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JIT applicability to balance supply chain and operations of fruits and vegetables processing industries

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Abstract
Fruits and vegetables are essential part of our food system. Wastage of these natural food product leads to economic loss for country as well as for human. The fruits and vegetable loss their nutritional values with time if handling and preservation is not efficient. Value chain for fresh fruits & vegetables describes range of activities from farm to fork. Fruit and vegetables are perishable commodities & these commodities are cheaper and better source for human nutrition requirement.

This study focuses on just in time tools that are used by industries to increase its operational efficiencies both backward as well forward to reduce their losses from supply chain and processing. JIT supply chain and JIT manufacturing elements acceptability is very necessary to reduce flow losses in system. This study is carried out to identify the number of JIT elements that contribute to the success of Small scale industries with special reference to fruit and vegetable industry.

This study is based on secondary data with more focus on food processing industry encompassing small scale sector. Result has been validated using t test. This study support the notion that Just in Time support the impression that JIT has potential to increase operational and supply chain efficiencies and effectiveness of fruit processing industries.

Keywords: just in time, supply chain, fruit processing industries, small scale sector

1. Introduction

Fruits and vegetables are essential part of our food system. Wastage of these natural food product leads to economic loss for country as well as for human. The fruits and vegetable loss their nutritional values with time if handling and preservation is not efficient. Value chain for fresh fruits & vegetables describes range of activities from farm to fork. Fruit and vegetables are perishable commodities & these commodities cheaper and better source for human nutrition requirement. If country is able to supply fresh and preserved for availability throughout year for human consumption, the national picture improves greatly. If we are able to process more and more fruits and vegetables we can reduce fresh market waste.

As per data collected from NHB India, it is found that India is second largest producer of fruit and vegetables. India's fruit production is 88.285 MT and vegetable production is 162.187 MT as NHB annual report 2014-15. India is sharing 14% of global fruit and vegetable production. It is found that more than 70 types of vegetables are grown in our country in which India's position is shown in table 1. Table shows that our fresh production is very high but the processing was 4% recorded only. So it is necessary that our supply chain of these fruits and vegetables should be closely link to processing units so that we can be reduce storage time losses like weight loss, handling loss, grading loss and over ripening losses, distribution losses.

Table 1: India's rank in world in fruit and vegetables

Commodity-Vegetables	India ranks in world	Commodity -fruits	India ranks in world
Brinjal	2	Apple	10
Cabbage	2	Banana	1
Cauliflower	2	Lemon	2
Onion	2	Citrus fruits	8
Peas	1	Orange	4
Tomato	6	Grapes	16
Potato	3	Mango	1
Sweet Potato	9	Papaya	5
Lettuce	5	Pineapple	5
Pumpkins/Gourda	2		
Beans	6		
Cassava	8		

***Source*:** Rais M, Sheoran A (2015) Scope of supply chain management in fruits and vegetable in India.

According to NHB it was found that growth in fruit production in 2014-15 was 3.9% and with respect to fruit processing sector 20% per annum. Whereas of vegetable production is less as compared to 2013-14 is 2.1% but due to growing export demand as well as domestic demand vegetable processing sector is growing 121% per annum and dehydrated fruits and vegetables section is growing with 24%. If we saw overall growth was very effective. In the mean time it is necessary that we grow production capacity of processing plant and industry players more focus to integrate with backward supply chain line. The table 2 is given below.

Table No. 2: Status of processing of fruits and vegetables in 2013-14

F&V sector	Growth
Fruit production	3.9%
Fruit processing sector	20% per annum
Frozen fruits and vegetables	121% per annum
Dehydrated fruits and vegetables	24%
Vegetable production	2.1%

***Source*:** National horticulture Board report 2013-14

Table 3: Domestic demand in Indian retail market of fruit and Vegetables

Year	Total demand(Million tonnes) Per capita demand(kg)		Per capita demand(kg)	
	Fruits	Vegetables	Fruits	Vegetables
Base Year 2010	17.43	103.16	14.78	87.51
2015	21.06	119.12	16.67	94.28
2020	25.47	137.25	18.93	102.00

***Source*:** Assocham Report, May 2013

Note:
2015 production of fruits= 81 MT
2015 domestic demand of fruits = 21 MT
Availability of raw material for industry= 60MT
2015 production of vegetables=162 MT
2015 domestic demand of vegetables= 119 MT
Availability of raw material for industry= 40 MT

2. Research Design

2.1 Research Objective

1. To identify challenges in supply chain of fruit processing industry.
2. To analyze obstacles in implementation of JIT elements in fruit processing industry
3. To suggest appropriate measures for implementation of JIT elements in Food Processing Industry.

2.2 Scope of the Research

Geographical scope: India
Time scope: Year 2016-17
Contextual scope: Fruit Processing Industry, India

2.3 Need and Significance of study

It was recognized that about 18% of fruit and vegetables are getting waste in marketing as well as manufacturing channel. India's share globally is 14% around in fruit and vegetable sector and processing is only 4%. So it is necessary to study JIT implementation in food processing sector. So that company can increase their capacity and profitability.
Just in Time supply chain as well as manufacturing elements is found very profitable in various industries. On the basis of available literature it was found that these tools are reducing cost as well waste from flow of manufacturing and supply chain. This study creates a systematic approach to improve these JIT elements in Food Processing Industry.

2.4 Research Hypotheses

1. H_0= There is no difficulty in implementation in JIT elements in Indian fruit processing industry
   Alternative Hypotheses: H_a= JIT elements are difficult to implement in fruit processing industry
2. H_0= All listed expected benefits could not be achieved through JIT implementation
   Alternative Hypothesis: H_a= Companies have achieved any expected benefits by implementing JIT
3. H_0= All causes given below are not responsible for slow implementation of JIT in fruit processing industry
   Alternative Hypothesis: H_a= Companies are facing problem due to given causes in JIT implementation in fruit processing industry

2.5 Research Methodology

During review literature various issues, scope and elements of JIT were identified. A Questionnaire has been prepared containing JIT benefits, constraints and difficulty in implementation.
The responses were collected through survey to the processing plants in Delhi NCR region, Kundli and Sonipat areas. Online responses have been collected by sending questionnaire to fruit and processing companies.

2.6 Sampling Frame

The responses were collected through survey to the processing plants in Delhi NCR region, Kundli and Sonipat areas. Most of the fruit processing industries producing different fruit juices, in which most of the companies were taking fruit pulp from third parties from different locations have responded. Total 22 responses have been collected.

3. Data collection and analysis

3.1 Population and response: The population of this study refers to 22 fruit processing industries producing different fruit juices in Delhi NCR and Sonepat District of Haryana.

3.2 Data collection

Data was collected through stratified random technique method.

3.3 Data Analysis

Data Analysis was done using various statistical tools and techniques. t-test was used to test the hypotheses.

3.4 Hypotheses testing
t-Test

Table 4: T-test analysis on JIT elements to find out degree of difficulty in implementation

S. No	JIT elements	Very High(5) ← Degree of difficulty → Very low (1)					Means by t -test	Results Let H_0=3.400
		5	4	3	2	1		
1	Effective communication	1	8	6	5	2	3.05	H_0=accepted
2	Error prevention (Poka - yoke)	1	8	6	5	2	4.36	H_0=rejected H_a=accepted
3	Frequent and reliable deliveries of raw material	9	12	1	0	0	4.05	H_0=rejected H_a=accepted
4	Kanban system or visual communication	12	4	2	3	1	2.5	H_0=accepted
5	Process control	1	1	6	14	0	3.41	H_0=rejected H_a=accepted
6	Set up time reduction	1	13	4	2	2	4.45	H_0=rejected H_a=accepted
7	Short lead time	14	6	1	1	0	3.95	H_0=rejected H_a=accepted
8	Strong buyer-supplier relationship	8	7	5	2	0	2.45	H_0=accepted
9	Vendor rating	1	2	6	10	3	1.68	H_0=accepted
10	Zero deviation schedule	0	0	4	7	11	4.82	H_0=rejected H_a=accepted
11	Smaller lot size	18	4	0	0	0	2.68	H_0=accepted
12	Standard containers	2	2	6	11	1	1.5	H_0=accepted
13	Standardization	0	1	2	4	15	2	H_0=accepted
14	Inventory turn	0	0	4	14	4	4.77	H_0=rejected H_a=accepted
15	Total preventive maintenance	17	5	0	0	0	2.95	H_0=accepted
						Grand mean	3.241333	

The result analyzed from table 4 indicates that JIT mean index is 3.24 on scale 1-5. It was identified that JIT implementation is slightly difficult in Indian fruit and vegetable industries. It was found that the elements which are difficult to implement in fruit processing industries are:

1. Error prevention (Poka – yoke)
2. Frequent and reliable deliveries of raw material
3. Process control
4. Short lead time
5. Set up time reduction
6. Zero deviation schedule
7. Inventory turn

The JIT elements which are not that much difficult in implementation in fruit processing industries are given as:

1. Effective communication
2. Kanban system or visual communication
3. Strong buyer-supplier relationship
4. Smaller lot size
5. Standard containers
6. Standardization
7. Total preventive maintenance
8. Vendor rating

Analysis of second hypothesis is given on table no. 5:

Expected benefits perceived from JIT element by respondent and rated as (5: very high, 4: High, 3: Medium,2: low, 1:very low)

Table 5: Expected benefits from JIT

S. No.	Expected benefits	Very high benefits, Very low benefits ←					Means by t-test	Results Let H_0=3.400
		5	4	3	2	1		
1	Increased productivity	0	13	9	0	0	3.5909091	H_0=rejected H_a=accepted
2	Low rework or scrap rate	5	9	6	2	0	3.7727273	H_0=rejected H_a=accepted
3	Improved work culture & administrative efficiency	8	12	2	0	0	4.2727273	H_0=rejected H_a=accepted
4	Improved visibility on process	7	10	4	1	0	4.0454545	H_0=rejected H_a=accepted
5	Reduced inventories	0	1	3	12	6	1.9545455	H_0=accepted
6	Improved quick response from vendors and suppliers	1	9	9	2	1	3.3181818	H_0=accepted

7	Reduced production lead time	1	12	8	1	0	3.5909091	H_0=rejected H_a=accepted
8	Reduced work in progress inventory	2	6	11	2	1	3.2727273	H_0=accepted
9	Reduce frequency of stoppages	5	11	3	3	0	3.8181818	H_0=rejected H_a=accepted
10	Reduced purchase lot size	2	0	2	10	8	2	H_0=accepted
						Grand means	3.363636	

Most expected benefits from JIT elements can be achieved:
1. Increased productivity
2. Low rework or scrap rate
3. Improved work culture & administrative efficiency
4. Improved visibility on process
5. Reduced production lead time
6. Reduce frequency of stoppages

Least expected benefits in fruit processing industry are:
1. Reduced inventories
2. Improved quick response from vendors and supplier
3. Reduced work in progress Inventory
4. Reduced purchase lot size

Analysis of third hypothesis is given table no. 6: The reason behind slow implementation of JIT in fruit and vegetable processing sector has been rated as (5: very high, 4: High, 3: Medium, 2: low, 1:very low)

Table 6: Constraint analysis by t-test for slow implementation of JIT in Industry

S. No	**Constraints**	**Very high Very low**					**Mean by t-test**	**Let H_0=3.40**
		5	**4**	**3**	**2**	**1**		
1	High cost of implementation	11	10	1	0	0	4.4545455	H_0=rejected H_a=accepted
2	Lack of effective communication platform	2	4	10	4	2	3.3454545	H_0=accepted
3	Lack of integration with vendors as well as farmers	2	12	6	2	0	3.6363636	H_0=rejected H_a=accepted
4	Seasonality of products	13	9	0	0	0	4.5909091	H_0=rejected H_a=accepted
5	Perishabilty of products	19	3	0	0	0	4.8636364	H_0=rejected H_a=accepted
6	Lack of quick response and slow travelling of fruit and vegetable in distribution network	2	8	11	0	0	3.5636364	H_0=rejected H_a=accepted
7	Lack of skilled worker	0	4	4	13	1	2.5	H_0=accepted
8	Lack of training	6	10	3	1	2	3.8636364	H_0=rejected H_a=accepted
9	Processing constraints	12	10	0	0	0	4.5454545	H_0=rejected H_a=accepted
10	Lack of understanding of JIT techniques	18	4	0	0	0	4.8181818	H_0=rejected H_a=accepted
11	Work cultural issues in organization	6	13	2	1	0	4.0909091	H_0=rejected H_a=accepted
12	Climate conditions	0	5	5	8	4	3.2363636	H_0=accepted
13	Price fluctuation of fruits and vegetables	5	1	7	8	1	3.0454545	H_0=accepted
14	Demand fluctuation due to seasonal demand	0	16	5	0	1	3.6363636	H_0=accepted
15	Lack of support from supplier	2	2	5	12	1	2.6363636	H_0=accepted
						Grand Mean	3.848485	

Constraints which are highly impacted the implementation of JIT in fruit processing industry are:
1. High cost of implementation
2. Seasonality of products
3. Perishabilty of products
4. Processing constraints
5. Lack of understanding of JIT techniques
6. Work cultural issues in organization
7. Lack of support from supplier
8. Lack of quick response and slow travelling of fruit and vegetable in distribution network

Constraints which is having low impact on slow implementation are:
1. Price fluctuation of fruits and vegetables
2. Demand fluctuation due to seasonal demand
3. Climate conditions
4. Lack of effective communication platform
5. Lack of integration with vendors as well as farmers
6. Lack of skilled worker
7. Lack of support from supplier

3.5 Result Analysis

Table 7: Elements which are difficult to implement and constraints of JIT

Element difficult to implement	Constraints
Error prevention (Poka – yoke), Short lead time, Set up time reduction, Zero deviation schedule	Lack understanding of JIT technique, work culture, high cost of implementation
Frequent and reliable deliveries of raw material, inventory	Seasonality, perishability, climatic condition
Process control	Perishability, processing constraints, work culture issues in organization

The study indicates that strong buyer-supplier relationship can be build by vendor rating system. It would increase the quick response and slow travelling of fruit and vegetables in distribution network. It can curb the price and demand fluctuation over the time therefore companies would be able to reduce purchase of lot size to reduce raw material inventory turn.

In this study it was found that by giving proper training on JIT employee would be able to improve the understanding of JIT techniques which would help them in easy implementation of JIT elements like small lot size processing, standardization of containers, bottling line and standardization of process.

4. Discussion

In a study of Lehtinen Torkko (2002), was found that frequent delivery of raw material and inventory turn are difficult to achieve due to seasonality of raw material and climatic condition.

Saurav Negi1 and Neeraj Anand (2015) [3] said that perishabilty is a big consideration for the fruit processing industry. During transportation climatic condition highly affect the fruit and vegetables and underutilization of multi-commodity cold storage is major consideration.

Study result indicating that JIT element strong relationship between supplier, vendor rating, and effective communication platform are not that much difficult to implement. This indicates that under utilization of cold storage and speed of transportation will increase.

As study reflecting that expected benefits are least for reduction in inventory and improved quick response from vendors and suppliers.

These result are supported by Cognizant 20-20 insights and CIPHET Ludhiana that Indian fruit and vegetable supply chain is highly fragmented, forecasting is very poor and middle men structure is highly dominated.

This study indicates that price fluctuation and demand forecasting is not major constraints for implementing JIT element in supply chain because by strong collaboration with supplier, vendor rating these constraints can be reduced.

These supporting JIT elements, Kanban smaller lot size, Standardization of containers and process which is easy to implement and expected benefits are increased productivity, low scrap rate, improved work culture and administrative efficiency, improved visibility and reduction in production lead time.

The study carried out by Miettinen, 2011 [17] indicates that major issues with manufacturing process is understanding of lean or JIT tools and work culture. This finding support this study that work culture is major issue in Indian industry which make difficult to implement JIT element such as error prevention (Poka – yoke), Short lead time, Set up time reduction, Zero deviation schedule which is highly difficult to implement.

4.1 Recommendation

Issues with supply chain and processing operations with expected solution with JIT elements was given as:

Table 8: Solution for identified issues in Supply chain and processing

Issues in supply chain	Solution
Cold chain issue: Under utilization of multi commodity cold storage, inefficient handling, uneven distribution of cold storages	JIT element strong relationship with supplier and vendors can improve the utilization, efficient handling and correct location of cold storage
Speed of travelling of fruit and vegetable, Fragmentation issue and supply chain inefficiencies	Through strong relationship, vendor rating companies may able to increase quick responses from their supplier as well as able to integrate fragmented supply chain such that waste and cost minimizes.
Production list adjustment up to last moment of production begins	Zero deviation schedule is identify difficult to implement but it can be achieve by divided into groups A, B & C.
Problem of waiting missing material, work in progress inventory related issue increase down time on process	Companies find Kanban or visual communication is easy to implement so we can implement material control system or standardization of process and containers be a solution
It is found problematic that part of products return to the process	First –time correct approach may improve this problem or by implementing JIT element low rework or scrap is expected benefits
Product exchange time increases on process units mixing and pasteurization	Manufacturing lines interconnection may increase automation and remove waiting time, standardization of process, containers, lead time reduction
Production planning method causes troubles with control during busy season	Small lot sizes, total preventive maintenance element easy to implement according to study and One JIT element find set up time reduction is found difficult so there is need to focus in production planning to give information about production ramp-ups and shut down process in order to able to prepare for next batch

Employees walk movement is lot to maintains the line's action or during product exchange	By visual communication and companies expected benefits is that work culture and team building will improve by JIT such that it operators and supervisors will take their responsibility and their response on work increases
SOP and standardization of time is missing	By standardizing job descriptions and task companies can be improve their system
Machine problems	By total preventive maintenance break down may be reduce

4.2 Future scope

This study motivates food processing industry to adapt JIT tools in industry. There are some JIT elements that are difficult to implement but if partially implemented it would increase the expected benefits by working on constraints. Other specific areas related to fruits and vegetables considering different geographical location could be the future scope of this study.

5. Concluding Remark

This study support the notion that Just in Time have potential to increase operational efficiencies as well as improve supply chain inefficiencies and effectiveness of fruit processing industries. In this study it was identified that some JIT elements are difficult to implement in existing production system. It was also identified that some elements are having potential to generate benefits which were identified in expected benefits analysis. In this study it was identified that standardization, generalization and automation are some issues that can be resolved. Constraints like high cost of implementation, seasonality, perishabilty, Processing constraints, work culture issues, climatic conditions and lack of understanding of JIT techniques make it difficult to implement some of JIT elements. If these issues in supply chain are encountered through JIT elements effectively industry will get benefited and productivity will increase.

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