

ORIGINAL RESEARCH ARTICLE

Moving towards a sustainable world with the circular economy practices concerning the SMEs in Visakhapatnam's ice-cream industry

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ABSTRACT

The Circular Economy (CE) is getting its attention these days, which has a massive impact on the industries, particularly in the manufacturing segment. The countries worldwide started believing in CE, and its practices got the benefits after thoroughly implementing it to their current practices. The concept is not new, but it came up with a new ideology and new techniques already proven by countries like China and the UK. Different industries show their innovativeness by adapting to the change for the future. We found that the Ice Cream Industry is one of them that adopt change quickly. The paper discusses the introduction of the CE, the current trends, the comparison of the olden style with new style after implementing CE practices, the challenges and barriers in implementing, and the benefits of implementing CE Practices in Visakhapatnam's dairy industry. We followed a personal interview method for getting first-hand and rich information from the CEOs and operational managers of the company. Also, we followed the case study method to extract how they shifted from traditional manufacturing practices to the current and latest trends in manufacturing. In their manufacturing practices, we aimed to get factual information on the changeover from linear to circular.

Keywords: Circular Economy; Sustainability; Indian SMEs; Challenges; Barriers

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1. Introduction

The notion of circular economy has garnered escalating interest in contemporary times, propelled by the necessity to tackle worldwide environmental difficulties such as climate change, pollution, and resource exhaustion. The CE is a conceptual framework designed to foster sustainable economic expansion through waste minimization, resource retention, and mitigation of the adverse environmental effects of human activities. The adoption of CE principles is gaining traction in the manufacturing industry, specifically within the dairy and ice cream sector, to promote sustainability and minimize waste in the production process. CE is a closed-loop system that is a Resource-Product-Renewed resource-based system, which is quite different from the traditional "Resource-Product-Waste" linear system, which involves the concepts of Reducing, Reusing, and Recycling^[1]. The resource input and emissions that are not useful, and energy leakage are decreased by narrowing, slowing, and closing the Material Loops. China faces many resource supply and assimilation challenges,

including acid rain deforestation, land degradation, Greenhouse gas emissions, geological process, and water resource depletion. So, they came up with this new ideology already existing. Still, CE development evolved into a different set of names and concepts.

There are different phases of developing CE worldwide. Firstly, the concept was introduced in 1990–2002. The terminologies involved are the recycling economy and society, including “reduce, reuse, recycle,” generally known as 3R’s, which some countries already accept in their shared aspects. The State Environmental Protection Administration of China (SEPA) has played a major role in promoting CE around the country. They claimed their stakeholders are paying attention to supporting studies from the pilot projects on cleaner production. They also made recommendations to State Council for drawing attention on implementing CE.

The discussions accelerated after the National Government decided (2003–2005) to promote CE as a long-term strategic input of Chinese Economic Development. As a result, CE got a place in the 11th five-year plan in 2004. To eradicate the situation, the nations started adopting new techniques and technologies to overcome the issues in the future^[2]. An SLR approach has been followed to find the relevant information regarding the literature, trends, challenges, and barriers in the CE and Dairy Industry. Hence, it is defined that the search process is different from the traditional scientific approach to reduce the bias on concepts published on various platforms^[3,4]. The primary reason for the SLR approach is to eliminate the irrelevant information apart from the concept we are following^[5,6]. The rationale behind our research’s exclusive reliance on the Scopus database was predicated on its extensive recognition, all-encompassing disciplinary coverage, sophisticated search functionalities, and the reliability of its indexed publications^[7]. Our study focused on a singular database, which allowed for a manageable scope and ensured consistency and efficiency. A keyword search in the Scopus database follows the step-by-step process of eliminating irrelevant

information. The first wave of search is followed by “circular economy” and (“SME” or “small”) and “SMEs” which resulted in 123 documents. Next, the filtration steps, including the abstracts, title, and keyword analysis resulted 85 documents.

Further the papers were eliminated by abstract filtration, and criteria filtration. The criteria selected for this study is a) the papers should especially discuss about SMEs and CE, b) the paper at least discusses about the sustainability aspect of the Dairy Industry, and c) the paper should include the research on CE by discussing challenges and trends and barriers in the current industry scenario. Finally, the papers with cross references and seminal papers addition lead to 46 articles. These articles were finalised for the study and used to develop a literature synthesis. The case study with unstructured interview process has been picked for the discussions from the Dairy Industry experts. These interviews cover the topic on sustainability development in their industry as a whole and steps can be taken to implement CE in their processes. The paper’s structure flows with the study’s background, methodology, case brief, Analysis, discussions, and findings from the cases with conclusion remarks.

Within the Ice Cream Industry, various research areas^[8] warrant exploration to advance the principles of the circular economy. Initially, exploring novel packaging alternatives is imperative in promoting sustainability^[9]. This entails the examination of other options, such as biodegradable substances, reusable receptacles, and tactics to mitigate packaging waste^[10]. Adopting such packaging solutions has the potential to enhance the circularity of the ice cream sector.

The implementation of CE principles within the dairy and ice cream sector has the potential to result in a decrease in environmental impact, an increase in resource efficiency, and a boost in profitability. An essential domain for scholarly investigation pertains to reducing and managing waste in the context of ice cream manufacturing procedures. The implementation of effective strategies aimed at optimising ingredient utilisation, reducing water consumption, and adopting effi-

cient waste management practises can lead to a significant reduction in waste generation^[7].

The assessment of the practicability and advantages of implementing closed-loop supply chains within the ice cream sector is of utmost importance. The implementation of systems that enable the reutilization or recycling of by products or waste generated during ice cream production can significantly augment circularity. This study aims to examine the technological components of the CE as they pertain to the machinery utilised in the ice cream sector, and to assess their efficacy in realising circularity. The study's objectives are to identify the state of art in CE adoption in technological perspectives, and to identify technological barriers and challenges faced by the dairy SMEs influencing adoption of CE. The outcomes of this study will enhance comprehension of the circular economy within the dairy and ice cream sector, and offer perspectives on the pragmatic application of CE principles in production procedures.

2. Background of the study

2.1 Circular economy: Theoretical analysis of the concept

The theoretical analysis indicates that there are two dimensions in which materials move between eco- and socio-economic processes. Compared to pre-industrialization, the imbalance in material exchange becomes more pronounced with industrialization. A key factor contributing to this imbalanced exchange is the existence of sub-sites, which serve as critical nodes where various materials are transferred between socio-economic and ecological systems. These two dimensions of material exchange—ecological and socio-economic—require careful consideration. Ecological exchanges involve the interaction between industrial processes and the environment, where materials are extracted, transformed, and eventually discarded. On the other hand, socio-economic exchanges encompass the movement of materials within the economic system, including production, consumption, and waste management activities.

Understanding and effectively managing these dimensions is crucial for achieving a more

sustainable and balanced material exchange within a circular economy framework. However, these transfers often adhere to the principles of a linear economy, which operates within the constraints of scarce resources^[11]. As a result, the continuous depletion of product resources and the generation of waste become significant challenges, leading to a research shortage in this area^[7].

Researchers and businesspeople are aware of various R principles, such as Reduce, Reuse, Remake, Recycle, and Refurbish^[12-14]. The principles are instrumental in serving as a conduit for the transition from linear to circular production patterns^[13]. The objective of reducing resource consumption is to promote the reuse of products and identify viable avenues for generating additional revenue by repurposing damaged goods^[12]. The promotion of a CE is widely acknowledged to necessitate the implementation of recycling practices, albeit exclusively for products that have reached the end of their useful life^[15].

From a practical standpoint, it is possible to implement three zones or circles in order to achieve improved outcomes. The initial category comprises corporate ensembles, ecologically conscious designs of manufacturing facilities, waste reduction, systems for managing the environment, and the implementation of cleaner production techniques^[16]. The second zone pertains to the intra-firm exchange of commercial by-products, such as residual, and manufacturing waste^[17]. The third zone pertains to societal aspects or macro levels, encompassing eco-provinces and eco-cities that promote regional industrial networks.

The reflections indicate that despite the existence of various possibilities to mitigate long-term uncertainty, there is still a dearth of unseasoned production technologies and drawbacks^[18,19]. The prioritisation of cost reductions while adopting CE adjustments is recommended. The CE is perceived by companies to be influenced by three primary factors, namely financial advantage, material provision, and resource reutilization. Effective communication has the potential to enhance a firm's standing, while the utilisation of resources and the creation and capture of

value from the market can yield cost savings and financial gains.

2.2 The latest trends in smart manufacturing related to the Ice Cream Industry

Industrialization and digitalization have increased the bar in living standards and created adverse environmental effects resulting from unsustainable consumption and production habits^[20]. The emergence of Industry 4.0 and smart manufacturing technologies, driven by digitalization and the Internet of Things (IoT), offers opportunities for addressing these challenges^[21].

Industry 4.0, also called smart manufacturing, is based on the systems of manufacturing techniques determined by Information Technology (IT)^[18,22]. The involved combination of smart Industries, products, and the Internet of Things (IoT)^[18,23,24]. It can also trigger the components rejected for quality purposes can be returned to the main component for reprocessing, tracking the post-consumption components. However, these dairy industries are not fully automated. There is a need for human interference to complete such top-priority tasks that automation cannot be done^[25].

Man and Strandhagen^[26] suggested that through data collection and exchange, Industry 4.0 technologies help to sustainable operations management choices and new business models based on integrated value chains^[27]. The latest technologies can understand resource usage and optimize processes^[23]. However, the disclosure of operational data to develop industry metrics and use big data-driven analytics to benchmark mutual trust is a challenge in corporate culture. The emerging technologies and smart manufacturing techniques are not yet implemented^[21] and adapted in Indian SMEs. Since the emerging technologies are mainly based on the principles of Industry 4.0. The technology may now be possible to overcome barriers to the CE by adopting the new emerging technologies related to smart manufacturing^[28]. In a McKinsey Global Expert Survey on attitudes toward Industry 4.0, it was discovered that just a small proportion of respondents had a clear path for adopting Industry 4.0^[29].

However, there have been barriers to fully adopting CE principles within organizations and supply chains^[1,19,27]. It has been discovered, for example, that a lack of product life cycle information and a scarcity of modern technology for sustainable production have limited the reach of CE principles^[19,30].

By co-creating and sharing expertise between organizations and mixing up the competencies from different types of actors, promising networking with international partners would create a solution for the challenges involved, and network with domestic partners could be increased (Strategic Research Council at the Academy of Finland). At the product level, there are several ways to improve circularity^[28]. For example, transitioning to longer-lasting products, modularization and re-manufacturing, component reuse, and product design that uses less material. Materials should be devoid of harmful chemicals, easily disassembled, and recyclable or compostable.

3. Research methodology

The study's research design and protocol are based on a social constructivist paradigm, which involves constructing knowledge through real-world experiences and reflections. The study employs a qualitative exploratory inquiry to achieve its overarching goal. An unstructured interview format by personal interview, to refine the research that exploratory as the adoption of CE involves^[31]. A systematic review of the literature was undertaken to investigate contemporary practices in the field of circular economy (CE), as well as the technological factors that facilitate or impede their implementation within the dairy industry. A focus group session was organised, wherein nine dairy industry representatives were invited to engage in a brainstorming exercise aimed at identifying relevant CE practices.

Subsequently, visits were conducted to three small and medium-sized enterprises (SMEs) to evaluate the implementation of best practices within SMEs in the context of CE. The case study methodology was selected for two main reasons, as stated by Eisenhardt^[32]. Firstly, the research

was conducted with an exploratory purpose to gain a deeper understanding of small and medium-sized enterprises (SMEs) that have implemented circular economy (CE) practices, as highlighted by Bititci *et al.*^[31]. The utilisation of the case study approach facilitates the acquisition of comprehensive and profound comprehension, which was employed to elucidate the technological catalysts and hindrances of implementing CE^[33].

The unit of analysis for the study was determined using purposive sampling technique, focusing specifically on SMEs involved in producing technologically prepared products rather than service-oriented industries. The study specifically targeted the dairy industry, recognizing its significant impact on technological dimensions. Within the nine SMEs, a snowball sampling technique was employed to filter and select three companies that were invited for a meeting, during which they had already expressed willingness to provide access to data.

The study will help the industries to know about the issues and challenges of implementing the CE. Industries or practitioners can gain knowledge on current trends and relevant facts on the ongoing issues. The method followed in the study was inspired by the Model of professional practice judgement artistry^[34] that makes the reader easily understand the content delivered through output^[35]. The case study methodologies and a case study protocol (CSP) has extracted rich and pure^[36,37] on the current practices and knowledge

on the topic. The CSP is adapted from^[32] and developed by Maimbo and Pervan^[37]. The industries are the key factors for implementation, and impact levels would be adequate on the dimensions of sustainability^[9]. So, we selected the industries where they directly access the data^[33].

The research design (**Figure 1**) consists of three phases with two steps in each phase. The first undergo reviewing the currently existing literature reviews around sources from the internet. The Selection of the industries and preparing with an interview protocol (**Figure 2**). The overview of the entire cases has been disclosed (**Table 1**). The second phase is selecting the cases and doing case studies by extracting information from our primary contacts. The findings will be generated after initiating the cross-case analysis (**Table 2**) of the above three cases, basically from the third phase.

The guidelines to follow the case protocol^[33] are to understand and initiate the stepwise process from start to end and then follow up^[37]. To inform the uniformity in the progress while taking interviews and data collection in the same region but multi-locations. The research design (**Figure 1**) is qualitative that allows for careful consideration^[38].

The primary emphasis at Level 1 is centered on initiating the company selection process. The process entails acquiring authorizations from the designated representative of each organisation to procure the requisite information for the research. Establishing a suitable communication channel and obtaining requisite approvals before commencing study is paramount.

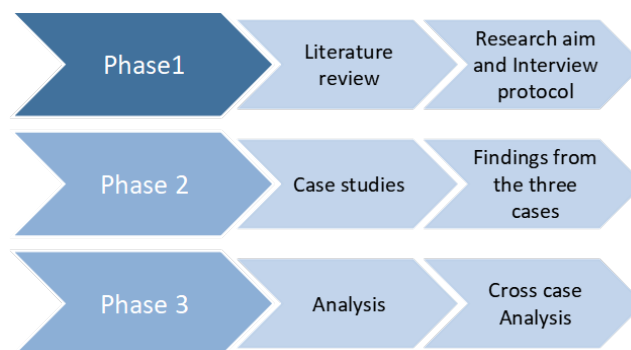


Figure 1. Research design for this study.

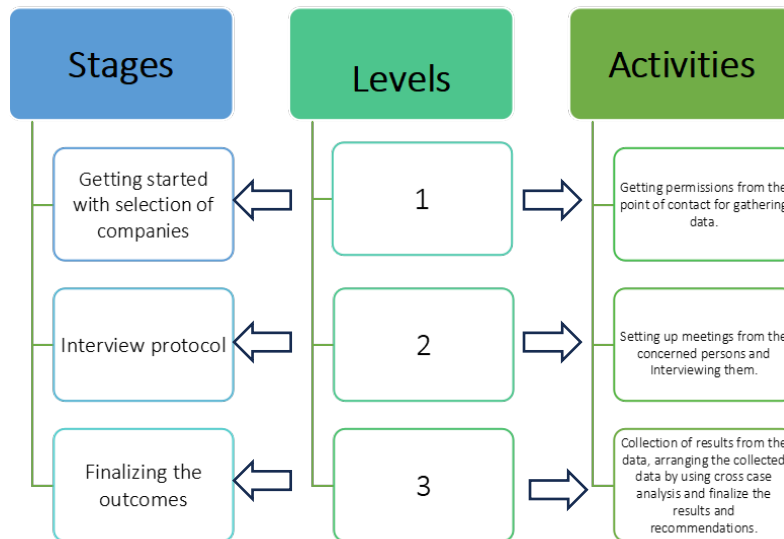


Figure 2. Case study Protocol (CSP).

Table 1. Overview of the investigated cases

Case	Data source (personal interview)	Length of interviews	Type of product	Number of employees	Year of foundation	Location	Findings and suggestions
A	CEO and manager	1 × 1.5 hrs 2 × 2 hrs	Dairy products and bakery items	104	2015	Vizag Industrial area	Recycle more, rent or lease goods
B	Operations managers and senior supervisor	1 × 45 mins 1 × 1.5 hrs 1 × 1 hr	Premium dairy products, ice cream cakes	45	2019	Vizag Industrial area	Recycle more, periodic maintenance for expanding machine life
C	Senior manager and managing partners	1 × 2 hrs 2 × 1.5 hrs	Ice creams and frozen foods	30	2017	Pendurthi, Vizag	Installing recollection booths, better policies for Industry-wise

Table 2. Cross-case analysis

	Case A	Case B	Case C
Design	√	√	√
Carbon involvement	×	×	×
Renewable energy	√	×	×
Zero waste	√	√	×
Technology	√	√	√
Automation	×	×	×
Environment factors	√	√	√
Sage disposals	×	×	×
Waste recovery	√	×	×
Knowledge on CE	√	×	×
Reusage of waste	√	√	√
Subsidies	√	√	√
Support from senior management	×	×	×
Health and safety	√	√	√
Learning and development	×	×	×

The second stage of the process entails the creation of an interview protocol. This entails arranging appointments with appropriate personnel within the designated organisations and conducting interviews with them. Interviews are fundamental to gathering data, enabling a comprehensive comprehension of the topic and acquiring first hand insights from the respondents.

At Level 3, the focus pertains to concluding the case study results. This process entails the compilation of findings derived from the accumulated data. Subsequently, the built-up data is systematically arranged and scrutinized through cross-case analysis methodologies, facilitating a holistic comprehension of the recurring themes, tendencies, and discoveries across the diverse cases. The conclusions and suggestions drawn from the analysis offer significant perspectives and feasible courses of action for the research.

The cross-case analysis is a technique used in qualitative case study research to draw comparisons between different cases or study sites^[39]. During this procedure, we look for similarities and differences between different examples so that we can draw more accurate conclusions. The research questions are specific to SMEs within the supply chain blocks identified in the literature: design, procurement, manufacturing, distribution, use, and recovery. In addition to essential components pertaining to the utilisation of renewable energy, the utilisation of technology, waste management, government financial assistance, occupational safety and health, automation, and discussions related to development were deliberated during the meeting. By comparing data from different cases, researchers can identify commonalities and trends. Research in business, administration, education, and medicine all benefit from this strategy and analysis from the social sciences. The technique can be used to better understand and explore complicated phenomena^[38]. It is possible to create more generalizable theories and frameworks with the aid of cross-case analysis.

4. Analysis and discussion

4.1 Context of the cases (individual)

4.1.1 Case A

The industry was established in 2015 as a dairy product manufacturing company in the Industrial sector, with a space of 30,000 sq. ft. Visakhapatnam. The industry is dealing with more than a hundred employees for different roles in production with an annual turnover of 12 crores. Some unofficial distributors are working under the company based on an incentive. The industry first followed the traditional production process that involved more men. The working hours are the same but, it takes much time to produce a quality product with limited flavours. There is less research available in product mixes and flavours. There are minimal regulations in making the product variants. Earlier, limited product varieties like ice creams, cup variants, stick variants, and bulk boxes were used to manufacture. There is a much wastage produced during the production process. The workers do not consider the things involved in environmental factors even if the dairy product does not harm the environment. Still, they are lacking knowledge on these sensitive aspects. Then the management decided to expand the market and break the barrier of limited products. The decision to upgrade machinery with some new attachments leads to increased product varieties—the pieces of training for the proper and required amount for the usage of raw materials. The process optimization has been initiated, and the wastage is being reduced day by day. They manufacture cream shakes, candy bars, pastries, waffles, ice cream cakes, and flavoured milk products with organic fruit mixed premium segment ice cremes, low-fat products, zero fat products, and many. The company followed all necessary standards for the product's perishability, and to protect shelf life, the temperature needs to be monitored carefully.

The industry achieved all the standards and milestones by following these necessary steps. They followed efficient manufacturing handling systems, including power stabilizing equipment, cut-offs ideal power while running time. They have installed separate electrical lines for big and small machines to divert power issues and provided training to the practical usage of production

lines, leading workers to handle the equipment by themselves. They have their transport system for transporting big orders to long distances like more than 300 kilometres is the highest distance delivered the products, rest of the order will be taken from the distributors from the company which installed from various key areas to avoid unnecessary small order transportation. This reduces the carbon footprint of the company to save the environment. Installing a new Thermo controlled system preserves the unused cream and can be collected to utilize other product variants. They follow the best practices to reduce water waste. Also, they implemented to reuse the water in different ways like diverting the water used for cleaning into the Well, then reused to clean for the next batch after the purification process. Some other water used for the production process will be diverted to the harvesting system. The company is looking for the government on the subsidies for upgradation on automating to sustain the future technology that involves huge financial expenses. As SMEs, they cannot afford this at the moment. After getting knowledge on CE, the industry achieved maximum inputs and implemented gradually in their production system, which leads to change slowly. Now, they are planning to eliminate plastic usage and recollection of the plastic to recycle them and shifting partially from electrical to solar and playing their part in reducing the waste and effects in the environment.

4.1.2 Case B

The industry was established in 2019 as a premium dairy products manufacturer in the Industrial sector, Visakhapatnam. The company is covered in a 12000 sq. ft area with more than 40 employees with an annual turnover of 3–4 crores. This industry directly jumped to the latest technology in manufacturing but has not yet upgraded to upcoming technologies. They are into the modern way of producing ice cream by automatic machines installed in some production parts. The dairy industry is one industry that needs human involvement as the quality and safety matter is a concern in the product. They have a skilled workforce on environmental aspects, and others can

handle all equipment breakdowns include effective maintenance. This industry usually recruits educated people on the best environmental practices, safety standards, and efficient handling of machinery and electricity. The company follows all standards, including ISO. Their product segments prime focus on premium products with zero-fat products. They also deal with frozen foods like green peas, frozen nuggets, ready-to-eat foods, ice cream designer cakes. The company claims that they are the best in recycling the waste it produces and reusing the products. First, they recycle all the water that is being utilized for several purposes. The water will recirculate for cleaning the vehicles, some pure water for purification, and the RO cleansing system purifies the water to be drinkable. Second, the dry ice, which generally protects the cooling from the cooling boxes. However, the dry ice is collected back while unloading the boxes into storage rooms. The collected dry ice is recollected back to the industry and reutilized for the next batch delivery.

After gaining some knowledge on the CE practices from the authors, the company decided to control their plastic waste. They already eliminated plastic packaging to their ice cream bars and changed it with recycled paper packaging boxes. They will plan to install a collection box in their ice cream outlets. The waste will be recollected while delivering the stock, the collected plastic sent to recycling units. Their vision is to upgrade their unit with a smart manufacturing system that the technology mixed with IoT systems can take extra care of their products by tracking the freshness and shelf life with the specification levels like energy and fat percentage. As the company is new to the market, they are going slowly in implementing changes. Once the premium market is captured and some financial support, they are willing to adapt to the change slowly to gain brand value in the Indian market. They believe that adopting CE can be a breakthrough for Manufacturing segments.

4.1.3 Case C

The industry was established in 2009 as a frozen foods company in the Pendurthi zone near

the Industrial hub, Visakhapatnam. The company covers an area of 10,000 sq. ft, with more than 30 full-time employees and ten contract workers altogether, generating an annual turnover of more than five crores. The company deals with all types of vegetarian frozen foods, including butter, green peas, corn, dairy protein products, and some ice cream variant. The company is associated with one of the aged ice cream brands, and they share 49% of the turnover. The company followed the traditional way of making ice cream, and also it partially and slowly adapted modern technology by upgrading some of the machinery to work effectively. The employees are semi-skilled, but they are being trained for the company's necessities. The production process involves raw materials that need to be cleaned with bare hands. The boilers, ovens are worked under firewood. The smoke evolves, damages the surroundings worker's health, and excessive temperatures create suffocation. The company realized that they lack speed, technology, and demand fulfilment from the market demand. This made some of the design processes change, and they increased output.

They generally produce lots of waste in the traditional process. After upgrading, they implemented some new processes and equipment to eliminate the excess usage of raw materials, energy, and waste. Waste reduction is not up to the mark, but they have saved something compared to the olden days. The company agrees that there is a need to update technology and standards to sustain the market in the future. They must ensure that everyone follows all types of standards and protocols for product quality using the technology in the future. They are a top priority on delivering the quality product then delivering it in quantity. Now the focus is expanded to produce more at the same time not to compromise on quality. For this, they are trying to implement CE practices. They believed that CE practices would help them achieve the zero-waste policy, reducing raw materials and energy. They are planning to reduce plastic involvement in packaging their products by switching them into paper-based packaging items.

The summary of company details and participant profile.

4.2 Cross-case analysis

Cross-case analysis is a qualitative research methodology employed in case studies to scrutinize and contrast data obtained from various cases or study locations^[39]. The process entails the identification of shared characteristics and distinctions among instances, and utilising this examination to derive more comprehensive inferences regarding the subject under investigation. The utilisation of cross-case analysis holds significant value in case studies due to its ability to surpass the constraints of single case analysis, which may not comprehensively comprehend intricate phenomena^[40]. Through comparative analysis of data from multiple cases, researchers can discern patterns and interrelationships that may have remained obscure in a singular case study. This method and analysis are frequently employed in research within the social sciences, encompassing domains such as commerce, administration, pedagogy, and medical services^[39]. The utilisation of this tool yields significant potential in the investigation of complex phenomena, ultimately resulting in a heightened comprehension of the subject matter under scrutiny. Furthermore, the utilisation of cross-case analysis has the potential to facilitate the advancement of theories and frameworks that possess applicability across diverse contexts.

The analysis shows that the cases adopted and used circular practises to varying degrees. When it comes to the integration of the circular economy, Case A stands out as the most advanced. It possesses knowledge of the principles of the circular economy, incorporates design elements, uses renewable energy sources, employs waste recovery techniques, and encourages waste recycling. Furthermore, Case A receives subsidies and gives special attention to environmental, health, and safety concerns. Case B, on the other hand, demonstrates a moderate level of adoption of the circular economy. It uses technology, incorporates design elements, takes advantage of subsidies, and has policies in place for reuse and zero waste. Case B, however, does not participate in pro-

grammes to reduce carbon emissions or use renewable energy sources. Contrarily, Case C shows only a few examples of circular economy practises. It incorporates design elements but lacks waste recovery, zero waste, and circular economy principles measures.

The application of CE principles in three food-related businesses was the main topic of our study. We discovered that all three of these companies viewed integrated design as a key component in their CE initiatives from our in-depth interviews with these businesses' CEOs, managers, and operations managers. The businesses had also adopted renewable energy sources, with Case A being the only one to do so thoroughly. Only Cases A and B had implemented any waste reduction strategies, indicating that no company had fully adopted a zero-waste strategy.

Cases A and B also implemented waste recovery procedures, and all three businesses incorporated technology into their CE initiatives. Case C, in contrast, had not yet considered this possibility. None of the businesses had yet put safe disposal practices into place, even though they were aware of how important environmental factors were to their operations and had taken steps to address them.

It is interesting to note that even though all three businesses had included design and technology in their CE initiatives, only Case A had a thorough understanding of and fully embraced CE practices but not effectively. Cases B and C did not fully adopt the concept and its guiding principles in their operations because they had only a superficial understanding of them. All three businesses understood the potential advantages of subsidies for the adoption of CE principles, though.

Additionally, our interviews with the three companies showed that they all understood the value of senior management backing and health and safety in their CE initiatives. Cases B and C, however, had not yet made any investments in learning and development opportunities for their staff members to comprehend the CE concept and its guiding principles completely.

The analysis highlights the importance of technological aspects in driving circular economy adoption within the ice cream industry. Design plays a crucial role in facilitating circular practices, as it allows for product optimization and the reduction of material usage. Technology is another key factor, enabling efficient production processes and resource optimization. Although absent in all three cases, automation has the potential to enhance circular economy implementation by streamlining operations and reducing human intervention. Additionally, the reuse of waste and waste recovery measures are critical for minimizing waste generation and promoting resource efficiency.

These practices not only reduce environmental impact but also have the potential for cost savings. However, the analysis also reveals gaps and areas for improvement, such as the need for carbon reduction initiatives, greater utilization of renewable energy sources, and a stronger focus on knowledge development and senior management support for circular economy adoption. Addressing these gaps would contribute to a more comprehensive and effective adoption of circular economy principles in the ice cream industry.

Although there is still room for advancement, our findings indicate that companies in the food industry have made strides toward incorporating CE principles into their daily operations. All three businesses could do better when it comes to using renewable energy sources, adopting a zero-waste thinking, and putting safe disposal practices into place. Additionally, increasing understanding of the CE concept and principles and providing employees with learning and development opportunities may help businesses fully embrace CE initiatives.

5. Findings

The present study utilized primary data collected through personal interviews with CEOs, managers, and operations managers from three distinct companies operating within the food industry. Company A is a business enterprise that produces dairy products and bakery items. It was established in the year 2015 and is situated in the

Vizag Industrial area. The company currently employs 104 individuals. The implementation of additional recycling initiatives and the adoption of rental or leasing models have been proposed by the CEO and manager. Company B is a newly established enterprise in the Vizag Industrial area, which specialises in producing high-quality dairy products and ice cream cakes. The company has a workforce of 45 employees and was founded in 2019. The operations managers have suggested that increasing recycling efforts and implementing regular maintenance procedures would be beneficial in extending the lifespan of the machines. Company C is a business enterprise that specialises in producing and distributing ice creams and frozen foods. The company has a workforce of 30 employees and was established in the year 2017. It is situated in the locality of Pendurthi, which is in the city of Vizag. The senior manager and managing partners have recommended implementing improved waste management policies and installing recollection booths as potential solutions to address industry-wide waste management issues. The findings above and recommendations indicate the companies' endeavours to incorporate CE tenets in their business practices and product innovation.

These industry owners in the discussion revealed that they are using various reverse activities indirectly, mentioning the name of the Rtyologies such as reuse, recover, recycle, and more. A detailed discussion on R typologies has been discussed.

The possible suggestion from the industry experts for the other businesses to start adapting.

- 1) Recycle more and better
 - It is advised to practice more closed-loop Recycling.
 - The Units can reuse the processed water for purifying processes and cleaning purposes after separating flavors.
- 2) Renting or leasing the goods
 - Instead of buying goods, it is advised that turn to lease or rent instead.
 - Instead of having its transport system locally, handling the distributors on taking the load with some discounts.

3) Increasing the permanency of types of equipment

- Physical Goods like plastic cartons and crates can undergo "Remanufacturing" to extend their longevity.
- The traditional machines can be "Re-engineered" for up-gradation instead of direct upgrade.

4) Developing the Recollection booths

- The boxes used to store ice cream like tubs, and plastics packages can be recollected at the booths.
- Installing a collection bin in distribution centers and ice cream parlors can be utilized to recollect this recycled content.

5) Policies on the expiration date

- Bringing out a policy on ice cream standards can help reduce the usage of resources.
- Imposing strict policies can avoid over-producing the varieties and eliminate unhygienic practices that may affect consumers' health in the marketplace. It can also reduce the usage of raw materials and minimize food waste.

5.1 Barriers and challenges in adoption

According to the diverse workforce involved in these industries, we suggested some aspects to be followed or implemented to transform. This transformation process helps by upgrading gradually from a traditional way to a modern one by following the suggestions and preparing with a dedicated mindset to change the environment. The barriers were classified as lack of knowledge^[41], lack of financial support^[42], inadequate managerial skills^[11,43], lack of advanced technology^[7,42], lack of technical resource persons, lack of financial resources^[19], lack of consumer interest in the environment^[44], lack of support from local governing bodies like municipalities and governments on providing subsidies^[45], and lack of commitment on the environmental aspect as part of organization's leaders^[46].

Insufficient knowledge, awareness, and comprehension regarding the significance of adopting a CE is evident. The reluctance of small

and medium-sized enterprises (SMEs) to invest and enhance their knowledge and competencies may be impeded by this factor. The prioritised obstacle that necessitates substantial investment in development is the consideration of cost. The lack of a conducive policy framework and regulatory environment can present considerable obstacles^[47]. In the absence of well-defined protocols and standards, enterprises may encounter difficulties in rationalising the supplementary expenses linked to circular methodologies. Insufficient collaboration among diverse stakeholders in the supply chain has the potential to hinder the implementation of circular practises. The implementation of circular practises may entail technical challenges, such as those pertaining to product design or the reprocessing of waste streams. Addressing these obstacles will necessitate a collaborative endeavour from all pertinent stakeholders within the sector, encompassing corporations, policymakers, and consumers. Establishing a conducive milieu that fosters the uptake of circular practises and incentivizes corporate endeavours is imperative. This result shows that SMEs are not convinced about the financial benefits they could get from CE. Lastly, sustaining in the current market is the least-rated opportunity with a decent number of SMEs.

6. Conclusion

The findings of the study indicate that the implementation of CE approaches is crucial for the ice cream industry at the local level to address issues related to waste, energy consumption, and resource utilization. Implementing CE principles in the manufacturing industry holds promise for improving its sustainability. Empirical studies have indicated that the industry's carbon footprint is negligible, thereby establishing it as an eco-friendly and consumable commodity that extends beyond its expiration date. It is essential to offer governmental assistance to small-scale industries to surmount the challenges and hindrances associated with implementing CE principles. It is anticipated that the adoption of these measures will lead to the development of innovative regulations

about food grade and quality, thereby augmenting the industry's brand equity and market credibility.

Further investigation is required to tackle the constraints of the study, particularly with regard to the remembrance procedure at different categories, encompassing individuals, eateries, food service providers, and wholesalers. The findings of the study provide a preliminary measure for the industry to improve its sustainability practices, reduce its environmental impact, and promote a more sustainable future. The CE is currently witnessing a rising trend worldwide, primarily driven by the need for sustainable economic growth and environmental conservation. The adoption of circular economy principles within the local ice cream sector has the potential to improve sustainability, reduce waste and resource usage, and enhance brand reputation and consumer confidence. Through collaborative efforts supported by governmental backing, the sector has the potential to achieve a more sustainable future that yields benefits for all stakeholders.

Conflict of interest

The authors declare no conflict of interest.

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