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Abstract

Purpose: The food organisations are pushing to adopt circular economy initiatives to enhance economic-ecological-social sustainability of supply chains. The adoption of circular economy and sustainability aspects is complex to the point of view of developing nations compared to developed nations. In this sense, the present work aims to develop a model of the challenges for implementing the successful circular economy led sustainability concepts in food supply chains in emerging economies especially in Indian context.

Design/methodology/approach: We recognised eleven circular economy led sustainability related challenges and analysed appropriate interactions among the identified challenges. Delphi method is used for confirmation of identified challenges. The challenges were identified initially with the help of literature. Interpretive Structural Modeling (ISM) method has been used for modeling the challenges. In addition, MICMAC analysis was used for classifying the challenges based on their dependence and driving power. A case study of diary food processing company in India is conducted.

Findings: According to the findings, Poor government policies, Lack of technology and techniques, and Lack of farmers' knowledge and awareness come under the driving challenges.

Practical implications: Understanding of circular economy led sustainability related challenges would help managers and policy makers in sustainable management of natural resources in food value chains.

Originality/value: This is one of the initial work conducted on identifying and evaluating the challenges to circular economy based sustainability aspects in food value chains.

Keywords: Challenges, Sustainability, Circular Economy, Food Supply Chain, ISM-MICMAC, Developing Economy, Management Decision.

1. Introduction

In order to deal with issues of food wastage and safety, industries and policy makers are seeking to adopt green and/or circular economy and sustainability aspects in their business (Grimm et al., 2014; Mangla et al., 2018). Adding circular economy and sustainability is crucial to the point of view of food industry, to manage the higher demand and cost of food products, higher energy and natural resources requirements (The State of Food and Agriculture, 2014). The circular economy and sustainability initiatives allow managers to consider economic, environmental and social dimensions derived from customer and stakeholder contexts (Seuring and Müller 2008; Seuring 2011; León-Bravo et al., 2017). Implementation of circular economy and eco-friendly initiatives creates an industrial system, which allows organisations to recycle the materials to enhance the overall sustainability (Mathews and Tan, 2011; Bayona-Saez, et al., 2017). However, organisations lacks in utilising the environmental and social sustainability considerations in value chain practices, due to lack of awareness, resources, infrastructure etc. (de Sousa Jabbour et al., 2013; Sivaprakasam et al., 2015; Govindan and Hasanagic, 2018).

In food value chains, most of the studies have been conducted on evaluating the behavior of consumers to avoid the food wastage, analysing rapid transformation of food system to increase the farmer's income and lower the food prices, strengthening the national food control system to achieve food safety, and implementing of proactive strategies to enhance their sustainable performance (Fearne et al., 2013; Glover et al., 2014; Akhtar et al., 2016; Zhu et al., 2018). In recent years, FSC management has been widely recognized as a subject of research by both practitioners and academia (Aschemann et al., 2017; Reardon et al., 2018; Lusk et al., 2018; Darbari et al., 2018). In this scenario, organisations of developed and developing nations are seeking to adopt circular economy concepts to ensure food security and increase sustainability of supply chain (Schroeder et al., 2018; Irani et al., 2018). Food Safety and Standards Authority of India (FSSAI) and Ministry of Agriculture estimated that Rs. 50,000 crores is wasted every year in various processes of FSC, such as processing, packaging and distribution (The Economic Times, 2017).

Thus, it is important to understand and develop the circular economy aspects to improve the overall sustainability of food value chains in a developing economy context. Present work mainly focused

on the challenges that are the hurdles for the implementation of circular economy driven sustainability in FSC. In this work, we conducted case study with one of the Indian diary food-processing organisation for the collection of data and to understand their problems in the implementation of circular economy driven sustainability in the processes. Need of the present work is to fulfill the requirement of sustainability in FSC through circular economy concept. This work fills the gap of sustainability concept in emerging economies especially in Indian food value chain context. Notably, the development of circular economy led sustainability in an organisational food value chain is very complex, so as several challenges are linked with this process. Hence, managers and policy makers need to investigate the challenges to circular economy led sustainability in FSC in an industrial and nation context. In fixing the aims of this research, we seek to keep the content of this study as generic as possible for a wider applicability in emerging economies.

In particular, this study has the following research aims:

I. To identify the challenges of circular economy led sustainability in FSC;
II. To discover the interaction among identified challenges of circular economy led sustainability in FSC.
III. To classify the challenges in different categories.

The aim of the present work is to examine the various challenges linked to successful implementation of circular economy led sustainability in FSC. This research addresses a multi-criterion decision type problem. In this sense, we propose to use a mixed approach based on Delphi and Interpretive Structural Modeling (ISM) - MICMAC for analysis. Challenges that were identified through literature needs to finalize and validate with the help of Delphi technique (Akkermans et al., 2003). The ISM, technique reveals the interaction among identified challenges and differentiate in different levels according to their importance (Sage, 1977). Later, MICMAC analysis based model is developed based on the dependence and driving power of identified challenges.

The structure of this paper is given as: The introduction and motivation for the study is given in Section 1.The literature review for this work is presented in Section 2. The research methods used in this work are presented in Section 3. The framework proposed for this work is shown in Section

4. Data analysis and results along the description of case company is presented in Section 5. The implications for the managers are presented in Section 6. In Section 7, the conclusions along with the limitations and future scope of work are presented.

2. Literature Review

This section explains the literature on circular economy to implement sustainability in FSC and identifies the relevant challenges as well. The gaps for this research are also presented. In this research, the literature survey is done with the help different keywords like "Food Supply Chain", "Sustainability", Circular Economy", "Challenges to sustainability" and "Indian context". Combinations of these keywords were used including "Food Supply Chain and India", "Food Supply Chain and Sustainability and Circular Economy", and "Food Supply Chain and Sustainability and Circular Economy and Challenges and Indian Context". Google scholar, and Google search database were the sources for gathering the research articles. We selected the papers that were written in English language only.

2.1 Circular Economy and Sustainability Practices and FSC

Food organisations needs to work in a sustainable way to enhance the loyalty and trust of customers. Besides, consumers are now conscious about the health benefits and risks associated with consumption of food (Mishra et al., 2018). In addition, customers are keen to know the origin and sustainability of various processes being involved in value chains, such as procurement, manufacturing, distribution, packaging etc. (Wognum et al., 2011). In this sense, many food companies are conscious about the integration, coordination, and management of food products to sustain in the competitive market (Pagell and Wu, 2009; Bloemhof and Soysal, 2017). Sustainability is an emerging concept in the food supply (Beske et al., 2014; Genovese et al., 2017). Due to higher consumer's awareness and increased resources consumption, organisations are forced to move towards the concept of circular economy and sustainability in their business models (Ageron et al., 2012; Jabbour et al., 2017). Circular economy pushes the organisations for triple bottom line of sustainability by implementing the recycling processes to modify the products based on their relationships between economic growth and ecological systems.

Circular economy helps managers to focus on the economic, social and environment gains in a supply chain context (Hamprecht et al., 2005; Ross et al., 2012). Circular economy based sustainability initiatives helps to reduce the food wastage and impact of pollution and improve the overall performance through various R's (recycle, reuse, reduce etc.) (Yong 2007; Geng et al., 2013; Govindan and Hasanagic, 2018). Circular economy based sustainability aspects also helps in providing safer and higher quality food to the customers (Beske et al., 2014). Circular economy and sustainability may be implemented by up-gradating and modifying the existing technologies and processes in a FSC context. Circular economy helps organisations to reuse natural resources to extract the maximum value from them (Bergstrom and Randall, 2016; Bag et al., 2018). In circular economy, product and its material are recovered, regenerated and reused at the end of their life (Genovese, 2017). Circular economy may help organisations in achieving business sustainability in terms of higher material cost savings, improved brand image, increased profits (Geissdoerfer, 2017). Circular economy allows organisations to deliver the high quality and secure products in a most sustainable way. This well justifies the need of implementation of circular economy and sustainability initiatives in a FSC context.

2.2 Challenges to circular economy led sustainability aspects in FSC

To identify the circular economy led sustainability focused challenges in FSC, a literature review was carried out. As a result, 11 challenges were identified, which are illustrated in the subsequent sub-sections. These challenges were also validated for expert's agreement (as discussed in Section 5).

Table 1: Challenges to circular economy led sustainability in FSC

Challenges to circular economy led sustainability in FSC	Description	Literature support
Poor Government Policies (CH1)	In case of developing nations, relatively less importance is given to the food sector during planning and the government often fails to reduce the food wastage due to lack of resources and adequate infrastructure.	Henson and Reardon, 2005; Kirwan et al., 2017
Transportation and Infrastructure Issues (CH2)	In case of a developing country, transportation includes several critical issues in terms of transportation mode, unavailability of low temperature-controlled vehicles and higher cost etc. In addition, appropriate	FICCI, 2010; Chatziioannou and Alvarez-Icaza, 2017

	infrastructure is needed to improve the effectiveness of food value chain	
Traceability Issues (CH3)	Traceability helps organisations to reduce the wastage to maintain the economic and ecological sustainability.	Regattieri et al., 2007; Fassam and Dani, 2017; Pappa et al., 2018
Packaging Issues (CH4)	In developing nations, most of the food is wasted due to packaging issues. Packaging plays an essential role in food sector, so as the perishable goods needs extra care in handling and thus, results in increasing their shelf life.	Cheruvu et al., 2008; Manzini and Accorsi, 2013; Sharma et al., 2018
Lack of Cold Chain (CH5)	In case of developing nations, organisations generally lack in awareness, infrastructure and resources, and results in diminished performance of cold chain system.	Joshi et al., 2009; Meneghetti and Monti, 2015
Lack of Technology and Techniques (CH6)	In a developing nation like India, food organisations need to be developed superior technologies and processing techniques to meet the ever increased demand of food products. However, the development of higher technologies and processing techniques needs higher investments.	FICCI, 2010; Sharma et al., 2018
Lower productivity (CH7)	To enhance ecological, social and economic sustainability, therefore, organisations may use circular economy initiatives, such as recycle, reuse etc	Popp et al., 2013; Fortin et al., 2017
Lack of farmers knowledge and awareness (CH8)	In case of a developing nation like India, farmers generally lacks in their awareness on sustainable uses of recourses and information about superior quality of seeds and post-harvest production methods	Sokoya et al., 2014; Altenbuchner et al., 2017
Food safety and security problems (CH9)	Food safety and security is a very critical issue in a developing nation context. Quality of the food is an essential factor as it directly influences the health of the people.	Ziggers, 1999; Clarke, 2010
Poor corporate social responsibility (CH10)	Food organisations should be responsible in maintaining the adequate environmental and safety standards for their products. Food organisations are also lacking in effective collaboration and partnerships with their suppliers.	Maloni, 2006, Bharti and Mittal, 2017

Greenhouse gas emission (CH11)	Higher greenhouse and carbon emissions are critical issues during the transportation and distribution of food products.	Audsley et al., 2010

2.3 Research gaps

Based on literature review, emerging gaps for this research are determined, as below:

- Food wastage is a very critical issue for food manufacturing organisations in a developing nation context. Food wastage generally caused by several reasons, including poor transportation and infrastructure, lack of refrigeration, insufficient market services, poor packaging, poor storage facilities, poor quality checks, etc (Glover et al., 2014). Therefore, organisations should move towards circular economy driven sustainability oriented practices to manage the issues of food wastage or food loss in value chains.
- Most of the studies focused on understanding the sustainability concept by means of technology up-gradation, greater resource efficiency, better understanding of consumer demands and education in FSCs (Beske et al., 2014; Touboulic and Walker, 2015). However, very few researchers worked on the circular economy initiatives to develop sustainability in food value chains (Sarkis, 2008; Halloran, 2014)
- The need for sustainable practices in FSC is becoming very crucial (Baldassarre et al., 2017; Bloemhof and Soysal, 2017; Govindan, 2018). The food industry at present must compete with global sustainable manufacturing standards to ensure safer and higher quality products for their customers (Boiral, 2006). Sustainability in the food industry is becoming one of the main important topics but the implementation of circular led sustainability in the food industry is still a question to address for policy makers and managers.
- This is one of the very initial works conducted on identifying the challenges to circular economy based sustainability aspects in FSCs. In addition, literature also greatly lacks in studies analysing the interactions between the challenges to implement circular economy based sustainability aspects in FSCs (Turi et al., 2014).

In this sense, this paper seeks to contribute to the literature by examining the challenges to circular economy led sustainability from the perspective of FSC especially in a developing nation like India through combined Delphi – ISM based MICMAC approach.

3. Research Methods

The Delphi and ISM techniques have been used as research methods. Delphi technique is very useful to finalise the identified challenges for the implementation of circular economy led sustainability in FSC. Thus, interactions among the challenges were determined by ISM. The combined Delphi- ISM technique is a methodical decision support, which provides practical means not only to select the circular economy led sustainability in FSC based challenges, but also investigate the interactions between the challenges based on their dependence and driving power. Details of both the research methods are given as below in the sections 3.1 and 3.2.

3.1 Delphi

The Delphi approach was developed by the RAND Corporation workers in 1950s during the project sponsored by U.S Air Force. Delphi is an effective tool, when there is lack of theory building. Delphi approach is very flexible in which decisions are reviewed and sent back for further analysis to the concerned group (Seuring and Müller, 2008). Delphi is one of the most effective used methods in program planning, resource utilization, safety and security, supplier selection, supply chain management, project management and location decision, etc. (Luthra et al., 2017; Holmberg et al., 2017). This work employs Delphi analysis to confirm and validate the challenges for expert's feedback.

3.2 ISM-MICMAC

ISM was first developed in 1970's by Warfield (Warfield, 1974). ISM can be used to determine the interrelationships between the factors and structured them into a systemic model (Mangla et al., 2014). ISM can predict the hierarchical arrangements of factors, which describes a problem (Sivaprakasam et al., 2015; Kapse et al., 2017). ISM is generally preferred over other modeling techniques, due to its 'leads to' relationship type (Shen et al., 2016; Luthra et al., 2016). The steps used in ISM methodology were explained in figure 1.

ISM follows several steps (Sajid et al., 2017), which are described as:

i. Identify the variables. In the current work, challenges linked to implement circular economy led sustainability in FSC have been listed as variables.

ii. Develop the contextual relationships between challenges using expert's inputs.

iii. Develop the Structural Self-Interaction Matrix (SSIM). The opinion of experts is used for this purpose.

iv. Develop the reachability matrix. SSIM is used for developing the initial reachability matrix, which is further converted to final reachability matrix by checking the transitivity relations among the identified challenges.

v. Form the different levels using final reachability matrix.

vi. Conduct the MICMAC analysis for listed challenges.

vii. Form the digraph.

viii. Form the ISM model.

ix. Test the developed ISM model for any theoretical inconsistency.

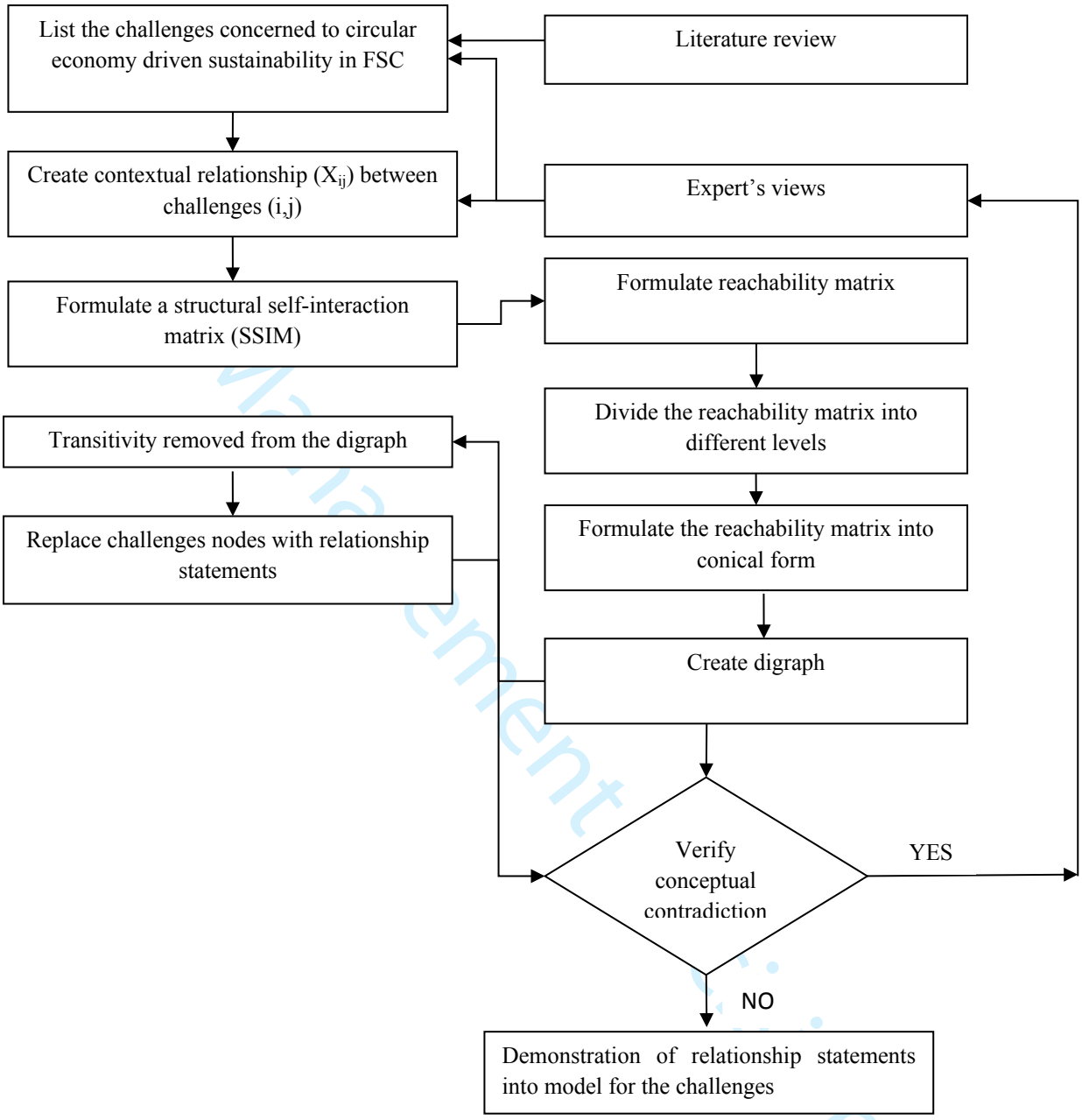

Figure 1: Flow chart to prepare ISM model

4. Research Framework

The proposed research framework for analysing the challenges in FSC, based on Delphi and ISM – MICMAC approaches is shown in figure 2. The proposed research framework is mainly focused into the processes that are used for this work only, selection of challenges, selection of approaches,

etc. In addition, each process of this framework is validated with literature and experts agreement. The framework is developed by following the guidelines of Platts and Gregory (1990). The conceptual research framework consists of three phases. Phase 1: identification of challenges - in this phase, the literature survey was used to determine the challenges to the successful implementation of circular economy led sustainability in FSC. Phase 2: validation and finalisation of challenges using Delphi technique - in this phase, the identified challenges from the extent literature were validated with the help of Delphi technique. In the beginning, a group of experts from industries and academia was formed. Based on Delphi analysis, the inputs acknowledged from the experts are useful in finalising the challenges.

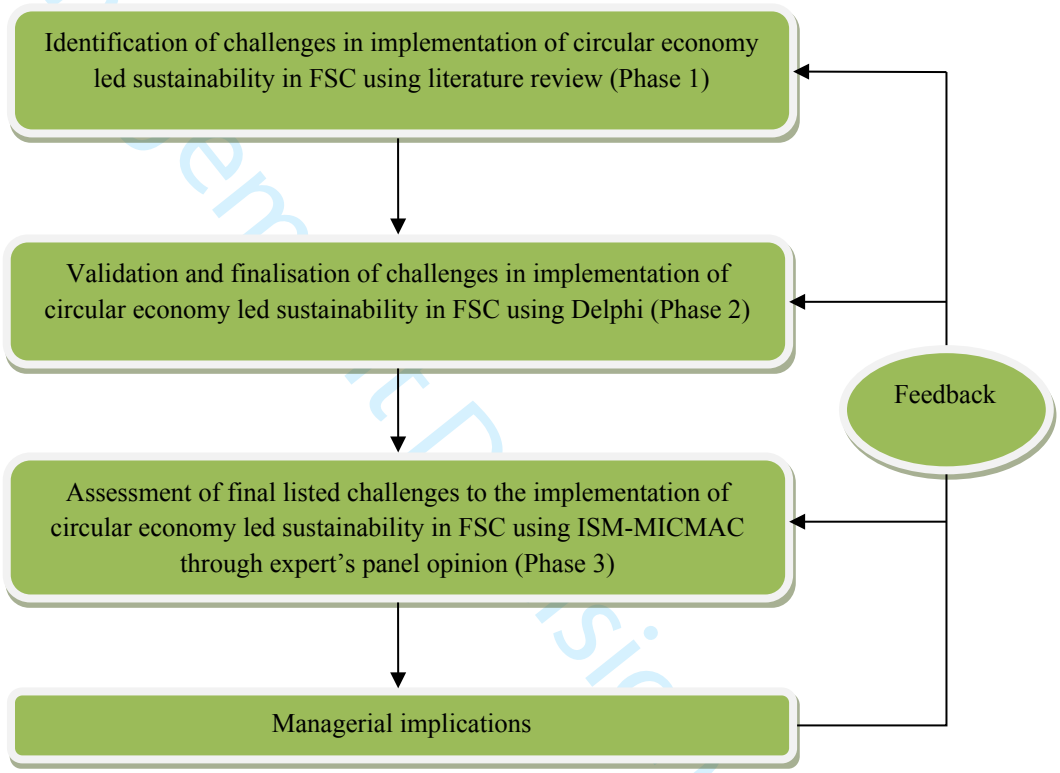

Figure 2: Research Framework

Phase 3: assessment of final listed challenges using ISM-MICMAC through expert's panel opinion - The final phase listed the challenges that were analysed to different sections like dependent, driving, linkage and autonomous by using ISM-MICMAC method through expert's panel inputs. This allows the managers to manage the circular economy led sustainability concerns in FSC in a most effective manner.

5. Data Analysis and Results

In the current work, dairy food Business Company (XYZ) operating in India is selected. It was established in 2008 and the yearly turnover of this company is approximately 900 Crores (Indian rupees). The company has employee strength of more than 1000. The company's main motto is to provide healthy and safer food to their consumers locally and globally. The top management of the company is highly committed towards sustainability. Management is seeking to implement circular economy initiatives, such as life cycle analysis, carbon neutrality, technological innovations, and various R's (reuse, recycle, reduce) in its value chain.

We have discussed our research objectives with the case company manager's and they were agreed to participate and share their knowledge and experience for the better output of the research work. Figure 3, explains how the product is processed in the supply chain, firstly the product is manufactured and then follows the packaging and distribution section and finally out for sale, under the forward process. Once the consumer used the product, then the product follow the reverse process in which the product will return for evaluation and send it to the respective departments i.e. recycling and recovery facilities. After evaluation, the product which has less defects move to the recovery facility and the product having more defects move for recycling, in worst scenario the product is disposed as eco-friendly waste. The application of proposed framework was explained in the previous section, into three stages and with respect to the dairy industry example, is discussed in the next subsections.

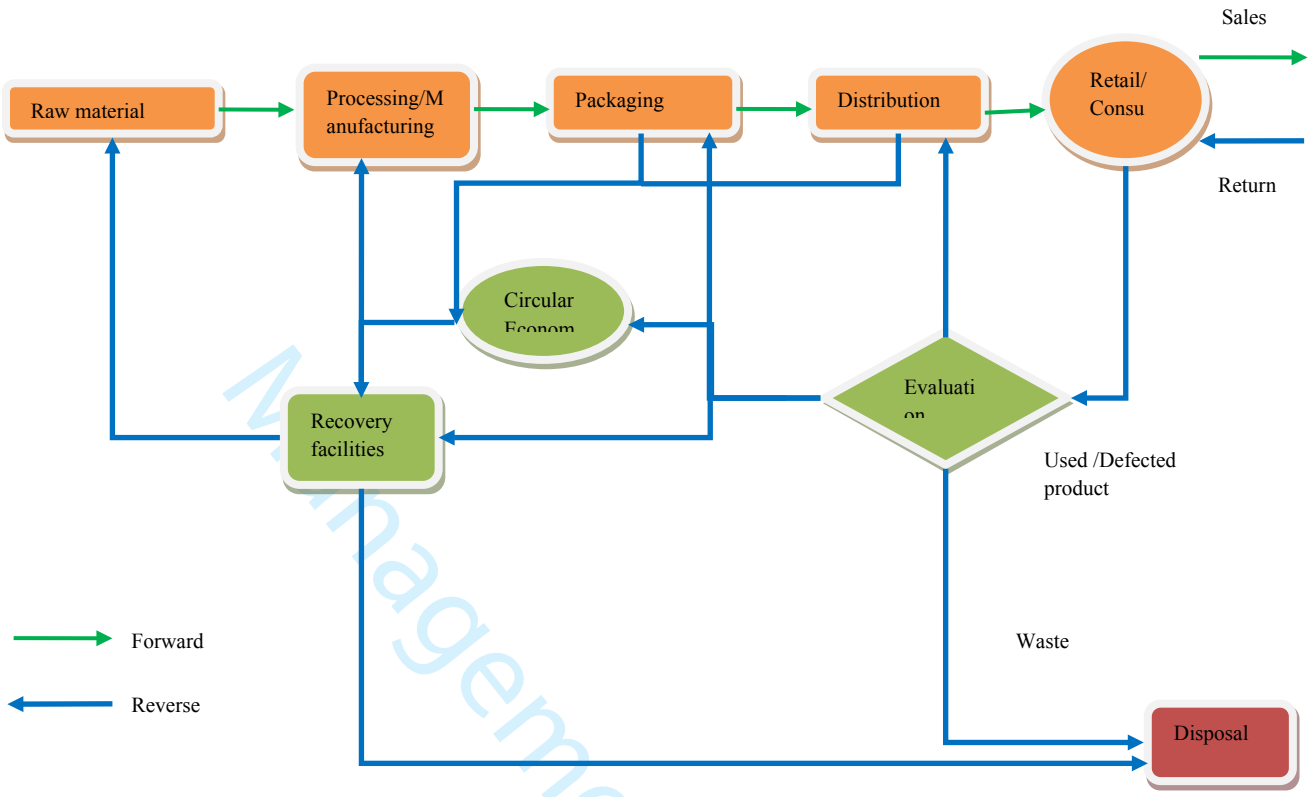

Figure 3: The food supply chain for the case company

5.1 Phase 1: Identification of challenges

In this phase, 11 key challenges to circular economy led sustainability in FSC are determined through the literature survey. The details of challenges have been provided in the section 2.2.

5.2 Phase 2: Validation and finalisation of challenges using Delphi

Originally, 11 challenges were determined using the literature review. Delphi analysis was carried out to finalising and validating the identified challenges. For this, a group of 14 experts (seven from industry and seven from academia background) and they both are highly qualified and having experience of more than 15 years in their domain, was formed to analyse the current problem. The selected industrial experts were engaged in various operations like manufacturing, production, distribution, dispatching and monitoring in the company. The selected academia experts were from Supply and Operations Management and Knowledge Management & Decision-Making background. The sample size for this case based work is considered to be satisfactory (Mangla et al., 2015). For data collection, a feedback survey (shown in Appendix A) was mailed to the experts to know their responses. The brainstorming session was carried out to reach a final agreement on

finalising the challenges. The challenges that are not suitable were deleted in the list and challenges that are suitable for the current study, according to expert's response is added to the list. In the present work, no changes were made in the initial list of challenges. Finally, 11 key challenges were decided to implement circular economy led sustainability in FSC in context of India through expert's feedback.

5.3 Phase 3: Assessment of final listed challenges using ISM-MICAMC through expert's panel opinion

The finalized eleven key challenges were analysed using ISM-MICAMC method. The contextual relationships between the challenges are determined through expert's feedback. This helps in developing the SSIM shown in Table 2. We used four symbols (V, A, X and O) (Sajid et al., 2017) for developing SSIM.

Table 2: Structural self-interaction matrix of challenges

S.No.	Challenges	11	10	9	8	7	6	5	4	3	2
1	Poor Government Policies (CH1)	O	V	O	O	O	A	O	V	O	V
2	Transportation and Infrastructure Issues (CH2)	O	V	V	O	X	A	O	A	V	X
3	Traceability Issues (CH3)	O	V	O	O	O	A	O	A	X	
4	Packaging Issues (CH4)	A	X	O	O	O	A	O	X		
5	Lack of Cold Chain (CH5)	V	O	O	A	X	O	X			
6	Lack of Technology and Techniques (CH6)	V	V	O	O	O	X				
7	Lower Productivity (CH7)	O	A	O	V	X					
8	Lack of Farmers Knowledge and Awareness (CH8)	A	A	O	X						
9	Food Safety and Security Problems (CH9)	O	A	X							
10	Poor Corporate Social Responsibility (CH10)	V	X								
11	Greenhouse Gas Emission (CH11)	X									

From Table 2, CH1, Poor Government Policies leads to CH2, Transportation and Infrastructure Issues, so as represented with symbol V. In the same way, CH6, Lack of Technology and Techniques leads to CH1, Poor Government Policies, so as represented with symbol A.

Next, SSIM has been converted into binary matrix using numbers 0 and 1. In this sense, initial reachability matrix for the challenges is developed as shown in Appendix - B.

Next transitivity is applied, and thus, final reachability matrix is obtained as shown in Table 3. The dependence and the driving power of challenges are also explained.

Table 3: Final Reachability Matrix of challenges

S.No.	Challenges	1	2	3	4	5	6	7	8	9	10	11	Driving power
1	Poor Government Policies (CH1)	1	1	0	1	1*	0	0	1*	0	1	0	06
2	Transportation and Infrastructure Issues (CH2)	0	1	1	1*	0	0	1	0	1	1	1*	07
3	Traceability Issues (CH3)	0	1*	1	1*	0	0	0	1*	0	1	0	05
4	Packaging Issues (CH4)	0	1	1*	1	0	0	1*	0	1*	1	1*	07
5	Lack of Cold Chain (CH5)	0	0	0	0	1	0	1	0	1*	0	1	04
6	Lack of Technology and Techniques (CH6)	1	1	1	1	1*	1	1*	1*	1*	1	1	11
7	Lower Productivity (CH7)	0	1	0	1*	0	0	1	0	0	1*	1*	05
8	Lack of Farmers Knowledge and Awareness (CH8)	0	0	1*	1*	1	0	0	1	0	1*	0	05
9	Food Safety and Security Problems (CH9)	0	0	0	0	1*	0	1*	0	1	0	1*	04
10	Poor Corporate Social Responsibility (CH10)	0	1*	1*	1	0	0	1	0	1*	1	1	07
11	Greenhouse Gas Emission (CH11)	0	1*	0	1	0	0	1*	0	0	1	1	05
Dependence power		02	08	06	09	05	01	08	04	06	09	08	66/66

Note: * values getting after applying transitivity

Next, we obtain different levels for the challenges. The antecedent and reachability sets were found for all the challenges. Thus, antecedent and reachability sets are intersection sets which are established for all the challenges. We have determined six levels in the present work. Challenge having the similar sets of reachability and incident is given as the highest value (Level 1) in the ISM hierarchy is shown in the (Table 4) and all the iterations for levels were explained in the Appendix C.

Table 4: Different levels of challenges

S.No.	Challenges to implement circular economy led sustainability	Level
1	Greenhouse Gas Emission (CH11) Lower Productivity (7)	1st
2	Food Safety and Security Problems (CH9) Lack of Cold Chain (CH5)	2nd
3	Transportation and Infrastructure (CH2) Traceability Issues (CH3) Packaging Issues (CH4) Poor Corporate Social Responsibility (CH10)	3rd
4	Lack of Farmers Knowledge and Awareness (CH8)	4th
5	Poor Government Policies (CH1)	5th
6	Lack of Technology and Techniques (CH6)	6th

Further, MICMAC analysis discovers the effect and dependence between challenges (Mangla et al., 2013) as shown by four quadrants in Figure 4.

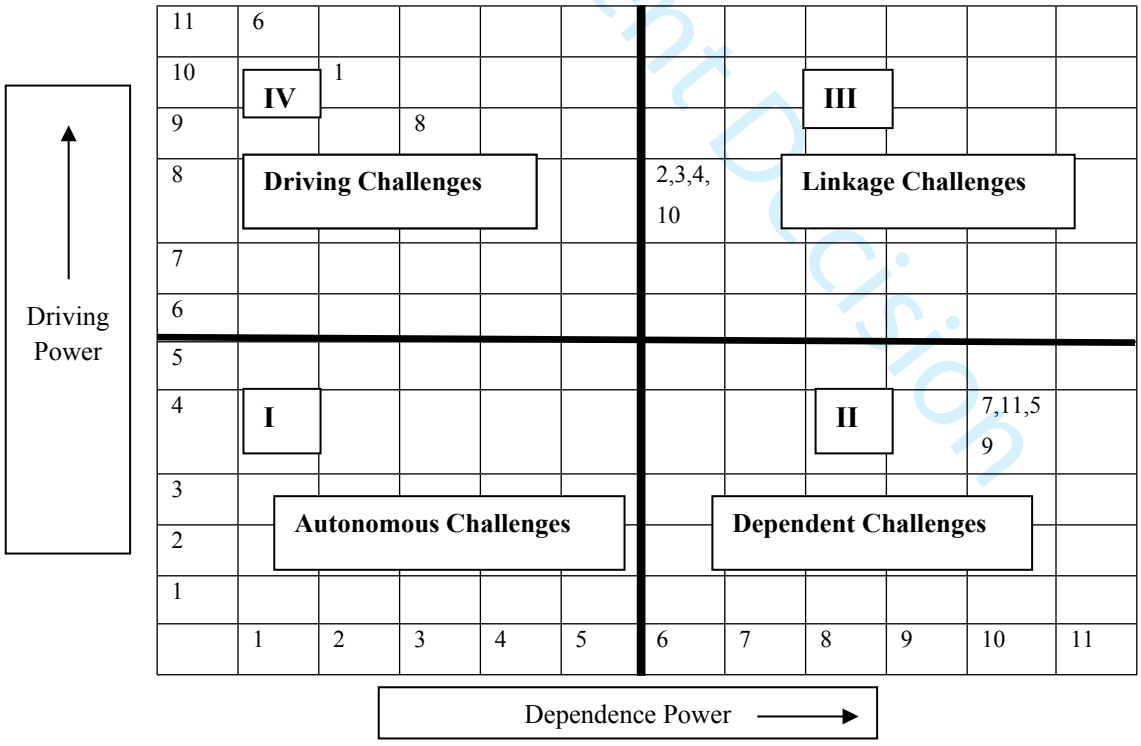

Figure 4: Driver-Dependence diagram of challenges

Quadrant I: This quadrant shows challenges with weak driving and dependency power and in this quadrant there is no challenge. These challenges are called autonomous challenges.

Quadrant II: This quadrant shows challenges (CH7, CH11, CH5, and CH9), with the strong dependency and having weak driving power. These challenges are called dependent challenges. Corporate social responsibility, greenhouse gas emission, cold chain and climate change are the dependent challenges and these challenges were highly influenced by other challenges like technology and techniques, farmer's knowledge and awareness.

Quadrant III: shows challenges (CH2, CH3, CH4 and CH10), having strong dependence power and driving power as well and these challenges are called linkage challenges.

Quadrant IV: shows challenges (CH6, CH1 and CH8), with weak dependency and strong driving power and thus these challenges are known as independent challenges. Any action on these challenges will influence the other challenges and feedback effect on themselves. Technology and techniques development should be analysed prior to producing any product in the market.

A digraph is drawn after the development of the final reachability matrix, which shows the transitivity relations among the variables in Figure 5.

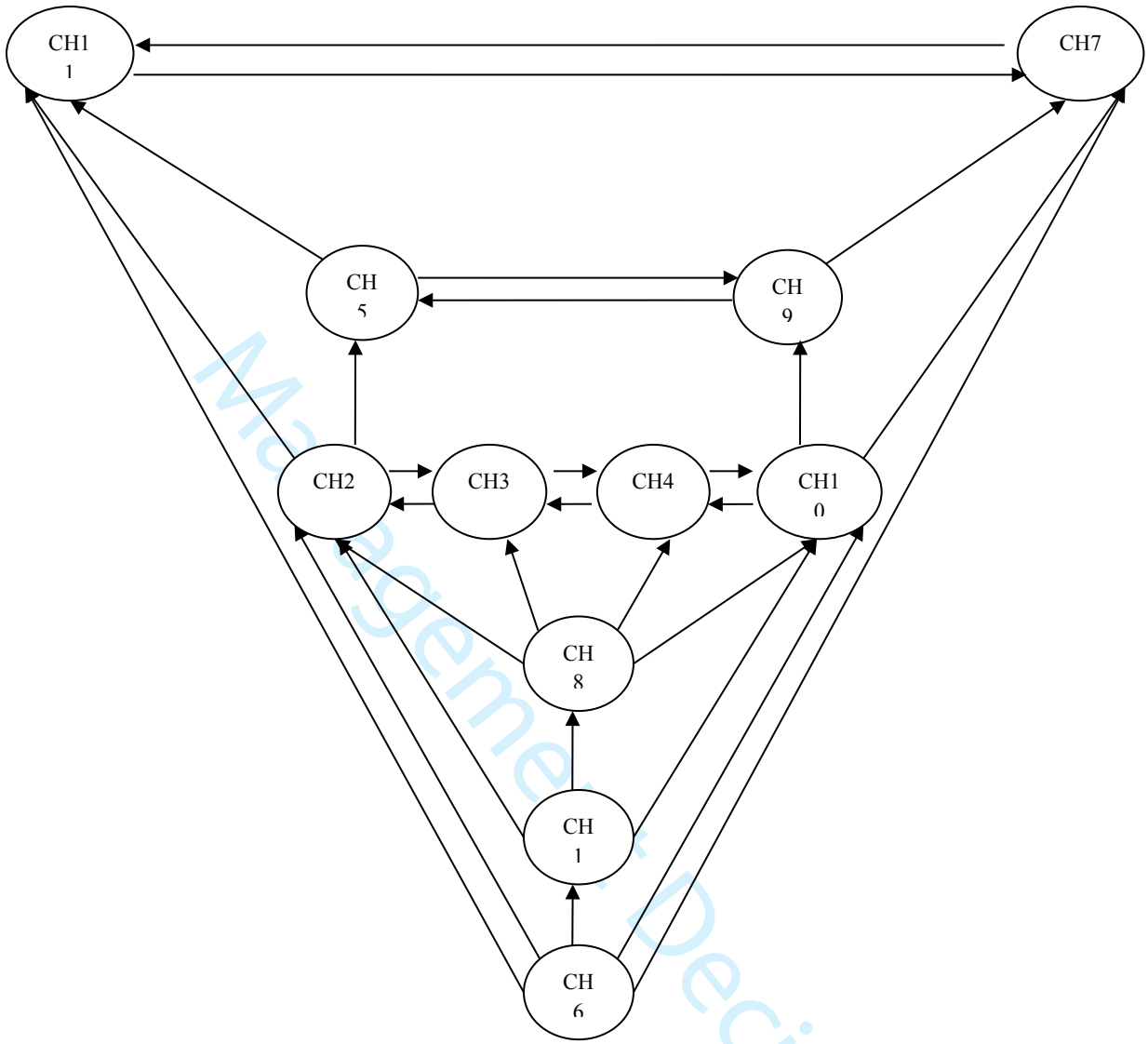

Figure 5: Digraph of challenges

This digraph (figure 5) is changed into the ISM- based model which is depicted in Figure 6. ISM hierarchy model also make sure that any challenge placed at certain level will not help any other challenge placed above it.

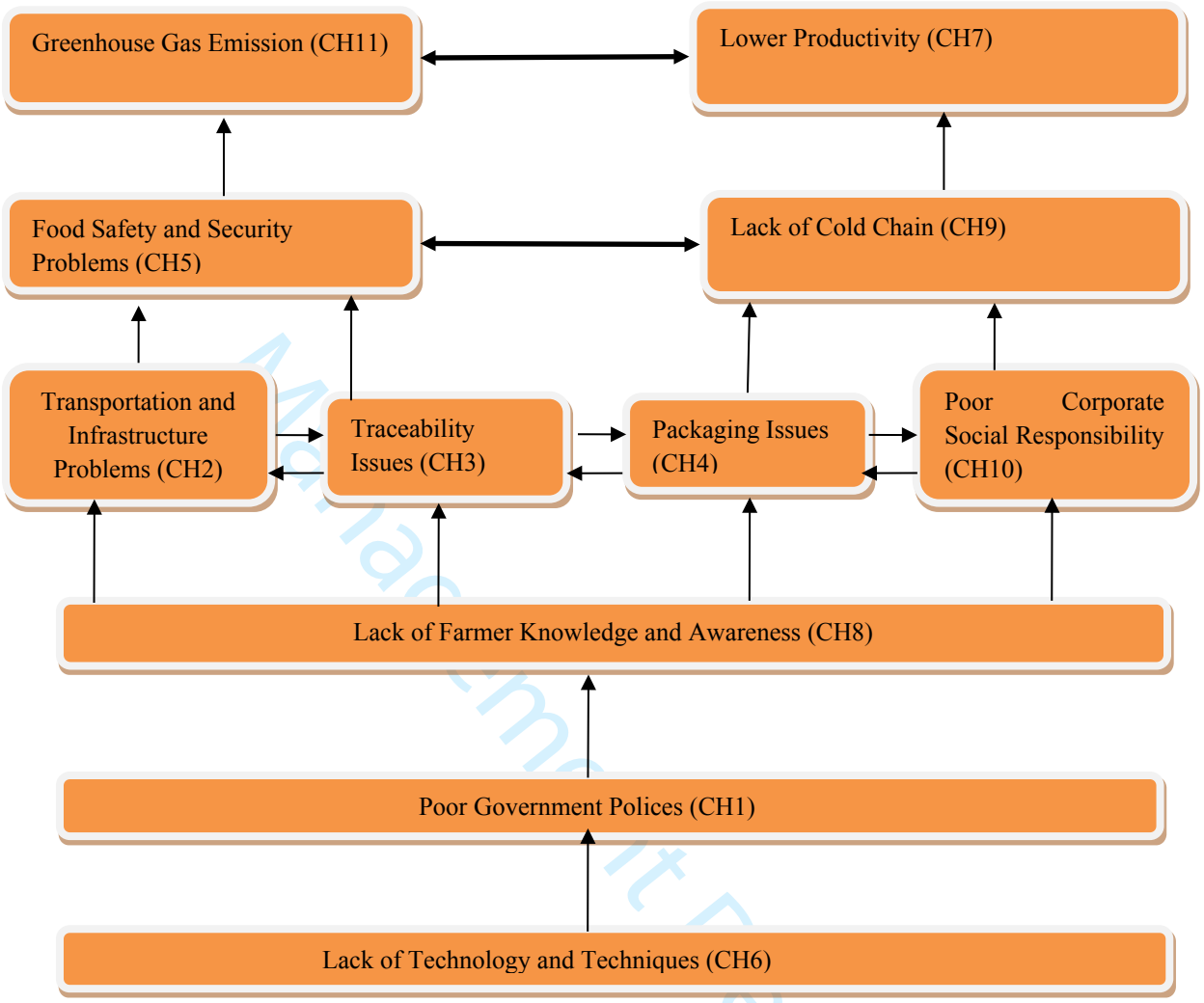

Figure 6: ISM model for challenges

Figure 6 indicates that greenhouse gas emission (CH11) and lower productivity (7) are at level-I (top-level). The second level (level-II) challenges are food safety and security problems (CH9) and lack of cold chain (CH5) and reflect a lack of technological support. Transportation and infrastructure (CH2); traceability issues (CH3); packaging issues (CH4) and poor corporate social responsibility (CH10) appears at level III and lack of farmers knowledge and awareness (CH8) appears at level IV. Poor government policies (CH1) appears at level V and lack of technology and techniques (CH6) appears at VI level (Darbari et al., 2018). Greenhouse gas emission (CH11) and lower productivity (CH7) appears at the top of the structure as the most dependent challenges in implementation of circular economy led sustainability in Indian food industry context. Both the challenges are highly affected by other challenges like technology and techniques, government

policies, farmers knowledge, transportation and infrastructure, packaging, corporative social responsibilities, safety and security and cold chains. These challenges are correlated to each other, if there is a lack in technologies and techniques it affects the transportation facilities, traceability facilities and packaging and they directly affect the productivity and greenhouse gas emission (Saengsathien, 2015; Grant et al., 2017). Poor government policies (CH1) and lack of farmer's knowledge (CH8) are among the crucial drivers to achieve sustainability in food industry. Farmer's knowledge is very important to enhancing green policies and regulations.

Government policies are also important because it affect transportation, farmers and organisation. Poor government policies directly affect the whole supply chain. In addition, to achieve security and safety issues in food sector, transportation and infrastructure (CH2); traceability issues (CH3); packaging issues (CH4) and poor corporate social responsibility (CH10) is important to implement sustainability in Indian FSC. Food safety and security problems (CH2) and lack of cold chain (CH5) led to economic-ecological and social sustainability in Indian FSC. Greenhouse gas emission (CH11) and lower productivity (CH7) are the desired outcome in the structure.

6. Managerial Implications

This work seeks to identify the challenges for achieving circular economy, which leads to sustainability of FSC in developing countries, like India. This research attempts to study interrelationships between the challenges, which could help managers, and policy makers in reducing the wastage throughout the food chain (Gustavsson et al., 2015) for the implementation of sustainability in sector.

Food organisation managers to sustain in the market should address sustainable practice. The sustainability initiatives in food sector are supported by several national and international organisations like World Trade Organization (WTO), FSSAI, South Asian Association for Regional Cooperation (SAARC), World Health Organization (WHO), Federation of Indian Chambers of Commerce and Industry (FICCI), etc. This research offers several significant management science implications for sustainability orientation in food value chain. Lack of technology and techniques and poor government policies are the two most significant issues in

effective adoption of circular economy and sustainability in food industry in India. From an organisational context, advancement of technologies and techniques is useful to reduce the food wastage and improve the overall quality. In India, farmers and organisations are still using conventional techniques and technologies in their food value chains activities, such as processing, production, distribution etc. In India, government policies are also not so supportive to farmers and organisations to adopt sustainability concepts. Compared to developed countries, the traditional command-and-control regulatory mechanism of Indian system fails to provide incentives for farmers and food organisations to maintain a definite level of emission or reduce food wastage. Therefore, poor government polices becomes a significant issue for Indian food sector and plays an important part in effective circular economy based sustainability adoption. From managerial perspectives, skilled employees are key to achieve higher quality and sustainability in FSCs. The Indian government recently added sustainability in their 5-year plans in the field of food and agriculture.

Government of India should also take initiatives to educate farmers to adopt sustainable practice in agricultural activities, such as green purchasing and green production. The lack of farmer's knowledge and awareness to adopt sustainable technology and procedures is a major problematic issue in food industry in India. To overcome the issue, managers and policy makers to motivate farmers to adopt sustainable practice may conduct proper training and workshops. Farmers' knowledge and awareness is very important for the right cultivation, right harvest and postharvest practices and proper use of technology and techniques in farming. Managers and policy makers have to provide regular trainings to develop necessary skill set among farmers and employees. This will help them to increase productivity and helps organisation to improve their ecological-economic and social gains. Managers should educate farmers and customers about importance of circular economy initiatives for sustainable agriculture and future. Circular economy, initiatives also helps food organisations to attain brand value in the competitive market.

Transportation and infrastructure, traceability issues, packaging issues and poor corporate social responsibility are correlated challenges according to the results. In India, most of the food is wasted because of poor transportation, infrastructure, and storage and packaging facilities. Managers should improve the standards of packaging to increase the quality of food and reduce the amount of wastage during the transportation and storage. Transportation and infrastructure is also a critical

issue for food organisations in Indian sector. Food Corporation of India (FCI) is taking some initiatives to manage the transportation related issues in food sector. FCI implemented national food security Act, 2013 (NFSA) to manage the transportation issues. According to FCI, if products are transported in containers, instead of gunny-bags, it will reduce food losses. In order to feed billions of mouths, organisations needs to adopt circular economy based sustainability concepts by using three R's i.e. reuse, reduce and recycle. Managers and policy makers can also prefer alternative fuel vehicles (electric, hybrid) to enhance sustainability in terms of lower greenhouse gas emissions. In the same way, traceability and packaging issues may rectified using contemporary technologies and techniques. Traceability is important to control and trace the hazards like poisoning in the food and fraud (Turi et al., 2014). The initiatives, such as radio-frequency identification (RFID) technology will help organisations to trace products for real time visibility of product (Zhang and Li, 2012). It can also improve the efficiency of FSC by reducing the overall food wastage. This will further help in managing the issue of food adulteration and contamination in a FSC context. Managers should focus on global reach and branding of the product for better product management. In India, there is a lack of quality, safety measures and improper collaboration between the partners (Prakash, 2015). This can overcome the poor corporate social responsibility of the organisations.

Proper government policies, infrastructure and cold chain facilities can help in reducing the food wastage. Managers should increase the standardisation of products to improve the efficiency of cold chain. They should focus on the reduction of mediators during the whole supply chain. They should recruit high skilled professionals to meet the technological changes in cold chain (Joshi et al., 2009; Joshi,et al., 2011). In India 70% of population resides in rural areas which lacks proper infrastructure to reduce the wastage of food during the transportation. Therefore, most of the food is spoiled or wasted because of improper storage or infrastructure (Gokarn and Kuthambalayan, 2017). Lower productivity and greenhouse gas emission issues may also managed by using pioneering sustainable practices, such as energy conservation, reusing and recycling the waste material and solid waste disposal. The adoption of sustainable practices helps organisation in many ways, such as increased market opportunities, higher quality etc. In order to enhance overall productivity, organisations may follow innovative sustainable practices, like environmental friendly process design, use of new techniques and materials, total quality management practices, environmental friendly transportation mechanism etc.

7. Conclusions

The adoption of circular economy based sustainability aspects is complex to the point of view of a developing nation like India. In this sense, the present work uses a combined approach based on Delphi and ISM – MICMAC to investigate the challenges and to analyses the contextual relationship between the challenges in a developing economy context.

We recognized eleven circular economy led sustainability related challenges through literature. Delphi method is used to finalise these challenges using expert's feedback. ISM approach is used to find out the contextual relationships between the challenges. In addition, MICMAC analysis was used for classifying the challenges. According to the findings, Poor Government Policies (CH1); Lack of Technology and Techniques (CH6) and Lack of Farmer's Knowledge and Awareness (CH8) come under the driving challenges. The Lower Productivity (CH7); Greenhouse Gas Emission (CH11); Food Safety and Security Problems (CH9) and Lack of Cold Chain (CH5) come under the dependence challenges. Understanding of circular economy led sustainability related challenges will help managers and policy makers in effective management of natural resources in food sector. This work seeks to contribute in literature by identifying the challenges in implementation of circular economy led sustainability aspects in FSC. A case study of company involved in diary food supply chain operating in India is conducted. This result will help managers of food industry in understanding the interrelationship between identified challenges.

The present work has certain limitations as well. In Delphi approach several issues needs to be managed, such as time and expenses on designing the questionnaire, survey, travelling, delay in responses from experts, difficulties in conducting questionnaire based survey, difficulties in compiling the data and follow-up the experts for their multiple responses. The model can then be tested in real world for different economies conforming whether these challenges are complete or present as same in the previous literature. For validating the ISM model, SEM can also be used.

Appendix A

Questionnaire Survey

Dear Respondent

Greetings!!!

This study has been conducted for determining the challenges for the implementation of circular economy led sustainability in food supply chain in a developing economy like India. This questionnaire is a part of the research work. Your response will be kept confidential. The questionnaire will enable to determine the familiarity and the level of interaction in Indian food industries. We would be grateful and obliged if you could spare some time to answer a few questions.

Role in Academics or in Industry: .....

Responsibility in Academics or in Industry: .....

Your Name: ……

Profile/ Department: .....

Qualification……..

All the personal information/identity will not be shared with anyone without your kind permission.

Sincerely

Authors

Response Sheet – Finalising the challenges

Determining and analysing the challenges relevant to successful implementation of circular economy led sustainability in food supply chain practices in developing economy especially in Indian context. So, it needs to identify their own priority of concern. Please mark your responses according to the given scale {1 Extremely Insignificant, 2 Very Insignificant, 3 Little Insignificant, 4 Normal, 5 Little Significant, 6 Very Significant, 7 Extremely Significant}.

	1	2	3	4	5	6	7
Poor government policies	☐	☐	☐	☐	☐	☐	☐
Transportation and infrastructure issues	☐	☐	☐	☐	☐	☐	☐
Traceability issues	☐	☐	☐	☐	☐	☐	☐
Packaging issues	☐	☐	☐	☐	☐	☐	☐
Lack of cold chain	☐	☐	☐	☐	☐	☐	☐
Lack of technology and techniques	☐	☐	☐	☐	☐	☐	☐
Lower productivity	☐	☐	☐	☐	☐	☐	☐
Lack of farmer's knowledge and awareness	☐	☐	☐	☐	☐	☐	☐
Food safety and security problems	☐	☐	☐	☐	☐	☐	☐
Poor corporative social responsibility	☐	☐	☐	☐	☐	☐	☐
Greenhouse gas emission	☐	☐	☐	☐	☐	☐	☐

Any other relevant factor/deletion/modification in the above mentioned challenges…….

Response Sheet: Study the interaction among the challenges for ISM approach

ISM methodology is applied to study the interactions among the challenges. According to the procedure of ISM, we need your judgement in development of SSIM. Following four symbols have been used which denotes the direction of correlation among two challenges 'x' and 'y'.

V represents the challenge 'x' leads to challenge 'y';

A represents the challenge y leads to challenge x;

X represents the challenge x and y leads to each other;

O represents the challenge x and y are not related to each other

Please put your response in below Table for SSIM development.

Table: SSIM for challenges to implement circular economy led sustainability

S.No.	Challenges to implement circular economy led sustainability	11	10	9	8	7	6	5	4	3	2
1	Poor government policies (CH1)										
2	Transportation and infrastructure issues (CH2)										
3	Traceability issues (CH3)										
4	Packaging issues (CH4)										
5	Lack of cold chain (CH5)										
6	Lack of technology and techniques (CH6)										
7	Lower productivity (CH7)										
8	Lack of farmers knowledge and awareness (CH8)										
9	Food safety and security problems (CH9)										
10	Poor corporate social responsibility (CH10)										
11	Greenhouse gas emission (CH11)										

Appendix B

Table B.1: Initial reachability matrix of challenges

S.No.	Challenges											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	Poor government policies (CH1)	1	1	0	1	0	0	0	0	0	1	0
2	Transportation and infrastructure issues (CH2)	0	1	1	0	0	0	1	0	1	1	0
3	Traceability issues (CH3)	0	0	1	0	0	0	0	0	0	1	0
4	Packaging issues (CH4)	0	1	1	1	0	0	0	0	0	1	0
5	Lack of cold chain (CH5)	0	0	0	0	1	0	1	0	0	0	1
6	Lack of technology and techniques (CH6)	1	1	1	1	0	1	0	0	0	1	1
7	Lower productivity (CH7)	0	1	0	0	1	0	1	1	0	0	0
8	Lack of farmers knowledge and awareness (CH8)	0	0	0	0	1	0	0	1	0	0	0
9	Food safety and security problems (CH9)	0	0	0	0	0	0	0	0	1	0	0
10	Poor corporate social responsibility (CH10)	0	0	0	1	0	0	1	0	0	1	1
11	Greenhouse gas emission (CH11)	0	0	0	1	0	0	0	1	1	0	1

Appendix C

Iterations process for ISM during partitioning of levels

Table C.1: First iteration

Challenges	Reachability set	Antecedent set	Intersection	Level
CH1	1,2,4,5,8,10	1,6	1	
CH2	2,3,4,7,9,10,11	1,2,3,4,6,7,10,11	2,3,4,7,10,11	
CH3	2,3,8,10	2,3,4,6,8,10	2,3,8,10	
CH4	2,3,4,7,9,10,11	1,2,3,4,6,7,8,10,11	2,3,4,7,10,11	
CH5	5,7,9,11	1,5,6,8,9	5,9	
CH6	1,2,3,4,5,6,7,8,9,10,11	6	6	
CH7	2,4,7,10,11	2,4,5,6,7,9,10,11	2,4,7,10,11	1
CH8	3,4,5,8,10	1,3,6,8	3,8	
CH9	5,7,9,11	2,4,5,6,9,10	5,9	
CH10	2,3,4,7,9,10,11	1,2,3,4,6,7,8,10,11	2,3,4,7,10,11	
CH 11	2,4,7,10,11	2,4,5,6,7,9,10,11	2,4,7,10,11	1

Table C.2: Second iteration

Challenges	Reachability set	Antecedent set	Intersection	Level
CH1	1,2,4,5,8,10	1,6	1	
CH2	2,3,4,9,10	1,2,3,4,6,10	2,3,4,10	
CH3	2,3,8,10	2,3,4,6,8,10	2,3,8,10	
CH4	2,3,4,9,10	1,2,3,4,6,8,10	2,3,4,10	
CH5	5,9	1,5,6,8,9	5,9	2
CH6	1,2,3,4,5,6,8,9,10	6	6	
CH8	3,4,5,8,10	1,3,6,8	3,8	
CH9	5,9	2,4,5,6,9,10	5,9	2
CH10	2,3,4,9,10	1,2,3,4,6,8,10	2,3,4,10	

Table C.3: Third iteration

Challenges	Reachability set	Antecedent set	Intersection	Level
CH1	1,2,4,8,10	1,6	1	
CH2	2,3,4,10	1,2,3,4,6,10	2,3,4,10	3
CH3	2,3,8,10	2,3,4,6,8,10	2,3,8,10	3
CH4	2,3,4,10	1,2,3,4,6,8,10	2,3,4,10	3
CH6	1,2,3,4,6,8,10	6	6	
CH8	3,4,8,10	1,3,6,8	3,8	
CH10	2,3,4,10	1,2,3,4,6,8,10	2,3,4,10	3

Table C.4: Forth iteration

Challenges	Reachability set	Antecedent set	Intersection	Level
CH1	1,8	1,6	1	
CH6	1,6,8	6	6	
CH8	8	1,6,8	8	4

Table C.5: Fifth iteration

Challenges	Reachability set	Antecedent set	Intersection	Level
CH1	1	1,6	1	5
CH6	1,6	6	6	

Table C.6: Sixth iteration

Challenges	Reachability set	Antecedent set	Intersection	Level
CH6	6	6	6	6

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