RESEARCHERID
THOMSON REUTERS

[Arunfred * *et al.*, 6(7): July, 2017]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

AN INTEGRATED APPROACH FOR TRACEABLE FOOD SUPPLY CHAIN MANAGEMENT

Dr. N. Arunfred[*1] & Dr. D. Kinslin[2]

[*1]Assistant Professor, Department of Management Studies, Nesamony Memorial College, Tamilnadu, India

Associate Professor, Faculty of Management Studies, Noorul Islam University, Kumaracoil, Tamilnadu, India

DOI: 10.5281/zenodo.829769

ABSTRACT

The recent ban imposed by the EU on Indian exports of mangoes and vegetables had a revealing story to be concerned with as a nation. Although predominantly an agricultural country, India is still far behind in adopting best farming practices with a major thrust on quality and safety of food. As a result of the recent crisis, exporters are reported to have lost money. In a larger context, this crisis also reveals the state of affairs in the supply chain management in our country. The paper is formulated to help the decision-makers to solve the statedproblems, by introducing a cooperate-centralised cluster approach that integrates simulation of fragmentedfood supply chains. It helps to access the qualitative expert and trace the food back to the farm. The paper addresses the key issues faced by different supply chain players in the distribution channel in Tamilnadu stating from farmers till it reaches the final customer.The models formulated have undergone expert opinion surveywith experts in the state of Tamilnadu on cluster sampling methodand is tested usingAnalytic Hierarchy Process (AHP)tool and the optimum model is presented. The paper presents an improved model with four key players (Packers, transporters, cold storage agent, 3PL service provider) and four stages of integration (baseline integration, functional integration, internal integration and external integration) which could be applicable for the state of Tamilnadu for the fruit and vegetable crops (Perishable produce).

KEYWORDS: Food supply chain management, perishable supply model, perishable produce, Distribution Channel, Food Traceability.

I. INTRODUCTION

Food Supply Chain are characterized by long lead times as well as production seasonality, legislation for food production/handling, strict shelf life constraints, and specific requirements for logistics processes like warehousing and transportation (van der Vorst, 2005).Traceability of food is essential in disaster management, particularly in the very early chaotic phases when demand and available resources are highly uncertain, information systems are disrupted, and communication between key players like farmers, intermediaries, retailers and customers is uneven (Moe,T 1998). Supply Chain Management (SCM) encompasses the planning and management of all activities involved in the sourcing, procurement, conversion and all logistical management activities (Burgess, K et al., 2006). The proposed model of Food SCM is intended to mitigate a major problem identified in the present supply chain by the key players. The key problems identified in the perishable channel are lack of following factors like credibility, communication, infrastructure, inventory control(Vorst,J.G.A.J et al., 1998). The model mainly addresses the immediate need of small and marginal farmers who face lot of problems which are concerned with the supply chain management. The main objective of this paper is to explore the possibility of using Third Party Logistics Providers (3PL's) for the provision of logistics services in the perishable supply chain. This research identified five logistical activities: procurement, warehousing, ordering, inventory and information system which form the main aspects of 3PL. We propose a new model of supply chain, in which the 3PL's procures the produce from the farmer(producer), do all logistical functions and distributeit to either distant or nearby market and sells it to end customers. The quality of the perishable produce will start to deteriorate immediately after the harvest, so it is the role of 3PL's to monitor, to protect the shelf-life of produce and to trace the produce during any criticality.We have tried to derive an optimal solution for the keysupply chain players in the perishable channel like farmers, intermediaries and

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

retailers through an improved model. The model of third party logistics aims at linking farmers with the retailer through proper distribution channel which will improve the profits of both farmers and retailers. The distribution channel is restructured based on the decentralised approach for each area based on the availability of crops based on the expert judgement from Tamilnadu. The paper is organised by briefing on the existing study in the area and then in the next section the methodology is explained. The detailed description of approved model by experts is presented in section 6

II. LITERATURE REVIEW

The term Agri-food supply chains (ASC) has been coined to describe the activities from production to distribution that bring agricultural or horticultural products from the farm to the table (Aramyan et al., 2006). Xiaoqiang Cai*et al.*,(2013), in their study elaborate on how the involvement of the 3PL provider could impact the supply chain, the model focused with deterministic demand, in which the decision maker aims to optimize the selling price and the order cycle length of inventory replenishment to maximize the average profit per unit time. Because of the vast distance between the production base and the target market, the transport time was long and usually quite unstable. Munzberg *et al.,* (2013) focus was solely applied in the areas of risk management or crisis management, some of them which hadn't been applied in FSCs. To support decision-makers facing these problems, this paper introduced a scenario-based approach that integrated simulation of disruptions in food supply chains, and qualitative expert assessment to develop consistent scenarios that demonstrated the consequences of different strategies. Rohit Joshi*et al.*,(2011) studied the performance improvement of the cold chain in an Indian context. The paper aimed to develop a benchmarking framework that evaluated the cold chain performance of a company, revealed its strengths and weaknesses. A Delphi-AHP-TOPSIS based methodology had divided the whole benchmarking into three stages. The first stage was the Delphi method, where identification, synthesis and prioritization of key performance factors and sub-factors are done, and a novel consistent measurement scale was developed. The second stage was the Analytic Hierarchy Process (AHP) that was based on a cold chain performance evaluation of a selected company against its competitors, so as to observe the cold chain performance of individual factors and sub-factors, as well as overall performance index. According to Frederiksen (2002), detailed step by step study in the supply chains is needed to better document each process. The food traceability is a pre-requisite to build a strong supply chain management.

Third Party Logistics (3PL), also known as logistics outsourcing or contract logistics and one of the most misinterpreted terms in supply chain management (Murphy& Wood, 2008). In the article Murphy argues that, 3PL is a long–term perspective arrangement, relationship between buyer and seller across range of industries. According to Delfman et al. (2003) Third Party Logistics (3PL), is a provider of logistics services that performs all or part of a client's company logistics, starting from procurement, ordering, warehousing (storage), transportation, inventory control, asset management, and information systems. Third Party Logistics Provider (3PL) is recognized as an integrated logistics provider, which offers a range of value added services like transport and storage, inventory control, maintenance activities, customs services, reverse logistics, processing orders etc. In this paper we have made an attempt to use the concept of 3PL in the perishable supply chain for the proper collaboration and coordination among different players.

III. NEED OF THE STUDY

The purpose of the study is to formulate a model on organised supply chain management for the perishable produce. The need for an improvement in the existing distribution channel is very crucial to mitigate the problems faced in the current supply chain. The case in point is the recent ban on Alphonsa mango by the European Union that has negatively impacted on the fruit export industry in Tamilnadu. The reason quoted is poor agricultural practice like over usage of pesticides and improper supply chain management to trace the produce. Few of other key issues faced by the current supply chain in the perishable management are listed below:

a. The amount of perishable produce is wasted in the country every year is found to be more than 30-40 percent of total production, accounting around 90 million tonnes of perishable produces
b. The usage of cold storage is limited for the perishable produce. The information related to the key players is very much limited related to the cold storage.
c. Increase in the nuclear farming activities among the farmers makes the collection of produce a difficult task mainly due to poor coordination.

d. The export share in fruits and vegetables is just 2 percent of total production because our products fail to meet global requirement standards
e. The organised retailers are finding it difficult to manage the fruit and vegetable market as there is a lack of transparency and dominance of middlemen
f. Traceability and critical evaluation methods are impossible in the present system.
g. In view of the above, an improved supply chain management is proposed in this paper

IV. METHODOLOGY

This paper aims to develop a framework that would enable to evaluate the performance of new supply chain model and thereby, reveal its strengths and weaknesses, related to the state of Tamilnadu.Based on the sample responses from the experts and though decision tools, the model is validated. A Delphi-AHP based methodology is followed. It divides the whole benchmarking into two stages. The first stage is Delphi method, where identification, synthesis and prioritization of key performance factors and sub-factors are done and a novel consistent measurement scale is developed. The Delphi technique is elaborated in the perspective to reduce layers of intermediaries and to develop an objective oriented value added perishable supply chain. Based on the study of problems faced by the farmers in the distribution channel the sub factors are identified as packers, transporters, cold storage agent and 3PL.The Delphi Study was administeredin the area of Tamilnadu with a sample of 50 respondents. The sample is drawn from the 6 categories through detailed questionnaire, viz. agricultural academicians, politicians, Farmer's association leaders, traders, bank managers and retailers, based on cluster sampling approach. Based on the preferencefrom the experts by considering the strengths and weaknesses of different models (Government model, Private model, Contract model) resultsare validated usingAHP model which is discussed in section below.

V. AHP MODELLING

An Analytic Hierarchy Process (AHP) based model is developed, so as to observe the perishable model of individual factors and sub-factors, as well as overall performance index. The advantages of AHP over other multi criteria methods are spontaneous appeal to the decision makers, its flexibility and its ability to check consistencies (Ramanathan 2001).By calculating the geometric mean of the individual pairwise comparisons the AHP method supports group decision−making through consensus (Zahir 1999). It is capable of deriving scales where ordinary measurement is not possible (Millet & Wedley 2002).In the paper AHP has been described at three levels. Level 0 is the perishable supply chain which isto be developed in the new model. At level 1 are four factors like packaging, transportation, cold storage and Third Party Logistics Provider (3PL) which is the new key players for revised model and the function of each key players is described in section 6. Level 2 is the three different types of proposed models like government, private and contract as shown in fig 1. The AHP model will be able to verify from the three models and identify the one that more appropriate model for perishable supply chain management. Individuals and groups use the AHP preference scale in table1 to form comparative matrix. The preference varies from maximum of 9 to minimum 1/9. Table 2 summarizes the attributes and model choices considered in the study. The preferences are compared as shown below.

<Table 1: Preference Made on the Performance Cycle>

< Table 2 CRITERIA AND ALTERNATIVES USED IN SELECTING THE Model>

<Fig 1 AHP model for the proposed system>

Steps in evaluating AHP model:

Step.1

Comparative matrix is developed using AHPand efficiency is validated. Table 3 shows criteria matrix for level 1 which is the preference among different functions (packaging, transportation, cold storage, 3PL). The table clearly suggests that from row weight 3PL service provider (0.652) is the key factor among all functions. Therefore the top most priority among key players is 3PL service provider followed by cold storage and transportation.

< Table 3 Criteria Matrix- Original Matrix (Level 1)>

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Step. 2

Table 4 shows criteria for level 2 decision making where different models government, private, contact are tested. The row wise weights clearly suggest that government control would be more effective model. Moreover fig 3 clearly gives the structural view of various preferences. This provides the diagrammatic view which suggests that to achieve level 0 the key factor in level 1 is 3PL service provider and the key player in level 2 is found to be with government. The detailed structure of accepted model based on the Government support is described in the section 7.

< Table 4 Criteria Matrix- Original Matrix (Level 2)>

< Table 5 Overall Score calculation)>

From table 5 the final score the following equation is derived as,
Y= 0.652 X1 +0.104 X2 +0.383 X3; (X1- Government, X2 -Private, X3 –Contract, Y- Perishable Supply Chain)
From the equation it is clear that to achieve a proper food supply chain management for perishables the study reveals that model 1 which is operated purely by horticulture board (government) is an ideal model (0.65). It has a clear advantage over contact (0.383) and private (0.104) in various aspects in packaging, transportation, cold storage and 3PL service provider. Bearing in mind the complexities and the layers of intermediaries, the experts opted that to have an organised supply chain management, horticulture board must be doing the 3PL activity as it can link and coordinate allied service like postal department and SHG who have close link to the rural agricultural base. Therefore the model of private and contract is rejected. Only the accepted government model and its detailed functions performed by each players are described in the following section. The figure 2 gives the overall picture about the preference of response by the experts in selecting each model.

<Fig 2 Overall score of each factors>

VI. CHARACTERISTICS OF SUPPLY CHAINKEY PLAYERS IN THE MODELLING FRAMEWORK

The players designed are based on the new proposed model of food supply chain management. The factors are framed based on the Delphi technique. This section covers role of new key players (Packers, transporter, Cold Chain, Third party logistics provider) in the supply chain and its functions to be performed in the new centralised cluster approach.

1. Packers and re packers

Packers transform loose product into a saleable product by packing it into cartons, boxes or bags as appropriate. Soon after the harvesting is done, the packers are directed by the 3PL service providers to the farm gate and perform their operation. Packers grade the produce based on size, colour and maturity fulfilling Good Management Practices (GMP). Based on different grades, type of transportation and the distance of transportation, the packing methods are selected. The packaging activity could be carried out by self-help groups in each rural area through proper training. The payment to the self-help group could be connected through bank as it functions now. This could eliminate the shortage in the demand of labourers. The demand, availability of the cold chain and cold storage are shared by the 3PL service provider and based on the above factors packers sort and pack the produce. The package varies from product to product, highly specialized designs that allow the produce to breath in the package. Eco- friendly package also makes the chain competitive.

2. Transporters

Transporting the perishable produce from one destination to other is the main task of the transportation. As the produce is perishable, the transporter is a key player. The transporter gets information from the 3PL service provider each day. With the network of logistics they have in an area, the produce could be collected and dispatched to the destination. The logistics agent is a key for the successful supply management. So there must be a dedicated logistics agent throughout the chain. The government logistics agents like post office is suggested by the experts for operating this logistics function. The government with private partnership should provide cold chain facility to the post offices and these post offices which have a concrete link in all rural area could collect the produce from the farm gate and could network to the destination of demand.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

3. Cold Chain

Storage of fresh produce is difficult, because the product is highly perishable. Therefore, the supply chain requires several climate-controlled environments for storage. Common types of storage for produce include cold storage and controlled-atmosphere storage. Cold storage generally refers to a refrigerated storage space that maintains temperatures less than 45° F (7° C). Controlled-atmosphere (CA) storage is accomplished by keeping the level of oxygen at about 5%, and carbon dioxide at 1% to 3% (Münzberg, T et al.,). Cold chain is a separate service provider (private-public partnership) operated independently in the supply chain with the coordination of 3PL service provider. They receive and send information related to the availability of space in the storage premises to the service provider. The produce is unloaded from the truck in the cold storage and the stock would be cleared based on first ripe first out procedure based on quality requirement.

4. Third party logistics service provider (3PL's)

In the proposed model, the third party is the key player in coordinating and controlling the chain. As we are more concerned about the small and marginal farmers, the optimum solution to control the chain is in the hands of government. As the private concerns would be focussed on the profit maximization, the plight of the small farmers will continue to worsen. The government with the guidance of agricultural universities and agriculture department must promote a separate department called 'Supply chain management'. This department must collect relevant data from all the sources and formulate a standard framework for each and every area on a decentralised basis.

Function of Third party logistics service provider:

a. **Business process:** The service provider must have the details of all the farmers and the type of crops grown. The farmers should grow only those crops that are recommended by the service provider. Service provider is responsible for the horizontal coordination among different small and marginal farmers in a particular area. The information related to soil testing, irrigation technique, pesticides are collected from the agricultural departments. With Good Agricultural Practices (GAP)a local practice is formulated and prescribed to the farmers in a data sheet. An inspection team to check the proper functioning of the standards is to be formed. It also incepts various other vertical key players like cold channel, packers, processors, retailers with farmer through information flow. This is the vertical coordination in the channel. At this level the service provider identifies what process to be linked with each key supply chain members in the chain.
b. **Management Components:** The service provider identifies the key members with whom to link the processes. The service provider provides information to each and every key players starting from packer to retailer. Information and communications technology (ICT's) is used by the service providers to supply only the required information to the particular key players. Management information systems like SAP and ERP could be used to collect and retrieve the data and provide information to the key chain members.

< Fig 3 Functions of 3PL service provider>

c. **Network Structure:** Level of integration and management should be applied for each process link in this phase. The service provider decides about the linking of vertical versus horizontal collaborations. As the model is based on demand based production, the information flow must start from the customer to grower and pull strategy of production is to be implemented. In this phase, each unique service provider must have the organisation structure and the roles/duties to be performed by each player must bespecifically described. The network must be created in such a way the information flow is even and transparent.

VII. DEFINITION OFMODELLING FOR PERISHABLE SUPPLY CHAIN:

As an organised supply chain is missing in the current perishable distribution channel, we have built an entirely innovative model from the existing one. The processes of integration of various key players are based on the supply chain concept to have a collaborative and transparent chain. Before formulating a supply chain model, the horticulture departmentshouldpromote an independent supply chain management department for perishable products based on the availability of produce.

<Fig 4: Supply chain Integration>

The board must function to regulate all the activities of the area locally. The horticulture board functions as the 3PL logistics service provider. The step by step procedure to implement the new supply chain management in an area is given below:

- **Step I Baseline integration**

After the identification of all perishable growers in an area, the first process is collaborating among themselves. The current practice of farmer's associations has been unsuccessful in many areas due to various factors. The task of integration must be done by the 3PL service provider. The service provider must have the control over the farmers in selecting the crop variety to be planted for the season. Therefore there is no need of an association among farmers instead the service provider bring uniformity in the perishable produce. This helps the group of small farmers to have a uniform output in large quantities. The process of crop selection is carried out through research work on soil testing on a particular area. This helps in the horizontal integration of supply chain management. The service provider also provides guidelines based on the Good Agricultural Practices (GAP) and Good Management Practices (GMP) to have a quality produce (Morris, M. L. 2007).

- **Step II Functional integration**

After the baseline is regulated now various functions must be controlled. The current supply chain is dominated with different intermediaries performing similar functions. The next task of the 3PLservice provider is to eliminate various intermediaries performing similar functions and convert them into separate business functionalities. For example, brokers and agents who have experience in the supply chain could be converted to a package business house. Such agents would only perform packing business. Similarly the service providers must organise cold chain logistic agent or retailer based on their functionality. In this process, the service provider could insist on the functional house to follow GMP practices.

- **Step III: Internal integration**

After the horizontal integration is over in terms of different business functions, the next process is integration of all key players. The integration process is fully controlled by the service provider. The service provider gives link to each and every business functionality by flow of information. The information flows from customer to the grower through the third party service provider. The integration is possible by ICT's aided with supply chain management software. Some of popular software for SCM areAMR, SAP, PeopleSoft, Oracle, i2, J.D. Edwards, Baan, Manugistics, etc., (Modrák, V., & Kiss, I. 2005). In this phase, the chain gets vertical integration of all business functions. This process can be monitored byHazard analysis and critical control points(HACCP) standard (Hulebak, K. L., & Schlosser, W. 2002).

- **Step IV: External integration**

After service provider successfully implements the vertical integration, the next process is collaborating with other service provider in the next area. Once the vertical integration is done the process of external integration would be taken care of by the supply chain management software for external integration. External integration must be done only with other service providers who follow the same process of integration. This process helps the perishable produce to travel along long distancescrossing borders. This integration also promotes export as the channel follow global standardisations like HACCP and GAP.

VIII. FRAMEWORKMODELLING FOR PERISHABLE SUPPLY CHAIN

Supply chains can be managed as a single entity through the dominant member or,alternatively, through a system of partnerships requiring well-developed cooperation andcoordination. Formulating supply chain objectives is therefore not an easy task since all partners share to agree on the selection of indicators, the definition of the indicators and the targetvalues.

In the supply chain model, each and every process is controlled by the 3PL service provider. The model is a centralised approach with all the activities coordinated and controlled by the one key supply chain player. The risk and return are fully borne by the service provider. Soon after the produce reaches harvest, the product transfers ownership to the service provider. The service provider communicates the amount of goods to be packed by the packer. Based on the amount of goods packed, the packing business unit gets payment in their bank account. The farmers also get money paid for their produce according to the market price to their respective accounts.

<**Fig 5: Block diagram of proposed model**>

- Then in the farm gate, the transporting agent (postal service) collects the fresh produce and delivers either to retail market or to the cold storage. As the cold transit and transportation is controlled by the

postal logistics service linking the rural place is easy as they have logistics throughout the rural area. On a monthly basis the price could be settled on a contract basis to the logistics provider. Finally the product is transferred to the retailer and the service provider gets the profit or else the service provider himself sells through his own retail chain. The service provider also links the financial provider to help all the key players throughout the chain in all operations.

<Fig 6: Operation of proposed food SCM modelling>

IX. BENEFITS

- Risk Management: The risk from the farmers is eliminated completely. The risk of loss of perishable produce is transferred from the farmer to the service provider soon after harvest and the farmer bear the risk only during cultivation which could be covered by crop insurance. Each key player would perform only his functions and the risk is taken up by the 3P service provider as he owns the produce till it reaches the retailer.
- Coordination and Collaboration: The collaboration with each key player would be more evident due to the centralised approach in the model. As suggested by the key players in the current supply chain, collaboration within vertical functions is the key for proper supply chain management. Thus the model provides a lot of scope for coordination and transfer of information.
- Elimination of layers of middlemen: The model eliminates layers of intermediaries and 3PL service provider only acts as a single efficient middle man.
- Food security and traceability: The model follows global standardisations like GAP, GMP and HACCP making the food more secure. The food can even be traced as they are packed and labelled at the farm gate.
- Information exchange: The information flow is easy and the needed information is transferred only to the key chain players. Currently there is a lot of information and no optimum information is provided.
- Pricing: The prices to each key player are fixed by the 3P service provider. The price structure is transparent and it is transferred through bank accounts.
- Cold channel: Cold channel is built for each distinct supply chain. This improves the quality and shelf life of produce. This creates the demand for perishable produce in the export markets.

X. CONCLUSION

A new model is established to address the supply chain management problems of a perishable product that involves long distance transportation, fragmented market and layers of intermediaries. Both types of perish-ability, risk management and obsolescence are considered. A demand based production is formulated, where the market size and the price are assumed to be functions of the product freshness to capture the sensitivity of the market demand to the product's freshness. The model addresses all the present problems faced by the key players in terms of supply chain management. The 3PL service provider being a government organisation helps in providing an optimum solution to the problems faced by the small and marginal farmers. The government logistics (postal service) which is covered throughout the rural area is facing threat due to the technological advancement and reduced users of postal services. Adding postal department with agricultural department for logistical activity makes sense instead of being converted to banking sector

XI. REFERENCES

[1] Aramyan, C., Ondersteijn, O., van Kooten, O., Lansink, A.O., 2006. Performance indicators in agri-food production chains. In: Quantifying the Agri-Food Supply Chain. Springer, Netherlands (Chapter 5), pp. 49–66.
[2] Burgess, K., Singh, P. J., & Koroglu, R. (2006). Supply chain management: a structured literature review and implications for future research. International Journal of Operations & Production Management, 26(7), 703-729.
[3] Charles X. Wang, (2002) "A general framework of supply chain contract models", Supply Chain Management: An International Journal, Vol. 7 Issn: 5, pp.302 – 310.
[4] Christopher, M. and Peck, H. (2004): Building the resilient supply chain, International Journal of Logistics Management, Vol. 15, No. 2, pp. 1-13
[5] Christopher, M., 2005. Logistics and Supply Chain Management. Prentice Hall, London.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

[6] David L. Olson, Desheng Wu, (2011) "Risk management models for supply chain: a scenario analysis of outsourcing to China", Supply Chain Management: An International Journal, Vol. 16 Issn: 6, pp.401 – 408.
[7] Delfmann, W., Albers, S., & Gehring, M. (2003). The impact of electronic commerce on logistics service providers. International Journal of Physical Distribution & Logistics Management, Vol. 32 No. 3, 203-22.
[8] Frederiksen, M., Osterberg, C., Silberg, S., Larsen, E., & Bremner, A. (2002). Info-Fisk. Development and validation of an internet based traceability system in a Danish domestic fresh fish chain. Journal of Aquatic Food Product Technology, 11(2), 13-34.
[9] Ho, W. and Emrouznejad, A., (2009), "Multi-criteria logistics distribution design using SAS/OR,". Expert Systems with Applications, 36, 7288-7298.
[10] Hulebak, K. L., & Schlosser, W. (2002). Hazard analysis and critical control point (HACCP) history and conceptual overview. Risk Analysis, 22(3), 547-552.
[11] Jake M. Kosior, Doug Strong, (2006) "Supply/demand chain modelling utilizing logistical-based costing", Journal of Enterprise Information Management, Vol. 19 Issn: 3, pp.346 – 360.
[12] L. Manning, R.N. Baines, S.A. Chadd, (2006) "Quality assurance models in the food supply chain", British Food Journal, Vol. 108 Issn: 2, pp.91 – 104.
[13] L. Manning, R.N. Baines, S.A. Chadd, (2006) "Quality assurance models in the food supply chain", British Food Journal, Vol. 108 Issn: 2, pp.91 – 104.
[14] Macharis, C., Springael J., De Brucker, K., Verbeke, A. 2004: Promethee and AHP: The design of operational synergies in multicriteria analysis. Strengthening Promethee with ideas of AHP. European Journal of Operational Research 153: 307−317.
[15] Millet, I., Wedley, W.C., 2002: Modelling Risk and Uncertainty with the Analytic Hierarchy Process. Journal of Multi−Criteria Decision Analysis, 11: 97−107.
[16] Modrák, V., & Kiss, I. (2005). Information and communication technology in Supply Chain. Management. Advanced Topics in Information Resources Management, 4, 251.
[17] Moe, T. (1998). Perspectives on traceability in food manufacture. Trends in Food Science & Technology, 9(5), 211-214.
[18] Mohammed Laeequddin, B.S. Sahay, Vinita Sahay, Kareem Abdul Waheed, (2012) "Trust building in supply chain partners relationship: an integrated conceptual model", Journal of Management Development, Vol. 31 Issn: 6, pp.550 – 564.
[19] Morris, M. L. (2007). Fertilizer use in African agriculture: Lessons learned and good practice guidelines. World bank Publications.
[20] Münzberg, T., Berbner, U., Comes, T., Friedrich, H., Groß, W., Pfohl, H. C., & Schultmann, F. Decision Support for Critical Infrastructure Disruptions: An Integrated Approach to Secure Food Supply.
[21] Murphy, Jr., P. R., & Wood, D. F. (2008). Contemporary Logistics. New Jersey: Pearson Prentice Hall.
[22] Omar Ahumada, J. Rene Villalobos (2009). Application of planning models in the agri-food supply chain: A review. European Journal of Operational Research 195 (2009) 1–20.
[23] Ramanathan, R., 2001: A note on the use of the analytic hierarchy process for environmental impact assessment. Journal of Environmental Management, 63: 27−35.
[24] Saaty, T.L., (1999), Decision Making for Leaders, 3rd ed., RWS Publications: Pittsburgh, PA Selçuk Perçin, (2006).
[25] Salin, V., 1998. Information technology in agri-food supply chains. International Food and Agribusiness Management Review 1 (3), 329– 334.
[26] Selviaridis, K., & Spring, M. (2007). Third party logistics: a literature review and research agenda. International Journal of Logistics Management, The, 18(1), 125-150.
[27] Vaidyanathan, G. (2005). A framework for evaluating third-party logistics. Communications of the ACM, 48(1), 89-94.
[28] Vorst, J. G. A. J., Beulens, A. J., Wit, W. D., & Beek, P. V. (1998). Supply chain management in food chains: improving performance by reducing uncertainty. International Transactions in Operational Research, 5(6), 487-499.
[29] Wang, X., & Li, D. (2006, June). Value added on food traceability: a supply chain management approach. In Service Operations and Logistics, and Informatics, 2006. SOLI'06. IEEE International Conference on (pp. 493-498). IEEE.
[30] William.C.W., Eng,U.G (2001), "Magnitude adjustment for AHP benefit/cost ratios", European Journal for Operations Research, Vol 133 No.2, pp 587-602

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

CITE AN ARTICLE

It will get done by IJESRT Team

Tables

Table 1: Preference Made on the Performance Cycle

	NUMERICAL RATING
Extremely Preferred	9
Very Strongly Preferred	7
Strongly Preferred	5
Moderately Preferred	3
Equally Preferred	1

Table 2: Criteria and Alternatives Used in Selecting the Model

Attributes	**Model 1 (Government)**	**Model 2 (Private)**	**Model 3 (Contract)**
3PL Service Provider	State Government	Private	Public-Private Partnership
Packaging	SHG	Private	Private
Transportation	Indian Postal Service	Courier Service	Local Agents
Cold Chain	Cooperative parties	Public-Private Partnership	Contract

Table 3: Criteria Matrix- Original Matrix (Level 1)

Original Matrix						
	Package	**Transportation**	**Cold Storage**	**Service provider**	**Eigen Value**	**Weights (Row Wise)**
Packaging	1	1/5	1/7	1/9	06.793	**0.0325**
Transportation	5	1	1/3	1/7	20.622	**0.0987**
Cold Storage	7	3	1	1/5	45.200	**0.216**
3PL Service Provider	9	7	5	1	136.410	**0.652**

Table 4: Criteria Matrix - Original Matrix (Level - 2)

Original Matrix					
	Government	**Private**	**Contract**	**Eigen Value**	**Weights (Row Wise)**
Packaging					
Government	1	9	3	43.8	**0.673**
Private	1/9	1	1/5	4.022	**0.061**
Contract	1/3	5	1	17.22	**0.264**
Transportation					
Government	1	7	3	45.0	**0.633**
Private	1/7	1	1/7	4.047	**0.062**
Contract	1/3	7	1	21.0	**0.304**
Cold Storage					

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Government	1	3	7	39.4	**0.649**
Private	1/3	1	5	16.74	**0.279**
Contract	1/7	1/5	1	4.18	**0.072**
Service Provider					
Government	1	9	3	49.28	**0.655**
Private	1/9	1	1/7	3.88	**0.055**
Contract	1/3	7	1	21.44	**0.289**

Table 5: Overall Score Calculation

	Packaging (0.032)	**Transportation (0.098)**	**Cold Storage (0.216)**	**Service Provider (0.652)**	**Final Score**
Government	0.67	0.633	0.649	0.655	**0.652**
Private	0.061	0.062	0.279	0.055	**0.104**
Contract	0.264	0.304	0.72	0.289	**0.383**

Figures

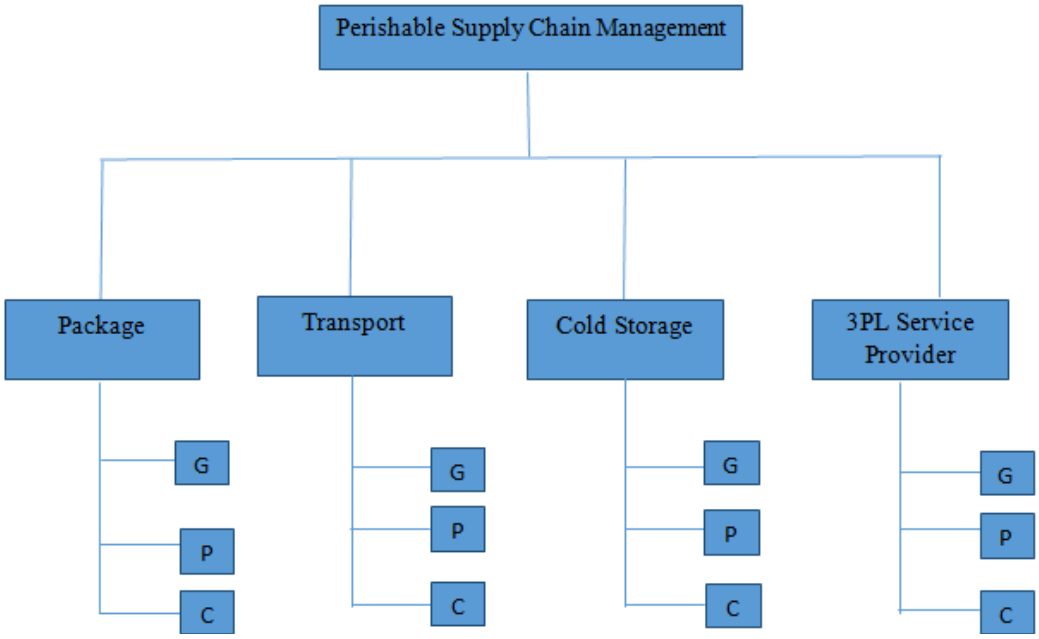

Fig 1: Hierarchy of Decision Making

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

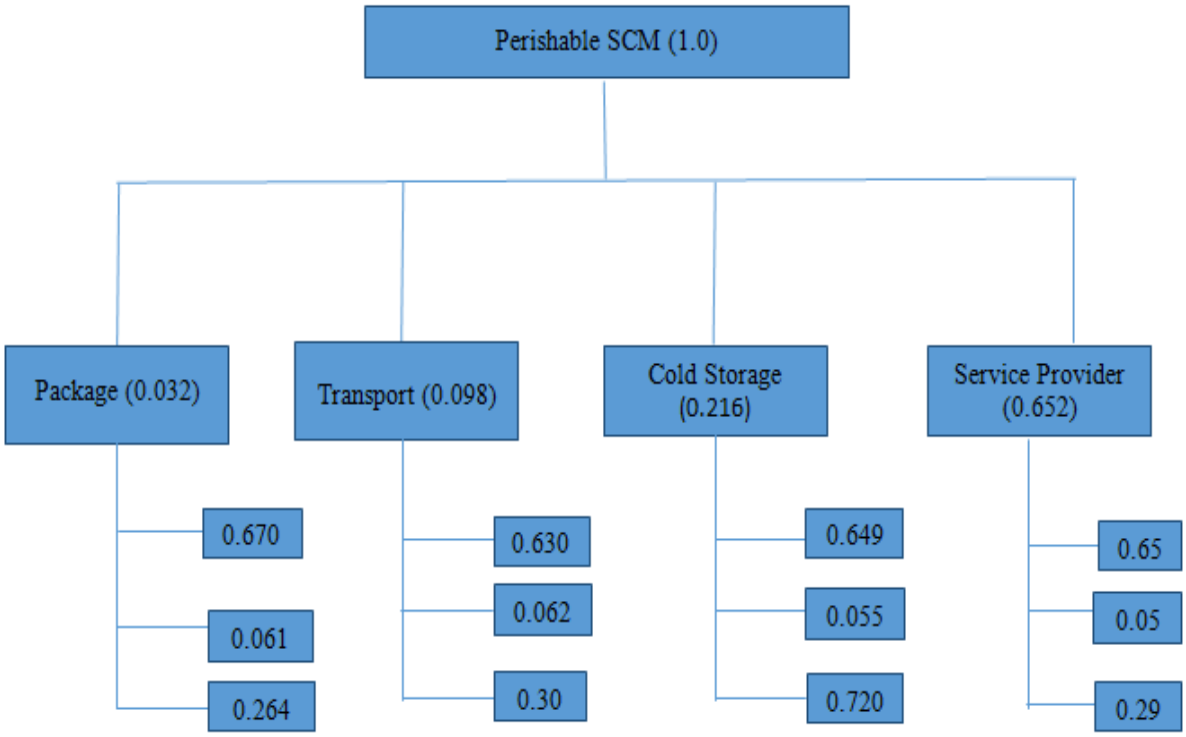

Fig 2: Overall Score of Each Factor

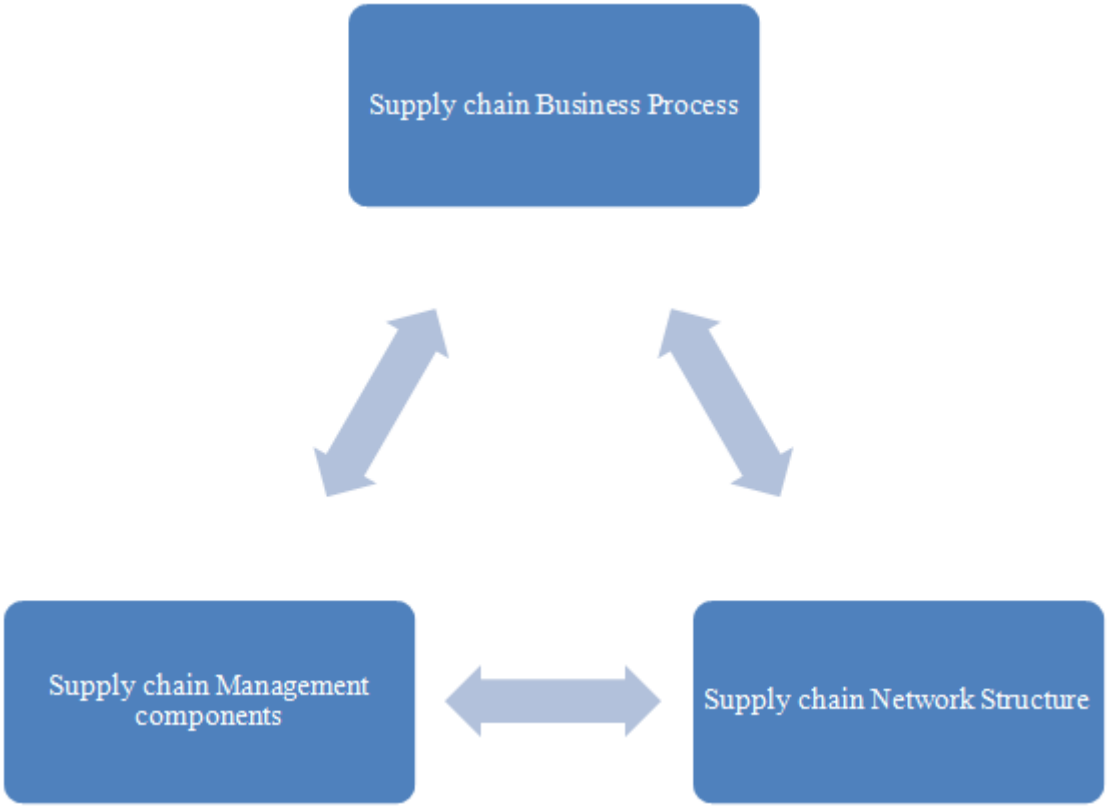

Fig. 3: Functions of 3P Service Provider

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

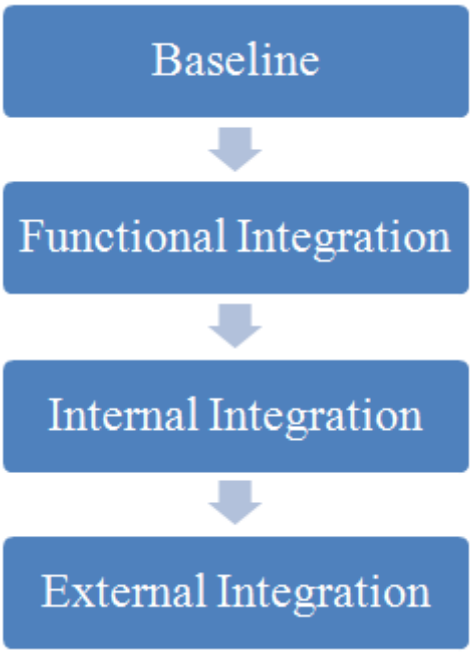

Fig. 4: Supply Chain Integration

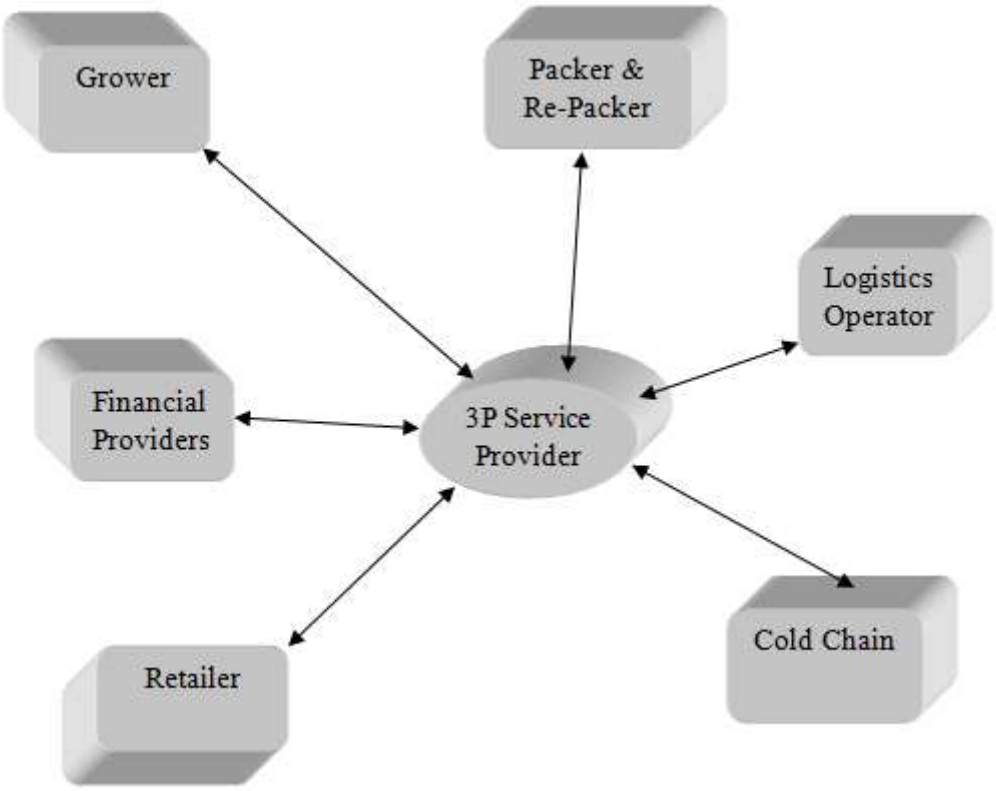

Fig. 5: Block Diagram of Proposed Model

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Fig. 6: Operation of Proposed Food SCM Modelling

CITE AN ARTICLE

Arunfred, N., Dr, and D. Kinslin, Dr. "AN INTEGRATED APPROACH FOR TRACEABLE FOOD SUPPLY CHAIN MANAGEMENT." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 550-62. Web. 15 July 2017.