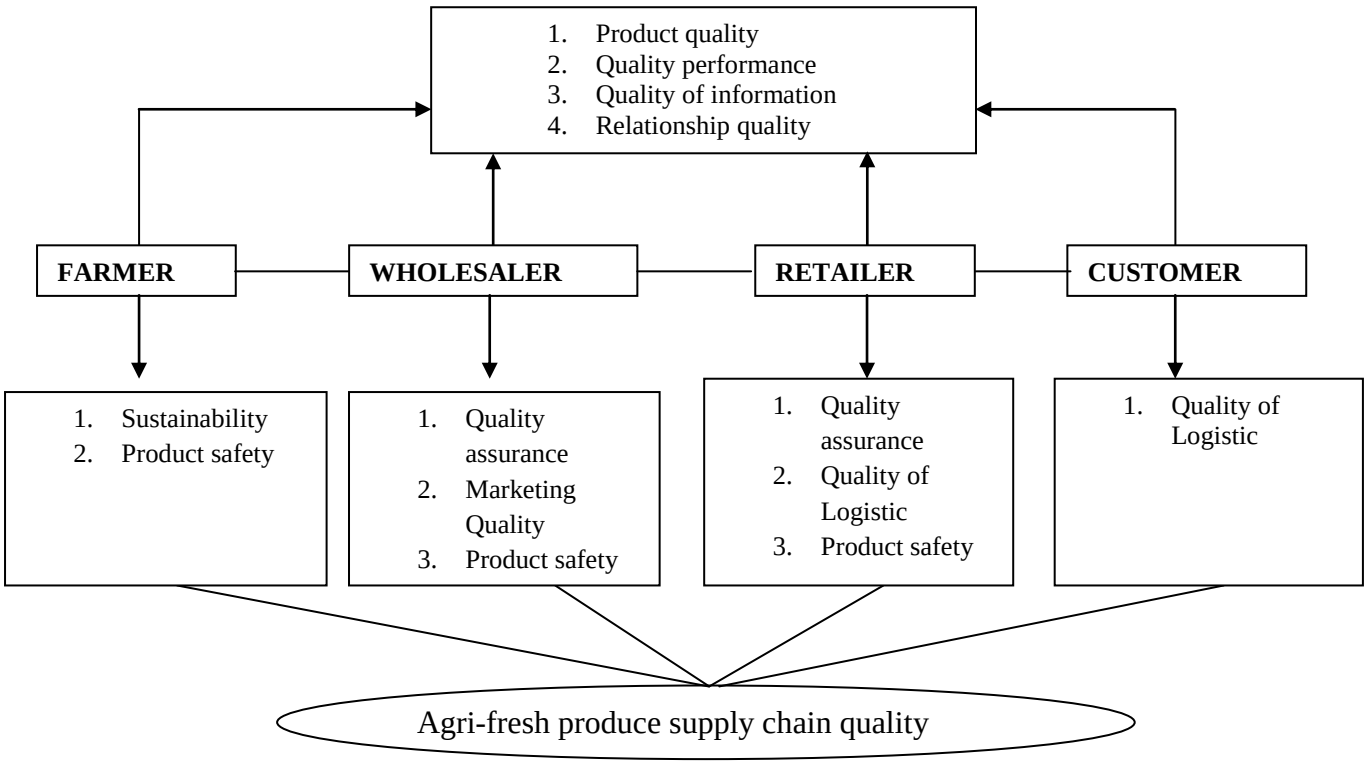

Figure 13: Final set of factors of Agri-fresh supply chain

From the figure 13 it is concluded that in agri-fresh supply chain quality for farmer 6 factors, for wholesaler 7 factors, for retailer 7 factors and for customer only 5 factors are extracted in analysis. .India is a fragmented country with 70 percent of the population residing in rural areas with over-reliance on the monsoons. The 52 percent of total land is cultivable as against 11 percent in the world. With such diversity production, processing, transporting goods and reaching consumers in right time and with preserved value is not an easy task, especially when agri-fresh foods are concerned. Indian situation echoes to the situation in most of the developing nations and similar inhibitors can be seen there also. A robust food supply chain is the solution that encompasses a strong and dependable food supply chain.

This study has tried to identify the critical factors that act as constructs to efficient agri-fresh supply chain in India. In this context, total 99 constructs were identified and contextual relationship was established between these quality constructs through

supply chain quality approach. It is observed that lack of adequate infrastructure along with high cost for installation and operation are the biggest bottleneck for strong and efficient agri-fresh supply chain. The Government would need to support industry players in their initiatives and provide for a more conducive enabling environment by continuing to upgrade infrastructure, accelerate drivers for organization and consolidation of the industry and providing recognition by granting "priority" industry status. Also, the Government could allow the use of reefer containers carrying import cargo for domestic use, which common practice in many countries. It would help to cut transport costs. There should be reduction in excise duty on processed food from existing levels to 3 percent. Tax holiday for investment in the agri-fresh supply chain infrastructure sector should be announced. 100 percent depreciation should be allowed on freezer cabinets and other agri-fresh supply chain equipment. Import duty on all capital equipment for food processing and agri-fresh supply chain sector should be reduced from existing levels to 4 percent. Excise duty on local freezer cabinets should be reduced from 18 percent to 3 percent (Khan, 2005).

The internet and mobile communications are used to enable information and financial transfer between the stakeholders. Awareness about the use of IT has great impact on agri-fresh supply chain integrity. The use of the internet in purchasing is 39 percent in India as compared to 86.7 percent in the USA, 30.1 percent companies that use internet for inventory management in India as compared to 48.5 percent in the USA, 50 percent of the firms used the internet for transportation as compared to 84.3 percent in the USA (Swaminathan, 2007). The usage of the internet as a medium in order processing, customer service, production scheduling and relations with the vendors is still very low in India.

Traceability, a key agri-fresh supply chain issue has come up as weak driver form analysis but strongly dependent on the other inhibitors. This barrier stood at the upper level of the hierarchy, therefore considered as the important barrier. Agri-fresh supply chains can take advantage of IT in improvements in data capture and processing, product tracking and tracing, auto adjustment in temperature, automation of ordering processes and payment mechanisms, control systems for quality assurance, synchronized transport transit times and reduction in lead time along the whole chain (Mangina and Vlachos, 2005). Recent advances in RFID technology will have tremendous impact in the management of the agri-fresh supply chain particularly for source identification and tracking and also in providing visibility throughout the chain. Very few companies in India are practicing towards RFID implementation and GPS tracking which is common in countries like the USA and UK. Such practices give visibility to the in process inventory in the agri-fresh supply chain and enable better decision making. (Kelepouris et al., 2007)"Too many intermediaries" has been deduced as middle level barrier has a significant role to increase prices of perishable items up to 60 percent without actually adding any value (Ruben, 2007). Creation of a robust institutional supply chain quality for creating logistics manpower, creation of incentives for development of skills for cold storage and transportation employees, and undertaking of initiatives to uplift the image of the agri-fresh supply chain industry can be the few initiatives required to be taken in consideration.

Customer ignorance also has come out as one of the powerful barrier. Although it is at the top in the model but decidedly relate to other ones. Until customer will demand for a quality and safe product the whole agri-fresh supply chain system will always look handicapped. Customer ignorance across all businesses, especially for unorganized sector has long been a reliable profit center and encouragement for poor practices. With increased awareness camps, extension-education and internet, consumers can know about the adverse effects of consuming unhygienic products and poor storage practices.

6.2 Future Scope

Finally, it is necessary to note that the proposed model is not without its own limitation. However, more operational comments can only be applied when the developed model is utilized for decision making in real scenario. Some of the limitations are: More number of constructs affecting subject can be identified to develop supply chain quality.

Experts' views have been sought to develop the contextual relationships for the supply chain quality model, which may have introduced some element of bias. The get together of all the experts could not be possible at same location because of the geographic. Although, discussing with the experts, as suggested in the supply chain quality technique a relationship model among constructs to efficient agri-fresh supply chain has been developed but this model is not statistically validated. Structural equation modeling (SEM), also commonly known as linear structural relationship approach has the capability of testing the validity of such analytical model. However, it may be suggested that due to complimentary nature of both of these techniques, the future research may be directed in first developing an initial model using supply chain quality and then testing it using SEM.

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Appendix A

Table A1: List of constructs for Wholesaler

Sr. No.	Constructs (Issues/constructs)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	Frequency
1.	Life cycle quality	1				2								04
2.	Quality of resources								3					05
3.	Prompt delivery			2				3				1		06
4.	Quality of packaging	1				2					1			05
5.	Quality of handling	1												01
6.	Quality of Transportation			1										02
7.	Delivery of fresh produce to Retailer		1											01
8.	Distribution quality													08
9.	Personnel quality	1			1					2				04
10.	Training to labor											1		01
11.	Quality of Communication										1			01
12.	Quality of sales forecast					1								01
13.	Data accuracy			1				1						02
14.	Traceability within supply chain						1							01
15.	E-commerce				2								1	04

Sr. No.	Constructs (Issues/constructs)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	Frequency
16.	Volume Flexibility in product availability			1			2			1		1		05
17.	Responsiveness					1								01
18.	Profit		1											01
19.	Environmental Quality		2											03
20.	Economic sustainability			1						1				04
21.	Collaboration Quality							1						01
22.	Commitment	1					1							02
23.	Quality of coordination		2						1			1		04
24.	Pricing according to quality of product					1					1			02
25.	Brand awareness	2		1				1						05
26.	Inventory cost		1				1							02
27.	Minimum pesticides residue				2				1			1	1	06
28.	Use of Biotechnology										1			01
29.	Quality standards			1				1						03
30.	Quality assurance	1				2								04

TableA2: List of constructs for Retailer

Sr. No.	Constructs (Issues/constructs)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	Frequency
1.	Life cycle quality		2						1			1		04
2.	Quality of resources					1					1			02
3.	Prompt delivery	2		1				1						05
4.	Quality of packaging		1				1							02
5.	Quality of handling				2				1			1	1	06
6.	Delivery of fresh produce to customer										1			01
7.	Quality of transportation			1				1						03
8.	Distribution quality	1				2								04
9.	Personnel quality								3					05
10.	Training to labor			2				3				1		06
11.	Quality of communication	1				2					1			05
12.	Quality of sales forecast	1												01
13.	Data accuracy			1										02
14.	Traceability within supply chain		1											01
15.	Reliability in product supply													08
16.	Responsiveness							1						01

Sr. No.	Constructs (Issues/constructs)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	Frequency
17.	Profit					1								01
18.	Volume flexibility in product availability		1											01
19.	Environmental quality		2											03
20.	Economic sustainability			1						1				04
21.	Collaboration quality							1						01
22.	Quality of co-ordination	1					1							02
23.	Commitment	1			1					2				04
24.	Pricing according to quality of product											1		01
25.	Brand awareness										1			01
26.	Inventory cost					1								01
27.	Quality standards			1				1						02
28.	Quality while competitiveness						1							01
29.	Appearance quality				2								1	04

TableA3: List of constructs for Customer

Sr. No.	Constructs (Issues/constructs)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	Frequency
1.	Prompt delivery	1												01
2.	Product quality			1									1	02
3.	Delivery of fresh produce	1		2				1						08
4.	Quality of facility location		1				1				1			04
5.	Quality of communication								2			1		04
6.	Volume flexibility of product		1				1							02
7.	Responsiveness					1								01
8.	Reliability in product supply	1									1			02
9.	Quality of customer satisfaction		1					1						02
10.	Collaboration quality	1												01
11.	Quality of co-ordination			1									1	02
12.	Commitment										1			01
13.	Pricing according to quality of product		1						1					02
14.	Brand awareness	1												01

Appendix B

Survey Questionnaire

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Survey Questionnaire (Farmer/Supplier)

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Introduction: Academic researchers / consultants/ organizations have proposed various constructs for managing Agri- fresh Supply Chain Quality (AFSCQ), which are available in literature. Supply chain quality is defined as a set of practices that emphasize continuous process improvement among partners (firms) in the supply chain in order to enhance performance and achieve customer satisfaction through emphasis on learning. The constructs for the same were identified from extant literature. Hence, the aim of this study is given below:

Aim: **Evaluating reliability and validity of constructs for managing Agri-fresh Food Supply Chain Quality**

==========

General-Information:

==========

Name of respondent (optional):

Respondent's designation:

Duration connected with wholesaler:

Indicate the importance of following factors for ensuring supply chain quality.

The level of importance is on 1 to 5 scales:

1: Extremely Important **2: Important** **3: Neither important nor unimportant**

4: Unimportant **5: Extremely unimportant**

Sr. No.	MEASURE	1	2	3	4	5
1	Quality of use of raw material (How important is the use of good quality seed and pesticides in farming?)					
2	Hygiene quality in farming (How important is it to maintain the quality of hygiene in farming?)					
3	Life cycle quality (How important is to maintain shelf life of produce reaching up to the Wholesaler / Retailer?)					
4	Quality of packaging (How important is the goods packaging and carrying system for produce transportation to Wholesaler/ Retailer?)					
5	Quality of handling (How important is the correct handling of produce during harvesting and in logistic in sense of product safety?)					
6	Delivery of fresh produce to wholesaler/retailer (How important is it to maintain freshness of produce until it reaches wholesaler?)					
7	Quality of transport medium (How important is it to have quality of transport medium for a product to be delivered to Wholesaler/ Retailer?)					

8	Training to labor (How important is it to give training to the labor?)					
9	Quality of communication or information (How important is it to have a good communication system for information sharing with Wholesaler/ Retailer?)					
10	Sales forecast (How important is to use of sales forecasting for product demand?)					
11	Data accuracy (How much important is it to maintain the accurate data within your system?)					
12	Responsiveness (How important is to have high responsiveness for any fluctuations in customer requirement?)					
13	Economic sustainability (How important is the economic sustainability in supply chain so as to ensure reliability of payment of money on time and in correct amount?)					
14	Quality assurance (How important is it to supply as per specification given by Wholesaler/Retailer)					
15	Volume flexibility in produce availability (How important is to have flexibility in product availability for catering variation in demand?)					
16	Quality of awareness about the produce (How important is it to create general awareness about ensuring good quality of produce?)					
17	Environmental quality (How important are the conducive environmental conditions while maintaining quality of product?)					
18	Collaboration quality (How important is it to have good collaboration practices with partners in your supply chain?)					
19	Commitment (How important is it for you to fulfill the commitment?)					
20	Payment according to quality of product (How important is it to have payment according to quality of product?)					
21	Production cost (How much important is the production cost for ensuring supply chain quality?)					
22	Inventory cost (How much important is to control inventory cost for ensuring supply chain quality?)					
23	Personnel quality (How important is it to have skilled personnel?)					
24	Minimum pesticides residue (How much important is use of minimum pesticide residue in farming?)					
25	Use of biotechnology (How much important is the use of biotechnology in agri-fresh produce?)					
26	Quality standards					

	(How much important is to meet quality standards in farming?)					

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Survey Questionnaire (Wholesaler)

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Introduction: Academic researchers / consultants/ organizations have proposed various constructs for managing Agri- fresh Supply Chain Quality (AFSCQ), which are available in literature. Supply chain quality is defined as a set of practices that emphasize continuous process improvement among partners (firms) in the supply chain in order to enhance performance and achieve customer satisfaction through emphasis on learning. The constructs for the same were identified from extant literature. Hence, the aim of this study is given below:

Aim: **Evaluating reliability and validity of constructs for managing Agri-fresh Food Supply Chain Quality.**

==========

General Information:

==========

Company's name:
Name of respondent (optional):
Respondents Designation:
Experience in Industry:

Indicate the importance of following factors for ensuring supply chain quality.

The level of importance is on 1 to 5 scales:

1: Extremely important **2: Important** **3: Neither important nor unimportant**
4: Unimportant **5: Extremely unimportant**

Sr. No.	MEASURE	1	2	3	4	5
1	Life cycle quality (How important is to maintain shelf life of produce reaching up to the retailer?)					
2	Quality of resources (How important is it to use the own resources to improve supply chain)					
3	Prompt delivery (How much important is the delivery of product from farmer and to retailer within time?)					
4	Quality of packaging (How important is the goods packaging and carrying system for produce transportation to retailer?)					
5	Quality of handling (How important is the handling of product in logistic in sense of product safety?)					
6	Quality of Transportation (How important is it to use good quality transport medium?)					
7	Delivery of fresh produce to Retailer (How much important is to give a good delivery to the retailer such that chance of spoilage of product is low?)					
8	Distribution quality (How important is to have a well planned system for delivering product to the retailer?)					

9	Personnel quality (How important is it to have skilled labor in the system?)					
10	Training to labor (How important is it to give training to the labor?)					
11	Quality of Communication (How important is it to have a good communication system for information sharing with grower, retailer and customer?)					
12	Quality of sales forecast (How important is the sales forecast techniques used by the wholesaler for forecasting demand?)					
13	Data accuracy (How much important is it to maintain the accurate data within your system?)					
14	Traceability within supply chain (How important is it to maintain traceability of your product within the supply chain?)					
15	E-commerce (How much important is to use e-commerce for improve supply chain quality)					
16	Volume Flexibility in product availability (How much importance to change the sale of volume of product according to demand?)					
17	Responsiveness (How important is it to quickly address retailer complaints regarding customer requirement, product quality, delivery etc.?)					
18	Profit (How important is to share of profit among the members?)					
19	Environmental Quality (How important are the environmental conditions while maintaining quality of product?)					
20	Economic sustainability (How important is the economic sustainability in supply chain so as to ensure reliability of payment of money on time and in correct amount?)					
21	Collaboration Quality (How important is it to have good collaboration practices with partners in your supply chain?)					
22	Commitment (How important is it for you to fulfill the commitment?)					
23	Quality of coordination (How important is the coordination with retailer & grower for information sharing?)					
24	Pricing according to quality of product (How important is it to have pricing according to quality of product?)					
25	Brand awareness (How important is to create brand awareness in market?)					
26	Inventory cost (How much important is to control inventory cost for ensuring supply chain quality?)					
27	Minimum pesticides residue (How much important is use of minimum pesticide residue?)					
28	Use of Biotechnology					

	(How much important is the use of biotechnology in agri-fresh produce?)					
29	Quality standards (How much important is to meet quality standards for ensuring supply chain quality?)					
30	Quality assurance (How important is it to supply product as per specifications given by retailer?)					

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Survey Questionnaire (Retailer)

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Introduction: Academic researchers / consultants/ organizations have proposed various constructs for managing Agri-fresh Food Supply Chain Quality, which are available in literature. Supply chain quality is defined as a set of practices that emphasize continuous process improvement among partners (firms) in the supply chain in order to enhance performance and achieve customer satisfaction through emphasis on learning. The constructs for the same were identified from extant literature. Hence, the aim of this study is given below:

Aim: **Evaluating reliability and validity of constructs for managing Agri-fresh Food Supply Chain Quality.**

==========

General Information:

==========

Company's name:
Name of respondent (optional):
Respondent's designation:
Experience in Industry:

Indicate the importance of following factors for ensuring supply chain quality.

The level of importance is on 1 to 5 scales:

1: Extremely important **2: Important** **3: Neither important nor unimportant**
4: Unimportant **5: Extremely unimportant**

Sr. No.	MEASURE	1	2	3	4	5
1	Life cycle quality (How important is to maintain shelf life of produce reaching up to the customer?)					
2	Quality of resources (How important is it to use the own resources to improve supply chain)					
3	Prompt delivery (How much important is the delivery of product from farmer/wholesaler within time?)					
4	Quality of packaging (How important is the goods packaging and carrying system for produce transportation to customer?)					
5	Quality of handling (How important is the handling of product in logistic in sense of product safety?)					
6	Delivery of fresh produce to customer (How important is it to maintain freshness of produce until it reaches to customer?)					
7	Quality of transportation (How important is it to use good quality transport medium?)					
8	Distribution quality (How important is to have a well planned system for delivering product to the customer?)					

9	Personnel quality (How important is it to have skilled labor in the system?)					
10	Training to labor (How important is it to give training to the labor?)					
11	Quality of communication (How important is it to have a good communication system for information sharing with Grower, Wholesaler and Customer?)					
12	Quality of sales forecast (How important is the sales forecast techniques used by the wholesaler for forecasting demand?)					
13	Data accuracy (How much important is it to maintain the accurate data within your system?)					
14	Traceability within supply chain (How important is it to maintain traceability of your product within the supply chain?)					
15	Reliability in product supply (How important is it to maintain reliable product supply to customer?)					
16	Responsiveness (How important is it to have high responsiveness regarding customer requirement, product quality, and customer complaints?)					
17	Profit (How important is to share of profit among the members?)					
18	Volume flexibility in product availability (How important is it to ensure product availability in supply chain according to fluctuating demand of product?)					
19	Environmental quality (How important are the environmental conditions while maintaining quality of product?)					
20	Economic sustainability (How important is the economic sustainability in supply chain so as to ensure reliability of payment of money on time and in correct amount?)					
21	Collaboration quality (How important is it to have good collaboration practices with partners in your supply chain?)					
22	Quality of co-ordination (How important is the coordination within supply chain members?)					
23	Commitment (How important is it for you to fulfill the commitment?)					
24	Pricing according to quality of product (How important is it to have pricing according to quality of product?)					
25	Brand awareness (How important is to create brand awareness in market?)					
26	Inventory cost (How much important is to control inventory cost for ensuring supply chain quality?)					
27	Quality standards (How much important is to meet quality standards?)					
28	Quality while competitiveness (How important is it to maintain the product quality in comparison to the competitor's product?)					
29	Appearance quality					

	(How important is it to ensure appearance quality of product?)					

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Survey Questionnaire (Customer)

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Introduction: Academic researchers / consultants/ organizations have proposed various constructs for managing Agri-fresh Food Supply Chain Quality, which are available in literature. Supply chain quality is defined as a set of practices that emphasize continuous process improvement among partners (firms) in the supply chain in order to enhance performance and achieve customer satisfaction through emphasis on learning. The constructs for the same were identified from extant literature. Hence, the aim of this study is given below:

Aim: **Evaluating reliability and validity of constructs for managing Agri-fresh Food Supply Chain Quality**

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General Information:

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Name of respondent (optional):

Respondent's area of living:

How long product used:

Indicate the importance of following factors for ensuring supply chain quality.

The level of importance is on 1 to 5 scales:

1: Extremely important **2: Important** **3: Neither important nor unimportant**

4: Unimportant **5: Extremely unimportant**

Sr. No.	MEASURE	1	2	3	4	5
1	Prompt delivery (How much important is the delivery of product from retailer within time?)					
2	Product quality (How important is it has a good quality product?)					
3	Delivery of fresh produce (How much important is to give a good delivery to you from retailer such that chance of spoilage of product is low?)					
4	Quality of facility location (How much important is the retailers location from your home?)					
5	Quality of communication (Please rate the importance of communication with retailer)					
6	Volume flexibility of product (How much important do you give to the factor that whether retailer can cater to your varying demand of quality or not?)					
7	Responsiveness (How important is it for your retailer responds to your complaints of product quality, delivery etc.?)					
8	Reliability in product supply (How important is it to maintain reliable product supply from retailer?)					
9	Quality of customer satisfaction					

	(How important do you give to satisfaction with product)					
10	Collaboration quality (How important is it to have good collaboration practices with partners in supply chain?)					
11	Quality of co-ordination (How important is it for you in sense of coordination between supply chain members?)					
12	Commitment (How important is it for you to fulfill the commitment?)					
13	Pricing according to quality of product (How important is it to have pricing according to quality of product?)					
14	Brand awareness (How important is to have brand awareness in market?)					