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INFORMATION COMMUNICATION TECHNOLOGY (ICT) INNOVATIONS FUELING SUSTAINABILITY IN MSMES AND PUBLIC PRODUCT MARKETING

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Abstract

The Indian food industry is currently facing a notable challenge, as an estimated 30% of agricultural produce is being wasted owing to operational inefficiencies in Small and Medium Enterprises (MSMEs). Micro, Small, and Medium Enterprises (MSMEs) operating within the Indian food sector encounter various obstacles, encompassing financial limitations, a dearth of technical proficiency, and inadequate investment in their enterprises. Therefore, a number of significant elements might have a decisive impact on the reduction of agricultural product waste and the minimization of energy use in order to foster sustainable development. Hence, the primary objective of this research is to identify and evaluate the crucial factors that facilitate the implementation of Information Communication Technology (ICT) applications to promote sustainable development in micro, small, and medium enterprises (MSMEs) operating in the Indian food sector. In order to examine these issues, the Grey-based Decision-Making Trial and Evaluation Laboratory technique was applied. The findings suggest that the elements with the greatest influence within the causative category are 'Government efforts and policies,' 'Public-private partnerships,' and 'Support for ICT service providers.' The variables that have been identified as having the most significant impact include the effective integration of information and communication technology (ICT) into the food supply chain, interdepartmental coordination, and collaboration and strategic alliances across the supply chain. The aforementioned findings highlight the fundamental significance of 'Government policies and actions' in the endeavour to improve the food supply chain. Considering the substantial client base of Micro, Small, and Medium Enterprises (MSMEs) that the Indian government represents, along with its significant impact on policymaking in the food industry, it is crucial for the government to adopt proactive measures. The recommended measures encompass the facilitation of private and foreign investments, the promotion of IT service providers, and the formulation of economic policies that are conducive to enhancing the competitiveness of the Indian food sector. This study is a significant resource for managers who aim to enhance the efficiency of information and communication technology (ICT) applications in order to promote sustainable growth in their food supply chains.

Keywords: *Indian food sector Agricultural product wastage Small and Medium Enterprises (MSMEs) Information Communication Technology (ICT) applications Sustainable growth*

INTRODUCTION

The Indian food industry, which holds significant importance in the country's economy, is currently facing a significant problem that poses a threat to its economic sustainability and its contribution to food security. The present concern pertains to the significant loss of around 30% of agricultural goods, mostly ascribed to the operational inefficiencies afflicting Small and Medium Enterprises (MSMEs) operating within this industry. The micro, small, and medium enterprises (MSMEs), which are widely recognised as the fundamental support system of India's food industry, encounter a diverse range of daunting obstacles. These issues encompass financial limitations, a dearth of technical proficiency, and insufficient investment in their enterprises. Given the aforementioned issues, it has become progressively crucial to ascertain and scrutinise essential elements that possess the capacity to bring about a paradigm shift in the Indian food industry. The pursuit of sustainable growth within the Indian food sector is currently of utmost importance. The objective at hand encompasses not alone the enhancement of economic prospects, but also the imperative of safeguarding food security for the rapidly growing population of the nation. In this particular context, the incorporation and assimilation of Information Communication Technology (ICT) applications have arisen as a symbol of optimism, offering the potential to alleviate the challenges faced by Micro, Small, and Medium Enterprises (MSMEs) and facilitate the development of a more robust, effective, and environmentally conscious food industry.

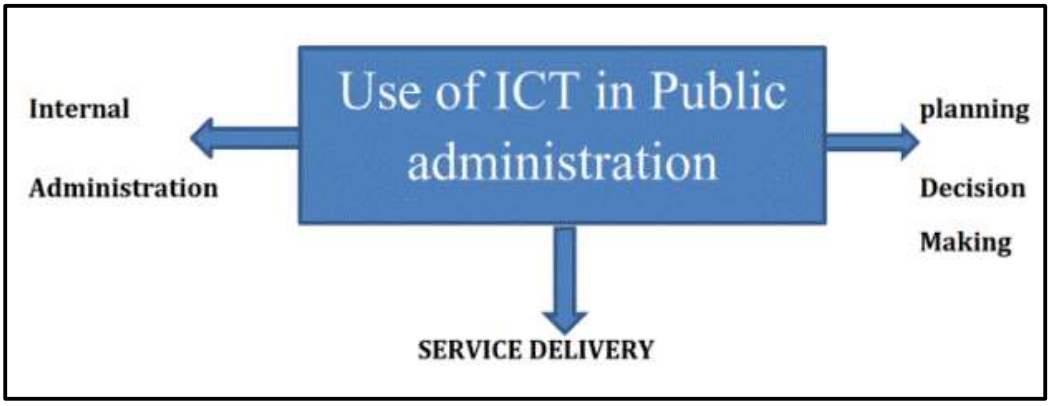

Figure 1: The different components involved in use of ICT in Public Administation

Information and Communication Technology (ICT) technology plays a significant role in various domains of government, including public administration. Information and Communication Technologies (ICT) have become an essential component of contemporary society. Public administration has embraced ICT technologies across all domains, utilising them to deliver services to residents and disseminate crucial information. Information and Communication Technology (ICT) plays a significant role in the domain of internal administration.

2. The process of strategic planning and rational decision making

The concept of service delivery refers to the process of providing services to individuals or groups in a systematic and organised manner. It involves the efficient and effective provision of services to meet (Figure 1). In order to thoroughly examine this intricate matter and reveal the crucial elements that contribute to the effectiveness of information and communication technology (ICT) applications in Indian food sector micro, small, and medium enterprises (MSMEs), a meticulous

analysis was conducted. By utilising the Grey-based Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique, a comprehensive comprehension of the underlying dynamics was attained. The analysis conducted in this study offers significant and necessary insights into the determinants that have the potential to alter the structure of the Indian food industry, enhancing its ability to withstand and adapt to contemporary challenges. One of the notable findings of this study underscores the significant role that the government plays in the process of transforming the food supply chain. Government actions and policies have a pivotal role in catalysing transformative change and fostering innovation within the sector. The Indian government, as the primary patron of Micro, Small, and Medium Enterprises (MSMEs) and the authoritative body responsible for crucial policy determinations in the food sector, wields significant influence on the trajectory of the business. In order to facilitate sustainable economic expansion, it is essential for the government to adopt proactive measures such as promoting private and foreign investments, advocating for the growth of IT service providers, and formulating economic policies that cultivate a favourable environment for enhancing the competitiveness of the Indian food industry. Furthermore, it is crucial to emphasise the significance of 'Public-private partnerships'. The full potential of ICT applications can be harnessed through the collaboration of public and commercial institutions. The aforementioned synergy facilitates the consolidation of resources, experience, and innovation, hence resulting in a heightened level of efficiency and efficacy within the food supply chain.

Concurrently, the crucial role played by ICT service providers in providing assistance and encouragement is evident. These service providers play a crucial role in enabling the adoption and integration of information and communication technology (ICT) applications. They provide the essential technical expertise and infrastructure for micro, small, and medium enterprises (MSMEs) to efficiently utilise these technologies. The active participation and endorsement of stakeholders have the potential to significantly impact the pursuit of sustainable development in the Indian food industry. When examining the complexities of the food supply chain, it becomes evident that the integration of information and communication technology (ICT) plays a crucial role. The significance of integrating ICT solutions throughout the whole supply chain, encompassing production and distribution, is emphasised by this element. The implementation of this method necessitates a comprehensive integration of various technologies, processes, and stakeholders in order to optimise resource utilisation and reduce inefficiencies.

Moreover, the concept of 'Interdepartmental collaboration' assumes significant importance in the pursuit of sustainability. The fragmented character of the food business requires a cohesive coordination across the different ministries, agencies, and players involved. The implementation of a unified approach is crucial in the process of streamlining operations, minimising redundancy, and optimising the allocation of resources. It is crucial to acknowledge the significance of collaboration and strategic alliances throughout the supply chain. In a food supply chain characterised by interconnectedness and interdependence, the key determinant of success lies in collaborative efforts. The establishment of strategic partnerships among various stakeholders, including producers, processors, distributors, and retailers, has the potential to facilitate the

creation of integrated solutions that optimise operational effectiveness, minimise resource inefficiencies, and guarantee the punctual provision of food items to end consumers. In the Indian context, it is noteworthy that small and medium companies (MSMEs) hold a substantial presence within the business milieu, accounting for around 95% of the industrial units in the nation. Although micro, small, and medium enterprises (MSMEs) have a significant presence in the economy, their contribution to the nation's gross domestic product (GDP) is only 6.29%. The limited economic impact observed can be partially ascribed to a hesitancy in embracing information and communication technology (ICT) solutions inside their supply chain activities. This hesitancy arises from a range of internal and external restrictions. A noteworthy characteristic of Micro, Small, and Medium Enterprises (MSMEs) in India is their functioning within constraints of limited resources and facilities. Despite the limitations they face, they have a strong desire to enhance their supply chain skills, which is a crucial objective for their continued development and long-term viability. In contrast to larger enterprises, micro, small, and medium enterprises (MSMEs) exhibit a deficiency in their implementation and incorporation of information and communication technology (ICT) solutions.

The integration of information and communication technology (ICT) tools into micro, little, and medium enterprises (MSMEs) is a matter of considerable importance within the food industry. In order to properly tackle this difficulty, it is imperative for managers to devise efficient processes for supply chain planning. These systems have the dual objective of delivering food items of superior quality and safety to consumers, while also addressing the imperative need to fulfil sustainability criteria in the contemporary global market. In order to achieve sustainable growth, it is imperative for micro, small, and medium enterprises (MSMEs) functioning within the food industry to expand their market presence to encompass both domestic and global markets. The careful choice of technology that facilitate cleaner production becomes crucial in this endeavour. In order to improve production efficiency, organisations should actively participate in global supply chains, particularly in light of the increased competition in international marketplaces.

The pursuit of innovation is a fundamental aspect for Micro, Small, and Medium Enterprises (MSMEs) seeking to enhance the effectiveness of their supply chains. The cultivation of a stronger focus on innovation is important in order to effectively respond to changing market conditions and sustain a competitive advantage. Furthermore, the necessity for traceability of food products arises as a crucial prerequisite for enhancing the effectiveness of supply chain operations. Traceability is the dissemination of crucial information on food goods throughout all key points of a supply chain, employing standardised terminology. The implementation of traceability measures has become a compulsory requirement in the food industry across numerous countries, with a special emphasis on exports to developed nations. In order to fulfil these criteria, India has implemented several measures, including the comprehensive computerization of the public distribution system and the direct transfer of cash and subsidies to the accounts of farmers. Nevertheless, the existing traceability systems encounter difficulties in guaranteeing the efficient connection of records along the food chain, maintaining accuracy, and facilitating timely sharing of data. In order to tackle these concerns, it is crucial to establish a linkage between tracking and tracing systems and

information systems, as noted by Stefansson and Tilanus (2001). The proficient utilisation of Information and Communication Technologies (ICTs) significantly contributes to the improvement of traceability within supply chains. Furthermore, the utilisation of technology can provide organisations with a durable competitive edge in the global marketplace.

Moreover, information and communication technology (ICT) has the potential to enhance the efficiency of logistics and supply chain operations in the food business. This upgrade ultimately facilitates the achievement of sustainable resource management for micro, small, and medium enterprises (MSMEs), harmonising with current sustainability imperatives and goals for resource optimisation. In short, the obstacles encountered by micro, small, and medium enterprises (MSMEs) operating in India's food industry are diverse and complex, spanning various aspects such as the use of technology, development into new markets, fostering innovation, and ensuring traceability. The incorporation of information and communication technology (ICT) tools, along with the deliberate and purposeful use of technology, presents encouraging resolutions to these obstacles. This enables micro, small, and medium enterprises (MSMEs) to not only effectively compete but also make significant contributions to the expansion and long-term viability of India's food industry.

LITERATURE REVIEW

The process of sharing information throughout the agri-food supply chain is intricate and multifaceted, mostly due to the participation of various stakeholders, including farmers, producers, distributors, and other relevant entities. The intricacy of this phenomenon may arise from various variables, such as the ambiguity around customer demand and the availability of resources. The industrial production of food encompasses a multitude of product alterations and processing procedures that are designed to modify the composition of food. If the monitoring of these alterations and processing stages is not conducted with due diligence, it can have a detrimental impact on the quality of food and various other elements. Hence, it is imperative to establish efficient communication channels among the several stakeholders within the agricultural and food supply network in order to facilitate the dissemination of customised information that aligns with specific demand needs.

Key factors to ICT applications	Brief description	References
Government initiatives and policies (F1)	Government is the central entity in food security of nation. Government supportive policies can help in enabling open market conditions, training and practical support to farmers, encouraging cooperatives, rural property clarification, assistance in risk management, investing in infrastructural development.	Kurnia et al. (2015); Aggarwal and Srivastava (2016); Sharma et al. (2019)
Public-private partnership (F2)	There is the need to strengthen public-private partnership through different channels. Government needs to in still faith in the private sector to invest in food sector's modernisation. Developing integration within supply chain partners is necessary for business organisations.	Flynn et al. (2010); Chen et al. (2015)
Encouragement to ICT service provider (F3)	Despite India's excellence in IT, this specialised service industry is unable to cater home demand, and support the critical sector SMEs like that of Food Supply Chain. Further, government' adoption of ICT applications in procurement, logistics etc. will not only encourage the SMEs but will also act as boost to ICT service providers. The efficient use of ICT Service Providers can result into cost reduction for carrying out various transactions within a business organisation.	Pramatari (2007); Singh et al. (2009); Tatoglu et al. (2016)
Low cost service model (F4)	With innovation in technology such as cloud computing, ICT service companies need to design innovative business models to make it affordable for all SMEs. Food sector typically is one where in demand and supply are dependent on season, so it makes less sense to the SMEs to invest in ICT infrastructure that is not required all round the year. However, if SMEs are offered services on the lines of "pay-as-you-go", they would certainly open up.	Thakkar et al. (2009); Kumar et al. (2013)
Improved coordination between government and SMEs (F6)	Together the SMEs will have synergistic impact by being able to bring sustainability in their businesses. Coordinating among various activities is important in the success of food industry.	Kumar et al. (2014); Akhtar and Khan (2015); Luo et al. (2018)
Stability in business environment (F7)	The food supply chain frequently faces the shock from climatic conditions, and thereby it is required that other shocks such as financial, policy-related etc. to this supply chain be minimised. Trust among partners is significant for long-term stability of a business organisation.	Barratt (2004); Ngai et al. (2008); O'Reilly et al. (2015)
Revenue certainty (F8)	The shocks need to be minimised, and set of cooperatives and other government initiatives will bring about the certainty in the food safety and quality.	Kritchanchai (2004); Vlachos (2015)
Collaboration and strategic alliances across supply chain (F9)	The increased collaboration and strategic alliances between growing entities will make ICT applications and systems reach more players at SME levels, which would improve their overall supply chain performance.	Mohezar and Nor (2014); Akhtar and Khan (2015); Dania et al. (2018); Raut et al. (2019)
Private and foreign investment (F10)	With recent opening up of FDI, government has taken a step for pushing investments in logistics and storage facilities across food sector. This initiative will show its results in coming years for improving the competitiveness of food sector. Expanding foreign market is a significant factor for improving the performance of food industry.	Vickery et al. (2003); Kumar et al. (2013); Saguy and Sirotinskaya (2014); Pan et al. (2018)
Investment in ICT infrastructure (F11)	ICT enabled food supply chain can be developed only when each player contributes its bit by investing in ICT infrastructure within its premises. The above factors directly or indirectly would contribute in making up the management minds to invest in ICT infrastructure after evaluating its worth for their business.	Bhatt et al. (2010); Saguy and Sirotinskaya (2014); Tatoglu et al. (2016); Song et al. (2018); Bamfo et al. (2019)
HR recruitment and training (F12)	Human resources are key to food industry growth. HR skills and adequate training is crucial in improving the performance and reducing food wastage.	Manning and Baines (2004); Mathur et al. (2012)
Organisational change/Re-engineering (F13)	In the present scenario, organisations need to derive value from its IT systems, rather than spending on it with not much useful work being done through it. The implementation of ICT would derive organisation for an improved change – deliver higher quality food at lower price.	Gunasekaran and Ngai, (2008); Tatoglu et al. (2016); Jakhar et al. (2018)

Table 1: Literature Review in tabular Form

In recent years, the commercial landscape of agri-food supply chains in the European Union (EU) has seen major changes due to heightened competition and developments in information and communication technology (ICT). This phenomenon is characterised by the widespread growth of small and medium-sized enterprises (MSMEs).

The Indian food market holds significant prominence, boasting an estimated value of US$ 182 Billion. Moreover, it is anticipated that the retail food industry in India would experience a substantial increase, expanding from a value of US$ 175 billion to US$ 400 billion by the year 2025.

PROBLEM STATEMENT AND RESEARCH OBJECTIVES

Agriculture serves as a significant contributor to employment in India. India has been recognised as a prominent participant in the global food industry, although its production levels are not particularly noteworthy. The aforementioned phenomenon can be attributed to a deficiency in comprehending and analysing various elements, including but not limited to a scarcity of proficient

labour, use of outdated technologies, challenges in governance, and so forth. It is worth noting that a significant proportion of food, specifically over 98%, is distributed through unorganised markets within the Indian context. The lack of coordination in operations has resulted in a limited level of integration between the majority of micro, little, and medium enterprises (MSMEs) and the overall supply chain. This phenomenon gives rise to considerable food waste and subsequently leads to diminished production. An annual loss of 6.7 billion US dollars is observed in the fruits and vegetables sector due to inadequate management and lack of integration among stakeholders. The lack of emphasis on ICT applications among Indian food MSMEs is apparent, resulting in operational inefficiencies.

The utilisation of Information and Communication Technology (ICT) has the potential to improve corporate efficiency through the optimisation of resources, reduction of waste and power consumption, and the creation of sustainable growth opportunities from a managerial perspective. Hence, it is imperative for micro, small, and medium enterprises (MSMEs) in the Indian food industry to incorporate information and communication technology (ICT) applications in order to enhance their supply chain integration and ensure long-term sustainability.

Contemporary scholarly investigations in the field of information and communication technology (ICT) mostly concentrate on technological progress and inventive developments. Nevertheless, the incorporation of ICT within the food supply chain remains relatively underexplored in existing academic literature. Hence, there is a necessity to identify crucial elements pertaining to the utilisation of Information and Communication Technology (ICT) in Micro, Small, and Medium Enterprises (MSMEs) in India, with a specific focus on the food industry, in order to promote the sustainable development of their supply chains. In light of the aforementioned conditions, the current study aims to achieve the subsequent objectives, as follows:

The objective of this study is to identify the main elements that contribute to the successful implementation of information and communication technology (ICT) applications for sustainable growth in micro, small, and medium enterprises (MSMEs) operating in the food sector in India. ii. Another aim of this research is to categorise the identified factors into cause and effect groups, with the intention of facilitating the promotion and adoption of ICT applications for sustainable growth in MSMEs.

The objective of this study is to examine and evaluate the several elements that play a significant role in the adoption of information and communication technology (ICT) applications for promoting sustainable growth in the Indian micro, small, and medium enterprises (MSMEs), with a specific focus on the food supply chain. In accordance with the primary purpose, a thorough review of the existing literature is conducted. The present study employs the Grey-based Decision Making Trial and Evaluation Laboratory (DEMATEL) methodologies. The utilisation of the Grey-based DEMATEL technique facilitates the systematic arrangement of causal connections among many components within an environment characterised by uncertainty and complexity, particularly when confronted with unclear and imprecise information. The utilisation of Fuzzy DEMATEL as a substitute for Grey-based DEMATEL is feasible; nonetheless, it is deficient in terms of the establishment of a membership function mapping inside a managerial framework.

The primary contributions of this study are outlined as follows:
The objective of this study is to identify and differentiate the primary elements that contribute to the utilisation of information and communication technology (ICT) applications for promoting sustainable and environmentally friendly growth in the context of Indian food micro, little, and medium enterprises (MSMEs). This study would contribute to the promotion of enhanced environmental performance and sustainable development within a country such as India.
This study provides a comprehensive analysis of the causal links among ICT-based elements from the perspective of food MSMEs. In this study, the Grey-DEMATEL approach was employed as a methodological contribution to create a causal model of components.

RESEARCH METHODOLOGY

The methodology employed in this study is the grey-DEMATEL approach. The grey idea was introduced by Professor Deng in 1982. The DEMATEL methodology facilitates the assessment of complex choice problems by elucidating the magnitude of relationships between various factors. The DEMATEL method is capable of visually representing the interrelationships among various elements through graphical representation and organising them into cause and effect groupings. Kumar and Dixit employed the DEMATEL approach to assess the significant obstacles in the management of waste from electrical and electronic equipment (WEEE). In contrast to DEMATEL, scholars may choose for the utilisation of interpretative structural modelling (ISM) and analytical hierarchy process (AHP) methodologies. However, it should be noted that these techniques do not offer a comprehensive analysis of the cause and effect relationships among the various elements. The application of grey set theory offers a potential solution to address the challenges posed by uncertainty arising from ambiguity and erroneous information. By leveraging this theory, it becomes possible to enhance the accuracy of human decision-making, even when working with limited sample sizes.
The present study used the combined grey-DEMATEL approach. The implementation of Grey-DEMATEL involves the following steps:
The aim of this study is to identify the decision aspects, namely the critical criteria, that contribute to the recognition of ICT applications for promoting sustainable growth in small and medium-sized enterprises (SMEs) within the Indian food industry. The decision elements are determined after a comprehensive assessment of relevant literature and the insights provided by experts in the field.
The process of constructing and calculating the comprehensive grey-direct-relation matrix among factors. In this study, professionals are requested to offer their expert opinions in order to assess the degree of correlation between two variables, using the rating scale provided in Table 2. The replies are recorded in a matrix denoted as Matrix A, with dimensions m×m, where m is the number of components.

Table 2
The grey linguistic scale for experts' assessments.
(Source: Cui et al., 2018).

Linguistic terms	Associated grey numbers	Values
No influence	(0,0)	1
Very low influence	(0,0.25)	2
Low influence	(0.25,0.5)	3
High influence	(0.5,0.75)	4
Very high influence	(0.75,1)	5

To standardise the grey number on the lower limit, the following phrases are utilised, considering a total of 'n' experts.

The coding for DEMATEL computations was implemented within an Excel spreadsheet. The computations have been performed using a custom-designed Excel spreadsheet. Additionally, a research framework is included in this study, as depicted in Figure 1. The present framework employs Grey-DEMATEL methodologies to categorise the enabling elements of information and communication technology (ICT) for small and medium enterprises (SMEs) operating in the food sector. During the initial stage, a comprehensive review of existing literature and consultation with experts were conducted to ascertain and authenticate the significant aspects. Finally, during phase 2, we conducted an analysis of the components in order to ascertain their causal relationships.

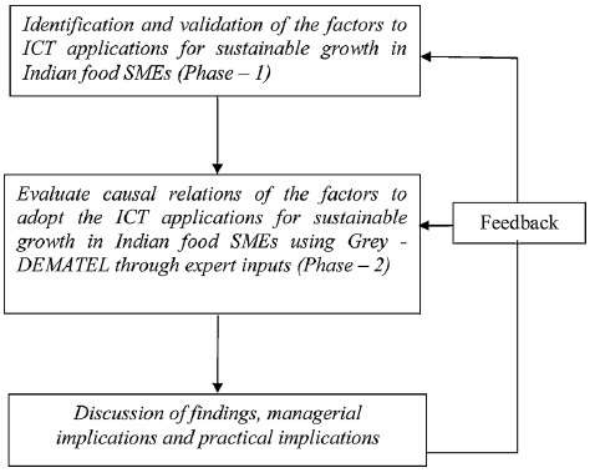

Fig. 1. Proposed research framework.

$$\underline{\otimes}\bar{x}_{ij}^{n} = (\underline{\otimes}x_{ij}^{n} - \min \underline{\otimes}x_{ij}^{n})\Delta_{\min}^{\max}$$

$$\overline{\otimes}\bar{x}_{ij}^{n} = (\overline{\otimes}x_{ij}^{n} - \min \overline{\otimes}x_{ij}^{n})\Delta_{\min}^{\max}$$

Among them,

$$\Delta_{\min}^{\max} = \max \overline{\otimes}x_{ij}^{n} - \min \underline{\otimes}x_{ij}^{n} \quad (1)$$

iv Transform the grey number into total normalized crisp value using Eq. (2):

$$Y_{ij}^{n} = \frac{\otimes\_\bar{x}_{ij}^{n}(1 - \bar{x}_{ij}^{n}) + \otimes -\bar{x}_{ij}^{n} * \otimes \ -\bar{x}_{ij}^{n}}{1 - \otimes\_\bar{x}_{ij}^{n} + \otimes -\bar{x}_{ij}^{n}} \quad (2)$$

v Further, the final crisp values are computed using Eq. (3):

$$Z_{ij}^{n} = \min_{j} \underline{\otimes} \ x_{ij}^{n} + Y_{ij}^{n}\Delta_{\min}^{\max} \quad (3)$$

$$D = A \times S \quad (4)$$

$$Where, \ S = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} \otimes a_{ij}}, \ i, j = 1, 2, 3.....n \quad (5)$$

Next, we obtain the total relation matrix (T) through Eq. (6):

$$T = D\,(I\text{-}D)^{-1} \quad (6)$$

viii. Compute the causal variables for the recognised factors: The summation of row (R_i) and column (Cj) are computed by using Eqs. (7) and (8).

$$R_i = \left[\sum_{i=1}^{n} t_{ij}\right]_{n\times 1} \quad (7)$$

$$Cj = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n} \quad (8)$$

Where, t_{ij} represents elements in total relation matrix.

iv. Next, a cause-effect diagram of the key factors is obtained using Eqs. (9) and (10).

$$P_i = \{R_i + C_j \,|i = j\} \quad (9)$$

$$E_i = \{R_i - C_j \,|i = j\} \quad (10)$$

DATA ANALYSIS AND RESULTS

This study employed a two-phase approach for data analysis. The initial step focuses on the validation of variables, while the subsequent phase involves the evaluation of causal relationships for the identified factors using the Grey DEMATEL technique.

4.1. Phase One: Validation of the Factors

According to comments from experts, all literature-based criteria that were discovered have been validated (for further information, please refer to subsection 2.2).

4.2. Phase 2: Assessment of Causal Relationships among the Factors

The factors that were presented underwent a process of pair-wise comparisons, and the responses of experts were recorded using a scale provided in Table 2. An average grey-direct relation matrix for factors was developed and shown in Table 3, based on the collective replies of experts.

Table 3
Average direct relation matrix of factors to ICT applications for sustainable growth in Indian food SMEs.

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
F1	0	3	3	3	2.67	3	3	2.67	2	1.67	2	1.67	2.67	2	2.67	2	2.67
F2	1.33	0	3	3	3	3	2.67	3	2.33	2	1.67	1.67	2.33	2.33	2.67	2	3
F3	1	2	0	3	3	2.67	2.67	3	2.67	2.33	2.33	2	3	2.33	2	2.33	2.67
F4	1.33	1.33	1.33	0	3	2.67	2.67	2.67	3	2.33	2	2	2	2	2.33	2.33	3
F5	1	2	2	1.67	0	2	2	3	3	2.67	2.67	2	2.33	3	2.67	2	2.33
F6	1.33	1	1.67	2	2.33	0	3	2.67	2.67	2.67	2.33	2.33	2.67	2	3	2	2.67
F7	1.33	1.33	1.67	2	2.33	1.67	0	2	2	3	2.67	2.67	2.33	2.33	3	2	3
F8	1.67	1.33	1.67	1.33	1.33	1.67	1	0	2.67	2.33	3	2.67	2.67	3	3	2.33	3
F9	2	1.33	2	1.67	1.67	1	1.33	1.33	0	1.33	1.67	1.33	1	1	1.33	1.67	2
F10	1.33	1.67	1.67	1.33	1.33	2	2	1.67	2.67	0	2.67	2.33	2.67	2.67	2.67	2.67	3
F11	2.33	1.33	1.33	1.33	2	2	1.67	2.33	2.33	2.33	0	2.33	2.33	2.67	2	2.67	3
F12	3	1.67	1.33	1.33	1.33	1.33	2.33	1.33	2.33	2	0.33	0	2.67	4	2.33	2.33	1.67
F13	2	1.67	1	1.67	1.67	1	1.33	1	2.67	1.67	1.67	2	0	2.33	2.33	2	1.33
F14	1	2	1.33	1.33	1	1.33	1.67	1.67	2.33	1.67	1.67	2.33	2	0	1.67	4	1.67
F15	1.67	1	1	1.67	1.33	1	1.33	1	2.33	1	1.67	1.67	2	1.67	0	1.33	2.67
F16	0.67	2	1.67	1.67	1.67	1.67	1.67	1.33	2.33	2.33	2.67	2.67	2.33	3	3	0	2.67
F17	2	2	2	1	1	2	1	3	1.67	1	1.33	2	1.67	1.67	1.33	1.33	0

Table 5
Prominence and Net effect datasets for factors to ICT applications for sustainable growth in Indian food SMEs.

Factors	Ri	Ci	Pi	Ei	Cause/Effect
F1	4.987	3.220	8.206	1.767	Cause
F2	4.861	3.364	8.224	1.497	Cause
F3	4.838	3.451	8.289	1.387	Cause
F4	4.446	3.576	8.022	0.871	Cause
F5	4.474	3.751	8.225	0.722	Cause
F6	4.465	3.684	8.149	0.782	Cause
F7	4.351	3.839	8.190	0.512	Cause
F8	4.227	4.139	8.366	0.088	Cause
F9	3.044	4.845	7.889	−1.801	Effect
F10	4.207	4.001	8.208	0.207	Cause
F11	4.208	4.030	8.238	0.178	Cause
F12	3.887	4.233	8.119	−0.346	Effect
F13	3.410	4.528	7.938	−1.119	Effect
F14	3.579	4.721	8.301	−1.142	Effect
F15	3.027	4.685	7.712	−1.658	Effect
F16	4.086	4.384	8.470	−0.298	Effect
F17	3.322	4.968	8.290	−1.646	Effect

DISCUSSION

The food sector in India exhibits substantial potential for the expansion of Micro, Small, and Medium Enterprises (MSMEs). Nevertheless, there exist a number of obstacles impeding their advancement. There are two primary factors that contribute to this phenomenon: a deficiency in knowledge and a hesitancy to embrace Information and Communication Technology (ICT) solutions. The objective of this study is to investigate the determinants that impact the utilisation of information and communication technology (ICT) applications in order to promote the sustainable development of micro, small, and medium enterprises (MSMEs) within the Indian food industry.

The use of Grey Decision-Making Trial and Evaluation Laboratory (DEMATEL) study has led to the identification of 10 components that can be categorised as cause group factors. These factors have been determined to be independent of each other and possess a significant impact on the system under consideration. The aforementioned factors are as follows:

The factor of government initiatives and programmes (F1) has a significant driving force and a relatively low level of dependence. The adoption of information and communication technology (ICT) in Indian food micro, little, and medium enterprises (MSMEs) is contingent upon the

provision of government support and the implementation of appropriate policies. Information and Communication Technology (ICT) applications have the potential to modernise food supply chains, mitigate wastage, and bolster competitiveness. Public-private partnerships (PPP): Public-private partnerships play a crucial role in facilitating the sustainable development of the agri-food sector by attracting investments and effectively channelling finances to promote comprehensive growth.

The encouragement of ICT service providers plays a crucial role in facilitating the adoption of technology within the food sector. The implementation of a low-cost service model, specifically referred to as F4, has the potential to facilitate innovation and yield economic advantages for food enterprises through the provision of affordable information and communication technology (ICT) solutions. Enhanced coordination between government entities and micro, small, and medium enterprises (MSMEs) can be facilitated by the utilisation of information and communication technology (ICT) applications. This utilisation has the potential to result in enhanced performance and collaboration between the government and MSMEs. The implementation of user-friendly and secure information and communication technology (ICT) applications, namely in the form of mobile platforms, has the potential to enhance the performance of food supply chains.

The maintenance of stability within the business environment is of utmost importance in ensuring price stability and fostering sustainable growth within the food sector. The acquisition of private and international investments plays a crucial role in enhancing the information and communication technology (ICT) infrastructure inside agri-food micro, little, and medium enterprises (MSMEs). The allocation of resources towards the development of information and communication technology (ICT) infrastructure is crucial in facilitating the integration of technological advancements within the food supply chain. The assurance of consistent revenue (F8) can enhance the confidence of small and medium-sized enterprises (SMEs) and their partners, thereby motivating them to enhance their operational infrastructure and sustain their competitiveness. Furthermore, a set of seven elements has been classified as effect group factors, signifying their significant interdependence and their contribution to the development of effective information and communication technology (ICT) applications in small and medium-sized enterprises (SMEs) in the Indian food industry.

The promotion and cultivation of the desire to adopt information and communication technology (ICT) applications are of paramount importance in developing a workforce that is proficient in managing contemporary systems. The recruitment and training of human resources play a crucial role in the optimal utilisation of ICT solutions. Organisational transformation and re-engineering procedures are crucial in facilitating the seamless integration of information and communication technology (ICT) applications. The successful integration and management of changes are essential factors in the deployment of information and communication technology (ICT) within food supply chains. The establishment of coordination among diverse departments within organisations is of utmost importance in facilitating strategic collaboration across the agri-food supply chain. The successful integration of Information and Communication Technology (ICT) into food supply chains has the potential to enhance traceability and foster collaboration.

Managerial Implications

The affordability of technology solutions is an additional crucial factor to be taken into account. Micro, Small, and Medium Enterprises (MSMEs) ought to consider investigating cost-effective information and communication technology (ICT) service models that are in line with their financial limitations. Policymakers possess the capacity to contribute in this domain through the facilitation of the advancement and accessibility of economically viable information and communication technology (ICT) solutions customised to cater to the distinct requirements of micro, little, and medium enterprises (MSMEs) operating within the food industry.

Workforce development is an area of significant emphasis. It is recommended that micro, small, and medium enterprises (MSMEs) allocate resources towards the implementation of training and upskilling initiatives for their workforce. This strategic investment aims to provide employees with the necessary skills and knowledge to proficiently leverage information and communication technology (ICT) tools in their professional duties. Policymakers can contribute to this endeavour by collaborating with industry organisations and educational institutions to provide training programmes that specifically target the adoption of information and communication technology (ICT) within the food sector.

In addition, it is imperative for micro, small, and medium enterprises (MSMEs) to proactively anticipate and plan for organisational modifications and re-engineering procedures. This strategic approach will effectively enable the seamless assimilation of information and communication technology (ICT) applications inside their operational framework. Policymakers has the ability to provide guidance and allocate resources in order to facilitate the effective navigation of these transitions by MSMEs.

The optimisation of interdepartmental collaboration within Micro, Small, and Medium Enterprises (MSMEs) is of paramount importance, as the integration of cross-functional teams enables the effective utilisation of Information and Communication Technology (ICT) to enhance the overall performance of the supply chain. Policymakers possess the capacity to foster collaboration throughout the agri-food supply chain by establishing forums that facilitate the exchange of information and promote cooperative efforts.

Investing in information and communication technology (ICT) infrastructure represents a crucial element. Micro, Small, and Medium Enterprises (MSMEs) ought to actively seek out avenues to attract domestic and foreign investment in order to bolster their information and communication technology (ICT) infrastructure. Policymakers has the ability to establish a favourable climate for the attraction of domestic and international investment in information and communication technology (ICT) infrastructure, potentially through implementing tax incentives and enacting supporting regulatory measures.

Finally, it is imperative to establish a sense of revenue certainty in order to foster trust and assurance among Micro, Small, and Medium Enterprises (MSMEs) and their respective stakeholders. The presence of a consistent and foreseeable source of income has the potential to foster additional investments in technological advancements and enhancements to operational procedures. Policymakers ought to prioritise the implementation of policies and initiatives aimed

at stabilising pricing and establishing a consistent business climate. By doing so, they may effectively mitigate uncertainty for micro, small, and medium enterprises (MSMEs) operating within the food sector. In summary, it is imperative for both micro, small, and medium enterprises (MSMEs) as well as policymakers to assume pivotal responsibilities in cultivating a technologically advanced and environmentally sustainable food supply chain within the context of India.

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