

ROLE OF ARTIFICIAL INTELLIGENCE IN THE ECONOMIC SUSTAINABILITY IN INDIA

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ABSTRACT

This research paper explores the role of Artificial Intelligence (AI) in promoting economic sustainability in India. The study focuses on five key factors where AI can contribute to improving the Indian economy and sustainability: employment generation, agricultural development, research and innovations, basic education structural development, and health sector improvement.

Using techniques such as Fuzzy Inference System, Machine Learning, and MATLAB, this research investigates the sensitivity of these factors in relation to economic sustainability. The findings reveal that health sector improvement emerges as the most sensitive factor, with a sensitivity value of approximately 50%. This implies that advancements in the health sector can have significant implications for economic growth and sustainability.

A healthy population plays a crucial role in increasing productivity and overall economic development. By leveraging AI technologies, the health sector can enhance disease detection, diagnosis, and treatment planning, leading to improved healthcare outcomes. The implementation of AI-based systems and tools in the health sector can result in optimized resource

utilization, reduced healthcare costs, and better accessibility to healthcare services, especially in remote areas.

Furthermore, this research highlights the potential of AI in generating employment opportunities by fostering innovation, entrepreneurship, and skill development. AI-driven agricultural solutions can enhance productivity, optimize resource management, and promote sustainable farming practices. The integration of AI in research and innovation processes can drive technological advancements and propel India towards becoming a global leader in cutting-edge technologies. (Jean N, 2016).

Additionally, AI can contribute to the development of basic education infrastructure, enabling personalized learning experiences and addressing educational disparities. By leveraging AI's capabilities, India can enhance the quality of education and bridge the digital divide, empowering individuals and ensuring a skilled workforce for the future.

The research concludes that AI has the potential to revolutionize various sectors in India, promoting economic sustainability, and improving the overall well-being of its citizens. However, it emphasizes the importance of addressing challenges such as data privacy, security, and ethical considerations to ensure responsible AI adoption.

Overall, this research provides insights into the critical role of AI in driving economic sustainability in India, particularly focusing on the identified key factors and highlighting the sensitivity of the health sector. It serves as a foundation for further exploration and implementation of AI-based strategies and policies to foster economic growth, innovation, and social well-being in the country.

1. INTRODUCTION

Artificial Intelligence (AI) has emerged as a transformative technology with the potential to revolutionize various sectors and industries worldwide. Its applications span from automation and data analysis to machine learning and predictive modeling. With its ability to process large volumes of data and perform complex tasks with speed and accuracy, AI has the power to drive significant advancements and innovation.

India, as one of the fastest-growing economies in the world, recognizes the importance of AI in fostering economic sustainability and addressing societal challenges. The country has been actively embracing AI technologies across different

sectors, aiming to leverage its potential for growth, development, and improved quality of life for its citizens.

2. RESEARCH OBJECTIVES

The research objectives of this study aim to explore and understand the role of AI in promoting economic sustainability in India. These objectives guide the research process and provide a clear direction for investigation. The research objectives include:

- To explore the role of AI in improving economic sustainability in India: This objective seeks to examine how AI can contribute to sustainable economic growth, resource optimization, and enhanced productivity in the Indian context.
- To identify key factors where AI can contribute to enhancing the Indian economy: This objective aims to identify specific areas or sectors where AI technologies have the potential to drive significant economic impact and sustainability.
- To examine the potential impact of AI on employment generation, agricultural development, research and innovations, basic education structural development, and health sector improvement: This objective focuses on understanding how AI adoption can positively influence these key areas and contribute to their growth and improvement.

2.1. THE RESEARCH POINTS FOR THIS STUDY INCLUDE

- How can AI contribute to improving economic sustainability in India? This question seeks to explore the various mechanisms and pathways through which AI can drive economic sustainability, such as increased productivity, efficient resource management, and innovation.
- What are the key factors where AI can have a significant impact on the Indian economy? This question aims to identify the specific sectors or domains where AI technologies can bring about transformative changes, thereby contributing to economic growth and sustainability.
- How does AI adoption affect employment generation, agricultural development, research and innovations, basic education structural development, and health sector improvement in India? This question delves into the specific impacts of AI adoption on these critical areas, highlighting the potential benefits and challenges.

By addressing these research questions, this study aims to provide valuable insights into the role of AI in promoting economic sustainability in India. (Acemoglu D. & Restrepo P, 2018). The subsequent sections will delve into each objective and research question, presenting analysis, findings, and recommendations to shed light on the potential of AI in driving sustainable economic growth and addressing key societal challenges.

3. ARTIFICIAL INTELLIGENCE AND ECONOMIC SUSTAINABILITY IN INDIA

3.1. DEFINITION AND OVERVIEW OF AI

Artificial Intelligence (AI) refers to the development of intelligent systems that can mimic human cognitive abilities, such as learning, reasoning, problem-solving, and decision-making. It involves the use of advanced algorithms and computational models to enable machines to perform tasks that typically require human intelligence.

In the context of economic sustainability in India, AI plays a crucial role in driving innovation, productivity, and efficiency across various sectors. It encompasses a wide range of technologies and techniques that enable machines to analyze data, recognize patterns, make predictions, and automate processes. Figure 1.0 shows some important benefits of AI. (Nagano A., 2018)

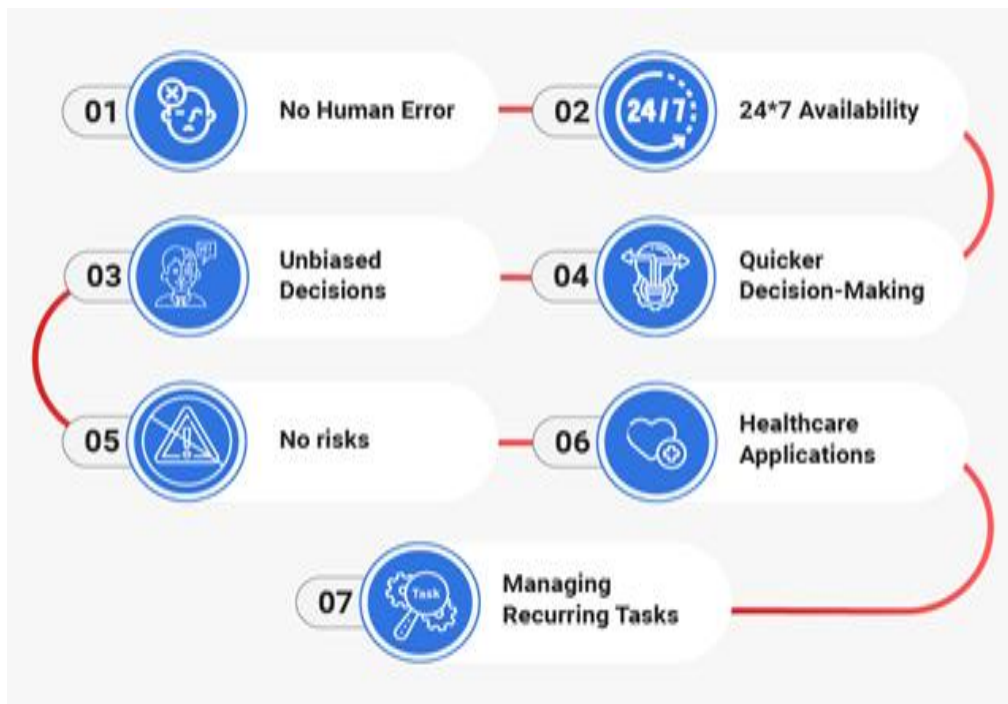


FIGURE 1 BENEFITS OF AI

3.2. AI TECHNIQUES AND TECHNOLOGIES

AI encompasses several key techniques and technologies that enable machines to exhibit intelligent behavior and capabilities. Some of the prominent AI techniques and technologies include:

- **Machine Learning (ML):** ML algorithms enable machines to learn from data and improve their performance over time. Through training on large datasets, machines can identify patterns, make predictions, and classify information. ML techniques, such as supervised learning, unsupervised learning, and reinforcement learning, are widely used in diverse applications. (Helbing, D. & Pournaras, E., 2015)
- **Natural Language Processing (NLP):** NLP focuses on enabling machines to understand, interpret, and generate human language. It involves techniques like text analysis, sentiment analysis, language translation, and speech recognition, which have applications in areas such as customer service, chatbots, and language processing.
- **Computer Vision:** Computer vision techniques allow machines to analyze and interpret visual information from images or videos. This technology finds applications in areas such as image recognition, object detection, facial recognition, and autonomous vehicles.
- **Robotics and Automation:** AI-powered robots and automation systems are capable of performing tasks autonomously or in collaboration with humans. Robotic process automation (RPA) automates repetitive tasks, while robots equipped with AI capabilities can handle complex tasks in industries such as manufacturing, healthcare, and logistics. (Allaoui H., 2019)

4. AI APPLICATIONS IN DIFFERENT SECTORS

AI has the potential to significantly impact various sectors in India, contributing to economic sustainability and growth. Some notable applications of AI in different sectors include:

- **Healthcare:** AI can enhance disease diagnosis, drug discovery, and treatment planning. Machine learning algorithms can analyze medical images for early disease detection, while AI-powered chatbots provide personalized healthcare advice and support. AI also enables remote patient monitoring and predictive analytics for healthcare resource management.

- **Agriculture:** AI-driven solutions optimize crop management, resource allocation, and pest control. Through data analysis, AI can provide insights on soil health, weather patterns, and crop diseases, aiding farmers in making informed decisions. AI-powered drones and sensors enable precision agriculture and yield optimization.
- **Education:** AI can revolutionize the education sector by personalizing learning experiences, adaptive testing, and intelligent tutoring systems. AI-based virtual assistants and smart content delivery platforms cater to individual student needs. Additionally, AI can automate administrative tasks, freeing up time for teachers to focus on personalized instruction.
- **Manufacturing:** AI technologies, such as predictive maintenance and quality control, improve operational efficiency in manufacturing processes. AI-driven robots and automation systems enhance production speed, accuracy, and flexibility. AI-enabled supply chain management optimizes inventory, demand forecasting, and logistics.
- **Financial Services:** AI enables fraud detection, risk assessment, and personalized customer experiences in the financial sector. Machine learning algorithms analyze transaction data for detecting fraudulent activities. AI-based chatbots provide customer support and personalized financial recommendations. (Raissi, et al., 2017)

These are just a few examples of how AI is transforming various sectors in India, promoting economic sustainability and driving innovation. The integration of AI techniques and technologies in these sectors holds the potential to optimize resource utilization, improve productivity, and address societal challenges, contributing to the overall economic growth and sustainability of the country. (Bao J., 2019).

5. ROLE OF AI IN IMPROVING ECONOMIC SUSTAINABILITY IN INDIA

Artificial Intelligence (AI) plays a pivotal role in driving economic sustainability in India. With its transformative capabilities, AI has the potential to revolutionize various sectors, fostering innovation, and enhancing productivity. This section delves into the specific ways AI contributes to improving economic sustainability in India, focusing on employment generation and fostering innovation and entrepreneurship. (Abdella GM, 2020)

6. VARIOUS FACTORS TO IMPROVE ECONOMIC GROWTH

Improving economic growth is essential for the prosperity and development of a nation. Several factors contribute to fostering economic growth and sustainability. Below are some key factors that can positively impact economic growth: (Fuso Nerini, F, 2017)

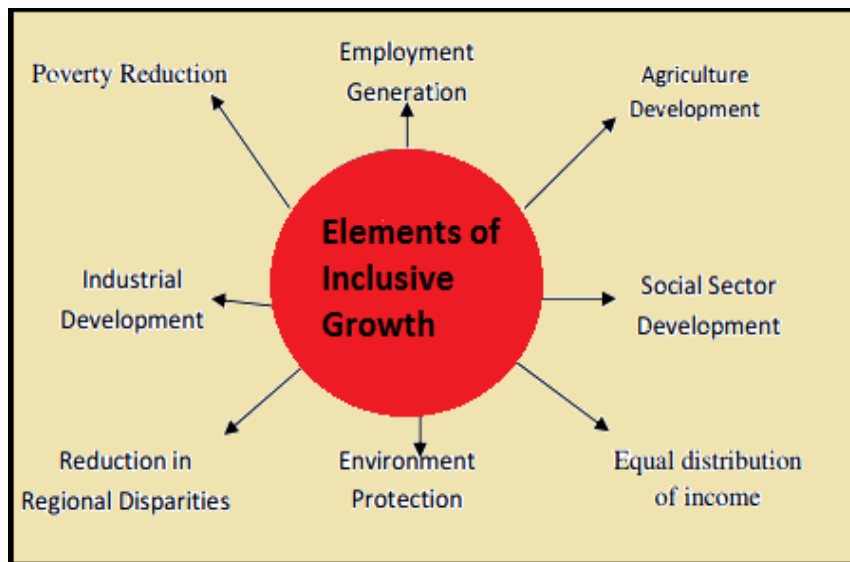


FIGURE 2 FACTORS TO IMPROVE ECONOMIC GROWTH

- Investment in infrastructure
- Environment Protection
- Reduction in Regional Disparities
- Employment Generation
- Promoting innovation and research and development
- Enhancing education and skill development
- Implementing favorable fiscal and monetary policies
- Encouraging entrepreneurship and startups
- Improving trade and foreign investment policies
- Strengthening the healthcare system
- Efficient resource utilization and sustainability practices

- Enhancing access to finance and credit facilities
- Addressing income inequality and poverty alleviation measures.

7. RESEARCH DISCUSSION

In this research study we have identified five subfactors of where AI helps to improve Indian economic and sustainability with the help of allied literature review, questionnaire, interviews in various companies etc.

During research studies various factors like Employment Generation, Agricultural Development, Research and Innovations, Basic Education Structural Development, Health Sector Improvement have been observed. Table-1 shows the key factors name and its abbreviation.

- **EMPLOYMENT GENERATION:** AI adoption drives innovation and automation, creating new job opportunities in AI-related fields, and supporting ancillary roles in industries by streamlining processes and increasing productivity.
- **AGRICULTURAL DEVELOPMENT:** AI-powered solutions optimize resource management, enhance crop monitoring, and enable precision farming techniques, leading to increased agricultural productivity and sustainable practices.
- **RESEARCH AND INNOVATIONS:** AI accelerates research processes, aids data analysis, and fosters breakthroughs in various fields, propelling India towards becoming a global leader in cutting-edge technologies.
- **BASIC EDUCATION STRUCTURAL DEVELOPMENT:** AI enables personalized learning experiences, bridges educational gaps, and improves the quality of education by offering tailored content and empowering students and teachers with digital tools.
- **HEALTH SECTOR IMPROVEMENT:** AI aids in disease diagnosis, treatment planning, and health monitoring, resulting in improved healthcare outcomes, reduced costs, and enhanced accessibility to healthcare services, especially in remote areas.

TABLE 1 KEY FACTORS WHERE AI HELPS TO IMPROVE INDIAN ECONOMIC AND SUSTAINABILITY

FACTORS	ABBREVIATION
Employment Generation	SF1
Agricultural Development	SF2
Research and Innovations	SF3
Basic Education Structural Development	SF4
Health Sector Improvement	SF5

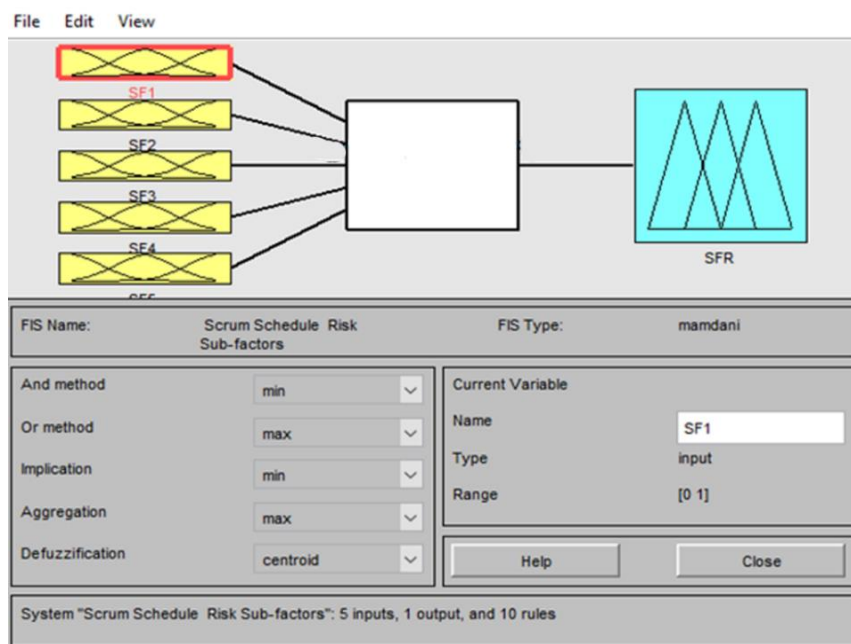


FIGURE 3 INDIAN ECONOMIC AND SUSTAINABILITY MODEL USING FIS

The proposed model can be seen in Figure 3 in which 5 factors and identified rule base have been applied in Fuzzy Inference System using MATLAB simulator. In this study, for the fuzzification and defuzzification process, we have chosen *Mamdani*

method and for the association of subfactors in rule base AND method is preferred. We have applied centroid method for the aggregation of rules in FIS editor.

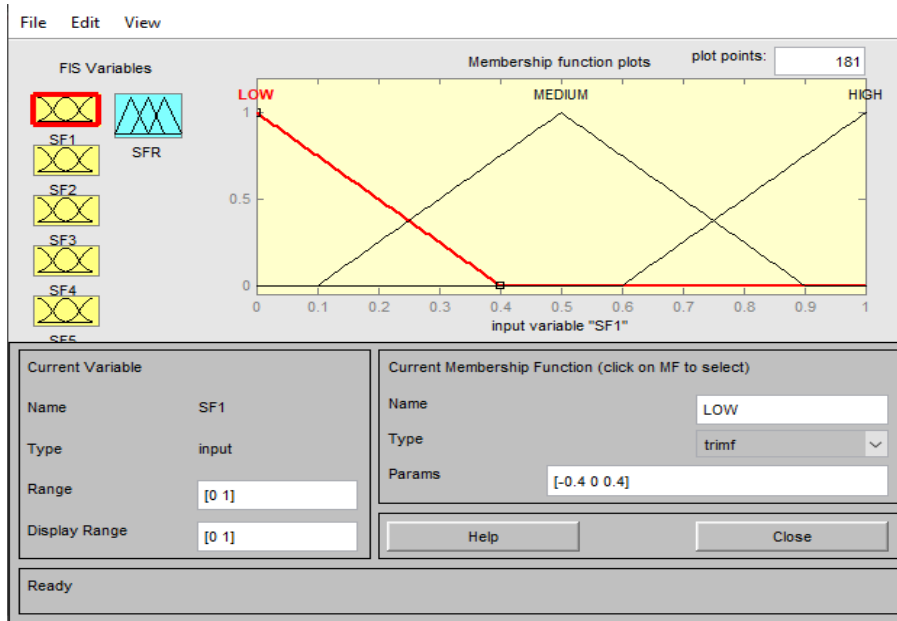


FIGURE 4 TRIANGULAR FUNCTION FOR FUZZIFICATION AND DE-FUZZIFICATION PROCESS

TABLE 2 FUZZY MEMBERSHIP FUNCTION WITH CRISP INPUT

SL	Input Value	Low	Medium	High	Qualitative value
1	0	1	0	0	Extreme low
2	.1	.75	0	0	Low
3	.2	.5	.25	0	Low
4	.3	.25	.5	0	Medium Low
5	.4	0	.75	0	Medium
6	.5	0	1	0	Medium
7	.6	0	.75	0	Medium
8	.7	0	.5	.25	Medium High
9	.8	0	.25	.5	High
10	.9	0	0	.75	High
11	1	0	0	1	Extreme High

In Table 2, it is described that how the qualitative values band depends on the crisp input values and its membership function. Pictorial representation of the Table 2 is shown in given Figure 4, which shows the three triangles and each triangle represent

low, medium and high qualitative values domain. We can see in Figure 4, vertical line shows the crisp membership function values and horizontal line shows the crisp input values. It can be observed in the figure 4, if input value is 0 then its membership function value is 1 then it can be assumed that its qualitative value would be Extreme low. We have divided the qualitative values in seven band that is extreme low, low, medium low, medium, medium high and extreme high.

We have formulated 10 rules on the basis of some case studies and it has been observed that when Employment Generation(SF1) is high, Agricultural Development(SF2) is low, Research and Innovations(SF3) is high, Basic Education Structural Development(SF4) is low, Health Sector Improvement (SF5) is low then Economic Sustainability Factor (SFR) goes Median.

TABLE 3 AI RULE BASE USED TO OBSERVE INDIAN ECONOMIC SUSTAINABILITY

S.N.	SF1	SF2	SF3	SF4	SF5	SFR
1	H	H	H	H	H	H
2	H	L	H	L	L	M
3	L	L	L	M	M	L
4	M	M	M	L	L	L
5	H	H	L	L	L	M
6	L	L	L	L	L	M
7	M	M	M	H	H	H
8	L	H	H	H	L	L
9	M	M	H	H	H	M
10	H	H	M	L	L	L

In the given Table 3 which shows 5 Economic Sustainability factors possess the value in qualitative form Low (L), Medium (M) and High (H) on the basis of these qualitative values we have performed case studies and created the rule base for the same.

Finally, by using the centroid method we have aggregated the qualitative values of rule base in quantitative form. For this we have used Matlab FIS simulator figure 5.

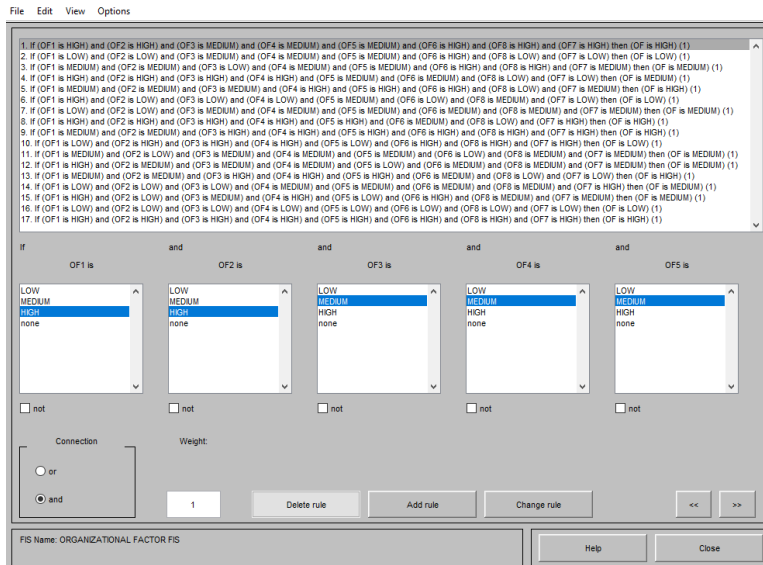


FIGURE 5 RULE BASE EDITOR OF ECONOMIC SUSTAINABILITY

These sub factors possess qualitative values and we can understand that with the help of qualitative values we cannot make any decision precisely. To overcome this problem we have developed the model for quantification of the sub factors

We have used the FIS Editor which manages high-level program issues: As the number of entries is too high, or the number of membership activities too large, it can also be difficult to analyze FIS using other GUI tools.

The Rule Editor is for editing a list of rules that define system behavior. Rule Viewer is used for viewing, the crisp values of organisational agility and sub factors.



FIGURE 6 RULE VIEWER OF ECONOMIC SUSTAINABILITY

We can find the new values by moving slider which are given with each subfactor in the given figure and finally we get the result on the basis of rule base applied in the fuzzy inference editor.

In the Rule Viewer when we slide the ruler and value of Employment Generation (SF1=0.2143), Agricultural Development (SF2=0.1859), Research and Innovations (SF3=0.2273), Basic Education Structural Development (SF4=0.1104), Health Sector Improvement (SF5=0.05844) then Economic Sustainability Factor (SFR=0.455).

TABLE 4 QUANTITATIVE VALUES OF INDIAN ECONOMIC SUSTAINABILITY KEY FACTORS GENERATED BY FUZZY INFERENCE SYSTEM

S.NS.	SF1	SF2	SF3	SF4	SF5	SFR
1	0.7747	0.85	0.85	0.6648	0.9167	0.593
2	0.7747	0.85	0.7389	0.7747	0.8056	0.674
3	0.6099	0.3944	0.3167	0.1374	0.0000	0.15
4	0.6099	0.3944	0.3167	0.3242	0.2056	0.179
5	0.2143	0.1859	0.2273	0.1104	0.05844	0.455
6	0.2143	0.4167	0.487	0.1104	0.05844	0.17
7	0.2143	0.1859	0.2532	0.1623	0.1883	0.45
8	0.3831	0.09615	0.2273	0.2143	0.2403	0.443
9	0.1753	0.3782	0.2273	0.2143	0.2403	0.309
10	0.1753	0.3782	0.3182	0.3571	0.2403	0.367

8. SENSITIVE ANALYSIS

we have used range sensitivity analysis to find the sensitivity of Indian Economic Sustainability. In Figure 6, we can see the Matlab rule viewer , To find out the most sensitive sub factor, we keep the value of seven subfactors at extreme low(0) and one subfactor whose sensitivity is to be detected, we keep it at extreme high(1) and finally we observe the sensitivity result.

TABLE 5 SENSITIVITY ANALYSIS OF INDIAN ECONOMIC SUSTAINABILITY KEY FACTORS

S.N.	SF1	SF2	SF3	SF4	SF5	SFR
1	1	0	0	0	0	.402
2	0	1	0	0	0	.0717
3	0	0	1	0	0	.110
4	0	0	0	1	0	.454
5	0	0	0	0	1	.504
Sensitivity order SF5>SF4>SF1>SF3>SF2						

The result of sensitivity analysis we can see in given Table 5. we found in this analysis that health sector improvement is highly sensitive with quantitative value with .0504 (50%). The priority order of the sensitivity of subfactors are shown in given Table 1.5.

9. CONCLUSION

The AI have been properly used in various areas for the enhancement of Indian economy. In our research analysis I can provide some insights on the potential sensitivity of each observed factors in which we found that health sector improvement is highly sensitive with quantitative value with .0504 (50%). Because health sector can have significant implications for economic growth. A healthy population can contribute to increase productivity.

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