

Application of Mind Mapping Technique to Study the Fruits and Vegetables Processing Industry and Supply Chain^{*}

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Abstract

Supply chain management is a combination of many business processes and activities which are interacted together to reflect the holistic approach. Mind mapping, being one of the best techniques, is used to break down the whole chain into various processes and activities, helping to think through various problems and then presenting the information in a format that shows the overall structure of the subject after consolidating information from different research sources. In this study, mainly three organizations, Hungarian Interprofessional Organization for Fruit and Vegetables, Garten Ltd. and Callidatis Kft. were selected. These organizations are currently attached with and working at various parts of the whole supply chain from the availability of fruits and vegetables through processing to the integrated logistics management.

Mind mapping technique was applied as a reverse tool and a research method to break down the whole supply chain of fruits and vegetables into various processes, activities and units involved and mind maps have been developed, which, thereby, also helped to chalk out the current gaps being experienced, after analyzing the AS-IS and TO-BE approaches. On the basis of these mind maps, more than 90 questions have been prepared, which were related to different steps involved in the whole chain from farm-gate to the supermarkets. These questions were then used as bases to take interviews from the management of those organizations and exploring the information, required to format overall structure of supply chain management of fruits and vegetables as a holistic approach.

Keywords: Supply chain management; mind mapping technique; farm-gate; processing; integrated logistics management.

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1. Introduction

Fruits and vegetables are perishable in nature and cannot be stored for longer periods, which resulted in very sensitive and complicated trading of these horticultural commodities and exposing big challenges to suppliers, processors and traders. Therefore, to cope with these challenges and to establish consistent and sustainable supply system, a Farm-To-Fork approach, currently transformed as Supply Chain Management (SCM) is the only way out to be practiced. SCM is a complicated network of suppliers, manufacturing centers and retail outlets as well as raw materials, work-in-process inventory and finished products that flow between the facilities and distributed at the right quantities, to the right locations and at the right time in order to minimize system-wide costs while satisfying service level requirements (Liang 2003).

As the thematic approach of SCM in this business is to reduce inventory, reduce the lead time, flow of efficient and accurate information, first time right, increase the transaction speed by exchanging data in real time, increase sales by implementing customer requirements more efficiently and to generate traceability of produce at each step to cope with product recalls and health risks. Therefore, the efficiency of supply chain in this scenario, generally depends upon the specified number of processing stages and costs and interactive working between these stages and above all, speeding up upstream and downstream flow of information (Persson and Olhager 2002; Mentzer 2004). In addition, the inconsistent availability of healthy fruits and vegetables from farm-gate to the consumers, continuous quality assurance push by the traders and supermarkets, competitive global environment, increasing trend of better supply by companies of other competitive countries and also more and more implications of quality standards (Fruit & Veb. 2008) are also some other parallel competitive elements making this business more vulnerable and complex.

An efficient application of SCM system of fruits and vegetables (Figure 1) has not been designed to its heart, so far, due to the lack of detailed study regarding standardization of particular methodology for the purpose to collect information of each business process and the problems involved throughout the whole chain. Therefore, keeping in view the appropriate objectivity and applicability and thereby prospective sustainability to solve many of the problems mentioned above, a research study was carried out to develop a new methodology in the form of a specific questionnaire, which helped to collect all the specific and closely interacted information related to supply chain management of these perishable horticultural commodities.

2. Review of Literature

Foods and food related businesses due to their ever demanding potential and direct link with living and health of mankind are the biggest industry in the world. From fruits and vegetables to cash crops, grocery to catering businesses, food processing

industry to the ultimate consumers etc., all these correlated entities require specific and consistent supply chain of raw to processed foods, in order to cater and to develop competitiveness and sustainability in the businesses. Number of scientists have contributed by studying and devising the methods and business processes required to play remarkable role for giving birth to integrated supply chain management. Chiappe and Herrero (1997) studied the status of supply chain management in Argentina's Food Industry. After conducting survey and collecting data from both suppliers and buyers at three levels of the supply chain, they found a significant difference of SCM on food availability, lead time and also the cost. Smith (2007) also studied the sustainable food supply chains and reviewed the opportunities available for food businesses to encourage consumers to eat healthier and more nutritious diets, to invest in more sustainable manufacturing and distribution systems and to develop procurement systems based on more sustainable forms of agriculture. Similarly Stringer and Hall (2006) studied the generic model of the integrated food supply chain to aid the investigation of food safety breakdowns and emphasized its importance in relation to the total food chain implications and not one stage in isolation.

Athapol and Ahmad (2008) also reviewed the current state of agri-food business in East Asian countries regarding food supply chain management and food safety and found that the developing countries of this region, have evolved supply chain into a high-tech robust end-to-end distribution system with increasing emphasis on customer satisfaction. Countries like Thailand, have responded to changing faces of global agri-business by employing modern techniques like RFID traceability system.

Talamini et al. (2005) studied the growing concern about food safety and found that supply chains play predominant role as the productive process, in this regard. Food safety management systems (CCFRA 2003) are now built on a detailed understanding of all input variables to the manufacturing process. The internationally recognized approach for assuring food safety is HACCP (Hazard Analysis Critical Control Point). This requires an intimate understanding of the interaction between process and product and the identification of critical control points in the manufacturing process, through distribution and storage and including consumer practices.

In the food chain, traceability is also becoming an essential part, particularly with raw materials, to establish the control procedures for any risk which could happen at any step during the whole line, such as beef labeling and genetically modified materials. The new EC Regulation 178/2000 has a number of specific requirements for enhanced traceability (EC 2002). Indeed, recent food scares such as BSE and the dioxin crisis have demonstrated the need to be able to identify the origins of food to ensure consumer protection. Traceability also facilitates trade or public recalls. Under the new EC regulations, food business operators will have to have systems in place enabling them to identify immediate supplier(s) and immediate customer(s) of their products. Keeping in view the importance of traceability, Jozsef et al. (2009) made a survey and found that the Hungarian fresh vegetable and fruit sector has gone through a huge change during the last

decade. The most important changes include: creation of producing organisations (Pos), the increase in the market share of the retail chains and the change in the consumers' behaviour in the case of vegetable and fruit.

SCM and IT are closely interacted with each other for the purpose to reduce lead time and other chain costs. Hojat and Mollazade (2009) studied this correlation of IT and development of food industry and emphasized that application of IT parameters, is very important and effective to develop food industry. The parameters which could play vital role, are eCRM, MRP, MRP II, ERP, eSCM, Data Base Application, DSS, SIS, MIS, Networking, and EDI and can help improve the planning of managers working at various levels in food industry. Similarly, Jari and Karjaluo (2006) studied that SCM and IT are two areas of research, which have attracted a lot of attention in academic and practitioner's camps over the last decades. The authors pinpointed that there is a lack of research which integrates this highly inconsistent and fragmented field and information technology based supply chain management attempts to provide a framework that helps managers and practitioners to tackle this phenomenon of integrated approach.

3. Methodology

This study was carried out in the Department of Information Systems, Corvinus university of Budapest. The main objective of this study was to devise a standardized questionnaire methodology to collect information, which thereby, could be used to examine the whole system of supply chain management of fruits and vegetables.

Mind mapping technique was used in this study. Due to its exploratory and qualitative nature (Mind Tools Ltd. 2010) and common understanding regarding the relationships between research questions (as a holistic approach), this tool/technique helped to drag out the detailed information, down to core level, by unknitting and splitting all the business processes, throughout the whole supply chain of fruits and vegetables, starting from harvesting and farm gate collection of fruits and vegetables through every step of processing, downstream to shipment and logistics and ultimately, to the markets. The information then helped to developing the mind maps of all these business process activities and sub-activities involved.

On the basis of the mind maps so developed, a specific and integrated linked questionnaire methodology, consisting of more than 90 questions has been developed. This questionnaire was then pre-tested by applying on three Hungarian organizations dealing with supply chain management of fruits and vegetables, such as Hungarian Interprofessional Organization for Fruit and Vegetables (Fruit & Veb), Budapest, Garten Ltd. Budapest and Callidatis Kft. Budapest. This research study is in progress and still this methodology is required to be standardized.

4. Results and Discussions

Being one of the most sensitive food commodities, the trading of fruits and vegetables require specific business processes, application of quality assurance standards and IT control in the whole supply chain. Risk and uncertainty have been the hallmark of these horticultural products and food business. A long gestation period, seasonal production, significant transportation and logistical costs, the low value/weight ratio, poor infrastructure and lack of any effective legal system to enforce fair trading, accentuates risk and uncertainty along the chain.

Supply chain of fruits and vegetables, which is a combination of mainly four starting from receiving the fruits or vegetables processing to shipment for the supermarkets and regular marketing, principally requires an integrated management. In order to chalk out and analyse the problems and gaps in the SCM of fruits and vegetables, the mind maps of each component process has been developed in this study, however, the major mind maps of this study are detailed below:

4.1. Receiving of fruits and vegetable

Receiving is the first step within an organization before starting processing and packaging of these horticultural commodities. The mind map of this process (Figure 2) was also designed to collect all those information which were used afterward to prepare various questions related to this process. These information included as: the name of produce and variety, time of harvest, season, time and date, origin and distance of origin from the processing unit, weight of produce, freight charges and duration of travel, total time consumed in transportation, name of grower and orchard, harvesting method, pricing, packaging type (plastic crates, bulk packing and containers), labour cost per man per hour to complete this process, number of persons involved, total time used in receiving per ton of produce and total distance travelled and type of vehicle used. The pesticides may also cause some risk to human health, therefore, the information regarding pesticides such as name, date and time of use, name of active ingredient present and doses and times to apply are also the most important activities to be documented while receiving these products.

As good quality raw material always results in highly acceptable final product. Therefore, the apparent quality of fruits and vegetables at the time of receiving is also vital important in order to keep the sustainable flow of produce downstream throughout the supply chain. The information incorporated in this mind map regarding quality parameters of these living commodities were included as color, appearance, sizes (A, B and C Grades), flavor, peel thickness of fruits, texture or firmness and field heat or temperature of produce at the time of receiving.

4.2. Washing

Washing is the next important and vital process before grading and packing which, thereby, results in downstream maintenance of good quality produce throughout whole supply chain. Fresh fruits and vegetables have so many health benefits, but

they can also be a source of pesticide residues and bacterial contamination that can lead to food borne illness unless precautions are taken.

The mind map in Figure 3 depicts the details of all activities which are associated with washing of fruits and vegetables. These activities are washing methods both manual or mechanical (conveyor washing, rotary washing or perforated table washing), cold water or hot water washing, quality of water used, use of any antimicrobial agent or sanitizer in water, training of staff for washing of each produce, basic and personal hygiene, washing capacity of a unit, time used and the standard time of washing per ton of produce, hot air or forced air drying at ambient temperature etc. As each process in supply chain management has its own individuality and importance, therefore, the management of data-base or documentation regarding all activities of this process is also highly important to trace back if any product recall could occur.

4.3. Storage and shipment

In this mind map (Figure 4) the information related to various activities carried out during storage and shipment of these horticultural commodities have been collected as nodes and siblings of this mind map. These information included as space or capacity of finished goods store, hygienic conditions of store, training of staff for hygienic and cleanliness of storage area, supervision and monitoring to observe hygienic and occupational rules, fly proofing of main entrance, display of working instructions in store area, palleting and stacking height and size of each produce, any special space for particular produce, type of packing for bulk storage, tagging or identification mark, temperature and humidity required to be maintained for storing each produce.

Similarly, other important information required are: air flow, store insulation, thermostat quality and operation and periodic checkup of thermostat for accuracy, storage time and duration for each produce, refrigeration system to be used, storage cost of each produce, type of forklift (electric or hand forklift) to be used.

5. Conclusion

Fresh fruits and vegetables processing, trading and marketing require some vital support of integrated supply chain management system. Whereas, due to its perishable nature and more consistent application of quality standards, the organizations involved in business of these horticultural commodities have to face some colossal problems. Therefore, the main purpose of this research study was to collect information regarding current processing practices. For this purpose, a technique of mind mapping was applied as a new method for this field due to common understanding. As this research was more exploratory and qualitative, therefore, the mind maps so developed helped to collect information of each component part of processing flow which thereby resulted in generating more than ninety various questions. These questions then can be used to collect information regarding the current

supply chain system, problems and to devise certain required business processes.

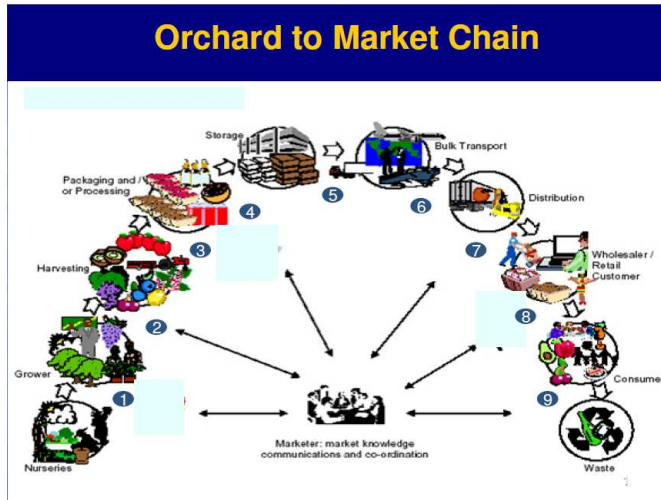


Figure 1

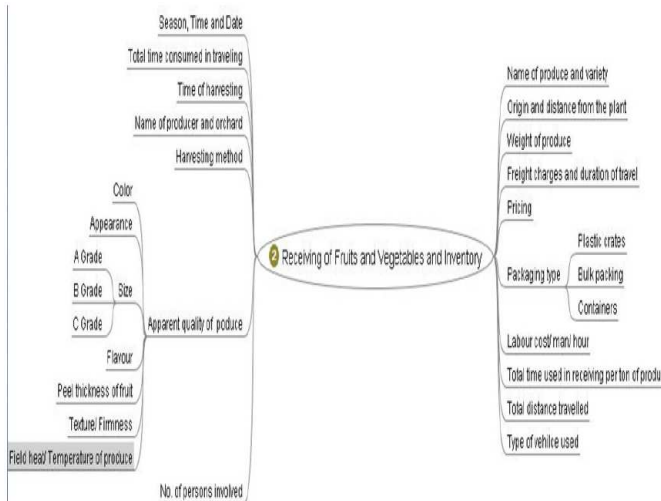


Figure 2

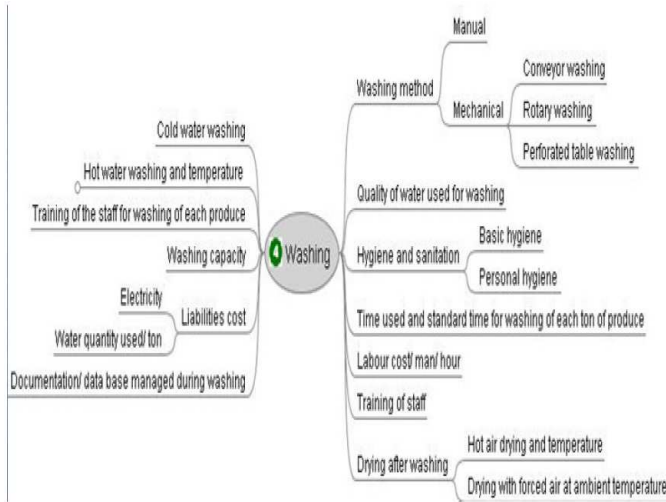


Figure 3

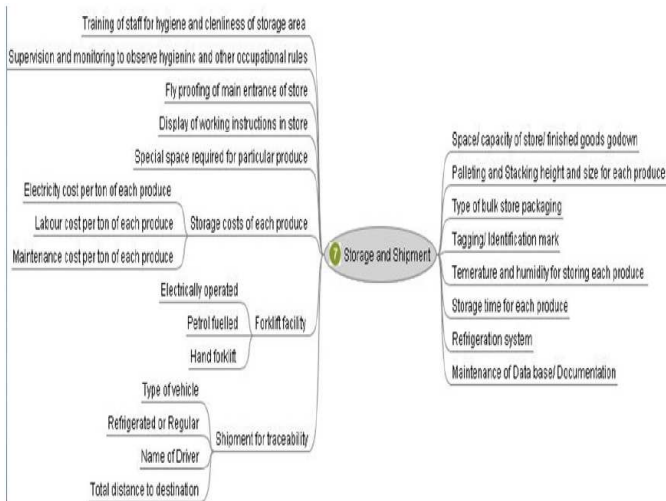


Figure 4

References

- [1] Athapol, N. and A. Imran (2008). "Food Supply Chain Management and Food Safety: South & East-Asia Scenario". Journal of Agriculture Information Research. (17:4), pp. 131-136.
- [2] Bachmann J. and R. Earles (2000). Postharvest Handling of Fruits and Vegetables. Horticulture Technical Note. Appropriate Technology Transfer for Rural Areas. USDA Rural Business-Cooperative Service.

- [3] CCFRA (2003). HACCP: A Practical Guide. Guideline No. 42, Campden and Chorleywood Food Research Association Group.
- [4] Chiappe I.S. and V.A (1997). Herrero. "The Status of Supply Chain Management in Argentina's Food Industry". *The International Journal of Logistics Management*. (8:1), pp. 87–96.
- [5] EC (2002). "Laying down the general principals and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. Logistics Integration Processes in the Food Industry". Regulation (EC) No. 178/2002 of the European Parliament and of the Council.
- [6] Fruit & Veb (2008). Annual Report of Hungarian Fruit and Vegetable Sector. Hungarian Interprofessional Organization for Fruit and Vegetables, Budapest.
- [7] Hojat A. and K. Mollazade (2009). "Determination and investigation of information technology parameters effective to food industry development". *Journal of Theoretical Applied Information Technology*. pp. 476–485.
- [8] József L., B I. Csaba, N. Komáromi and Z. Lehota (2009). "Development of Traceability in Hungarian fresh vegetable and fruit sector". *4th Aspects and Visions of Applied Economics and Informatics*. March 26–27, pp. 446–452.
- [9] Liang, J (2003). "Supply chain management, applied to the grocery sector". *California Engineer*, (82:1), pp 11–15.
- [10] Mentzer, J.T (2004). *Supply Chain Managemen*. Thousand Oaks, CA:Sage.
- [11] Mind Tools Ltd (2009). "Mind Tools, Essential Skills for an Excellent Career". 2nd Floor 145-157 St John Street London.
- [12] Persson F and J. Olhager (2002). "Performance simulation of supply chain designs". *International Journal of Production Economics* (77), pp. 231–245.
- [13] Smith, G (2007). "Developing sustainable food supply chains". Unilever Research and Development, Colworth House, Sharnbrook, Bedford MK44 1LQ.
- [14] Stringer M.F. and M.N. Hall (2006). "The Breakdowns in Food Safety". Food Technology Division, Campden and Chorleywood Food Research Association, Chipping Campden, Gloucestershire, GL55 6LD, United Kingdom.
- [15] Talamini, E., E.A. Pedrozo and A.L. Silva (2005). "Supply chain management and food safety: exploratory research into Brazil's pork export supply chain". *Gestation Production*. (12:1), pp. 107–120.