

Fallouts and Risks Challenging Global Food Supply Chain – An Analysis

¹Papri Ray, ²Y V Rao and ³Reno Varghese George,

¹Asst Professor of Department of Lean Operations & System, Christ University and PhD Scholar at Garden City University Bangalore, Karnataka, India

²Dean- Research and Development, Garden City University Bangalore, Karnataka, India

³Department of Lean Operations & System, Christ University, Bangalore, Karnataka, India

Abstract—Fallouts and Risks challenging food supply is a serious concern across world as it has impact on every lives. Every individual has the right to have good nutritious food and water for their life. Food risks can be aftereffect of a number of reasons like inefficient supply chain, undernourishment, economic, social or habitual factors, etc. Identifying these factors and taking actions to prevent them helps in bringing down global food crisis.

Keywords—Food supply chain fallouts; global food crisis; food supply chain risk management; phases of risk in food supply chain; risk-impact analysis

I. INTRODUCTION

Fallouts and Issues pertaining to food chain is of high consideration as it directly affects every individual's day to day life. The importance given to the different levels of the food supply chain is dependent upon the risk and safety issues related to that particular level. These issues are caused majorly due to the perishable nature of food, purposeful contamination for business motives and other external factors like environment. The supplier has to find the risk associated with it, find the critical issues, monitor them, and have a constant check on compliance before the food product reaches the consumer. The methods to address and minimize the risk associated with safety issues in food supply chain is formulated by Hogue (Blair & Thorn, 2003) which emphasizes on the importance of partnering with vendors and suppliers having proper documentation about their food safety practices, restricted entry to vulnerable places of food handling, proper sealing of the transportation vehicle, having a product recall strategy and closely monitoring the serving areas.

Companies must ensure a standard operating procedure and ambient temperature and should have pest control measures. 85% of the food borne illness has been caused due to safety issues in production and supply chain factors. Some of the issues are improper temperature control during storage, inadequate cooking, and poor personal hygiene of workers producing the food, using contaminated equipment for production, using raw materials from unsafe sources or vendors. Retail stores and other shops should have a proper check on the food products that they have in store for sale to ensure that it does not get contaminated due to customers coming in and checking on the food products which could contaminate the food item. Many more challenges keep coming in day by day in ensuring food safety and consumers play a major role in this. Consumers need to be educated on how to handle food properly and the proper preparation techniques for each food product so as to avoid any food borne illness. Some of the major risk factors caused in the food supply chain are discussed.

II. METHODOLOGY

A study has been done to identify areas of fallout in food supply chain, pillars for global food crisis, risk in global food crisis and its management. A survey has been conducted for 100 stakeholders in various aspects of the supply chain to try and understand the risks in food supply chain. An interview of the stakeholders and experts have also been done which could highlight the impact of these issues. A risk impact analysis has been done to identify the major risks and its impacts. Finally models has been suggested to reduce the risk associated with the food supply.

III. FALLOUT AREAS IN FOOD SUPPLY CHAIN

Any fallout pertaining to global availability, safety, sovereignty and security can be considered as risk in food supply chain. Food chain should be able to provide quality, nutritious, sovereignty and uncontaminated food for all without its wastage. This planning starts from the producer to the intermediaries to the consumer households and behaviours.

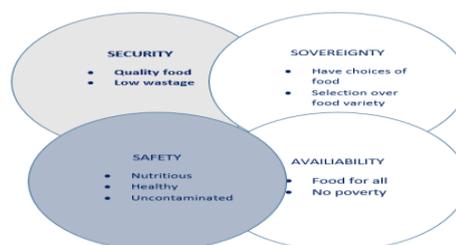


Fig. 1. Areas of fallout in food supply chain

According to FAO – Global report on food crisis, food crisis is on an increasing trend especially in the continent of Africa. Countries with refugees and low income is suffering food crisis extremely. High food prices, displacement and conflicts are found to be worsening the situation. Security, safety, sovereignty and availability are on extreme low marks. Food production also found to be decreasing due to losses of livelihood caused by war and other economic and social disruptions(Food Security Information Network, 2017).

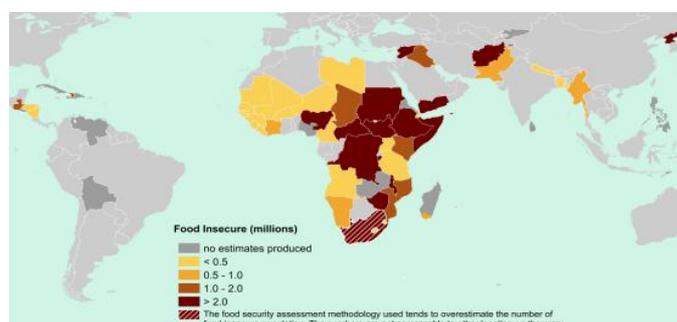


Fig. 2. Food Crisis Nations (Source: FSIN - Global Report on Food Crisis 2017).

IV. PILLARS OF GLOBAL FOOD CRISIS

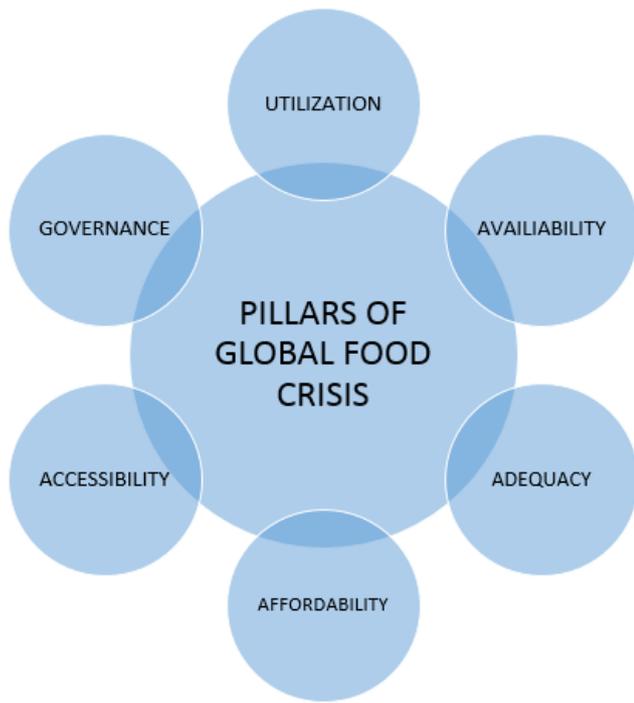


Fig. 3. Pillars of global food crisis

There are a number of factors that affects the food supply across the world. These factors includes utilization, availability, adequacy, affordability, accessibility and governance.

Availability refers to the supply of food, how much is available. It is commonly measured by national food grain availability and national buffer stocks available which are already at satisfactory levels; despite steep increase in procurement NFSA is not likely to have a significant impact on the availability dimension of food security. This depends on various secondary constraints like production of food, processing, environmental changes, training for farmers, harvesting methods, storage, abundance, seasonality, etc. Food is to be made available for all, which answers a major problem of global food crisis.

Adequacy is to improve the nutritional value of food. It is estimated that one in nine people, 795 million globally are undernourished according to (FAO, 2015). This shows how critical is the factor of under nourishment. It's very vital to tackle this scenario in order to provide stability for global food supply. Fig. 4. Shows the trends of undernourishment across world. There should be more involvement by NGO's or private firms to provide world nutrition.

Number of undernourished and prevalence (%) of undernourishment

	1990-2 No.	1990-2%	2014-6 No.	2014-6%
World	1,010.6	18.6	794.6	10.9
Developed regions	20.0	<5	14.7	<5
Developing regions	990.7	23.3	779.9	12.9
Africa	181.7	27.6	232.5	20.0
Sub-Saharan Africa	175.7	33.2	220.0	23.2
Asia	741.9	23.6	511.7	12.1
Eastern Asia	295.4	23.2	145.1	9.6
South-Eastern Asia	137.5	30.6	60.5	9.6
Southern Asia	291.2	23.9	281.4	15.7
Latin America & Carib.	66.1	14.7	34.3	5.5
Oceania	1.0	15.7	1.4	14.2

Fig. 4. Undernourishment around the world (Source: FAO The State of Food Insecurity in the World 2015 p. 8)

Affordability talks all about peoples capability to have food. The major factor behind affordability of food is income of people or poverty. There are further secondary factors leading to poverty like wars, economic instability, social instabilities, etc. Food production cost increasing and high importing cost can be of reasons for affordability factors.

Accessibility refers to the ease of availability of food. This is being effected by economic conditions, factors of transportation, etc. Accessibility is also being contributed by availability and affordability.

Governance issue is yet another factor contributing to food crisis across nations. Political instability, conflicts, poor recovering mechanisms from natural disasters, food distribution policy, inability to forecast and work for better food production etc, leads to food crisis. Wars and increasing refugees, destruction production fields also worsens the situation.

Utilising better food in terms of quality, nutritional value, sanitation etc also defines food crisis. This answers on how efficiently and effectively food is utilised to have an increased value for the security and value of food.

(Paloviita, Vol. 10, No. 2, 2017) points out crucial elements in food supply chains in support of a sustainable food system, which ultimately enhances food security. Hence, food security is defined here in terms of a sustainable food system, where the core goal is to feed everyone sustainably, equitably and healthily, which addresses needs for availability, affordability and accessibility, is diverse, ecologically sound and resilient, and which builds the capabilities and skills necessary for future generations. The essential elements of sustainable food systems are, 1) Feeding everyone sustainably, equitably and healthily, 2) Availability, affordability and accessibility, 3) Ecologically-sound and resilient and 4) Maintaining capabilities and skills necessary for future generations.

V. RISK IN GLOBAL FOOD CHAIN

There are a number of risks existing in global food supply chain leading to poor quality of food or poor nutritional value to the consumers. These can be of reasons based on the supply of food, demand of food and also integration issues. Supply issue majorly pictures the production deficiency, demand issues portrays unequal access to food due to factors like population pressure, poverty, etc. and supply-demand instability issues are those caused due inadequate integration and inadequate extension from service networks.

Some of the major risks in food chain can be further broken down into key issues that directly affects the food safety, availability and quality.

A. Risks caused by Infrastructure

Lack of infrastructure is the most common phenomenon that directly affects the food security especially with Cold supply chain, perishable supply chain and fruits and vegetables supply chain. Post-harvest losses are high in rate as there is lack of infrastructure in the sector and cold chain facilities that is affecting the fruits and vegetables supply chain and food security (Agarwal, 2017). Farmers do not store their products even though there will be higher returns if stored and sold on favourable market condition because of lack of storage facility. Also Cold storage facilities are available in wholesale markets and not in local markets (Negi & Anand, 2014). Even go downs where grain is kept for easy distribution have no

enough safety features incorporated in them which is highly risky regarding food security and major reason for food wastage (Jaswal, 2014).

B. Risks caused by Logistics and Transportation

Products undergoing less damage are those that moves more quickly and reliably across the supply chain. As the products are perishable in nature, more the product being in the supply chain it may become obsolete and might no longer provide quality to customer (Vanek & Sun, 2008). The optimal route and transport solutions may vary with products. For example, for products like ice creams, the maritime route is not suitable as their shelf life is shorter than the required travelling time. (Gallo, Accorsi, Baruffaldi, & Manzini, 2017). Though in Agro supply chain common attention is given to transportation cost whereas transaction cost plays important role in shaping procurement regimes. (Ruben, Boselie, & Lu, 2007). Reduction in transportation cost is being major challenge for most of food exporting companies such that product becomes affordable for more.

C. Risks caused by Temperature control issues

Temperature maintaining across the entire supply chain is necessary to ensure quality and safety of food products. Considering meat cold chain, where the chilling of products The growth of microbial like bacteria on meat surface is influenced by temperature, water activity and other factors. It is a constant challenge for industries, consumers, retailers and distributors though the importance of temperature monitoring is well known (Nastasijević, Lakićević, & Petrović, 2017). Temperature is the most important factor that have impact on storage life of food products after harvesting. Due to the variety of products and their different temperature requirements, the allocation of products to the appropriate refrigerated facilities is complex. (Aung & Chang, 2014).

D. Risks caused by Fragmented supply chain

Increase in number of intermediaries leads to higher probabilities of food safety issues. This can lead to longer holding period of products in the supply chain that drastically affects the product quality especially for products that are highly perishable in nature especially with Agro products (Agarwal, 2017). Due to the large supply chain, food wastage is also higher. Also the unorganised traditional retailing of vegetables also adds to the food security risks. Across the market, 97% is extremely localized retailers and are congested with too much of intermediaries (Hussain, 2013).

E. Risks caused by Seasonality

Non availability of products in off season leads to the use of expired products or adulterated products that creates critical food security concerns. Also there can be purposeful creation of demand for products in favour of profit. This includes application of chemicals that are hazardous to health for longer shelf life. There is a great challenge for private dairies in maintaining the balanced supply of raw milk to the processing plant (Kumar, Kumar, & Rao, 2012). This will also possibly lead to adding of water or other powder substances for increasing the supply that alters the perceived milk quality. Seasonality issues is common for most of the natural food products especially in fruits and vegetable supply chain.

F. Risks caused by inefficient preharvesting, harvesting and pre-consuming stages

High rate of inefficiency persists in pre-harvesting and harvesting which leads to poor quality food products and

wastage of food in supply chain. "In developing countries, losses along the entire value chain of food products are estimated to be 30% to 50%, and 40% of the losses occur at post-harvest and processing level" (Lemma et al., 2014). Using harvesting techniques that are outdated and traditional like using of sticks to pluck fruits like mango, papaya, etc. causes bruises on fruit, with loss implications for large supply chains. This leads to increased rate of perishability of the product and the product together with it, thus leading to high quality loss (Parfitt et al., 2010). This type of careless and inconvenient cultivation lead to distortion of product surfaces allowing bacterial or other fungal attack finally conforming to loss in food safety (Agarwal, 2017). Other risks include:

- Poor knowledge of farmers and lack of motivation given (Agarwal, 2017).
- It is necessary for the farmers to have proper knowledge and awareness, else the Fruits and Vegetable supply chain won't be efficient enough. They need to be trained as they are the main source fresh agro products. (Negi & Anand, 2015).
- The supplier-buyer relationship nature may alter across the phases of supply chain which can further increase the transaction cost (Ruben et al., 2007) and further result in increased carriage time and food quality.
- Another major challenge in food supply chain is the inappropriate quality control and excessive inventories leading to higher rates of wastage of food products. (Xiaojun Wang, 2012).
- Traceability issues is another concern regarding to food safety and supply chain (Xiaojun Wang, 2012). High traceability enables damaged or unsecure products to be called back. But industries with products like powders (powdered milk, cocoa, flour etc.), liquids (vegetable oils, milk, etc.), grains or crystals (e.g. sugar, salt) that are stored finds it very difficult to be traced as its inconvenience to associate any label, marker or identifier (Dabbene, Gay, & Tortia, 2014).

G. Risks caused post consumer.

In developed countries and even in BRIC countries, data study found that there is strong evidence of post-consumer waste on an increasing scale. The problem can be overcome through a number of solutions like raising awareness among consumers in aspects of food waste, direct communication, and interventions by government, improving food date labelling and advice on storage clarity, ensuring that there is appropriate range of size of food products or portion sizes are available according to requirements of households (Parfitt et al., 2010).

H. Risks caused by environment

Environment factors or variations also have impact on food safety. In country like India with huge population and uncertain monsoons, especially in states like Uttar Pradesh, West Bengal, Maharashtra Odisha, Chhattisgarh, Jharkhand, Bihar, and Madhya Pradesh have extreme levels of food insecurity (Balaban, 2017). Climatic conditions like humidity also results in wastage of grains during its drying stage (Parfitt et al., 2010). The impact of refrigerant leaked from reefer trucks result in CO₂ based wastage. The rotting fruit within the carton is also another source of CO₂ leading to degradation of product (Sukmeet et al., 2016).

VI. PHASES OF RISKS

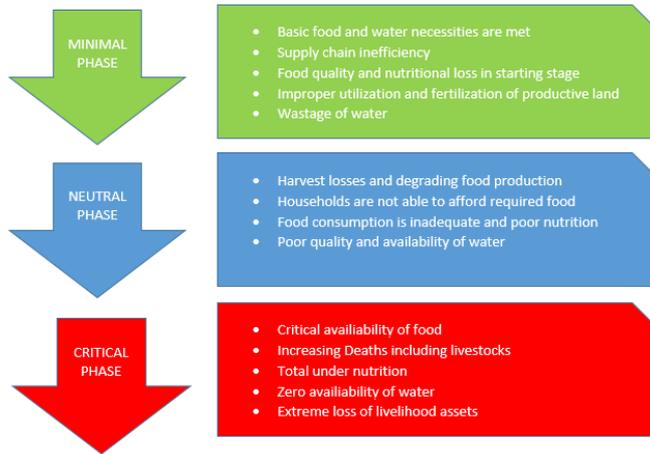


Fig. 5. Phases of Risks

The rooting risks in food security can be categorised into three major phases as in Fig.5, Minimal, Neutral and Critical phase.

The minimal phase of risk is common where wastage of water, food and inefficiency in supply chain persists. Risk elimination can be done once the risk has been brought to its minimal phase. This is the easiest phase to eradicate global food crisis. Improper consideration during this phase leads to neutral phase. Water wastage is a common crisis in this stage. Places having water abundancy tends to waste it without knowing the future hazards.

Condition gets worse in neutral phase, where availability and quality of food and water is very low. Harvest losses and production inefficiency due to number of reasons like unavailability of land or fertile soil leads to critical availability of food. Unaffordability due to increasing import rates of products, increasing production cost, etc. worsens the phase. Nutrition is vital factor in this phase. Governing level actions needed to be implemented at this stage to solve the issue.

Critical phase is where, water and food availability is zero and death occur. Total under nutrition and caused due to the zero availability of food. This cases occur as a result of environmental or geographical worse conditions or due to the after effects of war or economic or social conditions. Recovery at this stage is very hard. Sometimes infrastructure needed to be developed from scrap to overcome the situation.

VII. MANAGING RISKS

While there are numerous risks associated with the supply chain in today’s world, some of them are market related risks which are unavoidable, while there are few other factors are contributing to probable supply chain issues like biological and environmental risks, financial risks, logistics and infrastructure risks, policy and institution risks and operation related risks. Several researches have indicated the prevalent of disturbances to firms and its supply chain due to the unstable environment and the negative consequences of disturbances to firms (Martha and Subbakrishna, 2002; Chopra and Sodhi, 2004; Coleman, 2006; Hendricks and Singhal, 2005; Wagner and Bode, 2008).

The importance given to the different levels of the food supply chain is dependent upon the risk and safety issues related to that particular level. The supplier has to find the risk associated with it, find the critical issues and monitor them and have a constant check on compliance before the food product

reaches the consumer. Every company, no matter how small it is needs to focus on the safety issues of food supply chain and should have a person in charge for ensuring the safety. The company must ensure a standard operating procedure and ambient temperature and should have pest control measures. 85% of the food borne illness has been caused due to safety issues in production and supply chain factors. Some of the issues are improper temperature control during storage, inadequate cooking, poor personal hygiene of workers producing the food, using contaminated equipment for production, using raw materials from unsafe sources or vendors. Retail stores and other shops should have a proper check on the food products that they have in store for sale to ensure that it does not get contaminated due to customers coming in and checking on the food products which could contaminate the food item. Many more challenges keep coming in day by day in ensuring food safety and consumers play a major role in this. Consumers need to be educated on how to handle food properly and the proper preparation techniques for each food product so as to avoid any food borne illness.

VIII. GROWING TRENDS IN FACTORS OF FOOD RISKS

As the food demand and variety of food is increasing across the world, issues corresponding to food security is also on an increasing scale. Studies show that world consumption of food has been increasing year by year, so is it’s wastage. A major share of the production is lost due to various losses, which include Consumption level losses, Distribution losses, Processing and packaging losses, Post-harvest losses and Harvest losses. These categorized losses have to be curbed in all the ways possible in order to decrease the huge amount of losses that are incurred in this aspect. Though there is an improvement in terms of deficit of nourishment, from the past depression/recession period, the world has a long way to go in terms of efficient production techniques, which can be used in satisfying everyone’s needs, without losses.

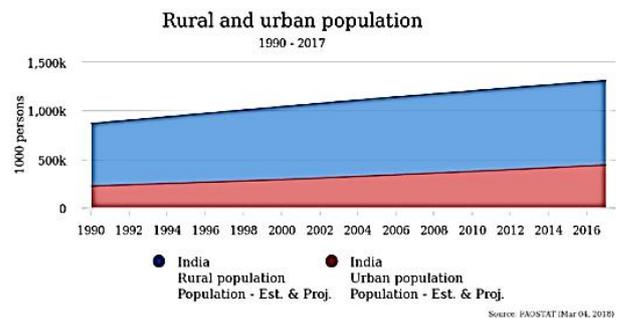


Fig. 6. Indian Rural and Urban population trend {Source: PAOSTAT(March 04, 2018)}.

The above graph shows that there is a huge increase in population in India that says there is food security and accessibility issues also in an increasing pace as infrastructure not being developed in the same pace.

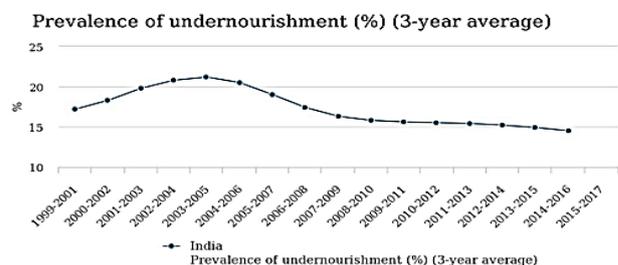


Fig. 7. Prevalence of undernourishment in India {Source: PAOSTAT(March 04, 2018)}.

From 2007 to 2017, there is no significant change in the country's undernourishment status that hovers around a mean of 15%, neither is there a steep decrease in food deficit, even though the period of 2003-2004 to 2006-2008 there seems to be radical reduction experienced of the same. Hence this calls for redesigning and reengineering the functional processes.

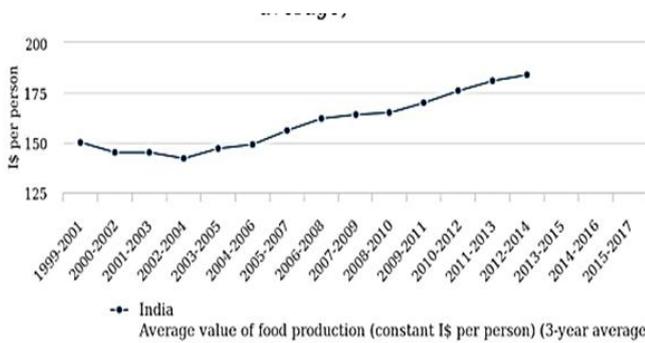


Fig. 8. Average value of food production in India {Source: PAOSTAT(March 04, 2018)}.

As seen above, the food production is also increasing, which is a good sign on account of the increasing population. But the produced food doesn't always end up with the consumer. This further raises questions on what happens to the food in the supply chain and more importantly where is the security compromised.

IX. RISK IMPACT ANALYSIS

TABLE I. RISK IMPACT ANALYSIS

Category	Risk	Severity	Occurrence	Detectability	Risk Priority = Severity*Occurrence*Detectability
SC/Logistics issue	Improper inventory management	8	7	6	336
SC/Logistics issue	Improper storage facilities	8	6	7	336
SC/Logistics issue	Packaging problems of various food grains and products	8	4	9	288
SC/Logistics issue	Lack of collaboration and coordination	7	8	5	280
Governance	Lack of education and training	6	6	7	252
SC/Logistics issue	Disposal and recycling mechanisms for food categories not clear	8	6	5	240
SC/Logistics issue	Improper transportation spoiling quality of perishable product	6	7	5	210
Producer	Lack of scientific farming	6	5	6	180
SC/Logistics issue	Reducing price transparency	6	6	5	180

Category	Risk	Severity	Occurrence	Detectability	Risk Priority = Severity*Occurrence*Detectability
Governance	Government Policies	8	3	7	168
SC/Logistics issue	Handling Issues	8	4	5	160
SC/Logistics issue	Lack of information	7	5	4	140
Infrastructure	Insufficient cold storage	7	5	4	140
Infrastructure	Fresh water scarcity	9	5	3	135
Infrastructure	Expensive agricultural production due to new technologies	8	8	2	128
Environmental	Reduced soil fertility	7	5	3	105
Producer	Improper management of bacterial growth	5	5	4	100
Infrastructure	Involvement of Middlemen	5	6	3	90
Environmental	Climatic shocks (draughts, flood etc.)	7	2	6	84
Infrastructure	Increase in price of energy (petroleum)	4	3	5	60
Producer	Non availability of funds	5	6	2	60
Producer	Reduced land area for cultivation	4	3	4	48
Environmental	Other Weather Issues	4	5	2	40
Environmental	Elevated levels of CO2 due to climate change	5	1	5	25
Environmental	Reducing sea level	5	1	4	20
Infrastructure	Increased use of pesticides and fertilizers and chemicals	5	2	2	20
Consumer	More demand of horticulture and livestock	2	2	2	8

Severity implies how severe this issue is in terms of its effect on the food supply chain. Occurrence implies how frequently this issue occurs to create an impact on the food supply chain. Detectability implies how easily this issue is identified in the chain and brought to the notice of stakeholders. The chart when sorted in descending order of the Impact Factor shows the most important and impactful factors that affect the food supply chain.

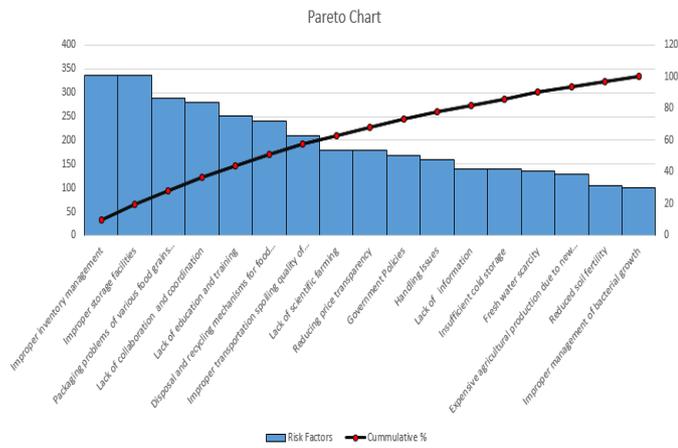


Fig. 9. Pareto of various Risk Factors

As from the pareto it is understood that 80% of total risk is being contributed by improper inventory management, improper storage facilities, packaging problems, lack of collaboration and coordination, lack of education and training, disposal and recycling mechanisms, lack of scientific farming, reduced pricing transparency, government policies and handling issues. This needed to be eliminated on first hand to reduce the risk level significantly. Priority needed to be given for reducing risk to top contributing factors like improper inventory management and improper storage facilities.

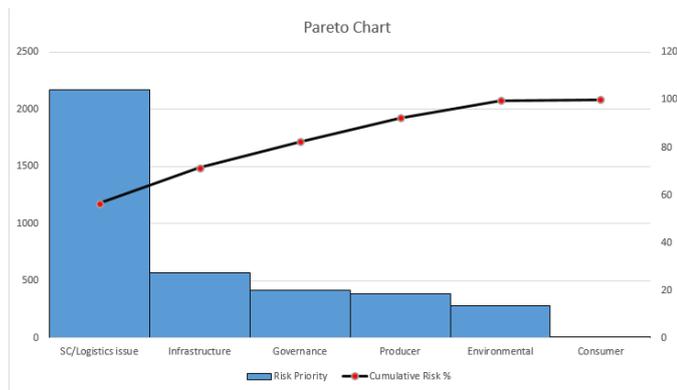


Fig. 10. Pareto of various Risk Categories

Fig. 10 shows the major categories of factors contributing to the risk. It is found that Supply chain logistics issues and Infrastructure issues are the 20% factors that contribute to 80% of the risk. There is a need for formulating solutions for overcoming logistical issues and infrastructure issues.

X. RECOMMENDATIONS AND SUGGESTIONS

It is important to identify the essential elements of food supply chain management in support of a sustainable food system, which ultimately enhances food security. The recommended model has been developed using factors of availability, accessibility, utilization and sustainability.

A. Model to address upstream supply chain challenges.

At the upstream supply chain level, food security has been assessed here in terms of sustainable primary production and processing, and the resilience of the upstream supply chain. Limiting resource consumption and reducing ecological footprint are crucial environmental measures of upstream supply chain sustainability. (Paloviita, 2017) talks about this being moderated by ecological and environmental thinking, social injustice and inequalities, supplier diversity and

vulnerability of farmers and SMEs. The important considerations should be as follows:

- Frequent and multiple quality check throughout the entire upstream process.
- Online Support on farming means and proficiency.
- Improve the availability of data indices:
 - Indicators of demand
 - Indicators of supply
 - Indicators of consumption
 - Indicators of security
 - Indicators of regulation
 - Indicators of entropy (uncertainty)
- Action Plan implementation for Improvement of Farmer productivity.
- Fertilizer and Pesticides: quality, availability, accessibility, cost.
- Integrated food security wherein grain production will be the primary concern. In order to provide relevant information to the policy makers an early warning system that evaluates food security status based on resources, environmental and socio-economic conditions is developed. (Qi, Zhong, & Liu, 2015)
- Reduction of too many middlemen with efficient governance.
- Hazard Trigger Signals at Control Points.

B. Model to address downstream supply chain challenges.

At the downstream supply chain level, food security has been assessed here in terms of sustainable distribution and consumption, and resilience of the downstream supply chain. (Paloviita, 2017) mentions that these are moderated by food insecure areas, wastes, human health and cost internalization. (Viswanadham, 2017) also give inputs about the importance of these factors. The important factors here would be as follows:

- An evolutionary integrated supply chain is an important factor for the consistency of food security systems.
- Automated Public Distribution systems,
- GPS enabled delivery vans can track the delivery route of the food and testing the quality,
- The process should be made automated from the currently being semi-automated state using information technology and sensor networks and other electronic aids and systems along with vocational training programs
- Conservation of products and delivery processes from farmer to consumer.
- Identification of categories and zones of food waste along the supply chain
- Identification of the insecure areas in the supply chain where food contamination and perishability are compromised
- Moderation by Cost internalization.
- Regular training programs by the National Rural Employment Generation Act (NREGA) would create an awareness about the importance of the food security and quality.
- Solar powered refrigerators and ovens can bring down the costs and bring eco-friendly environment.
- Warehouse and Transportation Penalties for noncompliance to food security norms
- The entire process of placing orders and other communication can be handled by a call center team.

C. Suggestions for overall governance issues.

- The government should take necessary steps to involve the food hawkers into the system, the raw material costs would be very less. This will prove to be an employment opportunity for the food hawkers as the majority of them belong to the lower and the lower-middle class.
- The improvement of the nutritional knowledge.
- Encouraging good traditional customs.
- Discouraging unwanted food usage related habits.
- Popularizing of good nutritional practices.
- The use of social marketing methods.

CONCLUSION

Paper figures out the areas of fallout, phases of risk, and pillars of food crisis. It analyzed various fallouts and issues challenging global food supply chain, how to mitigate the existing risks and recommended models for the same. The survey brings on board the important issues and is prioritized based on their impact. Recommendations for these issues have been suggested in a framework. Future studies and researches could actually bring forth an advanced Hazard and Criticality detection tool that can identify the food security gaps in any supply chain. High impact food security solution serving millions & generating millions of jobs is possible if we develop an Effective food security supply chain using ICT and develop a model on the same.

References

- [1] Agarwal, S. (2017). Issues in supply chain planning of Fruits and Vegetables in Agri-food supply chain: A review of certain aspects, 37–43.
- [2] Aung, M. M., & Chang, Y. S. (2014). Temperature management for the quality assurance of a perishable food supply chain. *Food Control*, 40(1), 198–207. <https://doi.org/10.1016/j.foodcont.2013.11.016>.
- [3] Balaban, D. (2017). Food Security in India Segurança alimentar na Índia Ranjana Ferrão.
- [4] BLAIR, A., & THORN, B. (2003). HOW SAFE IS THE FOOD CHAIN?. *NATION'S RESTAURANT NEWS*, 4.
- [5] Chan, T. F., Ji, K. M., Yim, A. K. Y., Liu, X. Y., Zhou, J. W., Li, R. Q., ... & Wu, Y. L. (2015). The draft genome, transcriptome, and microbiome of *Dermatophagoides farinae* reveal a broad spectrum of dust mite allergens. *Journal of Allergy and Clinical Immunology*, 135(2), 539–548.
- [6] Chopra, S., & Sodhi, M. S. (2004). Managing risk to avoid supply-chain breakdown. *MIT Sloan management review*, 46(1), 53.
- [7] Coleman, L. 2006. Frequency of man-made disasters in the 20th century. *Journal of Contingencies and Crisis Management*, 14(1): 3–11.
- [8] Dabbene, F., Gay, P., & Tortia, C. (2014). Traceability issues in food supply chain management: A review. *Biosystems Engineering*, 120, 65–80. <https://doi.org/10.1016/j.biosystemseng.2013.09.006>.
- [9] FAO The State of Food Insecurity in the World 2015 p. 8
- [10] Food Security Information Network. (2017). Global Report on Food Crisis.
- [11] Gallo, A., Accorsi, R., Baruffaldi, G., & Manzini, R. (2017). Designing Sustainable Cold Chains for Long-Range Food Distribution: Energy-Effective Corridors on the Silk Road Belt. *Sustainability*, 9(11), 2044.
- [12] Hendricks, K. B., & Singhal, V. R. (2005). An empirical analysis of the effect of supply chain disruptions on long-run stock price performance and equity risk of the firm. *Production and Operations management*, 14(1), 35–52.
- [13] Hussain, H. (2013). Strategic change in model of fruit and vegetables supply chain. *Global Journal of Management and Business Studies*, 3(9), 965–970. Retrieved from <http://www.ripublication.com/gjmbs.htm>.
- [14] Jaswal, S. S. (2014). Challenges to Food Security in India, 19(4), 93–100. <https://doi.org/10.9790/0837194293100>.
- [15] Lemma, Y., Kitaw, D., & Gatew, G. (2014). Loss in Perishable Food Supply Chain: An Optimization Approach Literature Review, 5(5).
- [16] Martha, J., & Subbakrishna, S. (2002). Targeting a just-in-case supply chain for the inevitable next disaster. *SUPPLY CHAIN MANAGEMENT REVIEW*, V. 6, NO. 5 (SEPT./OCT. 2002), P. 18-23: ILL.
- [17] Nastasijević, I., Lakićević, B., and Petrović, Z. (2017). Cold chain management in meat storage, distribution and retail: A review. *IOP Conference Series: Earth and Environmental Science*, 85(1). <https://doi.org/10.1088/1755-1315/85/1/012022>.
- [18] Negi, S., & Anand, N. (2014). Supply Chain Efficiency: An Insight from Fruits and Vegetables Sector in India. @BULLET Journal of Operations and Supply Chain Management, 7(2), 154–167. <https://doi.org/10.12660/joscmv7n2p>.
- [19] Negi, S., & Anand, N. (2015). Issues and Challenges in the Supply Chain of Fruits & Vegetables Sector in India: A Review. *International Journal of Managing Value and Supply Chains*, 6(2), 47–62. <https://doi.org/10.5121/ijmvsc.2015.6205>.
- [20] Paloviita, A. (2017). Food Security Is None Of Your Business?: Food Supply Chain Management In Support Of A Sustainable Food System. *Operations and Supply Chain Management*, 10.
- [21] Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554), 3065–3081. <https://doi.org/10.1098/rstb.2010.0126>.
- [22] Ruben, R., Boselie, D., & Lu, H. (2007). Vegetables procurement by Asian supermarkets: a transaction cost approach. *Supply Chain Management: An International Journal*, 12(1), 60–68.
- [23] Shekhar, S., Joe, J., Kumar, R., Jyothis, J., Kumar, K., Priya, Y. A. R. M., ... & Pagote, C. N. (2012). Effect of heat treatment of milk on the sensory and rheological quality of dahi prepared from cow milk. *J Food Dairy Technol*, 1(1), 9–15.
- [24] Sukmeet, S., Chetna, A., & S, S. S. M. M. (2016). Cold Chain Development for Fruits & Vegetables in India Kinnow Cold Chain Study F OREWORD.
- [25] Vanek, F., & Sun, Y. (2008). Transportation versus perishability in life cycle energy consumption: A case study of the temperature-controlled food product supply chain. *Transportation Research Part D: Transport and Environment*, 13(6), 383–391.
- [26] Viswanadham, N. (2017), (Indian Institute of science). Food Security in India- A Logistics and Supply Chain Challenge.
- [27] Wagner, S. M., & Bode, C. (2008). An empirical examination of supply chain performance along several dimensions of risk. *Journal of business logistics*, 29(1), 307–325.
- [28] Xiaojun Wang. (2012). Optimal Pricing with Dynamic Tracking in the Perishable Food Supply Chain. 17 Goals to Transform Our World. (2016). Retrieved from United Nations Sustainable