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RESEARCH ARTICLE

Examining the Linkages of Technology Adoption Enablers in Context of Dairy Farming Using ISM-MICMAC Approach

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Abstract: In the context of agribusiness, technology and innovation have led to major transformations in many countries. Precision dairy farming technologies enable cost optimization, quality control, waste reduction, achieving economies of scale, efficiency in dairy resource utilization, improvement in productivity, standardized processes, enhanced decision support system and overall farm management. Despite being an overall production-wise rich country, India's dairy sector lacks in terms of yield per cattle, overall dairy farm output, effective herd management and lack of effective technology acceptance and implementation. With the help of NGT based outcome, this research is an attempt to showcase the enablers of technology adoption in dairy farming and how these enablers interact with each other in a hierarchical form using ISM methodology. Experience in the dairy business, competitive pressure and digital literacy were found as the most crucial and driving enablers. However, agreeableness and managerial interest were found as the most dependent enablers of technology adoption. The interpretations drawn from the model can help the decision makers, policy makers and farmers not only in India but can serve as the base for other nations dependent upon agriculture to understand the inter dependency among enablers and suggestions to plan and channel technology adoption by focusing upon critical ones.

Keywords: Dairy business; Precision dairy farming; Technology adoption; NGT; ISM; MICMAC

1. Introduction

Dairy is a significant component of the Indian agricultural economy, and milk is a necessary consumable that helps rural and small-town households [1], generate revenue as well as a supplier for a number of other enterprises and activities. The livestock sector contributes about 6% of GDP and in the Indian economy; the livestock sector

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is a significant subsector of agriculture. It expanded at a 7.93% CAGR (Compound Annual Growth Rate) at constant prices from 2014-2015 to 2020-2021. Livestock now accounts for 30.13% of all agriculture and related sector GVA (Gross Value Added) at constant prices, up from 24.32% in 2014-2015. In 2020-2021, the livestock sector contributed 4.90% of the total GVA [2]. Animal husbandry, dairying, and aquaculture all significantly contribute to the country's socioeconomic development [3]. In such ways, dairy farming has contributed to uplift the poor farmers thus leading to a major portion of rural development. Global evidence shows that technology application improves cost optimization, quality control, wastage reduction, achieving economies of scale, efficient dairy resource utilisation, improved yield/productivity, standardized processes, enhanced decision support system, and overall management [4].

According to evidence from research studies, agribusiness has the ability to improve performance and bring about operational efficiency with the implementation of technology to ensure food safety and security, increase revenue, and achieve sustainability and regional development [5]. India is the greatest milk producer and consumer in the world, but it faces challenges with yield per unit, overall productivity, low rates of technology acceptance and implementation, health monitoring of milking units, documenting animal data, and the availability of dairy goods on the international market. India's milk market is still having trouble organising itself [6]. The unorganized market and the organised market are in competition over prices. Since clean milk from organised dairy farms is more expensive, a sizable segment of India's consumer base has not yet embraced it. The Amul model of cooperative milk supply chain originated in India during the operations flood programme in 1970 and is now adopted in many states and strengthened the rural and small farmers by enabling them to contribute and earn a livelihood. In this system, a farmer producing milk through its herd supplies to village-based milk cooperatives that are part of respective state-based milk marketing federations. This comprises 10% of the Nation's milk supply, the other 15% being supplied by private dairy farms, 5% going for self-consumption and the remaining 70% sector of India's milk supply is referred to as unorganized which means direct sales to consumers. With a constant rise in milk demand, other than the cooperative supply chain, dairy farms are also required to come forward to manage future demands [7].

The popular technologies available for dairy farming are artificial insemination, automatic milking systems, milk parlour, bucket/portable milking systems, robotic milking system, radio frequency identification (RFID) tagging in animals, information technology based database management system, enterprise resource planning (ERP), internet of things (IoT), using websites and other miscellaneous machinery for silage preparation, hydraulics for cleaning, etc. The government of India is active towards consolidating the milk cooperatives by attaching more and more farmers from villages to attach with this supply chain but has less focus on strengthening the dairy farms. Various technologies such as milk testers, collectors, and cold chain management technologies are part of these cooperative milk chains aided by government support at all village level milk collection centres.

In the presence of certain challenges of technology adoption, there is a second side of the coin which talks about certain enablers that facilitate the smoothness to adopt technologies. Whether somebody talks about enablers, challenges, determinants, consequents, facilitators or antecedents, the factors within these come from a variety of dimensions such as personal characteristics, organisational, micro or macro environmental, static or dynamic factors. The presence of these diversified factors creates a complex scenario since all cannot be taken at the same level. There are hierarchies, relationships, dependency, independence and interdependency among the factors that need to be examined to solve complexity, extract inferences and build strategic actions.

This paper analyses enablers of technology adoption in the case of dairy farming and analyses their interactions in the hierarchical based ISM (Interpretive Structural Modeling) model along with the MICMAC (Matrice d'impacts Croisés Multiplication Appliquée á un Classment) based analysis which divides the enablers into four categories based on driving and dependence power. These techniques are part of a systems approach to problem-solving. Systems thinking or systems approach is a way of looking at situations as a system which has a certain number of inside and outside sub-systems and numerous impacts of one on the other can be seen. This complexity needs to be resolved to plan action, solve problems and facilitate decision making. The findings of this study can serve policy makers, government, dairy farmers and service providers to get the idea about how enablers of technology adoption are related to each other and which enabler must be taken care of or targeted first on which the other enablers are dependent or help to drive it. The recommendations are solely based on the hierarchy that placed different elements at different levels and have the potential to significantly increase the rate of technology adoption and, ultimately, improve the social and economic well-being of Indian farmers at all levels of economic development, from micro to macro.

2. Literature Review

The impact of technology on the business sector has been quite enormous. As a result of the invention of technology, traditional business functions, models, and conceptions have been changed. That is because technology has provided a more innovative and effective way to do business. It has given a convenient, seamless, and efficient way of conducting business. Many businesses, regardless of their product or service focus, have discovered that technology adoption from procurement to delivery has resulted in a significant improvement in business operations, resulting in lower costs and higher profits [8].

The sustainability of the agro-food industry is significantly influenced by technological advancements in the fields of networking devices, sensors, and communication technology. As a primary type of technology under the roof of Precision Dairy Farming (PDF), the RFID ear tag or collar technology integrated with a database is used for the identification and record keeping of dairy cows [9]. The National Livestock Identification Scheme (NLIS) started using radio-frequency identification (RFID) tags in the year 2000. These tags have a microchip inside that can be electronically read in a split second by producers who have a suitable reader [10]. The advantages offered by RFID tags and related hardware and software include real-time monitoring, environmental sensing, tracing, and tracking. RFID tags can be incorporated into a variety of sensor types to collect data on various parameters. In addition, Eastwood et al. [11] identified a moral dilemma in the ethics of such precision technology devices that could spark societal discussions about animal welfare. Apart from the factors that influence the adoption of RFID like education of farmers, knowledge, age, farm size, business complexity, ownership, risk perception etc., Rathod and Dixit [12] highlighted several challenges in the adoption of such precision technology, like the incapability to assess cost-effectiveness, chances of technical failures due to high degree of automation, dependence upon technically sound and skilled workforce to access, interpret and analyze the generated data. Overall awareness, affordability and socio-cultural beliefs have been found the most prominent challenges in the adoption of digital devices such as RFID-based cow collars in India, because, most of the livestock is scattered by low-holding farmers in remote village areas where, even for the basic necessity, the population has to travel long distances. These areas do not have sufficient awareness and affordability to procure such high-end technology due to low herd size, leading to high fixed costs, training or access to after-sale support from the service provider. The livestock in India, primarily the indigenous cows, have a lot of religious beliefs attached to ancient mythology. Also, in some cases, the perception of farmers is more towards the ethical acceptability of such technologies and they feel like human touch, love and care are essential rather than treating animals like machines [13]. All these socio-cultural beliefs and economic constraints restrict the adoption of digital devices and PDF technologies in general.

The Internet and other technologies have ushered in a corporate revolution, demonstrating that technology is critical to the success of today's internet-based businesses. As a result, as tomorrow's managers, entrepreneurs, and business experts, one must learn how to use and manage a wide range of information technologies to revive dairy business operations [14] and obtain competitive advantages through improved managerial decision-making [15]. The enablers need to perform optimally in order to minimize the impact of challenges. Some of the major challenges are highlighted by Kaushik et al. [16] such as small herd size, unavailability of a trained workforce, high cost of adoption and maintenance, low awareness, huge investment requirements, inappropriate pricing policy of milk, shortage of funds, less number of course opportunities in dairy-based education, the low willingness of the market to pay against technology processed milk and milk products and less acceptance of the decision maker. While considering the listing of enablers, the challenges are also kept in mind to determine the scope to know where betterment is required or what must be the enabling factors to smoothly conduct the transition or change planning. Table 1 includes the list of enablers of technology adoption along with the references.

3. Problem Description

Agriculture has always been a prime pulse for the Indian economy and supports two-thirds of the total population in their livelihood, accounting for 18.3% of the GDP [38]. Dairy farming is an essential part of agriculture, since India is the largest producer as well as consumer of milk in the world. The credit goes to the white revolution when the cooperative milk movement came into the picture. With the advent of technology in agriculture, dairying has received support in the form of precision dairy farming technologies. Despite the largest production in which the large population of rural households has a role to play, India's 70% milk supply is through an unorganized sector and large dairy farms are not much motivated in the economy. The attention of the government is towards developing small holder farmers to maintain and operate technology-enabled dairy farms. Even in the existing private dairy farms, the level of technology adoption is not

Table 1. Enablers of technology adoption are indicated in previous research.

S. No.	Enablers	References
1	Access to financial and funding resources	Antwi-Agyei [17]; Galstyan & Harutyunyan [18]; Jharkharia & Shankar [19]
2	Government authorities support	Antwi-Agyei [17]; Stockdale & Standing [20]; Subba Rao et al. [21]
3	Technology infrastructure	LaLonde [22]
4	Awareness	Høyer et al. [23]; Quddus [24]; Jharkharia & Shankar [19]; Russell & Hoag [25]
5	Experience	Yadav & Naagar [26]; Abdullah et al. [27]
6	Accessibility	Antwi-Agyei [17]
7	Assertiveness	Van Akkeren & Cavaye [28]
8	Internal organisation culture	Abdullah et al. [27]
9	Absorptive capacity	Stornelli et al. [29]
10	Reliability	Jharkharia & Shankar [19]
11	Insurance facilities	Antwi-Agyei [17]
12	Willingness	Yengoh et al. [30]
13	Top Management commitment	Shoemaker et al. [31]; Jharkharia & Shankar [19]; Gallivan [32]
14	Perceived ease of use	McDonald et al. [33]
15	Perception of usefulness	McDonald et al. [33]
16	Competitive pressure	Ghadge et al. [34]; Wamba & Wicks [35]; Shoemaker et al. [31]; Zheng et al. [36]
17	Technology Self-efficacy	Venkatesh & Bala [37]

satisfactory.

There are several multilevel challenges in the adoption of technology, such as the low awareness, unaffordability, unavailability and promotion of such technologies that enable effective herd management like RFID, IoT, automatic milking, etc. Another important challenge is the yield per day of indigenous breeds, which does not provide much expected revenue to get the funds for technology adoption. These are the reasons why the presence of Indian dairy products is not impressive in the international market. This problem is solved by the use of artificial insemination (AI) technologies. Researchers indicate that India needs to strengthen its dairy farms in all respects to meet the constant rise in demand with the rise in the population.

Challenges and enablers are more or less the two sides of the same coin. While challenges are obstructions to achieve, on the other hand, enablers are requisites to not let obstructions restrict the achievement. Many studies have been conducted on the challenges of technology adoption in dairy farming as well as in other industries and sectors, but fewer studies are there in the context of enablers of technology adoption, specifically in the case of dairy farming. In the Indian context, the realization of the importance of technology adoption is vital to ensure the growth of farmers at the micro level and its impact on the nation's economy at the macro level.

This paper is an attempt to showcase that the enablers of technology adoption in dairy farming exist as a part of a complex system that needs to be resolved to have a suitable picture of how enablers impact each other. If enablers are not managed, they take the form of challenges. Thus, the results reflect how technology adoption can be maximized by focusing on the strengthening of crucial enablers identified as per the positions and linkages among enablers in the hierarchy.

4. Data Collection and Method

4.1 Nominal Group Technique

Delbecq et al. [39] and Delbecq and Van de Ven [40] created this technique. It is a cooperative process that primarily aims at problem-solving and decision-making. It can be utilized in groups of all sizes that wish to reach a conclusion fast, like by vote, but it also considers everyone's thoughts. In this study, a total of 10 domain experts involving 2 dairy farm owners, 3 academicians from dairy institutions, 2 dairy researchers, 2 dairy development board representatives and 1 owner of a technology service providing firm participated in the two NGT sessions given in Table 2.

4.2 ISM-MICMAC

The study has used ISM or Interpretive structural modeling [41] and MICMAC or Matrix of impacts cross multiplication applied to a classification [42] approach to develop a hierarchical model of enablers and divides the identified enablers into four categories based on the driving and dependence powers.

Table 2. Stages of NGT sessions.

NGT	Purpose	Outcome
Session 1	To finalize the list of enablers (elements) on the basis of literature review results and discussion	12 elements were finalized
Session 2	To define pairwise relationship among the finalized elements To make checks for any conceptual inconsistency in the software generated model result.	Construction of SSI matrix for ISM Development of final ISM and MICMAC.

5. Findings

5.1 Identification of Elements

On the basis of NGT led workshop sessions, the experts finalized the list of 12 elements (Table 3) to be taken forward in the study. The same order of elements (from E1 to E12) has been followed to carry out the ISM procedure.

Table 3. The final list of elements for ISM.

S. No.	Enablers of technology adoption in dairy farming
E1	Affordability to adopt and maintain technologies
E2	Awareness level of technologies
E3	Experience in the dairy business
E4	Technology maintenance ease
E5	Agreeableness of technology into dairy farming
E6	Managerial interest for technology adoption
E7	Availability of trained workforce to operate and manage technology
E8	Technology ease of use perception
E9	Perception of technology usefulness
E10	Competitive pressure for adoption
E11	Technology self-efficacy
E12	Digital literacy

5.2 Pairwise Contextual Relationship among Elements

The researchers have used freely accessible SmartISM software [43] to enter SSIM values. In SSIM, the elements are arranged row and column wise (see Figure 1) and experts are asked to choose the relation of influence by picking each pair of 'i' and 'j' intersections among V, A, X or O.

V → if row element influences column element

A → if column element influences row element

X → if column and row elements both influence each other

O → if there is no relationship of influence

After the SSIM, the ISM development procedure leads to the formation of the initial and final reachability matrix. The final reachability matrix (Figure 2) is formed after performing the transitivity checks. It means if experts have defined element 1 is related to 2 and element 2 is related to 3 but did not define that 1 is related to 3, and then

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E1		O	O	O	O	V	O	O	O	O	O	O
E2			A	O	V	V	V	V	V	A	V	A
E3				O	V	V	O	O	O	O	V	O
E4					O	V	A	O	O	O	O	O
E5						X	O	A	A	A	A	A
E6							A	A	A	A	A	A
E7								V	O	A	V	A
E8									V	O	V	A
E9										O	V	A
E10											V	O
E11												A
E12												

Figure 1. Image of the generated SSIM.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	Driving Power
E1	1	0	0	0	1*	1	0	0	0	0	0	0	3
E2	0	1	0	1*	1	1	1	1	1	0	1	0	8
E3	0	1	1	1*	1	1	1*	1*	1*	0	1	0	9
E4	0	0	0	1	1*	1	0	0	0	0	0	0	3
E5	0	0	0	0	1	1	0	0	0	0	0	0	2
E6	0	0	0	0	1	1	0	0	0	0	0	0	2
E7	0	0	0	1	1*	1	1	1	1*	0	1	0	7
E8	0	0	0	0	1	1	0	1	1	0	1	0	5
E9	0	0	0	0	1	1	0	0	1	0	1	0	4
E10	0	1	0	1*	1	1	1	1*	1*	1	1	0	9
E11	0	0	0	0	1	1	0	0	0	0	1	0	3
E12	0	1	0	1*	1	1	1	1	1	0	1	1	9
Dependence Power	1	4	1	6	12	12	5	6	7	1	8	1	

Figure 2. Final reachability matrix.

this error is rectified after the initial reachability matrix. The transitivity check error rectifications are denoted by 1* in the final reachability matrix. The final reachability matrix also tells the driving and dependence power of each element which means the number of elements that it drives or depends upon, respectively. These powers are determined to perform MICMAC analysis.

The level partitioning is the next stage in which hierarchical levels of ISM are distributed among various levels. The levels are formed by performing separate iterations for each level by eliminating the already designated levels before making a new iteration for the next level. The first level indicates that the element is placed at the top and is the most dependent element followed by the drivers at lower levels. The final allotted levels of each element can be seen in Figure 3 in the form of a conical matrix. Once the levels are divided, then in order to reduce complexity, unnecessary or unrequired links are removed from multi relation portraying digraph without sacrificing or impacting the basic structural foundation. Then, through the reduced links, the digraph is converted into a final model.

Variables	5	6	1	4	11	9	8	7	2	3	10	12	Driving Power	Level
5	1	1	0	0	0	0	0	0	0	0	0	0	2	1
6	1	1	0	0	0	0	0	0	0	0	0	0	2	1
1	1*	1	1	0	0	0	0	0	0	0	0	0	3	2
4	1*	1	0	1	0	0	0	0	0	0	0	0	3	2
11	1	1	0	0	1	0	0	0	0	0	0	0	3	2
9	1	1	0	0	1	1	0	0	0	0	0	0	4	3
8	1	1	0	0	1	1	1	0	0	0	0	0	5	4
7	1*	1	0	1	1	1*	1	1	0	0	0	0	7	5
2	1	1	0	1*	1	1	1	1	1	0	0	0	8	6
3	1	1	0	1*	1	1*	1*	1*	1	1	0	0	9	7
10	1	1	0	1*	1	1*	1*	1	1	0	1	0	9	7
12	1	1	0	1*	1	1	1	1	1	0	0	1	9	7
Dependence Power	12	12	1	6	8	7	6	5	4	1	1	1		
Level	1	1	2	2	2	3	4	5	6	7	7	7		

Figure 3. Consolidated level partitioning of elements.

5.3 ISM Results

The ISM has been divided into 7 levels (Figure 4). The elements at level VI are the strong drivers that strive to drive the elements at subsequent levels above. Whereas, the level I elements are the most dependent elements. The arrows explain the association of influence from driver to dependent.

Level I: Agreeableness of technology into dairy farming (E5); Managerial interest in technology adoption (E6)

Level II: Affordability to adopt and maintain technologies (E1); Technology maintenance ease (E4); Technology self-efficacy (E11)

Level III: Perception of technology usefulness (E9)

Level IV: Technology ease of use perception (E8)

Level V: Availability of trained workforce to operate and manage technology (E7)

Level VI: Awareness level of technologies (E2)

Level VII: Experience in the dairy business (E3); Competitive pressure for adoption (E10); Digital literacy (E12)

5.4 MICMAC Results

The MICMAC divides the elements into four distinct categories on the basis of dependency and driving powers already derived in the final reachability matrix (Figure 5). The elements in the first quadrant are known as autonomous and possess low driving and dependence power. The second quadrant is composed of dependence, the one with low driving but high dependence power. The elements at the top levels of ISM are the dependents. Linkages in quadrant three are the interdependent elements that have both high driving as well as dependence powers. Lastly, in quadrant four, the high driving but low-dependent elements are placed and known as drivers or independents.

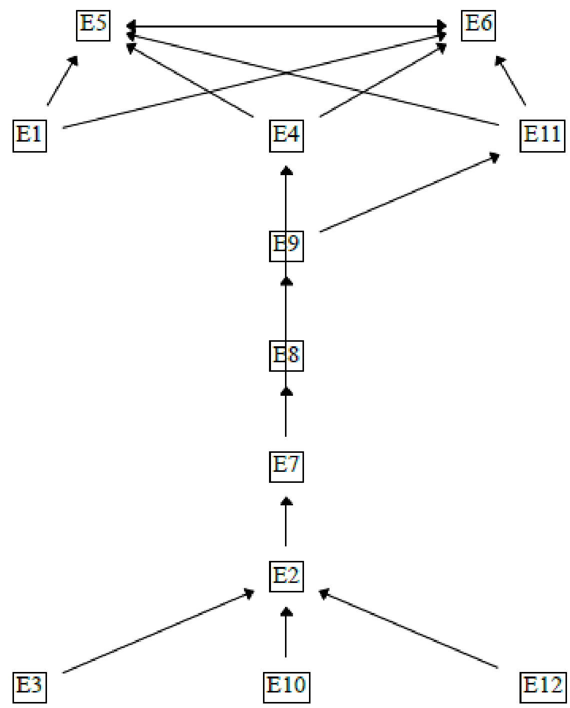

Figure 4. Interpretive Structural Modeling (ISM) for enablers of technology adoption in dairy farming.

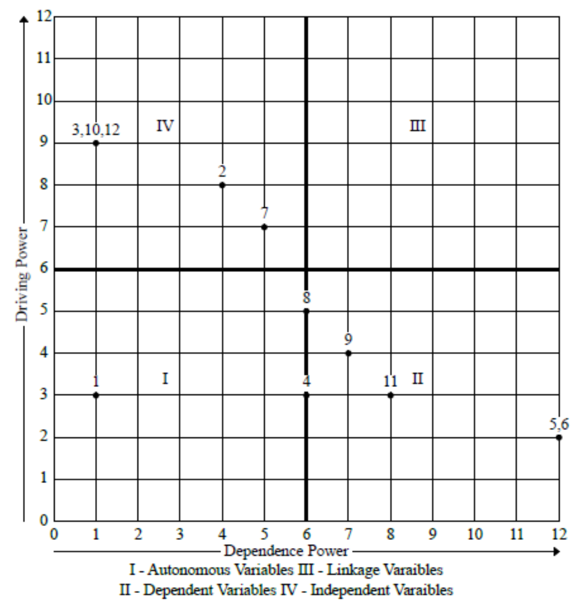

Figure 5. MICMAC.

Autonomous: Affordability to adopt and maintain technologies (E1).

Dependents: Agreeableness of technology in dairy farming (E5); managerial interest in technology adoption (E6); perception of technology usefulness (E9); and technology self-efficacy (E11).

Linkages: No element.

Independents: Awareness level of technologies (E2); experience in the dairy business (E3); availability of trained workforce to operate and manage technology (E7); competitive pressure for adoption (E10) and digital literacy (E12).

Exceptions: Technology maintenance ease (E4) and technology ease of use perception (E8) were found to be middle of the road elements between autonomous and dependent categories; and both have the same dependence power. Technology ease of use relatively has higher driving power than technology maintenance ease.

6. Discussion

On the basis of ISM and MICMAC results, the following points of interpretation can be drawn:

- Experience in the dairy business (E3), Competitive pressure for adoption (E10) and Digital literacy (E12) are present at the base level of the ISM, which means that they are the strong enablers of technology adoption and strong drivers in the given system of elements. It can be validated by MICMAC as all these are under the fourth quadrant that has high driving elements. All these three equally drive the element at level II. It is evident that farmers' experience in the dairy business or how much a farmer has invested in terms of years dedicated to dairy farming. It includes knowledge of all the ways to effectively perform activities related to herd management, procuring and processing. Next, competitive pressures also act as a strong driver for adopting technology. As technology gains popularity in dairy farming, other farmers also intend to adopt it in order to smoothly manage operations and ensure value deliverance in various tasks. Here, digital literacy or the knowledge of handling technology is also an important driver. If a farmer or any worker is aware of handling technologies and has a certain level of comfort, then the chances of a decision related to the adoption of technology become optimistic.
- All the above three enablers tend to drive the awareness level of technologies (E2). Experience in dairy farming enhances awareness as long tenure of service in dairying enables time to time updates in the field. In terms of technology, an experienced and informed farmer is aware of the technologies available for dairy farming. Competitive pressure also motivates farmers to stay aware and be in touch with the latest developments in the field of precision dairy farming technologies and other forms of innovative dairy technologies. Lastly, the digitally literate farmers or workforce get themselves regularly updated and aware of the technologies available.
- The availability of a trained workforce to operate and manage technology (E7) has been placed at level V. It means that the awareness of technology influences the availability of a skilled workforce to operate and manage technology. This link can be explained as digital literacy impacts awareness of technology and then it ensures that the workforce is aware of the chances of being capable of managing technology, primarily information and digital technologies.
- In the ISM figure, a continuous arrow can be seen crossing the element block. It means that this availability of a trained workforce to operate and manage technology (E7) has a direct impact on technology maintenance ease (E4) at level II. This can be interpreted as the trained workforce being capable of maintaining technology in case of minor issues or regular scheduled services.
- Technology ease of use perception (E8) at level IV is driven by the availability of a trained workforce to operate and manage technology (E7). If a trained workforce or an aware farmer is there, then it has an influence on the perception related to how easy a technology is to use. Since technology requires a certain level of awareness, knowledge and skills to operate and manage, it will be easy to use technology if technologically skilled workforce is there at the dairy farm.
- Technology ease of use perception (E8) influences perception of technology usefulness (E9) at level III. If the perception related to ease of using technology is favourable, then the perception related to the utility of engaging technology in one's dairy farm also moves in the positive direction. But if a farmer is not aware or tech-friendly, then he might not prefer to adopt it, thus affecting the unfavorable perception regarding the usefulness of technology in dairy farming and preferring to sustain with traditional farming methods.
- Perception of technology usefulness (E9) in the dairy farm business influences technology self-efficacy (E11) at level II. If the utility of technology is realised by the farmer, then it tends to encourage

the belief and motivation in a farmer's capacity to execute desired behaviour, which is in this case the adoption of technology.

- Technology maintenance ease (E4) and technology self-efficacy (E11) both directly influence the agreeableness of technology in dairy farming (E5) as well as managerial interest in technology adoption (E6) at level I. Here, the term managerial interest is referred to the decision maker in the dairy farm unit and can loosely be referred to as farmer also. If technology is easy to maintain, then both agreeableness and managerial interest can be positively influenced. As per the experts, the agreeableness and interest here differ in the sense that interest is somewhat related to the opportunity cost after comparing traditional farming methods versus technology enabled farming depending on farm size and other factors. Agreeableness is related to the acceptability of technology intervention in dairying. As some of the farmers did not find technology suitable to adopt, there is a perception that human touch and care are necessary and that maintaining technology is a burden. Most importantly, technologies like automatic milking can create harm to the animal's udders and further medical treatment for the cattle should be required. But it is assured now that there is no such harm due to more advanced forms of suction equipment.

There is another element present at level II; Affordability to adopt and maintain technologies (E1), which has no driving enabler at below levels and directly shows up. This is the reason why this enabler has been placed in the autonomous category in the MICMAC as it has almost no dependence power. In the end, technology is a cost-bearing decision. It involves one-time investment costs for adoption as well as maintenance costs, either regular or sudden. This enabler also directly influences agreeableness of technology in dairy farming (E5) as well as managerial interest in technology adoption (E6) at the level I. Cost versus benefit analysis is considered at this stage, which in turn develops interest among the decision makers in the dairy farm unit in whether to adopt any technology or not.

Also, it can be noted at level I, that a two-way relationship between agreeableness of technology in dairy farming (E5) and managerial interest in technology adoption (E6) has been explored. It means both have an impact on each other. The agreeableness to adopt technology influences the interest in adopting technology and interest developed in technology can influence the agreeableness to adopt technology. Both these enablers possess the highest dependence power and thus are placed in the second quadrant of the MICMAC.

7. Conclusions

This study has identified and established linkages among enablers of technology adoption specifically focused on dairy farming. The ultimate objective is to improve performance by enhanced or properly planned technology adoption and to aid stakeholders or decision makers in the Indian dairy farm business to develop strategic and action plans, and support policy planners in developing favourable policies based on an understanding of the contextual relationships between enablers. It is important that technology promotion, dairy related education and awareness of technologies of dairy farming must be enhanced first in order to ensure a trained workforce or trained farmers. This enabler can regulate other enablers such as perception regarding usefulness and ease of using technologies. Ultimately, the interest of the decision maker can be in the positive direction, but other important factors are also vital to play a role here, like affordability to procure and maintain technology, along with ease in the maintenance and constant technology management. Overall, the ISM and MICMAC as part of techniques under systems approach, are good ways to model poorly articulated problems within a system that has several sub-systems interlinked with each other in a proper interpretive form of hierarchical model that can help to resolve complexity and facilitate decision making. These techniques are backed by experts' discretion/opinion and ensure consensus building through discussion to get the maximum accuracy and closeness to the actual or real system. The NGT led discussion avoids bias and loudness of a single opinion. NGT ensures fair participation and a synergic impact on information gathering, building solutions and action plans.

This research shows the relationship among identified enablers along with their existence in the hierarchy and dependence and driving power, but it lacks the ability to statistically validate the findings using techniques like SEM. This can be taken as the future scope of this study, including fuzzy dominance considerations revealing the degree of association among identified elements. Also, this study can be taken as the basis to develop a modified model based on the dynamics of other nations than India. The model elements can be reworked, redefined and the contextual association may also be redefined as per the internal and external environment of the industry.

Author Contributions

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Data Availability

The data presented in this study are available on request from the corresponding author.

Conflict of Interest

The authors declare no conflict of interest in any form.

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