DIGITAL TRANSFORMATION AND ADMINISTRATION INNOVATION

**Citation**: Rezaei Malek Kheili, F., Radfar, R., & Toloie Eshlaghy, A. (2025). Proposing a Technology Development Model Based on Strategic Alliance with a Mixed-Methods Approach in Iran's Automotive Industry. *Digital Transformation and Administration Innovation*, 3(2), 1-15.

Received date: 05 November 2024 Revised date: 19 May 2025 Accepted date: 16 June 2025 Published date: 01 July 2025

# Proposing a Technology Development Model Based on Strategic Alliance with a Mixed-Methods Approach in Iran's Automotive Industry

**Fatemeh Rezaei Malek Kheili [1], Reza Radfar[1]*, Abbas Toloie Eshlaghy[1]**

**1. Department of Technology Management, SR.C., Islamic Azad University, Tehran, Iran**

*Correspondence: r.radfar@srbiau.ac.ir

**Abstract**

The present study was conducted with the aim of proposing a technology development model based on strategic alliance with a mixed-methods approach in Iran's automotive industry. The research methodology followed an exploratory mixed-methods design. Participants in the qualitative phase included 17 experts selected through purposive sampling, comprising professionals in the Iranian automotive industry and university professors with academic and research backgrounds in technology within strategic management. The statistical population for the quantitative phase, which involved fuzzy Delphi to screen dimensions, components, and indicators of the study and determine their significance, consisted of 18 selected experts. Additionally, the broader quantitative phase involved specialists and experts in the Iranian automotive industry, from which a random sample of 283 individuals was selected using simple random sampling. The research instruments included a semi-structured interview for the qualitative phase and a researcher-developed questionnaire based on the qualitative findings for the quantitative phase. For data analysis, the qualitative data were analyzed using the grounded theory method with a systematic approach as proposed by Strauss and Corbin (1998), supported by MAXQDA software. For the quantitative phase, fuzzy Delphi, confirmatory factor analysis, structural equation modeling, and best-worst method were applied using SPSS, SmartPLS, and LINGO software. A total of 203 initial open codes were extracted. After removing duplicates and merging similar codes, 78 final open codes were identified. From the interview text analysis, 14 axial codes under 6 selective codes were obtained. Based on the fuzzy Delphi results, all components of the technology development model based on strategic alliance in Iran's automotive industry were deemed significant and accepted by the experts involved in the study. In the next stage, using path analysis techniques, it was revealed that all path coefficients were greater than 1.96, and the resulting significance levels were below 0.05 and even 0.01, thereby confirming all hypothesized relationships. The prioritization of the indicators of the technology development model based on strategic alliance in Iran's automotive industry was conducted using the best-worst method through LINGO statistical software. The results indicated that these indicators significantly differed from one another. Among the indicators, "focus on innovation and advanced technologies" (0.191) ranked first, while "strengthening the position of domestic brands in the market" (0.029) and "expanding market scope and entering new markets" (0.022) ranked thirteenth and fourteenth, respectively. The findings demonstrated that the development of advanced technologies such as electric vehicles, autonomous vehicles, and connectivity is essential for competing in the global market and maintaining environmental sustainability. Strategic alliances in these areas can accelerate the development of these technologies through resource synergy and increased efficiency.

**Keywords:** Social Responsibility, Insurance Companies, Postmodernism

## 1. Introduction

The rapid technological advancements and intensifying global competition have pushed the boundaries of traditional business models, compelling industries to seek collaborative strategies for survival and growth. Among these, strategic alliances have emerged as a pivotal mechanism to drive innovation, enhance efficiency, and create sustainable competitive advantages, particularly within technology-intensive sectors such as the automotive industry. In this context, the Iranian automotive industry, despite its potential and market size, has struggled to maintain technological parity with global standards due to persistent structural, political, and economic challenges (Minaee et al., 2021). Consequently, designing a strategic technology development model grounded in alliances has become imperative to facilitate knowledge exchange, technological progress, and international integration.

Strategic alliances serve as a crucial platform for firms to overcome internal resource constraints, access external knowledge, and adapt to evolving market demands. They enable companies to pool capabilities and jointly engage in research, development, and innovation, thus fostering mutual growth (Debellis et al., 2021). This form of cooperation is particularly relevant in the automotive sector, which is characterized by high capital intensity, complex supply chains, and the need for continuous technological upgrades. The Iranian context, marked by a legacy of inward-focused industrial policies and insufficient investment in R&D, necessitates the adoption of such alliances to bridge the technological divide and enhance market resilience (Malek Akhlaq & Timouri, 2021).

Technological upgrading through strategic collaboration is increasingly mediated by digital transformation. Industry 4.0 technologies, including artificial intelligence, the Internet of Things (IoT), and blockchain, offer unprecedented opportunities to streamline operations and enhance inter-organizational knowledge sharing (Yu et al., 2022). However, the successful deployment of these technologies hinges on the existence of robust relational capabilities and a strategic vision for integration. Iranian automakers, who have traditionally lagged in the adoption of digital infrastructure, must therefore prioritize alliances that facilitate technological co-creation and capability building (Eslami et al., 2023). In this regard, digital transformation leadership plays a vital role in aligning alliance strategies with organizational culture and goals, particularly within the framework of local socio-cultural dynamics (Sohrabi et al., 2023).

Strategic agility—the capacity to swiftly adapt to changes in the external environment—also plays a key role in shaping successful alliances. This is especially true for family-owned and state-affiliated firms in emerging markets, where bureaucratic inertia and rigid hierarchies often impede responsive decision-making (Debellis et al., 2021). Strategic alliances, when embedded within a culture of agility and learning, can stimulate innovation and mitigate the risks associated with volatile market conditions. In Iran, where the automotive industry operates under both state influence and competitive pressures, the configuration of agile, knowledge-sharing alliances can be a critical lever for performance improvement and sustainable development (Noori & Fazl Zadeh, 2023).

The importance of aligning alliance strategies with market-oriented outcomes has also been highlighted in the literature. Firms that focus on customer satisfaction and loyalty while simultaneously enhancing operational capabilities tend to perform better in the long run (Sheikhi et al., 2023). In the Iranian automobile sector, attention to consumer behavior and market development strategies is essential, particularly in light of shifting preferences and the increasing penetration of foreign products. Strategic alliances can help firms localize production, tailor innovations to consumer needs, and enhance brand positioning in both domestic and international markets (Mousavian & Nikiaslan, 2023).

From a policy perspective, supportive regulatory frameworks and effective government interventions are indispensable for fostering successful alliances. Comparative studies between Iran and other emerging economies, such as Turkey, reveal that successful technology development hinges on coherent industrial policies, state support for innovation, and private-sector collaboration (Rahnamoon et al., 2022). In the Iranian case, despite the existence of privatization initiatives and policy incentives, the implementation has often been inconsistent and fragmented (Sheikh Rabii et al., 2023). Hence, there is a need for more targeted and systemic policy instruments that align national development goals with industrial strategies, particularly in the realm of technology alliances.

Technological catching-up, a critical objective for emerging economies, is influenced not only by the adoption of advanced technologies but also by the absorptive capacity of firms and their ability to learn from partners. Past failures in Iran's catching-up endeavors underline the need for better-designed alliances that focus on knowledge assimilation and capability development, rather than mere technology acquisition (Minaee et al., 2021). Furthermore, the integration of circular economy principles and sustainable supply chain practices can enhance the long-term value of such collaborations, contributing to both environmental goals and business competitiveness (Abbas & Tong, 2023; Yu et al., 2022).

In the face of rapid industrial change, human and behavioral factors are increasingly recognized as pivotal to the success of strategic alliances. Issues such as trust, communication, and shared vision can either facilitate or hinder alliance outcomes. In the Iranian context, organizational culture, leadership behavior, and staff competence play an outsized role in determining the effectiveness of alliance implementation (Gedam et al., 2023). Moreover, the alignment of strategic goals, mutual understanding of expectations, and transparency in resource sharing are critical to avoid conflict and ensure long-term commitment (Rajan & Dhir, 2023).

The global automotive industry is also undergoing a sustainability transition, characterized by an increased focus on green technology, energy efficiency, and environmental responsibility. In this context, strategic alliances have emerged as vehicles for co-developing sustainable innovations, such as electric vehicles, renewable materials, and low-carbon manufacturing processes (Fang, 2023; Sarwar et al., 2023). Iranian firms, by engaging in green alliances, can not only enhance their technological sophistication but also improve compliance with global environmental standards, thereby increasing their appeal in international markets (Abbas & Tong, 2023).

Another critical dimension in alliance-based technology development is supply chain integration. The automotive industry's success heavily relies on synchronized interactions among multiple stakeholders, including OEMs, suppliers, regulators, and consumers. The adoption of blockchain and other digital tools can streamline this integration by improving traceability, enhancing data transparency, and facilitating real-time coordination (Fan et al., 2022; Kamble et al., 2023). In Iran, the modernization of supply chains through alliance-enabled digital solutions could significantly reduce inefficiencies and operational risks.

Additionally, the success of alliances is contingent on a deep understanding of market dynamics and consumer preferences. As global competition intensifies, the ability to differentiate through innovation and localized value offerings becomes paramount. Strategic alliances that incorporate market intelligence and consumer insights can lead to more adaptive product designs, faster response times, and greater market penetration (Koushan & Ebrahimi, 2021). This is especially relevant for Iranian automakers aiming to re-enter regional markets or expand into new segments.

Emerging research also underscores the significance of internal capacity building in alliance-driven innovation. Knowledge transfer mechanisms, training programs, and shared R&D infrastructure within alliances can help local firms upgrade their technical and managerial competencies (Eslami et al., 2023). Such collaborative learning not only enhances innovation capacity but also strengthens firm-level resilience, particularly in uncertain and resource-constrained environments (Utama et al., 2024).

Digital adoption also plays a transformative role in shaping alliance outcomes. Strategic use of ICT tools enhances inter-firm coordination, supports remote collaboration, and fosters real-time decision-making (Raihan, 2023). In Iranian firms, where digital maturity remains uneven, investing in digital capacity building through alliances can act as a catalyst for wider organizational transformation and performance improvement (Lee et al., 2023).

Finally, the configuration of effective performance evaluation systems is essential for tracking alliance success and guiding strategic adjustments. Key performance indicators (KPIs) should align with both strategic goals and operational realities, encompassing dimensions such as innovation output, cost savings, market share, and customer satisfaction (Lee, 2023). Moreover, alliance governance structures must incorporate feedback loops and adaptive mechanisms to respond to emerging challenges and opportunities (Azizi, 2021). Given the above considerations, this study seeks to design and empirically validate a comprehensive technology development model based on strategic alliances tailored to the Iranian automotive industry.

## 2. Methods and Materials

The present study employed an exploratory mixed-methods design. Accordingly, the research design falls within the category of mixed designs, and the method applied is sequential exploratory (qualitative–quantitative), given that no prior model existed in this area and the researcher sought to discover a new model. In the qualitative phase, the grounded theory method was employed. At this stage, the researcher reviewed the gaps in the theoretical foundations related to the technology development model based on strategic alliance with a mixed-methods approach in the Iranian automotive industry, referencing categorized variables, components, and factors. The gaps that were inconsistent with the research topic and target population were excluded, while the remaining gaps were considered as the main factors in the field of technology development through strategic alliances in the Iranian automotive industry. These gaps formed the framework for the interview protocol.

The key dimensions obtained in the qualitative phase were subjected to expert evaluation, and their importance was quantified. Participants in the qualitative phase included 17 experts: organizational professionals in the Iranian automotive industry and university professors with academic and research expertise in technology within strategic management.

For the fuzzy Delphi process in the quantitative phase—used for screening dimensions, components, and indicators of the study and determining their significance—18 experts were selected. The selection aimed to involve the most suitable individuals in terms of deep knowledge, broad perspective, and sufficient experience to ensure valid and reliable results.

The broader statistical population in the quantitative phase consisted of all specialists and experts in the Iranian automotive industry with expertise in technology within strategic management. A total of 384 individuals were selected using simple random sampling.

The research instrument in the qualitative phase was a semi-structured, open-ended interview. In the quantitative phase, the questionnaire was developed based on the qualitative findings.

Given the interpretive nature of thematic analysis, the validity and reliability of the qualitative phase were thoroughly considered. To assess validity, the audit method was used and confirmed by two reviewers. This process was conducted in a consultative manner between the researchers and faculty members. For reliability assessment, two coders independently conducted line-by-line manual coding of selected sources. Upon completion, the results of the two coding processes were compared using the Holsti method.

To examine the validity of the questionnaire in the quantitative phase, expert review was applied. Initially, a draft version of the questionnaire was provided to five experts and faculty members to assess content validity. Their suggestions were subsequently incorporated into the final version of the questionnaire.

For data analysis, grounded theory analysis using MAXQDA software was applied in the qualitative phase. In the quantitative phase, confirmatory factor analysis, structural equation modeling, and prioritization of dimensions were conducted using SPSS, SmartPLS, and LINGO software.

## 3. Findings and Results

In the qualitative phase of this study, among the total of 17 participants, 94% (16 individuals) were male and 6% (1 individual) were female. Regarding age distribution, 12% (2 individuals) were between 30 and 40 years old, 41% (7 individuals) were between 41 and 50 years old, and 47% (8 individuals) were 51 years old or older. In terms of education level, 76% (13 individuals) held a PhD, 6% (1 individual) was a PhD candidate, and 18% (3 individuals) held a master's degree. Regarding work experience, 12% (2 individuals) had 1 to 10 years of experience, 23% (4 individuals) had 11 to 20 years, and 65% (11 individuals) had more than 20 years of experience. All qualitative analysis procedures followed the grounded theory method using the systematic approach of Strauss and Corbin (1994).

From the interviews, a total of 203 initial open codes were extracted. After eliminating duplicate codes and merging similar ones, 78 final open codes were obtained. Upon analyzing the interview texts in this study, 14 axial codes were categorized under 6 selective codes as follows:

**Causal Conditions** *(Factors)*

- Attention to customer satisfaction and loyalty
- Types of strategic alliances
- The need for technological advancement and quality improvement

**Core Category**

- The process of identifying, sharing, and transferring technology among strategic alliance partners in the automotive industry

**Strategies**

- Economies of scale, diversification, and performance improvement strategy
- Learning strategy and development of internal capabilities
- Enhancing the market position of domestic brands

**Intervening Conditions**

- A dynamic and competitive environment
- Effective government policymaking and support

**Contextual Conditions** *(Settings)*

- Focus on innovation and advanced technologies
- Facilitating knowledge exchange and technology transfer

**Outcomes**

- Increased innovation and development of advanced products
- Improved efficiency and competitiveness of automotive companies
- Market expansion and entry into new markets

**Table 1. Extracted Open Codes, Axial Codes, and Selective Codes from Interviews**

| Open Code | Axial Code | Selective Code |
|---|---|---|
| Attention to customer preferences and needs | Customer satisfaction and loyalty | Causal Factors |
| Need to improve safety, comfort, and efficiency features of cars | | |
| Attention to post-sale services and product support | | |
| Creating value from the customer's perspective | | |
| Partnerships | Types of strategic alliances | |
| Licensing | | |
| Joint production agreements | | |
| Joint research and development | | |
| Technology exchange | | |
| Relatively low quality of domestic automotive products | Need for technological advancement and quality improvement | |
| Need to meet international standards | | |
| Need to acquire technical knowledge and advanced technologies | | |
| Need for international investment and cooperation | | |
| Demand analysis and future trends in the industry | Process of identifying, sharing, and transferring technology | Core Category |
| Selecting strategic partners with complementary expertise | | |
| Defining common goals and mutual benefits in technology development | | |
| Developing a framework for cooperation in knowledge and resource transfer | | |
| Forming joint R&D teams | | |
| Planning and coordinating for new technology development | | |
| Using existing knowledge and experience of partners | | |
| Designing and producing prototypes | | |
| Testing and evaluating the performance of developed technologies | | |
| Launching and marketing new products | | |
| Monitoring and measuring collaboration outcomes | | |
| Adjusting goals and structures of cooperation when needed | | |
| Pooling resources and cost-sharing to create economies of scale | Economies of scale, diversification, and performance improvement strategy | Strategies |
| Supply chain integration and environmental adaptation | | |
| Developing complementary products/services through cooperation | | |
| Restructuring and improving alliance member performance | | |
| Transferring advanced technical knowledge through foreign partnerships | | |
| Process standardization and improved quality control | | |

| | | |
|---|---|---|
| Transferring tacit knowledge through joint activities | Learning and development of internal capabilities | |
| Creating organizational learning opportunities from partner experiences | | |
| Sharing technological and market risks among alliance members | | |
| Establishing common technical standards and collaborating with potential competitors | | |
| Joint R&D to achieve advanced and converging technologies | | |
| Gaining customer trust through quality enhancement | Enhancing the market position of domestic brands | |
| Collaborating with high-quality component suppliers | | |
| Improving integration and coordination in the value chain | | |
| Transferring technical knowledge and enhancing internal capabilities | | |
| Increasing innovation capacity and responsiveness to market needs | | |
| Supporting constructive competition and collaboration | Dynamic and competitive environment | Intervening Factors |
| Creating sufficient incentives for joint investment and participation | | |
| Necessity to enhance competitiveness in global markets | | |
| Competing with higher quality imported vehicles | | |
| Developing supportive laws and regulations for strategic alliances | Effective government policymaking and support | |
| Providing financial incentives and facilities to strengthen technological collaborations | | |
| Creating favorable regulatory frameworks for alliances | | |
| Developing legal and industrial infrastructure | | |
| Prioritizing the development of technologies like electric, autonomous, and connected vehicles | Focus on innovation and advanced technologies | Contextual Conditions |
| Level of R&D investment by alliance partners | | |
| Establishing tech parks and innovation centers | | |
| Emphasis on mission-oriented innovation by alliance partners | | |
| Commercialization of new technologies | Facilitating knowledge exchange and technology transfer | |
| Enabling technical cooperation among different companies | | |
| Building infrastructure for knowledge and technology sharing | | |
| Enhancing communication and data transfer infrastructure | | |
| Accessing converging and emerging technologies through cooperation | Increased innovation and development of advanced products | Outcomes |
| Accelerating the development of new products and services | | |
| Enhancing creativity and innovation diversity | | |
| Speeding up the innovation process | | |
| Improving product and process innovation levels | | |
| Knowledge and technology sharing | Improved efficiency and competitiveness of automotive companies | |
| Reducing R&D risks and costs | | |
| Achieving economies of scale and specialization | | |
| Enhancing integration and coherence in the value chain | | |
| Sharing technological development risks among partners | | |
| Upgrading technical and technological capabilities | | |
| Integrating diverse partner resources and competencies | | |
| Improving the quality and performance of automotive technologies | | |
| Access to resources and expertise | Market expansion and entry into new markets | |
| Increased bargaining power and market penetration | | |
| Entry into new markets | | |
| Standardization and technology convergence | | |
| Developing more integrated and compatible technologies | | |
| Access to market feedback | | |
| Entry into new distribution and sales networks | | |
| Diversifying technological fields | | |

In the first step of the quantitative phase, the fuzzy Delphi method was employed to identify the final components and indicators of the study. Based on the expert interviews conducted in the qualitative phase, the screening and assessment of the importance of the items were carried out through a questionnaire using the fuzzy Delphi method, according to expert opinion. Ultimately, all the identified factors in the technology development model based on strategic alliance in the Iranian automotive industry were deemed to possess the expected level of importance and were approved by the subject matter experts. The experts reached a consensus in agreement.

In the continuation of the quantitative phase, the general characteristics of the respondents, such as gender, age, and educational background, are described in Table 2.



**Table 2. Frequency Distribution of Respondents**

| Percentage | Frequency | Characteristics |
|---|---|---|
| 53% | 202 | Male |
| 47% | 182 | Female |
| 14% | 54 | Age 20–30 |
| 33% | 127 | Age 31–40 |
| 38% | 144 | Age 41–50 |
| 15% | 59 | Age 50 and above |
| 28% | 128 | Bachelor's degree |
| 57% | 220 | Master's degree |
| 7% | 27 | PhD student |
| 8% | 29 | PhD |

Subsequently, in order to validate the conceptual model of the study and test the hypotheses, the Partial Least Squares (PLS) method was utilized through SmartPLS software. In Table 3, the factor loadings, Average Variance Extracted (AVE), and Cronbach's alpha coefficients for each construct are presented. The values in this table indicate adequate and acceptable reliability of the constructs.

**Table 3. Indicators of the Constructs**

| Dimension | Component (Latent Variable) | Indicator | Factor Loading | t-value | AVE | CR | Cronbach's α |
|---|---|---|---|---|---|---|---|
| Causal Conditions | Customer Satisfaction and Loyalty | S1 | 0.809 | 4.564 | 0.528 | 0.866 | 0.720 |
| | | S2 | 0.846 | 6.382 | | | |
| | | S3 | 0.848 | 11.250 | | | |
| | | S4 | 0.717 | 8.419 | | | |
| | Types of Strategic Alliances | S5 | 0.868 | 8.432 | 0.670 | 0.890 | 0.840 |
| | | S6 | 0.815 | 10.765 | | | |
| | | S7 | 0.715 | 6.549 | | | |
| | | S8 | 0.725 | 5.378 | | | |
| | | S9 | 0.821 | 8.239 | | | |
| | Need for Technological Advancement and Quality Improvement | S10 | 0.894 | 18.739 | 0.822 | 0.900 | 0.901 |
| | | S11 | 0.717 | 9.099 | | | |
| | | S12 | 0.764 | 7.100 | | | |
| | | S13 | 0.890 | 9.265 | | | |
| Contextual Conditions | Focus on Innovation and Advanced Technologies | S1 | 0.731 | 6.289 | 0.677 | 0.858 | 0.807 |
| | | S2 | 0.917 | 5.311 | | | |
| | | S3 | 0.732 | 6.501 | | | |
| | | S4 | 0.852 | 4.703 | | | |
| | Facilitating Knowledge Exchange and Technology Transfer | S5 | 0.817 | 9.423 | 0.771 | 0.869 | 0.735 |
| | | S6 | 0.844 | 11.902 | | | |
| | | S7 | 0.920 | 7.786 | | | |
| | | S8 | 0.901 | 6.978 | | | |
| Intervening Conditions | A Dynamic and Competitive Environment | S1 | 0.824 | 6.456 | 0.697 | 0.839 | 0.807 |
| | | S2 | 0.942 | 5.918 | | | |
| | | S3 | 0.899 | 4.785 | | | |
| | | S4 | 0.840 | 7.310 | | | |
| | Effective Government Policymaking and Support | S5 | 0.844 | 7.328 | 0.623 | 0.820 | 0.735 |
| | | S6 | 0.922 | 8.592 | | | |
| | | S7 | 0.902 | 11.478 | | | |
| | | S8 | 0.891 | 7.611 | | | |
| Core Category | Technology Identification, Sharing, and Transfer Process | S1 | 0.728 | 7.213 | 0.711 | 0.869 | 0.922 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | S2 | 0.897 | 4.561 | | | |
| | | S3 | 0.804 | 9.601 | | | |
| | | S4 | 0.881 | 6.312 | | | |
| | | S5 | 0.849 | 10.111 | | | |
| | | S6 | 0.825 | 9.895 | | | |
| | | S7 | 0.880 | 5.907 | | | |
| | | S8 | 0.781 | 8.456 | | | |
| | | S9 | 0.752 | 9.605 | | | |
| | | S10 | 0.799 | 6.101 | | | |
| | | S11 | 0.782 | 7.119 | | | |
| | | S12 | 0.863 | 11.729 | | | |
| Strategies | Economies of Scale, Diversification, and Performance | S1 | 0.921 | 7.567 | 0.714 | 0.871 | 0.917 |
| | | S2 | 0.820 | 8.345 | | | |
| | | S3 | 0.811 | 9.789 | | | |
| | | S4 | 0.892 | 12.098 | | | |
| | | S5 | 0.729 | 10.765 | | | |
| | | S6 | 0.804 | 9.365 | | | |
| | Learning and Internal Skills Development | S7 | 0.821 | 8.678 | 0.733 | 0.892 | 0.828 |
| | | S8 | 0.704 | 6.789 | | | |
| | | S9 | 0.805 | 5.890 | | | |
| | | S10 | 0.769 | 8.321 | | | |
| | | S11 | 0.774 | 10.432 | | | |
| | Enhancing Domestic Brand Position | S12 | 0.854 | 9.765 | 0.643 | 0.877 | 0.867 |
| | | S13 | 0.933 | 11.543 | | | |
| | | S14 | 0.882 | 7.987 | | | |
| | | S15 | 0.918 | 6.654 | | | |
| | | S16 | 0.845 | 4.543 | | | |
| Outcomes | Increased Innovation and Advanced Product Development | S1 | 0.801 | 5.378 | 0.724 | 0.874 | 0.902 |
| | | S2 | 0.866 | 7.452 | | | |
| | | S3 | 0.801 | 9.564 | | | |
| | | S4 | 0.887 | 8.456 | | | |
| | | S5 | 0.806 | 6.478 | | | |
| | Improved Efficiency and Competitiveness of Automotive Firms | S6 | 0.821 | 5.209 | 0.800 | 0.830 | 0.910 |
| | | S7 | 0.818 | 7.398 | | | |
| | | S8 | 0.879 | 8.378 | | | |
| | | S9 | 0.913 | 4.654 | | | |
| | | S10 | 0.794 | 9.543 | | | |
| | | S11 | 0.864 | 11.461 | | | |
| | | S12 | 0.780 | 8.617 | | | |
| | | S13 | 0.760 | 5.583 | | | |
| | Market Expansion and Entry into New Markets | S14 | 0.761 | 5.429 | 0.748 | 0.869 | 0.819 |
| | | S15 | 0.918 | 9.678 | | | |
| | | S16 | 0.786 | 10.453 | | | |
| | | S17 | 0.843 | 9.345 | | | |
| | | S18 | 0.921 | 8.876 | | | |
| | | S19 | 0.876 | 5.910 | | | |
| | | S20 | 0.987 | 5.190 | | | |
| | | S21 | 0.724 | 7.670 | | | |

Regarding the factor loadings, since all loadings exceeded 0.50 (t-value > 1.96), all dimensions were included in the analysis, indicating adequate and appropriate construct reliability. To assess discriminant validity, the Fornell–Larcker criterion was applied. According to this analysis, the square root of the AVE for each construct was greater than its correlations with other constructs, thereby satisfying the discriminant validity requirement.

After determining the measurement models, in order to estimate the conceptual model of the research and to verify the existence or absence of causal relationships between the research variables as well as to assess the goodness-of-fit between the observed data and the conceptual model, the research hypotheses were evaluated using the structural equation modeling (SEM) approach.

A critical value of less than 0.05 for the significance level indicates a statistically significant difference between the estimated regression weights and zero, at a 95% confidence level. The output of the conceptual model, generated using SmartPLS software, is presented in Diagrams 1 and 2.

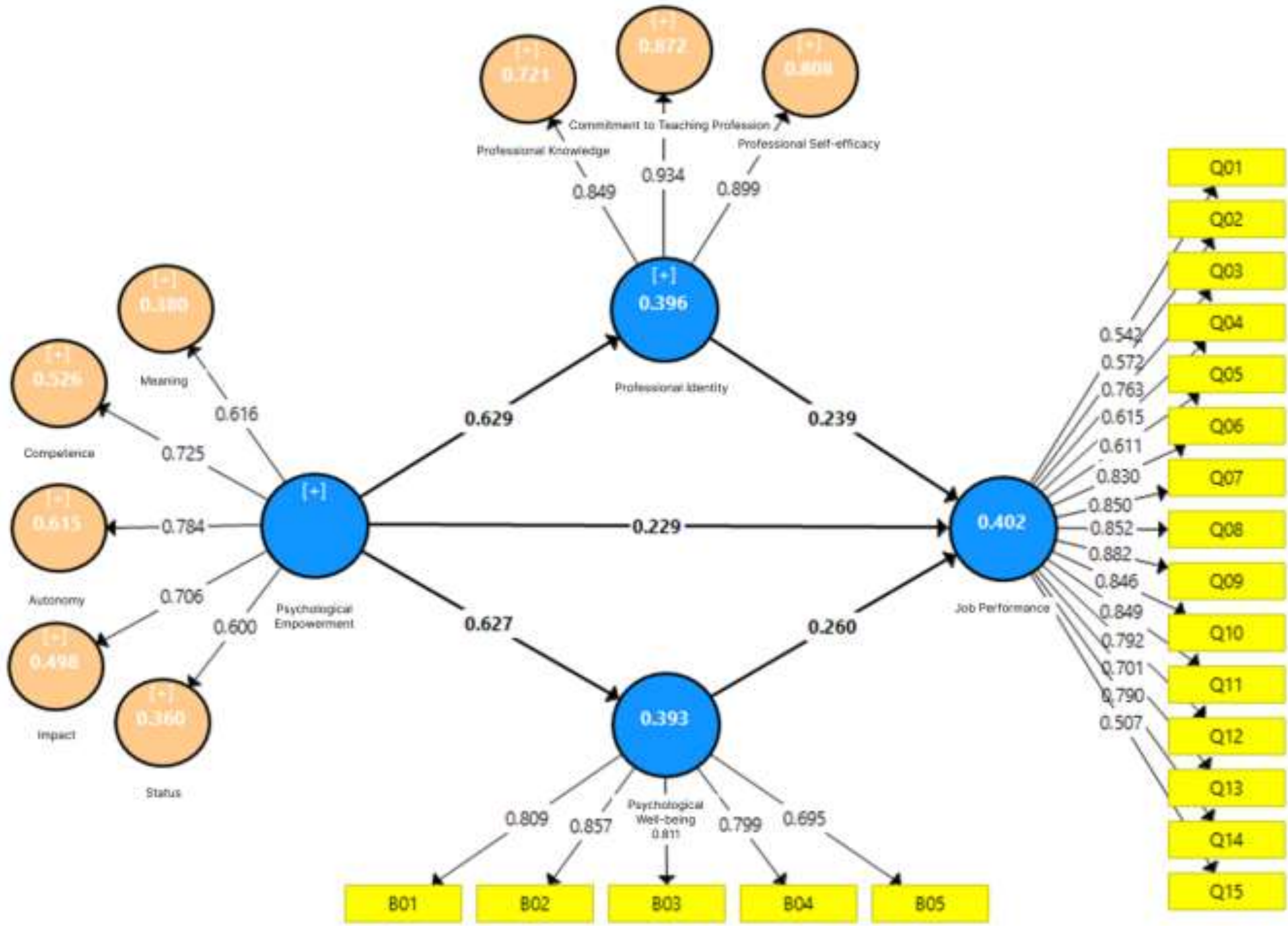


**Figure 1. Measurement of the structural model of the overall framework in the standardized state**

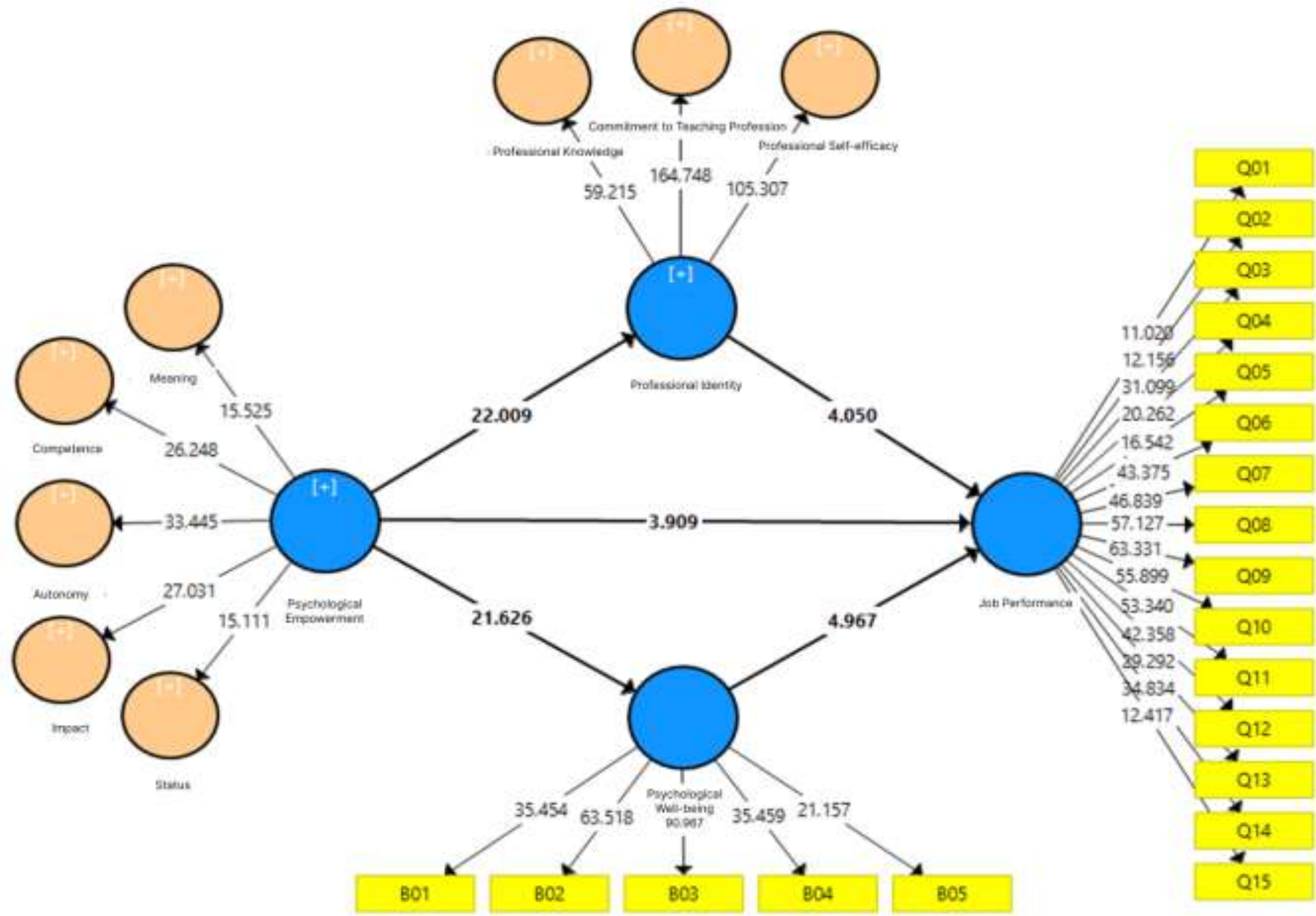


**Figure 2. Measurement of the structural model of the overall framework in the significance state**

At this stage, in order to evaluate the overall fit of the model, the GOF (Goodness-of-Fit) index was used, which covers both the measurement and structural components. The overall model fit value was calculated to be 0.506, indicating a strong model fit.

Subsequently, to examine the relationships between the independent and dependent variables and to confirm the entire model, the path analysis technique was applied. The significance coefficients and the results of the hypothesized relationships in the research model are reported in Table 4.

**Table 4. Significance Testing of Estimated Path Coefficients in the Technology Development Model Based on Strategic Alliance in Iran's Automotive Industry**

| Dimension | Path | Metrics | t-value | Path Coefficient | Standard Error | Significance Level | Result |
|---|---|---|---|---|---|---|---|
| Customer Satisfaction and Loyalty → Technology Identification and Sharing Process | 4.815 | 0.618 | 0.088 | 0.00005 | Confirmed | | |
| Types of Strategic Alliances → Technology Identification and Sharing Process | 8.947 | 0.589 | 0.089 | 0.000 | Confirmed | | |
| Need for Technological Advancement and Quality Improvement → Technology Identification and Sharing Process | 6.387 | 0.533 | 0.099 | 0.000 | Confirmed | | |
| Technology Identification and Sharing Process → Economies of Scale, Diversification, and Performance Strategy | 9.528 | 0.519 | 0.076 | 0.000 | Confirmed | | |
| Technology Identification and Sharing Process → Learning and Internal Skills Development Strategy | 10.468 | 0.367 | 0.087 | 0.00001 | Confirmed | | |
| Technology Identification and Sharing Process → Enhancing Domestic Brand Position | 13.366 | 0.702 | 0.115 | 0.000 | Confirmed | | |
| Focus on Innovation and Advanced Technologies → Economies of Scale, Diversification, and Performance Strategy | 8.999 | 0.367 | 0.073 | 0.000 | Confirmed | | |
| Focus on Innovation and Advanced Technologies → Learning and Internal Skills Development Strategy | 12.233 | 0.628 | 0.067 | 0.000 | Confirmed | | |

| | | | | | |
|---|---|---|---|---|---|
| Focus on Innovation and Advanced Technologies → Enhancing Domestic Brand Position | 7.338 | 0.710 | 0.059 | 0.000 | Confirmed |
| Facilitating Knowledge Exchange and Technology Transfer → Economies of Scale, Diversification, and Performance Strategy | 12.869 | 0.748 | 0.088 | 0.000 | Confirmed |
| Facilitating Knowledge Exchange and Technology Transfer → Learning and Internal Skills Development Strategy | 6.597 | 0.814 | 0.069 | 0.000 | Confirmed |
| Facilitating Knowledge Exchange and Technology Transfer → Enhancing Domestic Brand Position | 11.929 | 0.498 | 0.101 | 0.000 | Confirmed |
| A Dynamic and Competitive Environment → Economies of Scale, Diversification, and Performance Strategy | 6.735 | 0.713 | 0.089 | 0.000 | Confirmed |
| A Dynamic and Competitive Environment → Learning and Internal Skills Development Strategy | 6.660 | 0.477 | 0.099 | 0.000 | Confirmed |
| A Dynamic and Competitive Environment → Enhancing Domestic Brand Position | 8.012 | 0.557 | 0.076 | 0.000 | Confirmed |
| Effective Government Policymaking and Support → Economies of Scale, Diversification, and Performance Strategy | 4.826 | 0.659 | 0.087 | 0.00001 | Confirmed |
| Effective Government Policymaking and Support → Learning and Internal Skills Development Strategy | 4.907 | 0.620 | 0.115 | 0.000 | Confirmed |
| Effective Government Policymaking and Support → Enhancing Domestic Brand Position | 9.566 | 0.642 | 0.073 | 0.000 | Confirmed |
| Economies of Scale, Diversification, and Performance Strategy → Increased Innovation and Development of Advanced Products | 4.603 | 0.425 | 0.067 | 0.000 | Confirmed |
| Economies of Scale, Diversification, and Performance Strategy → Improved Efficiency and Competitiveness of Automotive Firms | 5.133 | 0.700 | 0.059 | 0.000 | Confirmed |
| Economies of Scale, Diversification, and Performance Strategy → Market Expansion and Entry into New Markets | 6.871 | 0.769 | 0.088 | 0.000 | Confirmed |
| Learning and Internal Skills Development Strategy → Increased Innovation and Development of Advanced Products | 9.198 | 0.782 | 0.069 | 0.000 | Confirmed |
| Learning and Internal Skills Development Strategy → Improved Efficiency and Competitiveness of Automotive Firms | 17.600 | 0.801 | 0.101 | 0.000 | Confirmed |
| Learning and Internal Skills Development Strategy → Market Expansion and Entry into New Markets | 9.403 | 0.578 | 0.089 | 0.000 | Confirmed |
| Enhancing Domestic Brand Position → Increased Innovation and Development of Advanced Products | 14.761 | 0.801 | 0.099 | 0.000 | Confirmed |
| Enhancing Domestic Brand Position → Improved Efficiency and Competitiveness of Automotive Firms | 9.322 | 0.578 | 0.076 | 0.000 | Confirmed |
| Enhancing Domestic Brand Position → Market Expansion and Entry into New Markets | 4.899 | 0.712 | 0.087 | 0.00001 | Confirmed |

According to the findings in Table 4, and given that the t-values for all relationships exceed 1.96 and the significance levels are less than 0.05 and even 0.01, all of the above relationships are confirmed.

To prioritize the indicators of the technology development model based on strategic alliance in the Iranian automotive industry, the Best–Worst Method (BWM) was employed using LINGO statistical software. The results indicate significant differences among the indicators. The priorities are as follows:

1. Focus on innovation and advanced technologies (0.191)
2. A dynamic and competitive environment (0.181)
3. Technology identification, sharing, and transfer process (0.148)
4. Learning and internal skills development strategy (0.062)
5. Increased innovation and development of advanced products (0.061)
6. Effective government policymaking and support (0.055)
7. Economies of scale, diversification, and performance improvement (0.053)
8. Improved efficiency and competitiveness of automotive firms (0.045)
9. Facilitating knowledge exchange and technology transfer (0.042)
10. Need for technological advancement and quality improvement (0.040)
11. Types of strategic alliances (0.038)

12. Customer satisfaction and loyalty (0.033)
13. Enhancing domestic brand position (0.029)
14. Market expansion and entry into new markets (0.022)

## 4. Discussion and Conclusion



The results of this study demonstrate that strategic alliances can significantly influence the development of technological capabilities in the Iranian automotive industry. The validated structural model indicates that multiple independent variables—such as customer satisfaction orientation, the variety of strategic alliances, the need to upgrade technologies, a focus on innovation, and facilitation of knowledge exchange—have a direct and significant impact on the processes of identifying, sharing, and transferring technology between alliance partners. These findings strongly suggest that in environments marked by technological lag and industrial fragmentation, like Iran, establishing inter-organizational collaborations is not merely beneficial but essential.

One of the key findings is the significant influence of customer satisfaction and loyalty orientation on the process of identifying and transferring technologies. This aligns with earlier work suggesting that customer-centric strategies in alliances lead to more adaptive and responsive innovation processes (Sheikhi et al., 2023). The high significance of this relationship reflects the pressing need for Iranian automotive firms to shift from supply-driven models toward demand-oriented value creation. Furthermore, the finding that diverse forms of strategic alliances (e.g., vertical, horizontal, and cross-sectoral) positively impact technology transfer highlights the versatility of alliances in providing firms with both tangible and intangible resources (Debellis et al., 2021; Malek Akhlaq & Timouri, 2021).

Additionally, the study confirms that a clear need for technological advancement and quality improvement acts as a driver for initiating and deepening alliance-based collaborations. This is particularly relevant in the Iranian context, where insufficient investment in R&D and restricted access to global technological markets have created systemic weaknesses in innovation capacity (Minaee et al., 2021; Noori & Fazl Zadeh, 2023). These challenges validate the strategic value of alliances in bridging technology gaps and accessing state-of-the-art expertise.

Another noteworthy result is the strong relationship between the technology identification/sharing process and the implementation of three key strategic outcomes: economies of scale and performance enhancement, learning and internal skill development, and strengthening of domestic brands. This confirms previous assertions that strategic alliances do not only serve immediate operational objectives but also contribute to long-term strategic renewal (Abbas & Tong, 2023; Rajan & Dhir, 2023). The high statistical significance of these paths reveals that such alliances in the Iranian automotive industry are capable of functioning as complex learning systems where joint capability building occurs.

The impact of focusing on advanced technologies and innovation was found to significantly influence all three strategic outcomes. This supports the argument that innovation-oriented alliances are more likely to yield positive economic, operational, and branding impacts when aligned with a strong internal commitment to modernization (Fang, 2023; Yu et al., 2022). Firms that actively invest in R&D and foster an innovation culture within the alliance framework are better equipped to develop advanced products and maintain competitive positioning in dynamic markets.

Furthermore, the analysis confirmed that knowledge exchange and technology transfer facilitation are critical success factors for achieving improved performance and competitiveness. This echoes prior literature emphasizing the importance of inter-organizational knowledge flows in enhancing the collective innovation capacity of the alliance network (Eslami et al., 2023; Kamble et al., 2023). In particular, the significance of this path in the Iranian context underscores the potential of strategic alliances to compensate for the weak national innovation systems through collaborative capability building.

The results also illustrate the considerable influence of a healthy and dynamic competitive environment on all three strategic outcomes. This finding is consistent with the proposition that competition fosters innovation, drives efficiency, and encourages strategic experimentation among firms (Kong et al., 2023; Sarfraz et al., 2021). In developing economies like Iran, where market distortions and state monopolies often inhibit healthy competition, strategic alliances can create micro-environments of constructive rivalry that push firms toward better performance.

Government support and effective industrial policy were also found to have a strong direct impact on strategic outcomes. This confirms the centrality of institutional frameworks in enabling or constraining alliance-based innovation (Rahnamoon et al., 2022; Sheikh Rabii et al., 2023). Iranian policymakers, therefore, must recognize the catalytic role that policy stability, subsidies, regulatory facilitation, and infrastructural investments play in ensuring the success of strategic alliances within the automotive sector.



The results further indicate that the realization of strategic outcomes—such as innovation development, efficiency enhancement, and market expansion—depends heavily on the proper design and execution of alliance strategies. This aligns with studies that stress the importance of alliance governance, performance measurement, and partner compatibility in determining alliance success (Gedam et al., 2023; Lee, 2023). Particularly, the study confirms that learning-oriented and scale-driven strategies within alliances have a high return in terms of innovative output and market share growth, highlighting the multidimensional benefits of alliance collaboration.

From a broader perspective, the prioritization analysis using the Best-Worst Method (BWM) reveals that focusing on innovation and advanced technologies ranks highest among all strategic drivers. This underscores the centrality of innovation in shaping competitive trajectories in the automotive industry (Fan et al., 2022; Faridvand et al., 2023). Moreover, the finding that customer satisfaction, despite being statistically significant, was ranked low in priority suggests that Iranian firms still prioritize production-centric and efficiency-oriented metrics over market responsiveness—an orientation that may need to be rebalanced in future strategic planning.

The prioritization of a healthy competitive environment and effective policy support further reinforces the structural and institutional requirements for alliance success. As literature indicates, alliances embedded within well-functioning ecosystems—where government, firms, and knowledge institutions collaborate effectively—are more likely to succeed in achieving long-term developmental goals (Azizi, 2021; ElSayed et al., 2023). The relatively lower ranking of factors like "customer satisfaction" and "domestic brand strengthening" suggests that branding and customer loyalty have yet to receive the strategic importance they merit in the Iranian context.

Ultimately, this study affirms the hypothesis that strategic alliances, if well-designed and supported, can serve as a transformative tool for technological upgrading in the automotive industry. These findings not only align with global research trends but also provide actionable insights for policymakers, managers, and researchers interested in enabling industrial progress in emerging markets through collaborative strategies.

Despite its valuable insights, this study is not without limitations. First, the empirical data was collected from a limited sample of organizations within the Iranian automotive sector, which may restrict the generalizability of the findings to other industries or countries. Second, the study primarily relies on perceptual measures and self-reported data, which may introduce bias in estimating the effectiveness of strategic alliances. Third, the model does not explicitly account for external shocks—such as international sanctions, currency fluctuations, or geopolitical tensions—that can significantly alter alliance performance in the Iranian context.

Future studies could explore longitudinal designs to track the evolution of alliance outcomes over time and assess the durability of performance benefits. Additionally, comparative studies across countries or sectors can help determine whether the proposed model holds under varying institutional and cultural contexts. Researchers are also encouraged to include variables related to digital maturity, environmental sustainability, and innovation intensity to capture the multifaceted nature of modern strategic alliances. Furthermore, qualitative case studies could provide deeper insights into the mechanisms of trust-building, governance, and conflict resolution within alliances.

Practitioners in the automotive and broader industrial sectors should view strategic alliances not merely as transactional partnerships but as dynamic, learning-oriented systems. Managers must invest in developing inter-organizational competencies, build robust digital infrastructures for knowledge sharing, and align alliance goals with customer-centric innovation. Policymakers, on the other hand, should focus on reducing regulatory frictions, offering targeted incentives, and fostering a competitive, innovation-driven ecosystem that supports alliance formation and growth.

**Ethical Considerations**

All procedures performed in this study were under the ethical standards.

**Acknowledgments**

Authors thank all who helped us through this study.

**Conflict of Interest**

The authors report no conflict of interest.

**Funding/Financial Support**

According to the authors, this article has no financial support.

**References**

Abbas, H., & Tong, S. (2023). Green supply chain management practices of firms with competitive strategic alliances: A study of the automobile industry. *Sustainability*, *15*(3), 2156. https://doi.org/10.3390/su15032156

Azizi, S. (2021). A review of the relationship between the economic value of the automotive industry and the competitive strategies of companies. Proceedings of the Sixth International Conference on Management, Global Trade, Economics, Finance, and Social Sciences, https://civilica.com/doc/1223156/

Debellis, F., De Massis, A., Petruzzelli, A. M., Frattini, F., & Del Giudice, M. (2021). Strategic agility and international joint ventures: The willingness-ability paradox of family firms. *Journal of International Management*, *27*(1), 100739. https://doi.org/10.1016/j.intman.2020.100739

ElSayed, N. A., Aleppo, G., Aroda, V. R., Bannuru, R. R., Brown, F. M., Bruemmer, D., & Gabbay, R. A. (2023). Diabetes technology: Standards of care in diabetes. *Diabetes Care*, *46*(1), 111-127. https://doi.org/10.2337/dc23-S007

Eslami, M. H., Achtenhagen, L., Bertsch, C. T., & Lehmann, A. (2023). Knowledge-sharing across supply chain actors in adopting Industry 4.0 technologies: An exploratory case study within the automotive industry. *Technological Forecasting and Social Change*, *186*, 122118. https://doi.org/10.1016/j.techfore.2022.122118

Fan, Z. P., Wu, X. Y., & Cao, B. B. (2022). Considering the traceability awareness of consumers: Should the supply chain adopt blockchain technology? *Annals of Operations Research*, 1-24. https://doi.org/10.1007/s10479-020-03729-y

Fang, Z. (2023). Assessing the impact of renewable energy investment, green technology innovation, and industrialization on sustainable development: A case study of China. *Renewable Energy*, *205*, 772-782. https://doi.org/10.1016/j.renene.2023.01.014

Faridvand, M. M., Elyasi, M., & Radfar, R. (2023). Selecting an appropriate credit guarantee model for technology startups in Iran using network analysis. *Industrial Management*, *15*(4), 595-620. https://imj.ut.ac.ir/article_96333.html

Gedam, V. V., Raut, R. D., Agrawal, N., & Zhu, Q. (2023). Critical human and behavioral factors on the adoption of sustainable supply chain management practices in the context of the automobile industry. *Business Strategy and the Environment*, *32*(1), 120-133. https://doi.org/10.1002/bse.3121

Kamble, S. S., Gunasekaran, A., Subramanian, N., Ghadge, A., Belhadi, A., & Venkatesh, M. (2023). Blockchain technology's impact on supply chain integration and sustainable supply chain performance: Evidence from the automotive industry. *Annals of Operations Research*, *327*(1), 575-600. https://doi.org/10.1007/s10479-021-04129-6

Kong, D. Y., Ma, S. J., Tang, W. C., & Xue, Y. X. (2023). The policy effect on the automobile industry considering the relationship between technology, market and production: The dual-credit policy as an example. *Transportation Letters*, *15*(3), 163-177. https://doi.org/10.1080/19427867.2022.2040280

Koushan, A. H., & Ebrahimi, S. A. (2021). A comparative study of success factors in localization policies for the automotive industry (Case study: Iran and Turkey). *International Business Management*, *4*(2), 1-20. https://jiba.tabrizu.ac.ir/article_13032.html

Lee, C. C. (2023). The effect of strategy alliance mechanism on the operating performance of accounting firms. *International Journal of Public Administration*, *46*(8), 587-601. https://doi.org/10.1080/01900692.2021.2005090

Lee, J., Chua, P. C., Chen, L., Ng, P. H. N., Kim, Y., Wu, Q., & Moon, S. K. (2023). Key enabling technologies for smart factory in automotive industry: Status and applications. *International Journal of Precision Engineering and Manufacturing-Smart Technology*, *1*(1), 93-105. https://doi.org/10.57062/ijpem-st.2022.0017

Malek Akhlaq, I., & Timouri, S. (2021). The application of strategic alliances in the automotive industry. Proceedings of the Sixth International Conference on Interdisciplinary Research in Management, Accounting, and Economics in Iran, https://civilica.com/doc/1275583/

Minaee, M., Elahi, S., Majidpour, M., & Manteghi, M. (2021). Lessons learned from an unsuccessful "catching-up" in the automobile industry of Iran. *Technology in Society*, *66*, 101595. https://doi.org/10.1016/j.techsoc.2021.101595

Mousavian, S. A., & Nikiaslan, H. (2023). Identifying and ranking factors affecting market development strategy adoption in the automotive industry. Proceedings of the Eighth National Conference on New Research in Humanities, Economics, and Accounting in Iran, https://elmnet.ir/doc/21424242-51014

Noori, F., & Fazl Zadeh, A. (2023). Identifying and explaining the model of strategic alliance capabilities in an innovative economy based on a meta-synthesis approach. Proceedings of the Fifth National Conference and the Second International Conference on New Business Management Models in Unstable Conditions, https://civilica.com/doc/1780281/

Rahnamoon, M., Haji Hosseini, H., & Masoum Zadeh, M. (2022). Investigating the causes of success and failure in technology development in the automotive industry in Turkey and comparing it with Iran. Proceedings of the International Conference on Knowledge-Based Production and Job Creation with a Focus on Urban Mobilization, https://civilica.com/doc/1568064/

Raihan, A. (2023). Economy-energy-environment nexus: The role of information and communication technology towards green development in Malaysia. *Innovation and Green Development*, *2*(4), 100085. https://doi.org/10.1016/j.igd.2023.100085

Rajan, R., & Dhir, S. (2023). Determinants of alliance productivity and performance: Evidence from the automobile industry. *International Journal of Productivity and Performance Management*, *72*(2), 281-305. https://doi.org/10.1108/IJPPM-02-2020-0079

Sarfraz, M. S., Hong, H., & Kim, S. S. (2021). Recent developments in the manufacturing technologies of composite components and their cost-effectiveness in the automotive industry: A review study. *Composite Structures*, *266*, 113864. https://doi.org/10.1016/j.compstruct.2021.113864

Sarwar, H., Aftab, J., Ishaq, M. I., & Atif, M. (2023). Achieving business competitiveness through corporate social responsibility and dynamic capabilities: An empirical evidence from emerging economy. *Journal of Cleaner Production*, *386*, 135820. https://doi.org/10.1016/j.jclepro.2022.135820

Sheikh Rabii, A., Sharif Zadeh, F., Vaezi, R., & Ghorbani Zadeh, V. (2023). A framework for evaluating the implementation of privatization policies in the automotive industry (Case study: Iran Khodro Company). https://journals.usb.ac.ir/article_8860.html

Sheikhi, R., Ravanbakhsh, A., Bayat, H., & Asgari, R. (2023). Improving management based on customer experience in the automotive industry. Proceedings of the Fourth International Conference on Management, Economics, and Accounting, https://civilica.com/doc/1705702/

Sohrabi, M., Heydarzadeh Henzaei, K., & Asadi, A. (2023). Analyzing the role of digital transformation leadership in strategic alliances within the framework of Islamic culture in Iranian organizations and companies. Quarterly Journal of Islamic Marketing Research, https://imr.yazd.iau.ir/article_709754.html

Utama, D. R., Hamsal, M., Rahim, R. K., & Furinto, A. (2024). The effect of digital adoption and service quality on business sustainability through strategic alliances at port terminals in Indonesia. *The Asian Journal of Shipping and Logistics*, *40*(1), 11-21. https://doi.org/10.1016/j.ajsl.2023.12.001

Yu, Z., Khan, S. A. R., & Umar, M. (2022). Circular economy practices and industry 4.0 technologies: A strategic move of the automobile industry. *Business Strategy and the Environment*, *31*(3), 796-809. https://doi.org/10.1002/bse.2918