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Development of circular supply chain implementation model for MSMEs using extended theory of planned behaviour and DEMATEL approach

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A B S T R A C T

This study emphasizes circular supply chain management (CSCM) implementation model development for Micro, Small, and Medium enterprises (MSMEs) in the context of India by using the Extended Theory of Planned Behavior (ETPB) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) method of decision making. This study identifies seven factors to develop ETPB with the help of experts and literature surveys. The DEMATEL method is used to analyze the prominence of factors, interrelationships, and causal relationships between the identified ETPB factors based on experts' opinions. The results indicate that there are three cause factors and the rest four are effect factors. 'Social Pressure', 'Circular Incentives', and 'Pro-environmental Behavior and Responsibility' are the significant causes. The Inbound Supply Chain is the prominent factor affected by all the six factors of ETPB. The research findings will be beneficial for academicians, policymakers, and practitioners as they provide insights into CSCM model development and help in recognizing significant measures to implement it.

1. Introduction

The Micro, Small, and Medium Enterprises (MSMEs) sector has great significance in building the nation's economy. It is the backbone of the country's socio-economic development. Through their innovative business practices, MSMEs are making a substantial contribution to the growth of entrepreneurial activities. The MSMEs are expanding into new economic areas and producing various goods in different industry segments. In addition to creating many jobs at a relatively lower capital cost than large industries, MSMEs are playing a critical role in India's industrialization of rural and underdeveloped areas. In the Indian environment, MSMEs are very important, and the government has been promoting their expansion through many initiatives and programs. The Indian economy heavily relies on MSMEs and has great significance in exports and imports as it contributes to fulfilling demands at both local and international markets through proper management of the supply chain. The supply chain is a network of stakeholders like suppliers, manufacturers, distributors, retailers, logistic service providers, third-party service providers, etc to reach the end consumers with products and services. Any disruption in the entire supply chain may result in temporary and permanent breakdown of businesses. National-international issues, war conditions between different countries, political landscapes, weather conditions, ecological disturbances, and heavy degradation of resources bring supply chain disruption and affect operations and enterprises (Upadhyay & Shukla, 2024). MSMEs are also responsible for producing huge amounts of waste, and unethical waste disposal practices at every level of the supply chain. To avoid such risks, uncertainty, and waste production in the supply chain, businesses need to be self-reliant and resilient from raw material

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extraction to end-of-life treatment of products. This can be achieved by transitioning from a linear supply chain to a circular supply chain, which is the union of circular economy principles and supply chain operations (Rathi et al., 2022).

Circular supply chains are an extension of the concept of green and sustainable supply chains. The circular supply chain is the integration of the circular economy and supply chain towards sustainability (Upadhyay & Shukla, 2024; Calzolari et al., 2021). CSCM is the phenomenon that encourages environmentally safe, end-of-life treatment of products either technically or biologically. Researchers are keen on finding and allocating supply chain solutions at different levels by bringing circular economy principles corresponding to sustainability principles and encouraging current and future firms to adopt and get facilitated with the new model.

The circular supply chain model is a zero-waste vision working on restoring technical materials and regenerating biological materials (DeAngelis et al., 2018). The circular supply chain model requires innovations in business to perform supply chain functions from product/service design to end-of-life and waste management (Farooque et al., 2019). A product in a linear supply chain starts life at material procurement and finishes with the consumer purchase (Upadhyay et al., 2019). A product in a circular supply chain starts life at material procurement and finishes when there is no physical evidence of that product ever existing on the planet (Howard et al., 2018). Ecological factors of supply chain management have been discussed with great urgency in the recent past (Mathivathanan et al., 2022; Upadhyay & Shukla, 2024). Circularity rates are higher in developed nations, showing a relationship between a nation's environmental performance and per capita gross domestic product (Kostakis & Tsagarakis, 2022). Green supply chain, sustainable supply chain, and now CSCM are the most researched topics for researchers and academicians.

CSCM holds immense potential for India's sustainable development and economic growth. Indian MSMEs have a significant opportunity to embrace circular supply chain practices and reap the associated benefits. By embracing circularity, MSMEs can not only mitigate environmental impacts but also unlock new opportunities for innovation, job creation, and competitive advantage. However, the successful implementation of circular supply chain practices requires a collective effort from various stakeholders, including businesses, government, academia, and consumers. Collaboration, awareness, and the integration of circular principles into business strategies will be key to realizing the future implications of CSCM in India.

So to mitigate the problem of CSCM implementation in MSMEs efforts are made to develop a model based on the theory of planned behavior. Hence following objectives are set for this research:

O1: To define factors for CSCM implementation in MSMEs based on the ETPB.
O2: To analyze the causal relationship between factors of the ETPB Model.
O3: To analyze interrelationships between factors.
O4: To rank the identified factors to know their significance.

2. Literature Review

With the evolution of the circular economy, its implementation on the supply chain has become an emerging topic of research. Hence after getting this important development agenda from the UN in 2015, the keen researchers started working on it. For a few months of this UN agenda, the literature came up with the connection between circular economy and supply chain management. And in 2016 this connection as a whole term circular supply chain came into literature. Green supply chain and sustainable supply chain got an extended version of supply chain which is the merger of circular economy into supply chain management and called ‘Circular Supply Chain Management’. CSCM is a vibrant, highly associated system where all stakeholders are closely associated and dependent on each other. Interchange of knowledge and alliance occur to achieve a mutual objective.

Defining and conceptualizing CSCM is a common first step for researchers. They provide several frameworks to help comprehend the essential elements and procedures of integrating circular practices into the supply chain (Panigrahi et al., 2023). Lahane et al. (2023) proposed a framework for performance measurement to analyze the impact of CSCM implementation in business organizations and manufacturing industries. In CSCM, organizations cooperate inside and cross-sectional sectors to maximize the worth of goods/materials (Luthra et al., 2022). Kashyap & Shukla (2022) derived a framework for barriers in CSCM implementation in the Indian MSMEs by recognizing barriers in CSCM implementation and exploring contextual relations between them. Supplier selection for sustainable operations is one of the biggest tasks and requires proper methodological assessment (Upadhyay & Shukla, 2023; Bhattacharya et al., 2022). The food supply chain in India is facing technological and awareness challenges in the adoption of circular measures (Sharma et al., 2019). Community welfare and governmental regulation are important factors to be considered for implementing sustainability principles in the supply chain in the context of India (Dohale et al., 2023; Bhattacharya et al., 2022; Nikolaou & Tsagarakis, 2021).

Academicians look into the reasons and forces for the implementation of circular supply chain strategies (Malik et al., 2022; Rathi et al., 2022). This covers financial rewards, ecological considerations, governmental constraints, corporate social responsibility, legal framework, dedicated research and development team for circular practices, helps in revenue gain, etc (Dohale et al., 2023, Patra et al., 2023). Dwivedi et al. (2023) argue that digitalization of the supply chain, and advanced

information sharing help in the achievement of sustainability goals. To incorporate CSCM implementation issues Singh et al (2018) & Centobelli et al. (2021) developed the extended theory of planned behavior (ETPB) for circular supply chain implementation by revising the theory of planned behavior (TPB). TPB is used for the assessment of behavioral intention and ultimate behavior and shows the likelihood of engaging in particular behavior (Ajzen & Schmidt, 2020). The main factors of TPB are attitude (behavioral belief about the outcome of a particular act), subjective norms (Motivation from society or perceived social pressure) and control factors (Perceived behavioral control as per perceived capacity and power) that affect individuals' intention and the ultimate behavior (Ajzen & Schmidt, 2020; Bosnjak et al., 2020). TPB can be revised by adding new variables to the framework of TPB to explore its usefulness in various domains like healthcare, manufacturing, foods, pharmaceuticals, etc (Ajzen, 2020). Lee et al. (2021) considered internal and external supply chains as the main variable to know consumer behavior towards green supply chain management. In the circular supply chain context, Singh et al. (2018) emerged circular incentives while social pressure is kept as a main factor in revised theory by Centobelli et al. (2021).

Despite several studies, there is a gap in understanding the behavioral approach of MSMEs towards CSCM implementation. To fill this gap The study aims to explore CSCM implementation in Indian MSMEs, hence efforts are made to revise the traditional TPB after a thorough review of the literature and finally ETPB with the following significant variables is proposed as shown in Table 1.

Table 1
Factors of ETPB

S.No.	ETPB Variables	Description	References
1.	Social Pressure (SP)	Environmental problems including climate change, pollution, and resource depletion are causing more people to become concerned, which has raised societal pressure on corporations to adopt sustainable practices.	Centobelli et al. (2021), Singh et al. (2018)
2.	Circular Incentive (CI)	The government of India has introduced several incentives and programs to promote environmental sustainability among MSMEs. These rewards are meant to encourage the use of eco-friendly practices, resource efficiency, and green technologies.	Centobelli et al. (2021)
3.	Pro-Environmental Behavior & Responsibility (PEBR)	Indian MSMEs may support environmental preservation, resource conservation, and sustainable development by adopting pro-environmental behavior and responsibilities.	Proposed
4.	Expected Benefits (EB)	MSMEs can contribute to a more sustainable and resilient future while ensuring their long-term viability. The benefits of CSCM implementation not only contribute to their bottom line but also support a more sustainable and responsible approach to business.	Proposed
5.	Inbound Supply Chain (ISC)	The transportation of materials, factors, and resources from suppliers to the MSMEs' manufacturing or service activities is an essential part of the inbound supply chain, which is critical for MSMEs.	Lee et al. (2021)
6.	Outbound Supply Chain (OSC)	The outbound supply chain is a critical component for MSMEs as it involves the movement of finished products or services from the MSMEs to customers or end-users.	Lee et al. (2021)
7.	Circular Supply Chain Capability (CSCC)	Circular supply chain capability enables MSMEs to unlock new opportunities, create value from waste, and improve resource efficiency, positioning them as leaders in sustainable business practices.	Centobelli et al. (2021)

By incorporating the principles of the 'Extended Theory of Planned Behavior', MSMEs can better understand the factors influencing the adoption of circular supply chains and design targeted interventions to promote circularity within their operations.

3. Methodology

To achieve the desired objectives of the study, the integration of ETPB derived from the literature review and Decision Making Trial and Evaluation Laboratory (DEMATEL) method is done (Sharma et al., 2020, Si et al., 2018). DEMATEL is one method for setting priorities while making decisions. It helps understand and show the causal relationships between factors in complex decision-making scenarios. Using diagrams and matrices to map out these linkages, decision-makers can identify significant causes and workable remedies. DEMATEL is widely used in many different fields, including healthcare, supply chain management, environmental planning, finance, and engineering. Initially structured literature review is conducted to obtain the significant variables to develop ETPB. After the development of ETPB, input is sought on the various factors of this theory from an expert panel consisting of industry executives, academicians, and research scholars. Fig 1 shows the methodology adopted for the study.

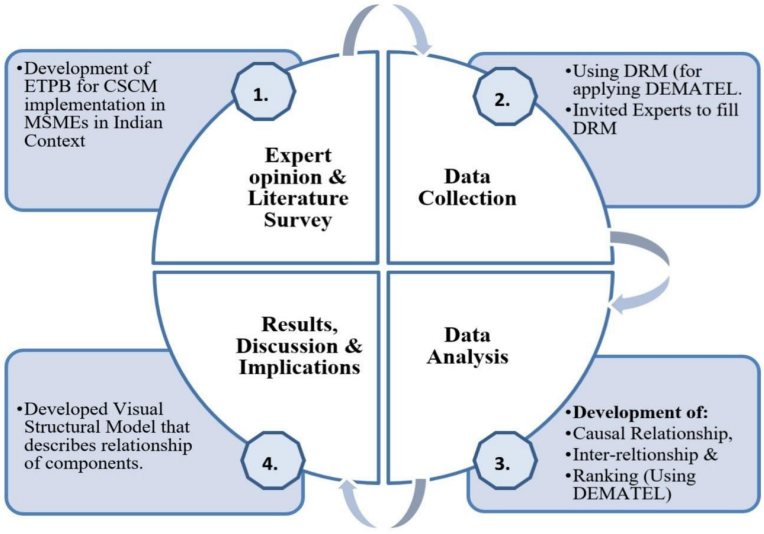

Fig. 1. Methodology Adopted for Study

Since to assess the relationships among variables we are applying the DEMATEL method of decision making. The DEMATEL approach consists of the following steps:

1. **Development of Direct Relationship Matrix**: DRM is obtained by putting 'n' components of ETPB in a matrix to get the score in 'n × n' matrix format. The experts were asked to provide an influence score on the integer scale from 0-4 in the direct relationship matrix (DRM).
2. **Development of Average DRM (D)** : Then after receiving responses from 'k' number of experts, an average matrix is calculated.
3. **Development of Normalized DRM (X)** : A normalized matrix is obtained by dividing the average DRM cells from the maximum sum of either rows or columns of average DRM.
4. **Development of Total Relationship Matrix (T)**: Total relationship matrix is calculated by multiplying normalized matrix to $(I-X)^{-1}$.
5. **Calculation of Causal Parameters**: The causal parameters Ri and Cj are calculated. Where Ri denotes the sum of rows and Cj denotes the sum of columns.
6. **Calculation of Prominence & Cause-Effect**: Prominence (P) is calculated by adding causal parameters Ri and Cj while Cause-effect is calculated by subtracting Cj from Ri. Negative Ri-Cj is termed as the effect component and positive Ri-Cj is termed as the cause component.

Table 2 shows the formulas and approach used for the DEMATEL method.

Table 2
Formulas used for DEMATEL Method

S.No.	DEMATEL Variables	Formula/Approach
1	Direct Relationship Matrix (DRM)	Filled by individuals in n × n matrix format.
2	Average DRM (A)	$1/k \sum x_{ij}$
3	Normalized DRM (X)	$(1/ \sum Max\ a_{ij})$ A
4	Total Relationship Matrix (T)	$X(I-X)^{-1}$
5	Causal Parameter (R_i)	Sum of Rows
6	Causal Parameter (C_j)	Sum of Columns
7	Ranking or Prominence (P)	R_i+C_j
8	Cause & Effect	$R_i- C_j$

Hence the above-mentioned method and formulas will lead our study to achieve the desired objectives.

3. Data Collection & Analysis:

Data has been collected from 51 experts in properly designed DRM. The experts belonged from different demographics having a common interest field. The demographic classification of experts is shown in Fig 2 in the form of a pie chart.

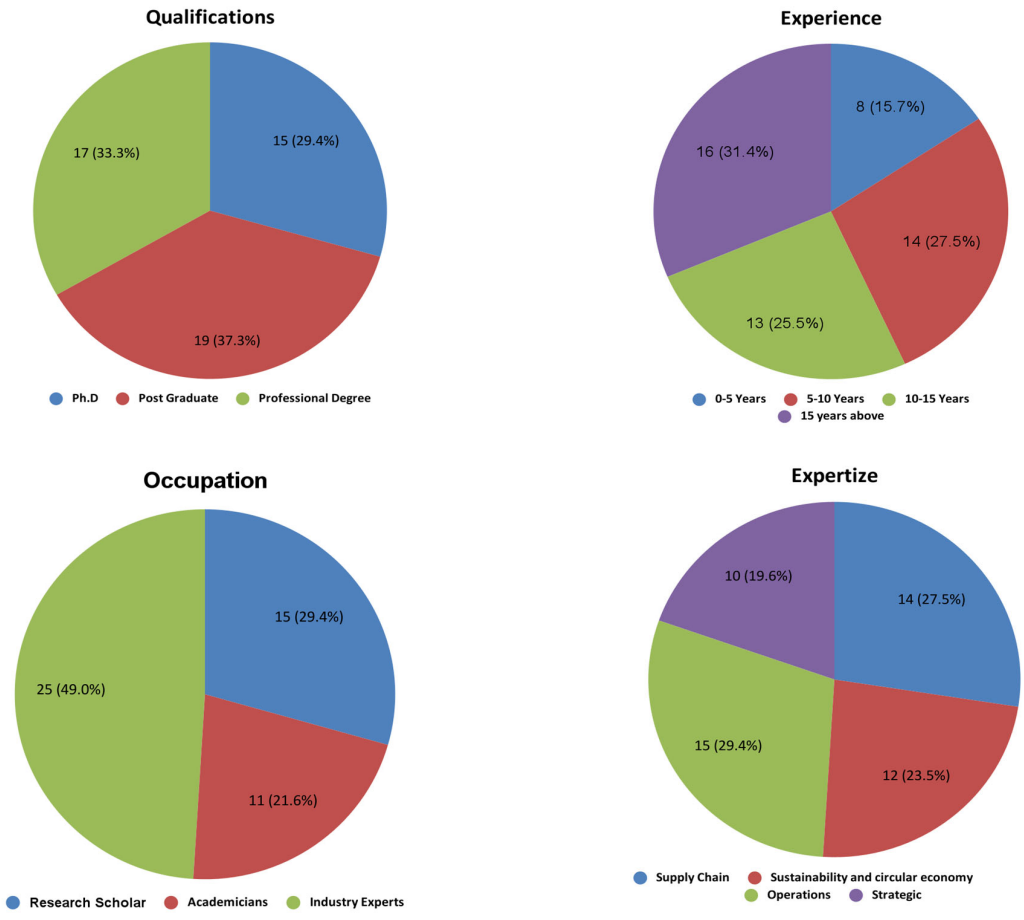

Fig. 2. Spectrum of Demographics of Experts

Experts provided their opinion as an influence score from 0-4 in each cell of 7 × 7 DRM and an average of this individual DRM has been calculated. The average direct relationship matrix and normalized direct relationship matrix are depicted in Table 3 and Table 4 respectively.

Table 3
Average Direct Relationship Matrix

Factors	SP	CI	PEBR	EB	ISC	OSC	CSCC
SP	0	2.2	2.4	2.4	2.6	2.4	2.2
CI	2.6	0	1.8	2.2	2.6	2.6	3.2
PEBR	2.8	0.8	0	2.2	2.8	2	2.2
EB	1.6	2	2.2	0	3.2	3.2	2.8
ISC	2.2	3.2	1.8	3.2	0	3.6	3.6
OSC	2.4	2.4	2.2	3	3.2	0	3.6
CSCC	1.6	2.8	1.6	2.6	3.4	3.4	0

Table 4
Normalized Direct Relationship Matrix

Factors	SP	CI	PEBR	EB	ISC	OSC	CSCC
SP	0.000	0.124	0.135	0.135	0.146	0.135	0.124
CI	0.146	0.000	0.101	0.124	0.146	0.146	0.180
PEBR	0.157	0.045	0.000	0.124	0.157	0.112	0.124
EB	0.090	0.112	0.124	0.000	0.180	0.180	0.157
ISC	0.124	0.180	0.101	0.180	0.000	0.202	0.202
OSC	0.135	0.135	0.124	0.169	0.180	0.000	0.202
CSCC	0.090	0.157	0.090	0.146	0.191	0.191	0.000

Further, this average DRM is normalized as per the DEMATEL approach explained in the methodology section. Finally, the total relationship matrix, prominence (P) & causal parameters (Ri & Cj), and cause-effect (C-E) were calculated by applying the formula mentioned in the methodology section. Table 5 shows the total relationship matrix.

Table 5
Total Relationship Matrix

Factors	SP	CI	PEBR	EB	ISC	OSC	CSCC
SP	0.651	0.799	0.722	0.894	**0.992**	**0.968**	**0.974**
CI	0.813	0.730	0.727	**0.929**	**1.041**	**1.025**	**1.065**
PEBR	0.730	0.678	0.551	0.820	**0.927**	0.878	0.898
EB	0.775	0.837	0.749	0.826	**1.074**	**1.058**	**1.057**
ISC	0.901	**0.997**	0.825	**1.099**	**1.056**	**1.207**	**1.225**
OSC	0.876	**0.926**	0.812	**1.050**	**1.163**	**0.994**	**1.179**
CSCC	0.795	0.895	0.741	**0.977**	**1.108**	**1.093**	**0.950**

The highlighted values shown in table 5 are greater than the threshold value of 0.9195804, the average of the total relationship matrix. Hence the structural influence diagram can be developed which shows the direct and indirect relationship of ETPB factors (Fig 3).

4. Results & Discussion

The ETPB is analyzed using the DEMATEL method to assess its relevance for CSCM implementation in MSMEs in the Indian context. Table 6 shows the causal parameters with cause-effect discrimination and prominence of ETPB factors. The values shown in Table 6 are obtained by applying the formulas presented in Table 2.

Table 6
Cause- Effect & Prominence of Factors

Factors	Rj	Cj	Ri-Cj	C-E	Prominence P= (Ri+Cj)	Rank
SP	6.001	5.542	0.460	Cause	11.543	6
CI	6.331	5.862	0.469	Cause	12.193	5
PEBR	5.483	5.127	0.356	Cause	10.610	7
EB	6.375	6.596	-0.220	Effect	12.971	4
ISC	7.311	7.360	-0.049	Effect	14.672	1
OSC	7.000	7.224	-0.224	Effect	14.223	2
CSCC	6.558	7.348	-0.790	Effect	13.907	3

Table 6 shows that the 'inbound supply chain' is the most prominent component followed by the 'outbound supply chain'. 'Circular supply chain capability', 'expected benefits', 'circular incentives', 'social pressure', and lastly 'pro-environmental behavior and responsibility' are prominent in descending order. Fig. 3 shows the relationship between factors of ETPB.

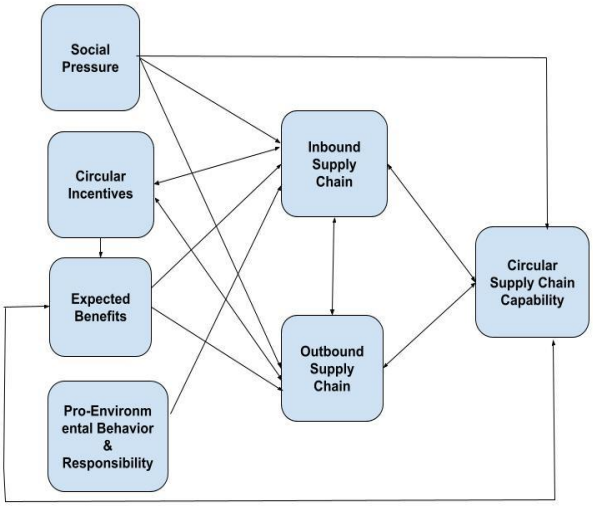

Fig. 3. Interrelationship of ETPB factors using DEMATEL

The 'pro-environmental behavior and responsibility' is influencing the 'inbound supply chain'. 'Expected benefits' have an influence relationship with 'inbound supply chain', 'outbound supply chain', ‘circular incentives', and 'circular supply chain capability'. Hence, from expert opinion, we can see that the 'circular supply chain capability' is influenced by almost all the factors except 'pro-environmental behavior and responsibility'. Fig. 4 shows the cause-and-effect factors using the DEMATEL approach.

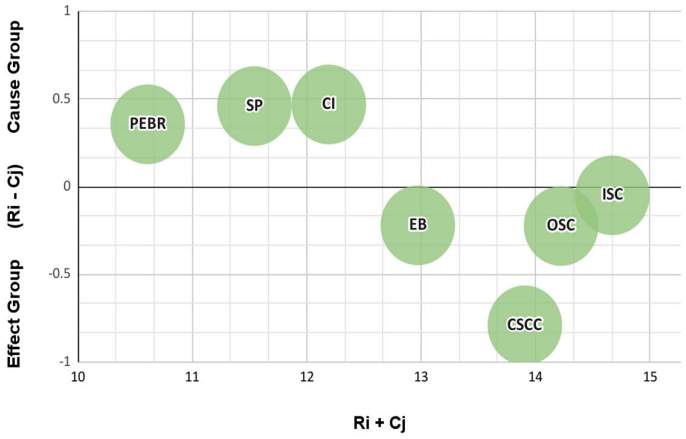

Fig. 4. Causal Relationship of ETPB factors

Hence, after the assessment of ETPB and analysis using the DEMATEL approach to decision-making, we come up with the following significant points

- Indian MSMEs are facing capability problems that can be resolved by providing substantial resources.
- PEBR, SP, and CI are the cause factors affecting the implementation of CSCM in MSMEs.
- ‘Circular Incentives’ are the prominent factor in the cause group influence highly to the CSCM implementation and having relationships with EB, OSC, and ISC.
- ‘Social Pressure’ being in the cause group influences ISC, OSC, and CSCC.
- EB, ISC, OSC, and CSCC are the factors in the effect group as per our DEMATEL analysis result and take a substantial part in the overall implementation of CSCM in the context of Indian MSMEs.
- ‘Expected Benefits’ is influenced by CI and has mutual influence with the effect factor CSCC.
- ‘Inbound supply chains’ is the prominent component that is influenced by cause factor PEBR and SP and with effect factor EB and has mutual influence with CI, OSC, and CSCC.
- ‘Outbound Supply Chains’ are influenced by cause factor SP and effect factor EB and have mutual influence with ISC and CSCC.

By focusing on efficiency, sustainability, and customer engagement in the outbound supply chain, MSMEs can enhance their environmental performance, improve customer satisfaction, and reinforce their commitment to responsible business practices.

5. Conclusions

The circular thinking for MSMEs is crucial for any developing country and needs proper attention. In our study, we drew up the relationship of various factors that can affect the CSCM implementation in MSMEs as per the Indian scenario and concluded that there are mainly three causes. The rest four factors stand as the effects of these crucial causes. This study brings a combination of ETPB and DEMATEL analysis that implies a new relationship of factors that we never thought of. This combination also provided us with the critical factors of the ETPB model. The critical factors that can bring change and key role in the implementation of CSCM in MSMEs are:

- **Social pressure** - This component is the crucial one and affects a firm's capability to implement a circular supply chain along with inbound and outbound supply chains. Social Pressure can lead to any ironic change in this world and CSCM implementation in MSMEs is one of them. Supply chain stakeholders are becoming more conscious of sustainable operations and are actively seeking products and services from businesses that align with their values. There is a growing demand for eco-friendly, socially responsible, and ethically produced goods and services
- **Circular incentives**: Our study results highlighted circular incentives as one of the major causes that make the CSCM effective for MSMEs. The government's focus on supporting and promoting these enterprises has been instrumental in their growth and development. Incentives are appreciated as well which helps the MSMEs to adopt circular practices.

- **Expected Benefits**: This significant component affects circular supply chain capability, inbound supply chain, outbound supply chain, and circular incentives. This is a prominent one and a big cause for MSMEs to adopt a circular strategy in the supply chain.

Table 7 depicts the objectives of the paper and how those objectives are achieved in terms of outcomes.

Table 7
Objectives and Outcomes

S.No.	Objectives	Outcomes
O1.	To define factors for CSCM implementation in MSMEs based on the theory of planned behavior.	We defined seven factors to develop ETPB by a thorough literature review. These are social pressure, circular incentives, pro-environmental behavior, expected benefits, inbound supply chain, outbound supply chain, and circular supply chain capability (shown in Table 1).
O2.	To analyze the causal relationship between factors of the ETPB Model.	The causal relationship between factors of ETPB has been analyzed using the DEMATEL method as shown in Fig 3 and Fig 4. and cause and effect factors are depicted in Table 6.
O3.	To analyze interrelationships between variables.	The interrelationship between factors has been analyzed as depicted in Fig 3.
O4.	To rank the identified variables to know their significance.	The Ranking of factors has been achieved by using the DEMATEL approach as shown in Table 6.

The scope of CSCM is broad and encompasses multiple dimensions of sustainability. It offers a framework for transforming the way we produce and consume goods and services, to create a more sustainable, resilient, and prosperous future for the planet and its inhabitants. By adopting circular principles and practices, businesses can play a vital role in achieving sustainability goals and making a positive impact on society and the environment. Developing countries like India are launching various schemes and programs to encourage the phenomenon of CE. Viksit Bharat@2047 is the initiative launched by India to chase the race of being a developed nation by 2047 (Singh, 2024). Schemes like Skill India, Make in India, and Atmnirbhar Bharat support CSCM practices.

6. Implications

Implementation of the CSCM in MSMEs requires a holistic approach, involving organizational transformation, collaboration, technology adoption, and continuous improvement. MSMEs need to consider these implications to effectively implement CSCM, drive circularity, and reap the benefits of resource efficiency, cost savings, and environmental stewardship. Hence our study provides several insights for practitioners and managers for the effective implementation of CSCM in MSMEs, which are as follows:

- The cause-and-effect relationship that we developed helps the practitioners to prioritize the factors to achieve the CSCM implementation goal.
- The interrelationship of various ETPB factors gives motivation to work accordingly.
- The ETPB model for CSCM implementation provides insights to revise the operations to gain the optimized circular solution.
- The analyzed prominence of ETPB factors guides them to think and work accordingly.
- MSMEs may improve their environmental performance, cut costs, and solidify their image as ethical and sustainable companies by emphasizing circularity, cooperation, and efficiency in the inbound and outbound supply chain.

Since Indian MSMEs are a vital component of the Indian economy and contribute to employment, industrial output, and exports. CSCM implementation in MSMEs not only benefits the environment and society, but also improves their competitiveness, reputation, and long-term viability in a market that is becoming more ecologically sensitive.

7. Limitations

Our study comprises several limitations just like any other study or research. We performed this pilot study with very few expert responses and our response sheet was in English language only. Time and resources were also limited. This study in the Indian context may resemble the situation of any developing country. This is a generalized study, specific industry types may have different ETPB factors on priority. In the future, more insights can be developed by applying other MCDM methods like FUZZY AHP, ANP, TOPSIS, MICMAC, etc.

Conflict of Interest Statement

The authors have no competing interests to declare that are relevant to the content of this article.

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