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Analyzing Strategies for Climate Resilience: An ISM MICMAC Approach with a Focus on Sustainable Development

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Abstract: In every sector, climate change necessitates proactive strategies that can enhance adaptability. The urgency for efficient frameworks that minimize risks and increase adaptation is further underscored by extreme weather events. In this study, we use Interpretive Structural Modeling (ISM) and MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) techniques to investigate the extent of alignment between strategies for building climate resilience and sustainable development goals. This research seeks to comprehend how various measures combine to ensure a society's resilience and sustainability. A model showing relationships between key strategies is developed using ISM. MICMAC analysis splits these strategies into clusters based on their influence or dependence as well as informs about which strategy has more impacts compared to others in terms of implementation priority. None of the recovery actions fell under 'Autonomous Variables' implying their absolute relevance in boosting climatic resilience. However, there are some other variables, such as Carbon Capture & Storage (CCS), Electric Vehicles (EVs), Forest Restoration (FR), Green Manufacturing (GM), etc., which were found to be linkage variables in this system. They build interconnections within the rest of the system. Climate Resilience (CR) was thus identified as the sole dependent variable since none met this criterion better than all others, thereby arguing for a comprehensive approach on how best to integrate these with one another to work best together. Independent variables, including Environment (Env.), Transportation (Trans), Industry (Ind), and Carbon Sequestration (CS) were found to have the highest driving power, serving as key drivers for achieving climate resilience. The study outlines different strategies and their implementation to achieve the objective of climate resilience. The study provides concrete, evidence-based policy recommendations to bridge the gap between theory and practice. Strengthening independent variables and enhancing linkage strategies can have a cascading positive effect, significantly improving climate resilience. The study emphasizes the significance of a cohesive, multi-dimensional approach, informed decision-making, and strategic focus to ensure a sustainable and resilient future. The work presents a clear strategy for implementing climate resilience measures for policymakers, stakeholders, and practitioners.

Introduction

Climate change is the paramount concern of our time that necessitates proactive measures to shore resilience in various sectors. It is important to have robust and risk-averse frameworks capable of responding to hazards while enhancing adaptive capacity due to increasing trends of extreme climatic events. This research examines climate resilience measures with respect to sustainable

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development objectives. To analyze these solutions, this study uses interpretive structural modeling (ISM) and MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) approaches. In order to develop effective strategies for combating climate change, it is important to understand how different actions interact and contribute towards achieving resilience and sustainability goals. This research identifies key tactics using ISM, while a structured model representing their interrelationships was developed. The strategy which is used here includes categorizing these tactics depending on their influence and dependence through MICMAC analysis thereby providing insights into their potential impacts and prioritization for implementation. This research moves beyond just theory; it seeks to fill the theory-practice gap by giving real policy recommendations that are supported by facts. This will guide the earth's inhabitants, practitioners, and policymakers on how they can implement some measures that boost our ability to adapt and make us avoid any climate change in the future.

The main aim of this study is not just to know what can be done so as to protect ourselves from being affected by climate change. Climate resilient policies rooted in evidence form the basis for these suggestions to close the gap between theory and practice. Policymakers, stakeholders or practitioners at the forefront should look upon these guidelines as an outline of what they can do next to strengthen our ability to deal with climatic changes and thus guarantee sustainable livelihoods.

This research attempts to demonstrate how we resist the changing weather patterns around us by specific measures. Therefore, key strategies required for climate resilience are identified in the study However, these steps are not confined to defensive strategy alone. In order to achieve sustainable development and resilience goals in relation to climate we need to have a roadmap that will guide us through increasing our ability to withstand the effects of climate change over time. Moreover, this study seeks to bridge the theory-action gap by submitting evidence-based policy recommendations. Accordingly, these policy recommendations would guide senior policymakers, stakeholders and implementers as they seek to defend their communities against climatic changes while pursuing general sustainability objectives. On its ultimate stage, the research intends to show what can be done to advance climate change resilience while enabling sustainable development for today's and tomorrow's generations.

Review of Literature

This literature review digs into different ways to boost climate resilience and sustainable growth. In semi-arid regions of India, retrospective assessments have shown that resilience has improved when agricultural productivity interventions were combined with water management, soil health and livelihood diversification strategies (Srinidhi et al., 2023). Regarding factors pertaining to resilience, research should look into psychological, social and community elements concerning the climate change coping process (Motevalli et al., 2023). In the year 2023 globally, there was an unusual weather pattern witnessed that had never been recorded before where it was ranked as the warmest since 1850. These include early hot extremes simultaneously occurring all over the world; intense cyclones that lead to precipitation extremes and some areas, like in China go from drought to flood conditions (Zhang et al., 2024). Such extreme weather is increasingly interacting with ecosystems through fires and sandstorms. Recent findings suggest that new approaches for improving resilience need to be developed because of changes in climate-related challenges' nature (Sanchez et al., 2024) and this creates further challenges for adaptation strategies and practices.

The Zimbabwe's dry areas were discussed, stressing how all players must team up for lasting livelihoods (Chitongo, 2021). The birth of national plans must be examined to cut disaster risk and amp up resilience, pushing for policies that play nice across the board (Wamsler and Johannessen, 2020). The ideas about climate-tough development have evolved since the IPCC's fifth big report. They spot four main approach groups and reckon that putting these into action means meshing climate moves with development choices (Werners et al., 2021). Sustainable growth shapes urban resilience game plans in Malang, Indonesia, with an eye on climate shifts and green hurdles (Lestari and Purnomo, 2021). Together, these studies hammer home the need for joined-up thinking policies that click and everyone pitching in to cook up climate resilience tricks that jive with sustainable development aims.

Forest restoration plays a key role in boosting climate resilience and reducing ecosystem harm. New studies show this. Forests bounce back better when restored. This cuts down big fires. It protects species. It helps forests stand up to climate shifts (Jones et al., 2021). In dry forests, restoration eases climate's toll on fires, plants, and water (O'Donnell et al., 2018). To fix forests right, we must know what makes them tough against climate change (Timpane-Padgham et al., 2017). We can sort

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these traits by single plants, groups, whole ecosystems, and how they work. This helps us choose what to fix first. But bad news came out. Forests worldwide are getting weaker. This happens most in hot, dry, and mild areas. Less water and wilder weather might cause this (Forzieri et al., 2022). We need to act fast. Forest restoration plans must start now to beef up ecosystems facing climate change.

During blackouts, EVs boost resilience for buildings, microgrids, and power systems (Hussain and Musílek, 2022; Razeghi et al., 2021). Yet, the stronger link between transport and power grids poses risks in long outages (Hussain and Musílek, 2022). Boosting EV resilience needs tactics like onsite storage, renewable energy mix, and off-grid charging spots (Hussain and Musílek, 2022). EVs back critical loads and help restore grids in outages. But their high use in normal times might speed up wear on power networks calling for smart charging fixes (Razeghi et al., 2021). Transport pumps out lots of greenhouse gases. So, switching to EVs cuts emissions and helps fight climate change (Oloriz et al., 2022). In short, EVs could make grids tougher but need careful planning and control (Saldarini et al., 2023).

There are opportunities for green manufacturing to reduce environmental impact through efficient use of resources, design of products and circular economy practices (Triebe et al., 2023). These initiatives are supported by Product Lifecycle Management (PLM) as it assists firms in implementing eco-friendly processes (Barreto et al., 2010). The world is increasingly dictating the necessity for adopting environmentally friendly production methods due to global ecological concerns coupled with regulations (Singh et al., 2018). The concept of sustainable manufacturing is unfolding with Industry 4.0, stressing on digital transformation and collaborative networks to tackle sustainability challenges (Camarinha-Matos et al., 2022). Indicators such as social as well as consideration of renewable energy in manufacture, an evaluation using unified metrics for sustainability, additive manufacturing which have life cycle impacts and Finally networks for collaboration that lead to a sustainable or resilient manufacture (Triebe et al., 2023; Camarinha-Matos et al., 2022).

Carbon capture and storage (CCS) can mitigate climate change until 2100 (Stone et al., 2009). Its long-term success depends on how well storage reservoirs retain carbon dioxide. The research (Gabrielli et al., 2022) analyses the optimization of CCS supply chains in which increasing resilience leads to an increase in costs ranging from 5-70% with respect to the most cost-efficient solution. Regarding global climate change, CCS and carbon capture utilization (CCU) are seen as promising strategies (Roy et al., 2023). Research pointed out the difference between current initiatives and industry's carbon intensity while highlighting challenges behind implementing CCS projects within the fossil fuel domain. They put forward a financial model for CCS projects in oil and gas sector along with a workflow for carbon resilience calibration (Talebian et al., 2023). Collectively, these studies demonstrate that CCS has potential for mitigating climate change but they also recognize the intricacies and costs involved in such an approach.

The risk of drought, heat waves, and floods in urban centers has enhanced the importance of their climate resilience (Kershaw, 2017). Multiple domains were addressed, such as natural and built environment, societal interactions; climate risks, and governance (Summers et al., 2017). Using deep learning techniques, big data analysis methodologies must be applied in tracking spatio-temporal variations on urban transport resilience during compounding extreme events (Ji et al., 2022). Some of the strategies that can enhance the resilience of farming communities against environmental shocks with a focus on rural farmers engaged in shrimp farming in Bangladesh were looked into (Kais and Islam's, 2020). The sustainable forest management practices are essential for effective carbon sequestration in Northeast China National Forest Region by integrating ecological sciences with social needs to increase carbon sequestration potential (Qiao et al., 2024). The implementation of Continental Carbon Sequestration (CoCS) was discussed through various stakeholders demanding interdisciplinary science and knowledge complexity at different scales can be achieved (Chevallier et al., 2020).

Materials and Methods

Climate change necessitates proactive measures that will enhance resilience in all sectors. We set out on this journey to study the topic and find solutions. It involved a detailed review of the literature and consultations with industry experts as well as academics.

25 respondents were contacted for the survey from manufacturing industries and 25 from academic institutions with over ten years of experience in the subject at hand. A mixed group was formed to provide a stronger and more reliable model by incorporating different perspectives. Time constraints, however, limited us to selecting only 30 experts for the purposes of this research work. Research involving diverse groups of experts requires a sample size of 10-15 participants

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(Novakowski and Wellar, 2008). Hence, it would be fair enough to say that a group of 30 respondents seemed sufficient for encompassing climate resilience strategies.

We aimed to find the most influential strategies with which to attain climate resilience and understand how they are interrelated. Through a rigorous process, we used Interpretive Structural Modeling (ISM) to identify these relationships. ISM is a tried and tested approach to understanding complexity, which provides insights for furthering research in different domains (David, 1975). ISM analysis can be utilized to assess how the eight identified "climate resilience" factors mutually relate to each other and their integrated realization.

ISM supports the development of a hierarchical structure that establishes a contextual relationship between factors whereas MICMAC analysis classifies those factors according to their driving and dependence power. The combined process helps in appreciating factor's influence and interdependence, hence making strategic decision-making and prioritizing easier.

Results and Discussion

Interpretive Structural Modeling (ISM) is a powerful technique for unraveling the complexities of systems and understanding how different variables interact. Developed by Warfield (1976), ISM leverages expert judgment and a hierarchical structure to uncover interdependencies and create a network that maps these relationships. This network visualization helps researchers gain valuable insights into the system's underlying behavior and structure. In the context of climate resilience and sustainable development, ISM is particularly useful. It allows researchers to identify key drivers among the various strategies and understand their influence on each other. This knowledge is crucial for informing strategic decision-making and policy development in various fields, including management and engineering. One of the key strengths of ISM is its iterative nature. This enables continuous improvement and validation throughout the process, ensuring the robustness and reliability of the analysis. By employing ISM, we can effectively disentangle the intricate web of strategies required to combat climate change and pave the way for a more sustainable future.

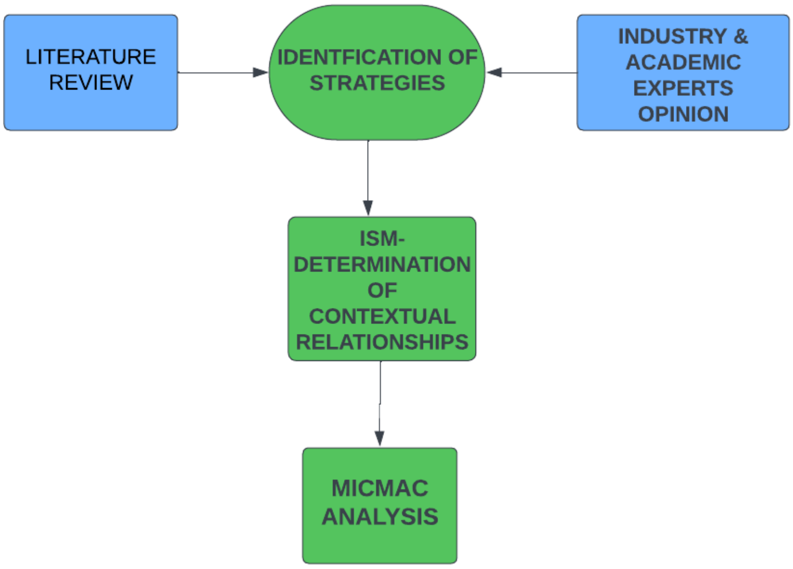

Figure 1. Flow Chart Representing Methodology.

The ISM analysis was supplemented by MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) to further explain these factors. The MICMAC analysis (Duperrin and Godet,1973) is a tool based on cross-impact matrix multiplication for classification. It provides a simple way to determine and understand complex situations (Kumar et al., 2014). This additional tool of analysis differentiates the factors in terms of their level of impact and strategy dependence.

Through combining these strong methods, our research aims to give detailed knowledge on the effective implementation of different climate resilience strategies. Such an understanding will be the basis for making sound policy recommendations. These evidence-based recommendations will guide policymakers, stakeholders, and practitioners in mapping out the way towards a more resilient as well as sustainable future. Figure 1 shows flowchart of methodology adopted.

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Table 1 shows the contextual relationships between different strategies (enablers) which affect climate change mitigation. The relationships are represented by four notations:

Modulates (V): Enabler (i) influences Enabler (j).

Modulated by (A): Enabler (j) is influenced by Enabler (i).

No Interaction (O): There is no significant influence between Enabler (i) and Enabler (j).

Mutual Influence (X): Enabler (i) and Enabler (j) have a two-way influence on each other.

Table 1. Structural Self Interaction Matrix for Climate Resilience Strategies.

Variables	1	2	3	4	5	6	7	8	9
Env		X	O	O	V	O	O	O	O
Trans			X	O	O	V	O	O	O
Ind				X	O	O	V	O	O
CS					O	O	O	V	O
FR						X	O	O	V
EVs							X	O	V
GM								X	V
CCS									V
CR									

simpler terms, we verify that if (j, k) equals 1 (meaning strategy j influences strategy k) and (i, j) equals 1 (meaning strategy i influences strategy j), then (i, k) must also be 1 (indicating strategy i indirectly influences strategy k). Entries in the final reachability matrix marked with an asterisk (*) highlight these transitive relationships. Table 2 presents the final reachability matrix with two important metrics of each strategy: driving power and dependence. Driving power is the total number of strategies (including itself) that a strategy can affect (directly or indirectly). Dependence is the total number of strategies that can affect a strategy, directly or indirectly. These metrics provide an indication of the relative importance and influence of each strategy within the defined climate resilience framework.

Table 3 shows the results of level partitioning, which is an important process in ISM analysis through which we can classify the climate resilience strategies identified (Enablers) based on their driving power and dependency in the system.

Elements (Mi): This column contains the name of each strategic (Enabler) design element (Mi) listed with its unique identifier (Mi).

Reachability Set (R(Mi)): In this column, we can see all the sets of strategies which can be directly or indirectly influenced by a particular strategy (Mi).

Table 2. Final Reachability Matrix for Climate Resilience.

Variables	1	2	3	4	5	6	7	8	9	Driving Power
Env	1	1	1*	1*	1	1*	1*	1*	1*	9
Trans	1	1	1	1*	1*	1	1*	1*	1*	9
Ind	1*	1	1	1	1*	1*	1	1*	1*	9
CS	1*	1*	1	1	1*	1*	1*	1	1*	9
FR	0	0	0	0	1	1	1*	1*	1	5
EVs	0	0	0	0	1	1	1	1*	1	5
GM	0	0	0	0	1*	1	1	1	1	5
CCS	0	0	0	0	1*	1*	1	1	1	5
CR	0	0	0	0	0	0	0	0	1	1
Dependence Power	4	4	4	4	8	8	8	8	9	

The Structural Self-Interaction Matrix (SSIM) is transformed into an initial reachability matrix by applying specific rules that convert the values to either 1 or 0. This initial matrix captures the direct influence between each pair of strategies. However, to gain a deeper understanding of the indirect influences, we must consider the transitivity concept. This property ensures that if strategy (i) influences strategy (j), and strategy (j) influences strategy (k), then strategy (i) can also be said to indirectly influence strategy (k). The final reachability matrix is derived by incorporating these indirect influences through a process of checking transitivity. In

Antecedent Set (A(Ni)): It represents all the strategies which can directly or indirectly affect a strategy (Mi).

Intersection Set (R(Mi)∩A(Ni)): This column highlights the common strategies present in both the reachability set and the antecedent set for each Enabler (Mi). This intersection essentially shows the strategies that a particular strategy (Mi) both influences and is influenced by.

Level: This is the most crucial column, assigned based on the values in the intersection set. It indicates the hierarchical level of each strategy within the system.

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Level 1 (Independent): Enablers categorized as Level 1 (like Enabler 9 in this example) have no other strategies in their intersection set. This implies they are independent strategies with no direct or indirect influence on other strategies and are not influenced by any other strategy themselves.

Level 2 (Drivers): Enablers classified as Level 2 (like Enablers 5, 6, 7, and 8 in this example) have an intersection set but only with strategies with a higher level (Level 3 in this case). This signifies that these strategies influence other (Level 3) strategies in the system but are not influenced by any of them. They can be considered drivers within the system.

Level 3 (Intermediate): Enablers assigned a Level 3 (like Enablers 1, 2, 3, and 4 in this example) have an intersection set that includes both Enablers with a higher level (Level 2) and those with the same level (Level 3). These strategies influence and are influenced by other strategies at the same level and are potentially influenced by driver strategies (Level 2). They represent intermediate elements within the system.

We can identify independent strategies (Level 1), driver strategies (Level 2) that have a significant influence on others, and intermediate strategies (Level 3) that play a crucial role in facilitating interactions within the system. This understanding can lead to policy recommendations by prioritizing the implementation of driver strategies and ensuring proper integration of all strategies at different levels for a holistic approach to climate resilience.

Table 4 represents, 'Reduced Conical Matrix'. This is the resulting grid from pasting the obtained results providing a succinct form to the ISM analysis demonstrating the relations between them and how they are structured according to hierarchy. To construct the matrix, the strategies or factors are transposed according to the hierarchy levels laid down in the last stage, which means every strategy in the same hierarchy level is grouped together. This modification falls in line with the final goal, building patterns such as digraphs and ISM models.

Table 4 is an example of the links among different strategies and a look at the magnitude of the two key statistics of dependence power and driving power. The

Table 3. Level Partioning of the Climate Resilience Strategies.

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 2, 3, 4,	1, 2, 3, 4,	1, 2, 3, 4,	3
2	1, 2, 3, 4,	1, 2, 3, 4,	1, 2, 3, 4,	3
3	1, 2, 3, 4,	1, 2, 3, 4,	1, 2, 3, 4,	3
4	1, 2, 3, 4,	1, 2, 3, 4,	1, 2, 3, 4,	3
5	5, 6, 7, 8,	1, 2, 3, 4, 5, 6, 7, 8,	5, 6, 7, 8,	2
6	5, 6, 7, 8,	1, 2, 3, 4, 5, 6, 7, 8,	5, 6, 7, 8,	2
7	5, 6, 7, 8,	1, 2, 3, 4, 5, 6, 7, 8,	5, 6, 7, 8,	2
8	5, 6, 7, 8,	1, 2, 3, 4, 5, 6, 7, 8,	5, 6, 7, 8,	2
9	9,	1, 2, 3, 4, 5, 6, 7, 8, 9,	9,	1

.

Table 4. Reduced Conical Matrix.

Variables	9	5	6	7	8	1	2	3	4	Driving Power	Level
CR	1	0	0	0	0	0	0	0	0	1	1
FR	1	1	1	1*	1*	0	0	0	0	5	2
EVs	1	1	1	1	1*	0	0	0	0	5	2
GM	1	1*	1	1	1	0	0	0	0	5	2
CCS	1	1*	1*	1	1	0	0	0	0	5	2
Env	0	1	1*	1*	1*	1	1	1*	1*	9	3
Trans	0	1*	1	1*	1*	1	1	1	1*	9	3
Ind	0	1*	1*	1	1*	1*	1	1	1	9	3
CS	0	1*	1*	1*	1	1*	1*	1	1	9	3
Dependence Power	9	8	8	8	8	4	4	4	4		
Level	1	2	2	2	2	3	3	3	3		

By analyzing Table 3, we gain valuable insights into the hierarchical structure of climate resilience strategies.

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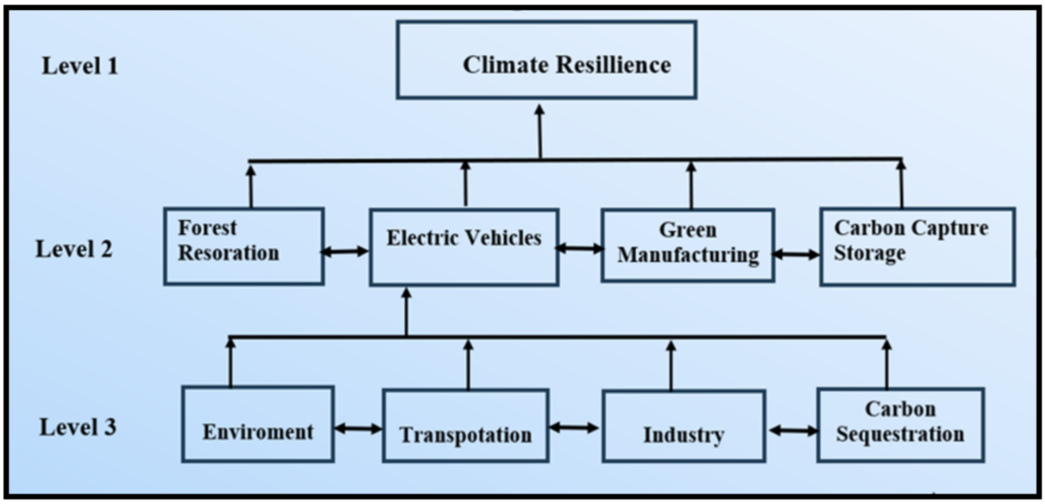

Figure 2. ISM Model of the contextual relationship between strategies.

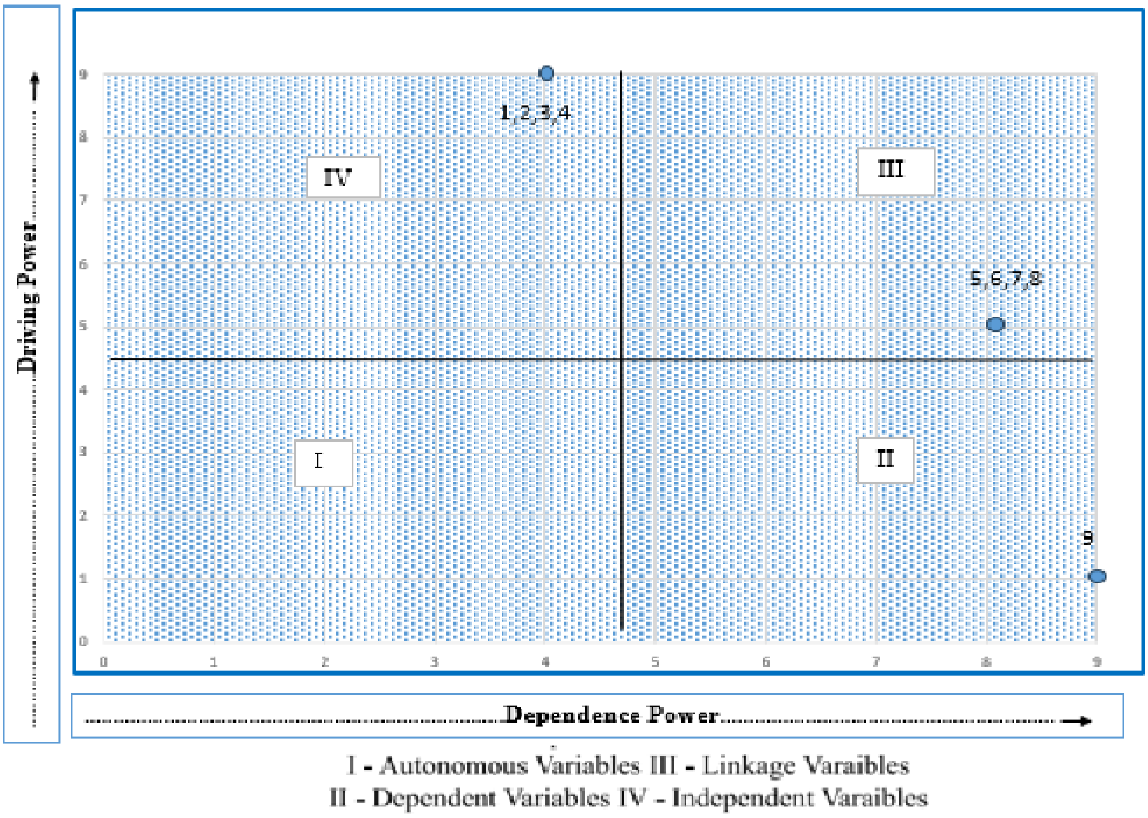

Figure 3. MICMAC Analysis Representing Dependence and Driving Power.

influence capacity of a strategy of the whole system could be represented through the Driving power which is defined as the total influence of a given strategy over all the existing strategies. It is defined as the sum of the number of strategies including the strategy, multiple interactions that can affect directly or indirectly. On the other side, Dependence Power illustrates the degree to which actions of a certain strategy are interlinked with the remaining strategies that make up the system. The number of strategies that can have a direct or indirect impact is investigated before the Dependence Power is created. Through the analysis of these metrics and the conical structure, we can identify the position of each strategy with their respective dominant effects in addressing resilience in the built environment. This knowledge is crucial to understand the order in which these strategies can be optimised and carried out efficiently and effectively.

The ISM (Interpretive Structural Modeling) model, which provides guidance on mitigating climate change, is shown in Figure 2. The main tactics and underlying sub-strategies that are crucial for accomplishing this goal are

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clarified by this model. Figure 2 illustrates contextual interactions that go beyond the mitigation of climate resilience. It provides a methodical framework for attaining sustainable development, guaranteeing advancement that satisfies current demands without jeopardizing the capacity of future generations to satisfy their own. The ISM (Interpretive Structural Modeling) model, which provides guidance on 'Climate Resilience', is shown in Figure 2. The main tactics and underlying sub-strategies that are crucial for accomplishing this goal are clarified by this model.

Figure 3 delves into the application of MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) analysis to categorize the identified climate resilience strategies (variables) based on their level of influence and dependence within the system. This analysis helps us identify strategic leverage points for promoting climate resilience.

The analysis results in four distinct clusters:

Autonomous (or Excluded) Variables: This cluster, if present, would contain variables with low driving power (minimal influence on others) and low dependence (barely influenced by others). However, Figure 3 suggests none of the strategies fall into this category, implying all play a role in the system.

Dependent Variables: This cluster includes variables significantly influenced by others but with limited influence themselves. In this case, Figure 3 highlights only one variable in this category - Climate Resilience (CR). This emphasizes that achieving climate resilience is the ultimate dependent variable, highly influenced by the effectiveness of the implemented strategies.

Linkage Variables: This cluster comprises variables that significantly influence other strategies while also being influenced by others to some degree. Figure 3 identifies strategies like Forest Restoration (FR), Electric Vehicles (EVs), Green Manufacturing (GM), and Carbon Capture & Storage (CCS) as linkage variables. These strategies act as crucial connectors within the system, influencing and being influenced by other strategies.

Independent (or Determinant) Variables: This cluster with the highest power (the power of the independent variables) is notable for having superior autonomy. That is to say, they exert primary control over lower-priority strategies but are themselves not subject to undue control by them. The authors were motivated to posit that the interventions in the climate system should primarily focus on some central economic factors. There are variables such as: Environmental (Env.), Transportation (Trans), Industry (Ind), and Carbon Sequestration (CS) that are independent variables in Figure 3.

In these categories, policymakers and stakeholders can select interventions. Directing interventions to improve the independent variable(s) could prove to have extraordinary effects. Lastly, the perspective of linkage variables will enhance strategies' overall effectiveness .Finally, this analysis will introduce a rational way to implement climate resilience and sustainable development to a greater effect.

Conclusion

The study aimed to identify and illustrate the major strategies for climate resilience using ISM (Interpretive Structural Modelling) and MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) techniques. Applying these two approaches helps organize the climate resilience strategies on the basis of their dependence and driving power in the network; this analysis represents a theoretical background for decision-makers and practitioners to recognize ranking intervention strategies. Direct interviews with experts from various disciplines were performed based on literature review. The results showed that no strategy was categorized as "Autonomous Variables" in MICMAC approach which revealed all identified strategies are system components towards achieving climate resilience.

The only "Dependent Variable" in the study was 'Climate Resilience (CR)' indicating that CR is the ultimate goal, and other strategies play a role in how effectively this outcome is realized. As such, a comprehensive strategy of improvement in adopting and maximizing other strategies will be necessary to achieve climate resilience. 'Forest Restoration', 'FR', 'Electric Vehicles', 'EVs', 'Green Manufacturing', 'GM' Carbon Capture and Storage, 'CCS' were classified as "Linkage Variables" in the study. These strategies act as critical connectors within the network, acting as influencers and influencers. Their dual roles pinpoint them as key junctures for increasing impact on climate resilience. The most significant driving powers were the variables Environment (Env.), Transportation (Trans), Industry (Ind), and Carbon Sequestration (CS), which serve as drivers for a number of other variables, but we found that they are not influenced as greatly. This means they are key drivers in the process of enhancing climate resilience and are the most important focus for policy action.

Because of their significant impact on the entire system, the most important strategies for funding and support include those related to Environment, Transportation, Industry, and Carbon Sequestration. Investments in these areas will likely have ripple effects that positively impact other strategies, which may lead to improved climate resilience. Also focus on enhancing and

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supporting linkage strategies, such as Forest Restoration, Electric Vehicles, Green Manufacturing, and Carbon Capture & Storage. These strategies facilitate key interactions within the system and by amplifying them, they could drastically improve climate resilience. As the ultimate dependent variable, Climate Resilience requires that a systems integration approach be applied that strengthens the effectiveness of all other strategies. This can be achieved through coordinated policy measures, cross-sectoral collaboration, and comprehensive monitoring and evaluation mechanisms. This will ensure that interventions remain relevant and effective in the dynamic context of climate change.

The application of ISM and MICMAC methodologies has provided valuable insights into the interrelationships and relative importance of various climate resilience strategies. By identifying strategic leverage points, this research offers a clear roadmap for policymakers and stakeholders to craft more targeted and impactful approaches toward achieving climate resilience and sustainable development. The ultimate success of these strategies hinges on a well-coordinated, multi-faceted approach that considers the complex interplay of various factors within the system. We can foster a resilient and sustainable future through informed decision-making and strategic prioritization.

The most important driving forces were variables- Env., Trans, Ind, and CS. These are critical drivers in the process of becoming a more resilient climate. They should be the prime focus for policy action.

The Specific Recommendations for Policymakers and Practitioners are as follows:

- Prioritize Investment in Key Drivers: Target Environment, Transportation, Industry and Carbon Sequestration funding and support. This will likely have implications that improve other strategies because these areas significantly affect the entire system.
- Enhance Linkage Strategies: Strengthening and supporting strategies such as Forest Restoration, Electric Vehicles, Green Manufacturing and Carbon Capture & Storage. When magnified, these linkage strategies promote vital interactions within the system, improving climate resilience significantly.
- Adopt a Systems Integration Approach: It is paramount to recognize that Climate Resilience is an ultimate dependent variable that requires a systems integration approach that strengthens all other strategies. This could be through aligned policy measures, cross-sectoral collaboration as well as comprehensive monitoring and evaluation
- Continuous Monitoring and Evaluation: This would involve implementing continuous monitoring and evaluation mechanisms to trace the progress and effectiveness of climate resilience strategies, thus allowing for necessary adjustments and improvements over time.

By following these suggestions, policymakers and practitioners can promote a resilient and sustainable future by leveraging the strategic insights from ISM and MICMAC analysis to enhance climate resilience strategies.

Limitations

The study examined eight elements and their associations using expert opinions, which could introduce biases. In order to overcome this problem Exploratory Factor Analysis (EFA) could also be conducted along with Interpretive Structural Modelling (ISM) and MICMAC analysis.

Conflict of Interest

The authors declare no conflict of interest in the publication of this paper.

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