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ORIGINAL RESEARCH ARTICLE

Designing a Smart Model for Implementing Industrial Policies Based on Article 4 of the Seventh Development Plan: A Case Study of Megamotor Saipa Company

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ABSTRACT

This research was conducted with the objective of designing an intelligent implementation model for industrial policies based on Article 4 of the 7th Development Plan, specifically focusing on Megamotor Saipa. The primary problem involves transforming macro-level industrial policies into operational smart mechanisms at the organizational level by leveraging modern data-driven governance approaches and digital technologies, such as the industrial metaverse and digital twins. The methodology follows a mixed-methods (qualitative-quantitative) design, utilizing Grounded Theory in the qualitative phase and Structural Equation Modeling (SEM) in the quantitative phase. During the qualitative stage, data were collected through semi-structured interviews with automotive experts, senior managers, and technology specialists, which were then analyzed through rigorous open, axial, and selective coding. In the quantitative stage, the relationships between the model's dimensions were tested using SEM and statistical analysis software, confirming the overall model fit and validity. The findings reveal that successful implementation is driven by causal factors including strategic leadership, sustainable financing, and governance mandates. Furthermore, contextual conditions such as digital infrastructure, policy stability, and organizational culture act as facilitators, while intervening conditions like international sanctions, employee resistance, and financial limitations function as deterrents. Executive strategies include digital twin development, metaverse-based training, reverse engineering, and industrial consortiums, leading to increased productivity, innovation, and enhanced organizational sustainability. Ultimately, the proposed model suggests that transitioning toward intelligent implementation requires a shift from traditional management to data-driven digital governance. **©authors**

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Introduction

In recent decades, widespread technological developments and the emergence of the Fourth Industrial Revolution have fundamentally changed the operating environment of industrial enterprises (Kliestik et al, 2024). Technologies such as artificial intelligence, the Internet of Things, big data, cloud computing, digital twins, and the industrial metaverse have transformed traditional patterns of production, management, and industrial policymaking. In such circumstances, in order to increase the competitiveness of their industries, countries are seeking to design smart mechanisms for the effective implementation of these policies in addition to formulating new industrial policies (Romanova et al, 2020). The experience of industrialized countries shows that the success of industrial development policies depends more on the quality of their implementation than on the quality of policy formulation (Younesi, 2024). Hence, the issue of smart implementation of industrial policies has become one of the main concerns of industrial governance systems in the world (Kniaziev, 2017).

In Iran, with the approval of the Seventh Development Plan of the Islamic Republic of Iran, the issue of industrial development and improving national production productivity has become the focus of policymakers (Daliri, 2024). Meanwhile, Article 4 of the Seventh Development Plan has outlined a strategic framework for the transformation of the country's industrial sector, emphasizing sustainable economic growth, the development of knowledge-based production, improving the productivity of production factors, developing new technologies, and increasing the competitiveness of industries. However, one of the fundamental challenges in achieving the goals of this article is the lack of smart and integrated implementation models to transform macro policies into operational measures at the level of industrial enterprises. In many cases, a significant gap is observed between approved policies and implementation results; such that some of the goals of development programs are not achieved due to weaknesses in implementation, monitoring, evaluation, and feedback mechanisms (Nourmohammadi, 2022).

The automotive industry, as one of the country's leading industries, has a significant contribution to employment, GDP, technological development, and the industrial value chain of Iran (Akbari et al, 2025). Meanwhile, Saipa Megamotor Company, as one of the most important suppliers of driving forces and strategic parts for the country's automotive industry, plays an important role in achieving the industrial goals of the Seventh Plan. However, this company, like many industrial organizations in the country, faces challenges such as the complexity of decision-making processes, lack of data integration, limitations in predicting environmental changes, weakness in real-time performance monitoring, slow transfer of organizational knowledge, and limitations in utilizing smart technologies. These challenges can reduce the effectiveness of industrial policy implementation and jeopardize the achievement of development goals (Jafari, 2024).

On the other hand, the emergence of artificial intelligence technology has provided unprecedented opportunities to improve the quality of industrial policy implementation. Artificial intelligence is able to identify hidden patterns by analyzing a huge amount of operational, production and management data and help managers in strategic decision-making (Bordegoni et al, 2023). Machine learning algorithms can also predict production trends, productivity, quality, demand and operational risks and provide the basis for data-based decision-making. In other words, artificial intelligence can strengthen the connection between macro-policy making and operational implementation and provide the basis for achieving the goals of development programs (Rahmani et al, 2023).

At the same time, industrial metaverse technology, as one of the most emerging transformative technologies in the field of industrial production and management, has created new horizons for the intelligent implementation of industrial policies (Lignell et al, 2026). By combining virtual reality, augmented reality, digital twins, and artificial intelligence, the industrial metaverse enables the creation of interactive and simulated environments in which managers, experts, and policymakers can visualize and evaluate the consequences of their decisions before they are implemented. This technology enables the design of virtual factories, intelligent employee training, real-time equipment monitoring, supply chain management, and the evaluation of various policy scenarios, and can significantly increase the effectiveness of industrial policy implementation (Júunior et al, 2023). Despite the vast potential of artificial intelligence and the industrial metaverse, a review of the research literature shows that studies have mainly focused on the formulation of industrial policies or the development of digital technologies, and few studies have focused on the design of intelligent models for the implementation of industrial policies at the level of manufacturing enterprises (Lazaroiu et al, 2024). Also, a comprehensive framework that integrates the requirements of Article 4 of the Seventh Development Plan with the capabilities of artificial intelligence, digital twin, and industrial metaverse in an integrated implementation model has received less attention so far. This research gap is especially clearly observed in the automotive industry and strategic supply chain companies such as Saipa Megamotor.

In addition, the complexity of the competitive environment, increasing stakeholder expectations, pressures from sanctions, the need to localize technology, reduce production costs, improve product quality, and move towards a smart industry have made the need to create a smart system for implementing industrial policies more urgent than ever. Such a system should be able to reduce the gap between policymaking and implementation through data integration, smart information analysis, simulation of implementation scenarios, continuous performance monitoring, and providing real-time feedback, and pave the way for achieving the country's industrial development goals.

Accordingly, the main issue of the present research is how to design a smart model for implementing industrial policies based on Article 4 of the Seventh Development Plan, by utilizing the capacities of artificial intelligence, industrial metaverse, digital twin, and transformative technologies of the Fourth Industrial Revolution, which, while increasing the effectiveness, agility, transparency, and productivity of executive processes, will pave the way for realizing industrial development goals in Saipa Megamotor Company. In addition to developing theoretical literature in the field of governance and industrial policymaking, the answer to this issue can provide a practical framework for industrial managers, policymakers, and decision-makers in the country and facilitate the path of Iranian industries towards smart industry, digital factories, and the industrial metaverse ecosystem.

Literature Review

Smart Implementation of Industrial Policies

Smart implementation of industrial policies means utilizing new data-driven technologies and advanced decision-support systems to transform macro-industrial policies into accurate, fast, and monitorable operational actions. In the literature of industrial governance, one of the most important challenges has always been the "policy-implementation gap"; that is, the gap between what is designed at the policy-making level and what is realized at the level of organizations and firms. Smart implementation attempts to reduce this gap through the use of tools such as artificial intelligence, big data analytics, real-time performance monitoring systems, and management dashboards. In this approach, the process of implementing policies is transformed from a linear and static state to a dynamic, learning, and feedback-enabled system. This means that policies are not only implemented, but also continuously modified and optimized based on real-world data (Khairussalam et al, 2026).

At the organizational level, smart industrial policy implementation requires the creation of integrated digital infrastructures that can integrate production, financial, supply chain, and human resource data into a single ecosystem. These infrastructures enable real-time performance analysis and prediction of policy outcomes. In such a model, decision-making moves from a mode based on the individual experience of managers to algorithmic and data-based decision-making. Also, the use of machine learning models in this process enables the organization to identify hidden patterns of inefficiency, implementation risks, and improvement opportunities (Alpala et al, 2026). Smart industrial policy implementation is not only a technological tool, but also a new governance approach that emphasizes transparency, accountability, agility, and organizational learning. In complex industries such as automotive, this approach can play a decisive role in increasing productivity, reducing costs, and accelerating the realization of development goals (Pan et al, 2026).

Artificial Intelligence and Industrial Metaverse

Artificial Intelligence and Industrial Metaverse are two transformative technologies within the framework of the Fourth Industrial Revolution that play an important role in redefining production structures, management, and industrial policy-making. With the ability to analyze huge volumes of data, identify complex patterns, and provide accurate predictions, AI acts as an intelligent decision-making engine in organizations. This technology can be used in areas such as demand forecasting, quality control, supply chain management, predictive maintenance of equipment, and production optimization. In fact, AI enables managers to make faster and more accurate decisions by transforming raw data into actionable insights (Zhang et al, 2025).

In addition, the industrial metaverse, as an advanced virtual environment based on augmented reality, virtual reality and digital twins, enables the full simulation of industrial processes. In this environment, factories, production lines and supply chains are digitally recreated and managers can test different policy and operational scenarios in a virtual space before actual implementation. This capability greatly reduces decision-making risk and enables a priori optimization of policies (Rathore, 2023).

The combination of AI and the industrial metaverse creates an integrated intelligent ecosystem in which data is analyzed in real time and the results of the analysis can be viewed in an interactive and simulated environment. This synergy enables organizations to achieve a level of digital maturity in which organizational learning, innovation and continuous improvement are systematically institutionalized. In the automotive industry, this combination can lead to smart factory design, reduced production downtime, optimized resource consumption, and increased product quality (Thakur et al, 2023).

Article 4 of the Seventh Development Plan

Article 4 of the Seventh Development Plan of the Islamic Republic of Iran is one of the key axes of the country's economic and industrial policymaking, which emphasizes sustainable economic growth, improving productivity, developing knowledge-based production, and increasing industrial competitiveness. This article actually provides a strategic framework for transforming the structure of the national economy from a traditional economy to a knowledge-based and technology-driven economy. Within this framework, the country's industries are required to increase their productivity levels and gain a greater share in the global value chain by utilizing new technologies, especially digital technologies (Ahmadi Shapourabadi et al, 2022).

One of the most important aspects of Article 4 is the emphasis on improving the productivity of production factors through innovation, technology, and smart resource management. This issue is directly related to the need for transformation in the system for implementing industrial policies; because without efficient implementation mechanisms, the achievement of the major goals of this article will not be possible. It also emphasizes the development of enabling industries, improving the business environment, and increasing economic resilience to external shocks (Vahidpour et al, 2025).

At the operational level, achieving the objectives of Article 4 requires a shift from traditional management to data-driven and smart governance. This shift requires the use of technologies such as artificial intelligence, big data, industrial metaverse, and digital twins in decision-making and policy implementation processes. In the automotive industry and companies such as Saipa Megamotor, this article can serve as a roadmap for moving towards smart manufacturing, reducing costs, increasing quality, and enhancing competitive position at the regional and global levels. As a result, Article 4 is not only a developmental document, but also a transformational framework for redesigning the country’s industrial system (Ranji Jafroudi, 2023).

Recent studies show that the implementation of industrial policies in the digital age has increasingly moved towards the use of data-driven and smart approaches. For example, a comprehensive report by Deloitte (2023) shows that the world’s leading manufacturing companies, by leveraging intelligent ecosystems including artificial intelligence, the Internet of Things, and digital twins, have been able to move industrial policies from the strategic planning level to the operational implementation level in manufacturing environments. The study emphasizes that “the implementation of smart industrial policies” is successful when organizations can collect real-time data from the entire value chain and use it in executive decisions.

In another study, Waehrens et al. (2026) showed that the transition from a traditional factory to a smart factory based on the industrial metaverse requires digital maturity and a redesign of executive governance structures. The study states that the main challenge in implementing industrial policies is not policy design, but “the organization’s capacity for adaptive and real-time policy implementation.” The results of this study also show that the use of digital maturity models can help reduce the policy-implementation gap and increase the efficiency of industrial policies.

In the field of artificial intelligence and industrial metaverse, extensive research has been conducted on the convergence of digital technologies to create intelligent manufacturing environments. The study by Tu et al. (2024) presents a comprehensive architecture for a data- and semantic-based industrial metaverse in which digital twins, artificial intelligence, and semantic models are integrated to connect the physical and virtual spaces of the factory. This research shows that the industrial metaverse can facilitate real-time interaction between humans, machines, and data and bring industrial decision-making to a new level of intelligence.

In another study, Stefko et al. (2025) showed that the combination of digital twins, cyber-physical systems, and artificial intelligence within the industrial metaverse framework enables predictive monitoring, intelligent maintenance, and production optimization. This study emphasizes that the industrial metaverse is not just a visual technology, but an intelligent decision-making infrastructure that can create significant economic value through the optimization of production processes.

Also, Yang et al. (2025) study shows that the manufacturing metaverse based on AI and XR can redesign industrial learning and training environments and improve the digital skills of the workforce. This study emphasizes that the convergence of AI and metaverse will shape the future of human-centered smart factories.

Although Article 4 of the Seventh Development Plan is a national document of Iran, similar concepts have been examined in the international literature in the form of “smart industrial policies, innovation-based development, and knowledge-based economy.” Kshetri’s (2023) research shows that globally, successful industrial policies are those that use digital technologies such as artificial intelligence and digital twins to increase productivity, sustainability, and innovation. The study emphasizes that governments should use data-driven governance models to implement policies dynamically and flexibly to achieve industrial development goals.

Also, Jurmu et al. (2023) in a study on digital transition and sustainability in manufacturing industries show that achieving the macro goals of industrial development requires “digital twin convergence and sustainability”. The study states that modern industrial policies should target not only economic growth, but also energy efficiency, cost reduction, and environmental sustainability. These findings are in line with the objectives of Article 4 of the Seventh Development Plan, especially in the field of productivity and knowledge-based development.

The theoretical framework of this research is based on the convergence of three key areas: industrial governance, transformative technologies of the Fourth Industrial Revolution, and policy implementation theory. In the literature of public governance, policy implementation is known as the intermediary link between policymaking and the realization of development results, the quality of which determines the success or failure of major development programs. Classical theories of policy implementation such as the "Top-Down" and "Bottom-Up" models emphasize the role of structures, organizational actors, and executive capacity, but in new approaches, policy implementation is considered as a data-driven, networked, and dynamic process. In this framework, the success of industrial policy implementation depends not only on policy design but also on the ability of organizations to process data, continuously learn, and respond in real time to environmental changes.

At the technological level, the theoretical framework of the research is developed based on the theory of the Fourth Industrial Revolution and digital transformation models. According to this approach, technologies such as artificial intelligence, the Internet of Things, big data, digital twins and the industrial metaverse provide the main infrastructure for the formation of "smart executive organizations". The theory of cyber-physical systems states that the connection of the physical space of production with the digital space enables real-time monitoring, prediction and control of processes. In this regard, artificial intelligence plays the role of the analytical brain of the system and the industrial metaverse, as an interactive and simulated environment, provides a platform for testing policies and decisions before actual implementation. This technological convergence forms a new concept of smart policy implementation that is based on continuous learning and dynamic optimization.

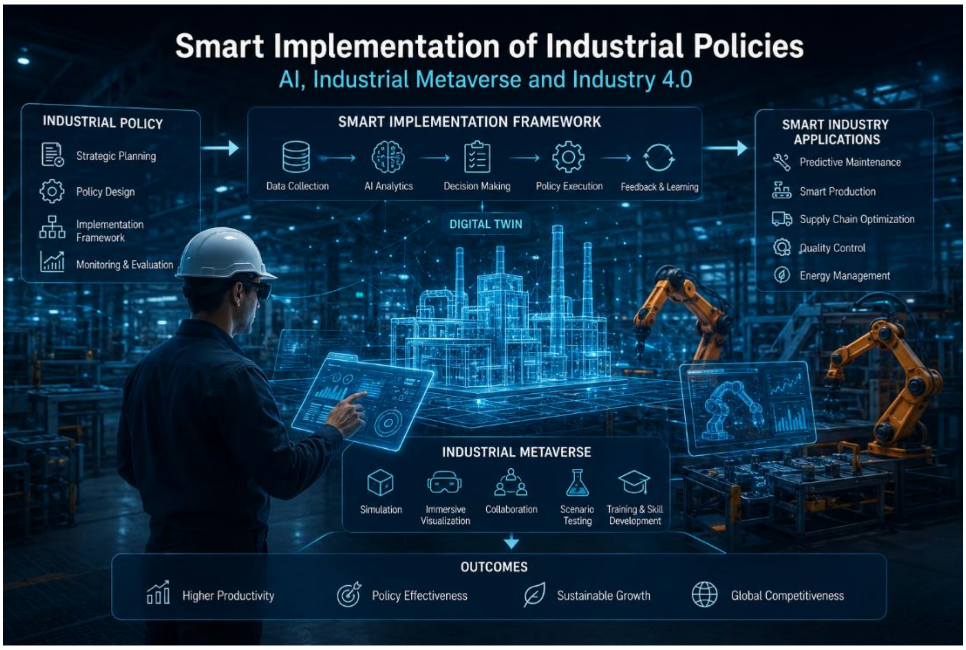

Figure 1. *Schematic of Smart Industrial Policymaking*

At the level of development policymaking, the theoretical framework of this study is aligned with the objectives of Article 4 of the Seventh Development Plan, which emphasizes sustainable economic growth, increased productivity, knowledge-based development, and enhanced industrial competitiveness. This article actually represents the transition from a traditional economy to a smart, technology-based economy in which industries must move from traditional management models to data-driven governance. Accordingly, smart implementation of industrial policies acts as a mechanism to achieve the objectives of this article, and artificial intelligence and industrial metaverse technologies play the role of enabling tools. As a result, the theoretical framework of this study shows that achieving the country's industrial development goals depends on designing an integrated and smart system for implementing policies at the level of industrial enterprises such as Saipa Megamotor; a system that can minimize the gap between macro-policymaking and operational implementation.

From the perspective of digital governance theory, the successful implementation of industrial policies in the digital age requires the use of data-driven mechanisms, information integration, decision-making transparency, and continuous interaction between the government, industrial enterprises, and other stakeholders. By providing technological infrastructure and intelligent decision-making systems, digital governance enables continuous monitoring, evaluation, and reform of policies. In this context, the effectiveness of the implementation of Article 4 of the Seventh Development Plan Law depends not only on the formulation of appropriate policies, but also on the existence of intelligent mechanisms to coordinate, monitor, and manage their implementation.

On the other hand, the theory of digital industrial transformation states that the competitiveness of industrial enterprises in the current changing environment depends more than ever on their ability to utilize emerging technologies, data analysis, process intelligence, and the development of digital capabilities. According to this perspective, digital transformation is not simply the application of new technologies, but also requires the redesign of processes, structures and business models in order to create more value. Therefore, designing a smart model for the implementation of industrial policies can be considered as a tool for aligning the legal requirements of the Seventh Development Plan with the needs of digital transformation in industrial enterprises.

Also, the theory of public policy implementation emphasizes that the gap between policy formulation and the realization of expected results depends on the quality of implementation mechanisms, organizational capacity, institutional coordination and management of environmental factors. According to this approach, the success of industrial policies is achieved when, in addition to legal objectives and requirements, implementation and contextual factors are also taken into account. Therefore, the smart model proposed in this study, by combining the components of digital governance, industrial digital transformation and public policy implementation, provides an integrated framework for increasing the effectiveness of the implementation of Article 4 of the Seventh Development Plan in Saipa Megamotor Company and explains the theoretical link between the different dimensions of the model.

Method

The methodology of this research is a mixed exploratory (qualitative-quantitative) type that uses the Grounded Theory approach in the qualitative part and the Partial Least Squares Structural Equation Modeling (PLS-SEM) in the quantitative part using SmartPLS software. In the qualitative stage, the goal is to identify the dimensions, components, and relationships between concepts related to the smart implementation of industrial policies based on new technologies. The statistical population of this section includes automotive industry experts, senior and middle managers of Saipa Megamotor Company, specialists in the field of industrial policymaking, and experts in digital technologies (artificial intelligence, industrial metaverse, and smart manufacturing systems). Sampling was carried out using a theoretical purposive method and continued until theoretical saturation was reached. Data were collected through semi-structured interviews and analyzed using three-stage coding (open, axial, and selective) to extract the initial conceptual model of the research.

The statistical population of the study included managers, experts, and employees of Megamotor Saipa Company. Given the large size of the statistical population and the lack of access to the exact number of members of the population at all organizational levels, the sample size was calculated based on the Cochran formula for unlimited populations.

Considering a confidence level of 95%, a permissible error of 0.05, and an estimated success-failure ratio of 0.5, the required sample size was determined to be 384 people. Also, in order to increase the generalizability of the results and reduce sampling error, questionnaires were distributed among eligible individuals in different departments of the company. The sampling method was simple random so that all members of the statistical population had an equal chance of being selected and to achieve an appropriate representation of the views existing in the organization.

In the quantitative stage, the model extracted from the qualitative section is entered into structural equation modeling as a conceptual framework. The goal of this stage is to test the relationships between the constructs, measure the fit of the model, and validate the proposed model. The statistical population includes experts, managers, and experts related to the automotive industry and the field of smart industrial technologies, who are selected through non-random and judgmental sampling. The data collection tool is a Likert-scale questionnaire designed based on the output of the database. The face and content validity of the questionnaire is examined through expert opinion and indicators such as CVR and CVI, and its reliability is also evaluated with Cronbach's alpha and composite reliability (CR).

For quantitative data analysis, SmartPLS software is used, which allows modeling complex relationships between latent constructs. At this stage, the measurement model is first tested for convergent validity (AVE), divergent validity, and reliability, and then the structural model (Inner Model) is evaluated to examine the causal relationships between variables. Indices such as Path Coefficients, R^2, Q^2, and the Overall Fit Index (GOF) are used to measure the explanatory power of the model. Finally, the final research model is presented as an intelligent model for implementing industrial policies that can be applied in real industrial environments such as Saipa Megamotor Company and can be used as a data-driven decision-making framework in the era of artificial intelligence and the industrial metaverse.

Findings

The sample population of this study includes 15 automotive industry experts and specialists who have been selected purposefully based on the criteria of expertise, practical experience, and deep understanding of industrial processes. The demographic composition of the sample shows that about 80% of the participants are male, and in terms of education level, nearly 70% have a PhD in fields related to industrial management, industrial engineering, automotive engineering, and technology management.

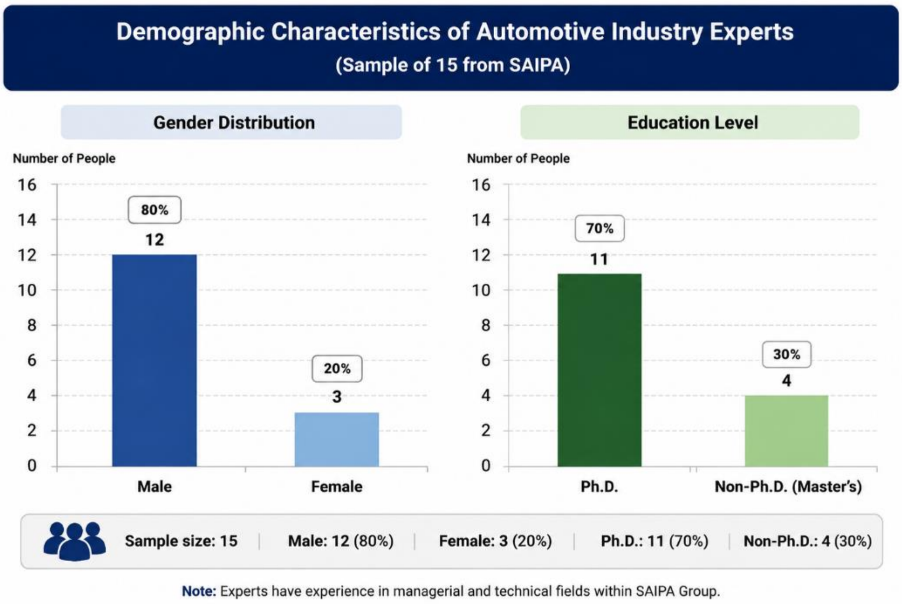

Figure 2. *Demographic Characteristics*

The other sample members also have at least a master's degree and are senior managers, experts, and key decision makers in Saipa and its subsidiaries. Due to their long experience in the fields of design, production, and industrial policy-making, these individuals have provided specialized and experience-based perspectives that are of great importance for in-depth analysis and validation of the research findings.

Table 2. *Selective Coding*

Core coding	Secondary coding	Open Coding	Selective coding
CEO support for knowledge-based projects	Strategic support	Senior Leadership	Causal conditions
Prioritizing Article 4 objectives			
Special budget allocation			
Continuation of programs with changes in managers	Management stability		
Consensus on the SAIPA Board of Directors			
Long-term advertising			
Allocation of a percentage of sales to research	Provision of financial resources	Investment in R&D	
Attracting government budgets			
Low-interest industrial loans			
Purchasing simulation software	Development of research infrastructure		
Establishing joint research centers with universities			
Upstream documents of the Seventh Program	Government requirements	National Will	
Parliamentary resolutions			
Monitoring pressures from the Ministry of Health			
National campaigns	Support for domestic production		
Restrictions on imports of similar engines			
Tully tax incentives			
Introduction of Chinese vehicles	Competitive pressure	Need for Innovation	
New emission standards (Euro 6)			
Need to reduce fuel consumption			
Demand for electric/hybrid engines	Change in customer needs		
Increased acceleration and power			
Ability of Megamotor production lines to accept new designs	Technical readiness	Industry Absorptive Capacity	
Technological literacy of engineers			
Documentation of previous experiences	Knowledge management system		
Enhanced technical database			
Contracts Operations with industrial universities	Bridge between industry and academia	Knowledge Commercialization	
Definition of military service deduction projects			
Transforming a laboratory sample into a marketable product	Mass production of ideas		
Reducing time			
Advanced CNC machinery	Production hardware	Infrastructure	Contextual factors
Engine testing center			
Robotic assembly lines			
Data Lake system for analyzing production data	Digital infrastructure		
ERP integration			
Coordination with component manufacturers	Interaction with the supply chain	Inter-organizational Coordination	
Quarterly meetings with SAPCO and SAIPA			
Formation of a joint committee with the National Standards Organization	Alignment with regulatory institutions		
Obtaining environmental pre-approval for proposed projects			
Synergy with environmental experts during the design stage			
Stability of tariff rates	Predictability of laws	Policy Stability	
Transparency in the executive regulations of Article 4			
Allocation of guaranteed purchase budget in SAIPA's annual budget	Investment security		
Establishment of a guarantee fund for the purchase of innovative products			
Concluding long-term purchase contracts			
Encouraging sharing of errors	Learning culture	Organizational Culture	
Teamwork spirit			
Suggestions system			
Acceptance of structural changes	Flexibility		

Reducing hierarchy in technical decision-making			
Fear of losing jobs due to automation	Psychological resistance	Employee Fear and Resistance	
Dependence on traditional methods			
Difficulty in learning new software	Skill resistance		
Guarding against changes in the production line			
Difficulty in purchasing licenses	Limited supply of parts	Sanction Challenge	
Foreign exchange transfer problems for laboratory equipment			
Forcing the localization of sensitive components (ECUs, etc.)	Opportunity for self-sufficiency		
Reliance on domestic capacity			
Lack of Collaboration in data recording	Latent sabotage	Employee Resistance	Intervening factors
Rumours about the inefficiency of new designs			
Prevailing habits over new methods	Cultural resistance		
Scepticism about the success of new designs			
Inability to work with complex systems	Technological alienation	Fear of Technology	
Fear of replacing humans with robots			
Fear of devaluation of traditional knowledge	Fear of losing position		
Feeling of the uselessness of old experiences			
Sudden increase in the cost of purchasing foreign steel	Unstable supply of materials	Currency Fluctuation	
Imbalance in the cost price			
Stopping the purchase of laboratory equipment	Financial risks of projects		
Budget deficit in R&D projects			
Outdated internal regulations	Baffling laws	Bureaucracy	
Complexity in registering financial and procurement documents			
Long approval processes	Hard hierarchy		
Multiple levels of management for small projects			
Highly outdated machinery	Equipment gap	Technological Gap with Competitors	
Lack of Industry 40 technologies			
Lack of specialists in the field of electric propulsion	Technical knowledge gap		
Reliance on outdated knowledge			
Professors' focus on publishing articles instead of solving factory problems	Prioritizing articles over implementation	Professors' Conflict of Interest	
Lack of understanding the reality of the production line			
Conflicts in problem-solving methodologies	Interactive challenges		
Lack of transparency in Research outputs			
Formation of the Supreme Council for Transformation	Governance structure	Article 4 Working Group	Strategies
Designation of a project manager for each legal clause			
Development of key performance indicators (KPI)	Monitoring and supervision		
Monthly reporting to upstream institutions			
Setting up a small-scale production line	Trial and error	Pilot Line	
Investigation of design defects before mass production			
Implementation of the platform-based design process	New product development		
Rapid prototyping			
Value engineering to reduce the cost price			
Analysis of foreign samples	Reverse engineering	Knowledge Transfer	
Localization of technical drawings			
Joint webinars	International cooperation		
Purchasing technical knowledge from Asian partners			
Courses working with five-axis machines	Upskilling	Education and Retraining	
Big data analysis training			
Creative problem-solving workshops (TRIZ)	Soft learning		
Change management games			
Emotional intelligence courses for managers			
Megamotor's cooperation with small knowledge-based companies	Strategic alliance	Consortia	
Sharing resources with competitors (Iran Khodro)			
Creating a technical data sharing platform	Joint technology procurement		
Formation of a consortium of main parts suppliers			
Breaking down the cost of purchasing License between Iran Khodro and Saipa			
Creating workshops near the factory	Practical training center	Skills Academy	
Training of engine technicians			
Conducting practical skills tests	Technical certification		
Developing job standards specific to Megamotor			
Issuing technical qualification cards for contractor technicians			

Eliminating intermediaries	Systemic transparency	Online Tender Platform	
Holding parts tenders on a digital platform			
"Innovation Growth" events (Demoday)	Identifying new suppliers		
Call in science and technology parks			
Online assessment of knowledge-based qualifications			
Testing new products by professional drivers	Market feedback	User Experience	
Survey of Saipa's end customers			
Navigation tests in different climatic conditions (heat/cold)	Quality assessment on the road		
Examining parts depreciation after 50 thousand kilometers			
Analysis of sensor data installed on test engines			
Long-term profitability	Economic sustainability	Sustainability	Consequences
Reducing waste and return costs			
Using renewable energy	Environmental sustainability		
Managing and recycling industrial waste			
Turning innovation into a public value	Paradigm shift	Cultural Innovation	
Breaking the barrier of traditionalism			
Holding festivals to appreciate Designers	Organizational self-confidence		
Documenting engineering successes in organizational books			
Relying on internal teams for "high-tech" projects			
Organic connection between Megamotor	Connected ecosystem	Innovation Network	
University and parts manufacturer			
Job rotation plan between research and production	Knowledge flow		
Holding internal experience transfer conferences			
Creating a mentoring system by industrial professors for newcomers			
Making Megamotor known as an environmental advocate	Positive public image	Green Brand	
Social responsibility			
Implementing an energy management system (ISO 50001)	Obtaining international certifications		
Automotive quality management certificate (IATF 16949)			
Euro 6 emission standard			
Improving the 1000PPM index	Reducing failure rates	Product Quality	
Increasing engine life			
Online satisfaction monitoring in after-sales service	Customer satisfaction		
Quick response system to technical defects			
Improving the quality of warranty services			
Familiarity with CAD/CAM software	Technical knowledge	Human Resource Skills	
Mastery of metallurgical processes			
Knowledge of machinery maintenance			
System thinking	Transdisciplinary Skills		
Working with data analysts			
Supply chain management			
Transparency in Information	Social Capital	National Trust	
Global quality			
"Iranian engine" campaigns			
Flawless engine performance	End-Customer Satisfaction		
Availability of parts			
Affordable maintenance costs			
Attracting finance for line renovation	International Financing	Attracting Foreign Capital	
Technology barter for cut exports			
Attracting foreign investors in the form of direct investment			
Free zone laws	Legal Facilitation		
Bilateral technological agreements			
Customs exemptions for equipment			

Finally, the proposed model is shown in Figure 3:

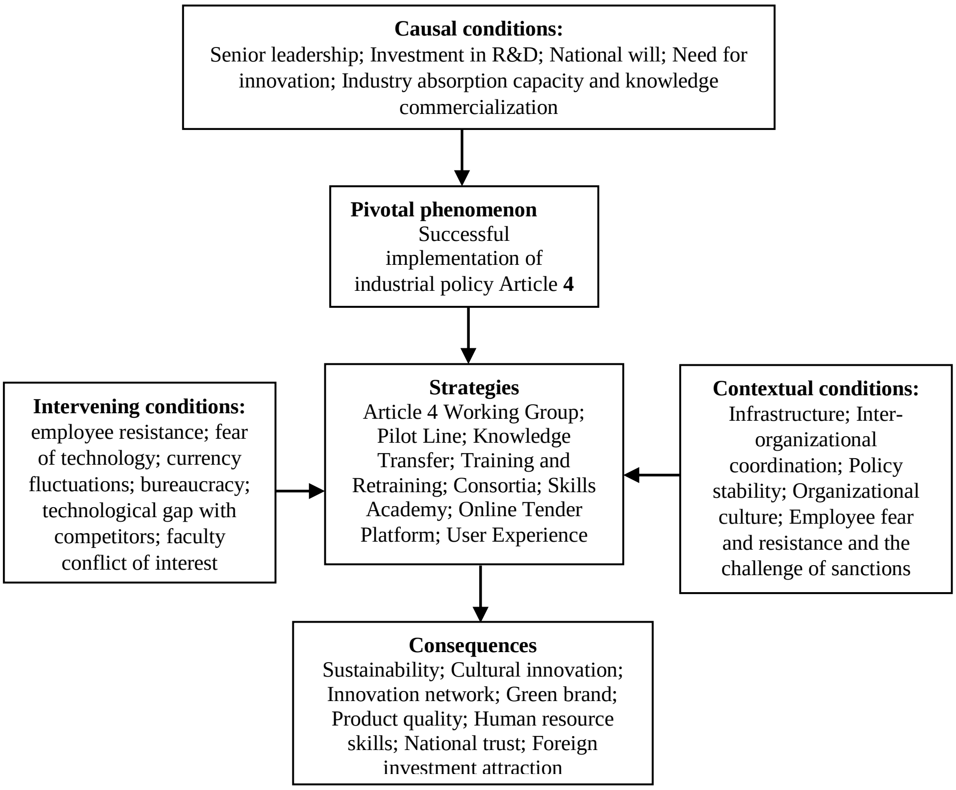

Figure 3. *Paradigm model for successful implementation of Article 4 industrial policy*

In the present study, structural equation modeling methods, namely the partial least squares (PLS) method, have been used to test the measurement model and research hypotheses. PLS software has less dependence on sample size, no need for data normality, and focuses on variance maximization, which makes this new method more suitable for real-world applications, unlike LISREL and AMOS software.

Following the reviewer's valuable comment, the model fit assessment section has been revised. The previously reported CFI and TLI indices were removed from the final version because these indices are primarily associated with covariance-based structural equation modeling approaches and are not standard outputs in SmartPLS. Consistent with current PLS-SEM guidelines, the evaluation of model fit was instead based on PLS-specific fit measures. The results indicate that the Standardized Root Mean Square Residual (SRMR) was below the recommended threshold of 0.08, while the Normed Fit Index (NFI) exceeded the acceptable value of 0.90, confirming an adequate model fit. Therefore, the assessment of the measurement and structural models is now aligned with the methodological requirements and reporting standards of PLS-SEM.

Each of the research hypotheses has been analyzed separately using the partial least squares technique. Finally, the overall research model has also been tested using the same technique.

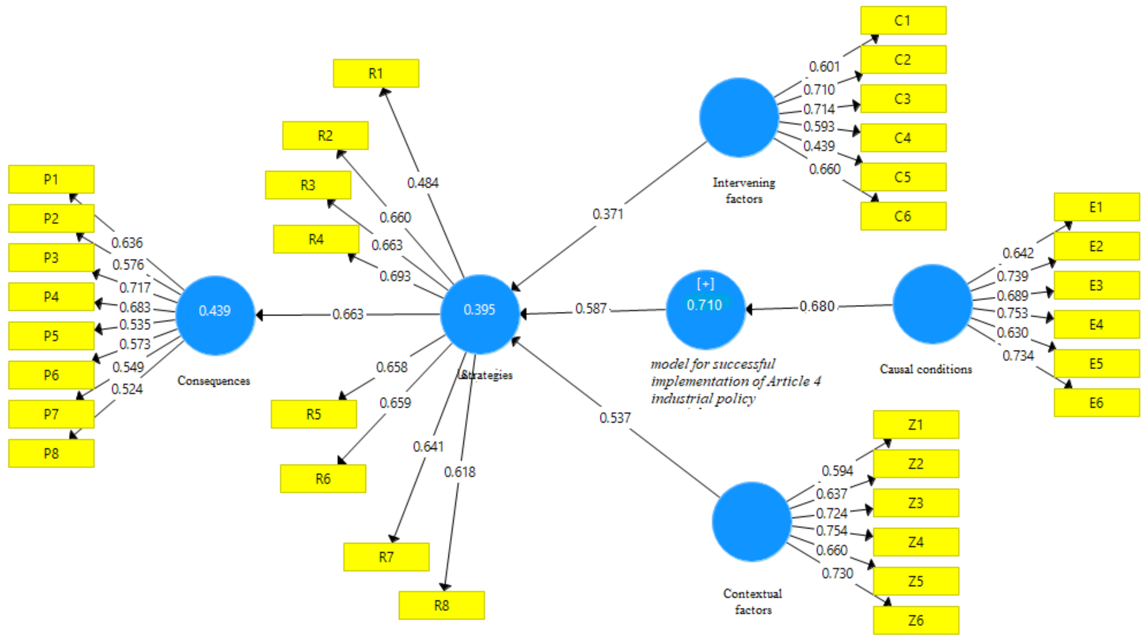

Figure 4. *Overall factor loading of the research model*

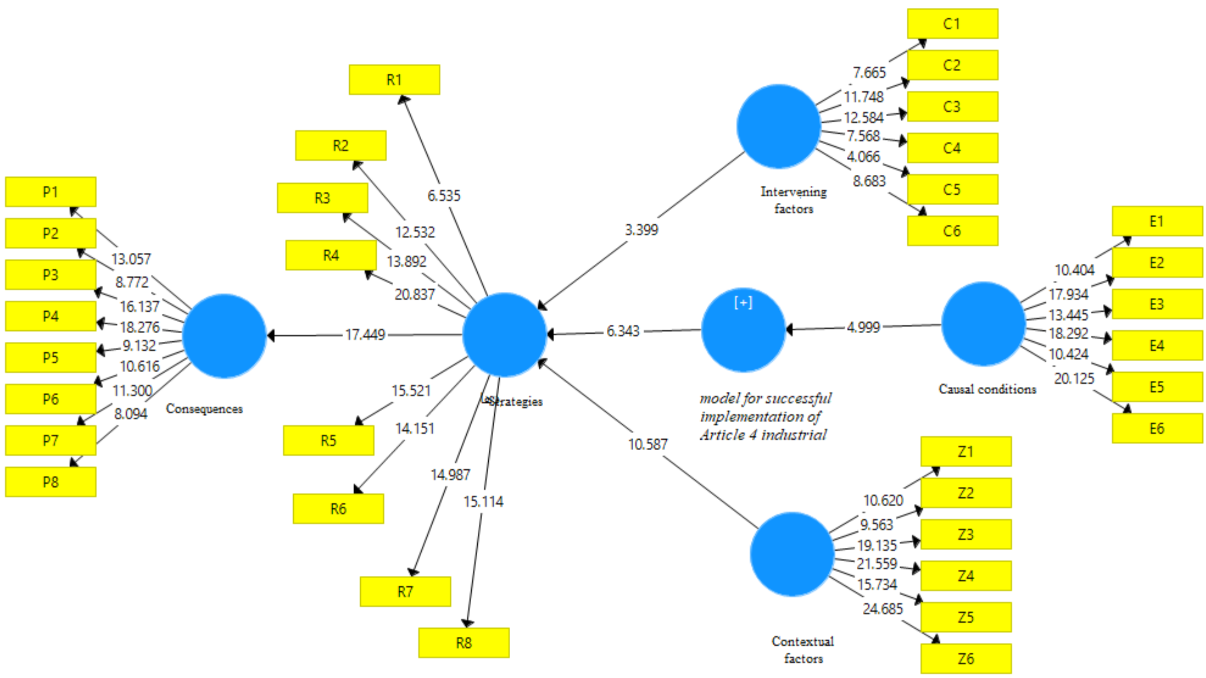

Figure 5. *Bootstrapping t-statistic of the model*

To evaluate and examine the validity and reliability of the measurement models in structural equations, partial least squares, factor loading coefficients, Cronbach's alpha, composite reliability (CR), convergent validity (AVE) and divergent validity (Fornell Larker) were calculated and presented.

The following relationships are established:

CR>0.7

CR>AVE

AVE>0.5

Table 3. *Convergent validity and reliability of research variables*

Variable	Cronbach's Alpha	CR	AVE
Causal factors	0.761	0.833	0.6
Contextual factors	0.736	0.825	0.687
Intervening factors	0.769	0.828	0.651
Strategies	0.793	0.734	0.678
Consequences	0.774	0.833	0.659
Phenomenon-centric	0.736	0.845	0.682

According to the results of the table above, Cronbach's alpha of all variables is greater than 0.7, so all variables are confirmed in terms of reliability. The average variance extracted (AVE) value is always greater than 0.5, so the convergent validity is also confirmed. The composite reliability (CR) value is also greater than AVE and 0.7, and each of the model's constructs has appropriate validity and reliability.

The degree of relationship between a construct and its indicators is compared to the relationship between that construct and other constructs; so that the acceptable divergent validity of a model indicates that a construct has more interaction with its indicators than with other constructs. Divergent validity is at an acceptable level when the AVE for each construct is greater than the shared variance of that construct and other constructs (the square of the correlation coefficients between the constructs) in the model.

Table 4. *Fornell and Locker Method*

Variable	Causal factors	Contextual factors	Intervening factors	Strategies	Consequences	Phenomenon-centric
Causal factors	0.774					
Contextual factors	0.551	0.828				
Intervening factors	0.478	0.598	0.806			
Strategies	0.418	0.474	0.536	0.823		
Consequences	0.513	0.509	0.587	0.470	0.811	
Phenomenon-centric	0.613	0.591	0.480	0.401	0.503	0.825

As shown in Table 4, the values on the main diagonal of the matrix are larger than all the values in the corresponding column, indicating that our model has good divergent validity. Recent research by Hensler et al. (2015) shows that the Fornell-Locker criterion does not work well when the factor loadings of the constructs are slightly different from each other. Therefore, Hensler et al. have proposed the HTMT criterion as an alternative. If the values of all the numbers in the columns in this method are less than 0.9, the model will have good divergent validity.

Table 5. *Results of the HTMT method to examine divergent validity*

Variable	Causal factors	Contextual factors	Intervening factors	Strategies	Consequences	Phenomenon-centric
Causal factors						
Contextual factors	0.737					
Intervening factors	0.620	0.797				
Strategies	0.430	0.573	0.711			
Consequences	0.748	0.684	0.485	0.739		
Phenomenon-centric	0.414	0.710	0.638	0.592	0.630	

According to Table 5, the value of the obtained numbers is less than 0.9, so the divergent validity of HTMT is acceptable.

-R2 coefficient of determination criterion

It is a criterion used to connect the measurement part and the structural part of structural equation modeling and indicates the amount of change in each of the dependent variables of the model that is explained by the independent variables. The crucial point here is that R2 is calculated only for the endogenous (dependent) structures of the model and in the case of exogenous structures, the value of this criterion is zero. The higher the R2 value related to the endogenous structures of a model, the better the fit of the model. Chin (1998) determines three values of 0.19, 0.33 and 0.67 as weak, medium and strong model. Also, Hensler (2009) and Herr et al. (2011) have defined three values of 0.25, 0.50, and 0.75 as criterion values for weak, moderate, and strong values of the structural part of the model fit using the coefficient of determination criterion.

$$R^2 = \frac{0.395 + 0.439 + 0.710}{3} = 0.514$$

Based on the results of Figure 4, the coefficient of determination (R2) of the endogenous constructs of the research model is desirable. The value of the coefficient of determination of the performance of the dependent components shows that 51 percent of the variations in the model variables are explained by the sum of the effects of the independent and dependent variables, which is strongly acceptable.

Effect size is another index of the structural fit of the model and is applicable to exogenous independent variables. The effect size index was introduced by Jacob Cohen (1988) and was also discussed in the discussion of calculating the Cohen index. The F2 index for an independent variable shows the amount of change in the estimate of the dependent variable when the effect of that variable is removed. According to Cohen, the values of this index are 0.02 (weak), 0.15 (moderate), and 0.35 (strong), respectively. The coefficient of determination is used to calculate the effect size.

$$F^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

Path coefficient with the presence of the predictor variable = $R^2_{included}$

Path coefficient in the absence of the predictor variable = $R^2_{excluded}$

Based on the above relationship, it is sufficient to calculate the coefficient of determination once by considering the effect of the independent variable in question and then calculate it by removing this effect. Then, the calculated value is interpreted based on the values proposed by Cohen.

The predictive power of the model or redundancy sharing is another criterion for examining the structural model. The predictive ability of the model can be measured using the nonparametric Stone Geiser test (1974), while Q^2 evaluates the success rate of this prediction. Herr et al. (2019) have expressed different values regarding the intensity of the predictive power of the model for endogenous constructs and have determined three values of 0, 0.25 and 0.50 as weak, medium and strong predictive power, respectively. To calculate the Q^2 value in PLS software, the blind folding technique is used.

Table 6. *Effect size criterion (Cohen index)*

Variables	Q^2	F^2
Causal Conditions	0.534	0.465
Contextual Conditions	0.635	0.354
Intervening Conditions	0.500	0.608
Strategy	0.457	0.546
Consequence	0.384	-

As shown in Table 6, the value obtained from the Q2 criterion, which indicates the predictive power of the model for noise-generating structures, indicates that the predictive power of the research structures is estimated to be strong.

Discussion

The results of this research, aimed at “Designing an Intelligent Model for Implementing Industrial Policies Based on Article 4 of the Seventh Development Plan (Case Study: Saipa Megamotor Company)”, show that the successful implementation of industrial policies in such a complex context is the result of a multilayered interaction of causal, contextual, intervening, strategic, and consequential factors. In the causal factors section, the key role of “senior leadership and strategic support of the CEO”, “providing sustainable financial resources”, and “governance requirements of Article 4” was confirmed as the main drivers of the formation of the model. These factors indicate that without managerial will at the macro level and alignment with upstream documents, it is not possible to institutionalize the implementation of industrial policies. In addition, competitive pressures, changing customer needs, and technological requirements (such as pollution and electrification) play an accelerating role as external drivers in the adoption of change. At the level of contextual conditions, technical and digital infrastructure, policy stability, supply chain interaction, and organizational culture were identified as key platforms for successful implementation. The results show that the existence of infrastructures such as data-driven systems (Etemadi et al, 2026; Jamshidi et al, 2026), robotic production lines, and ERP integration significantly increase the capacity to absorb innovation in Saipa Megamotor Company. In contrast, intervening conditions including employee resistance, sanctions-related restrictions, currency instability, and complex bureaucracy have a reducing effect on the effectiveness of policy implementation. In particular (Ashtiyani et al, 2024), the psychological and skill resistance of employees to automation is considered one of the most important challenges in implementing the smart model.

In the strategy section, the findings showed that a set of measures such as the formation of an Article 4 working group, the establishment of a KPI monitoring system, the development of rapid prototyping, reverse engineering (Fatemi et al, 2024), skills training, the creation of industrial consortia, and the digitalization of tender processes play a pivotal role in transforming policy into action. These strategies are in fact the intermediary link between macro-policymaking and implementation at the organizational level and reduce the gap between academic knowledge and industrial needs (Shahsavari et al, 2022). The results also show that participatory approaches (collaboration with universities, knowledge-based companies, and the supply chain) have a significant effect on increasing innovation capacity.

Finally, the model outcomes include “increasing productivity and product quality” (Zarandi et al, 2024), “reducing costs and waste”, “achieving economic and environmental sustainability”, and “strengthening social capital and national brand”. These results indicate that the smart implementation of Article 4 policies not only improves technical and economic performance (Kanani et al, 2025; Shaukat Murad al-Rubaei et al, 2025), but also leads to a change in the cultural paradigm in the organization and the formation of an innovative identity in the automotive industry.

From the perspective of the Structural Equation Model (SEM), the model fit also indicates the favorable structural validity of the model. The results of the path analysis indicate that “causal factors” have the most direct and significant effect on “strategies” high and significant at the 0.01 level, while “contextual conditions” have a positive moderating effect and “intervening conditions” have a negative and significant effect on the relationship between policy and implementation. Also, the path “Strategies → Outcomes” is the strongest path of the model, indicating that the success of policy implementation is ultimately determined by the quality of the implementation strategies. The model fit indices are also reported to be within the desired range, such as CFI and TLI above 0.9 and RMSEA below 0.08, indicating a good fit of the data with the theoretical structure of the model.

In summary, the model presented for Megamotor Saipa Company provides an integrated, multi-level framework based on smart governance logic that can be used as a generalizable model in other automotive industries in the country.

Conclusion

The findings of this study show that if metaverse approaches are developed in the implementation of industrial policies, the decision-making and implementation process of Article 4 of the Seventh Development Plan in Saipa Megamotor Company will be transformed from a traditional and linear structure to an interactive, simulable and data-driven ecosystem. In this approach, the creation of a “digital twin of the engine production line” allows testing policies, simulating resource allocation scenarios, and predicting the consequences of strategic decisions before actual implementation. This reduces policy risk, increases accuracy in resource allocation, and accelerates the realization of industrial goals, and elevates the role of senior leadership from a mere decision-maker to a “manager of the digital policy ecosystem.”

At the infrastructure level, the results show that combining metaverse technologies with existing systems such as ERP, Data Lake and smart production lines leads to the formation of an industrial twin space in which interaction between engineers, managers and even suppliers takes place virtually and in real time. This digital convergence reduces the gap between industry and academia and enables co-design and co-development of products in simulated environments. The findings also show that the use of the industrial metaverse reduces employees’ resistance to technological change and facilitates the learning process and adoption of new technologies through immersive training. The model results indicate that the implementation of the metaverse model of industrial policy implementation has broad strategic implications, including increased productivity, reduced trial and error costs, enhanced innovation and the formation of “smart industrial governance”. Within this framework, Article 4 policies are implemented, monitored, and continuously modified not only at the upstream document level, but also in a 3D simulation space. This will lead to a transition from “experience-based policy implementation” to “simulation and prediction-based policy implementation,” ultimately making Megamotor Saipa a leading model in the metaverse automotive industry at the national and regional levels.

One of the limitations of this study is its focus on Saipa Megamotor Company as a case study. Although this company, due to its strategic role in the country's automotive industry supply chain, provides a suitable platform for designing and evaluating the proposed model, its structural, managerial, and operational characteristics may limit the ability to fully generalize the results to other companies and industries. Also, the automotive industry in Iran has specific conditions, including dependence on government policies, market structure, technological constraints, and legal requirements, which can affect the implementation of industrial policies.

In addition, the country's economic and political environment, especially international sanctions, currency fluctuations, restrictions on access to advanced technologies, and continuous changes in regulations and macro policies, are among the external factors affecting the performance of industrial firms that may affect the effectiveness of the proposed model. Therefore, it is suggested that in future research, the designed model be tested in different companies and industries and the impact of environmental variables and economic conditions on the process of implementing industrial policies be examined in a comparative manner to increase the generalizability and external validity of the findings.

Declaration of Competing Interest

The author declares that he has no competing financial interests or known personal relationships that would influence the report presented in this article.

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