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Identifying Dimensions and Components for Improving Technology Transfer Capabilities in Automotive Safety Systems and Ranking Them Using the Analytic Network Process

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Abstract

Purpose: The present research aims to identify the components for improving technology transfer capabilities in automotive safety systems and to rank them accordingly.
Design/methodology/approach: A mixed method of structural equation modeling and the Analytic Network Process (ANP) has been employed to achieve this. The technology transfer capabilities were derived from a literature review, previous research, and interviews with experts from these companies. The identification and categorization of the 37 indicators into four dimensions were based on the meticulous design of the research questionnaire. To assess the validity of the theoretical model, factor analysis was conducted using structural equation modeling and PLS software, resulting in the removal of five indicators at this stage.
Findings: The confirmed dimensions and indicators significantly impact the success of the technology transfer process. Furthermore, the ranking of the capabilities influencing the success of the technology transfer process was conducted using the Analytic Network Process and Super Decisions software, revealing that the capability for localization and technology deployment ranked as the highest priority, followed by technology negotiation and acquisition, development and commercialization, and technology identification and selection in subsequent ranks.

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Introduction

In developing countries like ours, technology transfer is viewed as a means to achieve economic reconstruction goals and reduce the technological gap, and consequently, it is considered one of the dimensions of industrial policies. However, this transfer should not only facilitate the transfer of technical knowledge and foster industrial thinking within the country but also pave the way for acquiring dynamic technologies and understanding the underlying principles. Given that multinational companies from industrialized nations dominate the global technology trade, the issue of technology transfer is among the most crucial and complex economic decisions for developing countries. Nevertheless, it can only contribute to resolving economic crises and raising living standards if the factors involved in this transfer are implemented scientifically and correctly. Moreover, the technology transfer process often necessitates establishing various communication and collaborative activities between parties that differ in cultural and organizational structures. As effective technology transfer is one way to enhance the level of technology in different industries, it is imperative to address it from various angles. This comprehensive approach is crucial to understanding the complexities of technology transfer fully and exploring how to improve its mechanisms. Considering the points above, the importance of conducting comprehensive academic-industrial research to develop suitable technology transfer solutions and establish a technological foundation within the country becomes even more apparent. An examination of the automotive and parts manufacturing industry over the past three decades reveals growth and development from both quantitative and qualitative perspectives. Despite this, its customers consistently criticized its lack of balanced qualitative growth in line with its quantitative indicators. Undoubtedly, one of the main reasons for this is the absence of a suitable platform and mechanism to enhance the necessary capabilities for transferring appropriate technologies, which can implement suitable technology in the country's automotive industry with the same quality as the source. Despite all these justifications, comparative studies and investigations into the technological development issues of the country's automotive industry show that the technology transfer process in this industry faces numerous obstacles and hindering challenges from various aspects. In light of the above, the present research was initiated with this initial question: Why is there a discrepancy between the level of transferred technologies in the automotive industry and the level of technologies at the source, and why is the level of safety system technologies in cars lower than that of the technology transfer source?

Based on the notion that the qualitative characteristics of automotive parts constitute a significant portion of a car's overall quality indicators, and considering that the domestic parts manufacturing industry has not been able to comprehensively compete with its prominent global counterparts throughout its existence, and also relying on the fact that one of the primary concerns of car customers and regulatory organizations in the country has always been the gap between the safety standards of assemblies and parts related to the health and comfort of users in domestically manufactured cars compared to modern vehicles worldwide - an issue that has led to numerous accidents for car users - the health, safety, and comfort of customers and end-users are crucial factors in car quality. Leading automakers worldwide continuously enhance quality levels in safety systems related to health and comfort by utilizing new technologies such as advanced airbag systems, collision avoidance systems, and adaptive cruise control, resulting from their research and development efforts. Upgrading safety assemblies can reduce injuries to drivers in accidents or mitigate their vulnerability.

This research aims to identify and rank the dimensions and components of improving technology transfer capabilities in automotive safety systems. These dimensions and components could include factors such as knowledge transfer, organizational culture, and absorptive capacity. The results can be utilized by all automotive companies and their supply chains. Organizations such as the Industrial Development and Renovation Organization of Iran, the Ministry of Industry, Mine and Trade, and major domestic automakers can benefit from the findings of this research. Based on this, the main research question is: What are the dimensions and components influencing the improvement of technology transfer capabilities in automotive safety systems? And how are these dimensions ranked in terms of importance based on technology transfer objectives?

Based on the conducted studies, this research is the first of its kind in the field of technology transfer for automotive safety systems in the country. It pioneers identifying and validating the dimensions and components that enhance technology transfer capabilities in automotive safety systems, utilizing a structural equation modeling approach. Another innovation of this research is ranking automotive safety system dimensions through the Analytic Network Process (ANP). In today's world, technology transfer has evolved into a mechanism that transcends inter-organizational collaboration. This is because it necessitates the active participation of all partners and collaborators to collectively enhance their learning and absorptive capacity (Woong Min et al., 2019). The absorptive capacity of the technology recipient plays a crucial role in technology transfer. Before organizations can utilize newly acquired technology for commercial purposes, they must first comprehend it (i.e., absorb and analyze it), as the mere acquisition does not lead to such mastery. On the other hand, Saad et al.(2002) argue that a significant portion of technology is tacit and embedded within individuals and organizational styles. Therefore, effective transfer involves more than just information transfer; it also encompasses the capabilities of the technology owner. In reality, the success of the complex and dynamic technology transfer process depends on various factors originating from different sources. K
hamseh et al. (2020) believe that technology transfer is a complex and dynamic process that results in learning through repetition. The success of the technology transfer process hinges on the complete execution of its phases. A process-oriented approach to technology

transfer ensures that the transferred technology is acquired not only for producing innovative products and services but also for creating a foundation for technology development and creation. Heiden et al. (2016) emphasize that our conceptualization of absorptive capacity necessity as a dynamic organizational capability is crucial in technology transfer. Furthermore, Algieri et al. (2011) state that it is important to recognize that technology transfer is a critical and precise process. If its stages are not fully implemented, it will not only be unhelpful. Still, it may also lead to wasted capital, time, and the weakening of technology, resulting in delayed and costly delivery of the final product to the end-user. Appiah-Adu et al. (2016) also indicate in their research that acquiring knowledge and improving business performance through technology transfer is one option for increasing companies' revenue and wealth. Technology transfer involves acquiring a set of capabilities simultaneously, thus enabling organizations to develop capabilities after acquisition. On the other hand, Bagheri & Davoudi (2017) claim in their research that technology transfer can assist organizations in product innovation, process improvement, implementing productivity and effectiveness solutions, gaining a larger market share, and increasing profits. This is particularly beneficial for small and medium-sized enterprises due to their size and resource limitations.

Chen (2018), in his research, considers South-South technology transfer to be more effective than North-South technology transfer. The reason behind this is the local workforce's cultural compatibility and knowledge level (soft technology). Therefore, utilizing technologies transferred from the South is more efficient and productive. Additionally, Horner et al. (2018) present a model for technology transfer effectiveness within a cohesive framework. In this framework, the characteristics of the transferor and transferee, the transferable items, and the transfer method are crucial factors influencing technology transfer's effectiveness. Market influence and human capital are important in the appropriate and strategic selection of the technology transfer method outside the transfer environment. Horner et al. (2019) demonstrate in their research that supporting organizational infrastructure is necessary but insufficient for improving technology transfer effectiveness. They particularly emphasize the central mediating role of strategic choices and show that the alignment between the strategic choices made by managers and the supporting organizational infrastructure leads to changes in the effectiveness of technology transfer, empowering the audience to make strategic decisions. In their research, Haseli et al. (2017) state that some of the most important solutions introduced by experts for selecting appropriate technology transfer methods include effective communication management with intermediary companies, utilizing managers specializing in technology management, and considering local factors influencing the relevant industry. In their book on technology management, Radfar & Khamseh (2016) view the technology transfer process as comprising three main stages: selection and acquisition, technology deployment, and technology maintenance. These three stages encompass six phases: technology identification and selection, technology acquisition, technology adaptation, technology utilization, technology development and improvement, and technology dissemination. Mazurkiewicz & Poteralska (2017) in their research, identify barriers to technology transfer as technical barriers, organizational-economic barriers, and system barriers. These barriers should be recognized before making decisions about technology development and during the technology transfer process .

The results of the study by Son et al. (2019) indicate that the level of collaboration between public research organizations and industry positively impacts technology licensing agreements and their revenue. Furthermore, technological entrepreneurship, both at the organizational and individual levels, positively affects technology licensing revenue. Steruska et al. (2019) also consider the roles of science and technology parks in supporting technology transfer to be effective in their study. On the other hand, Woong Min et al. (2019) explore the factors influencing the chances of successful commercialization of transferred technologies in their research. This study reveals that strategic management of companies' absorptive capacities and their partnerships with universities and public research institutions are essential components of successful technology transfer in coordination with the intensity of competition the company faces in the market .

Chen (2018), in his study, evaluates four dimensions of the impact of technology transfer: capital goods and equipment, direct skill transfer, indirect skill transfer, and knowledge and expertise. This study shows that the host government, rather than the technology-providing country, has a significant role and capacity in technology transfer and can play a crucial role in negotiating and maximizing the success of technology transfer. Akbari et al. (2015) also concluded in their research that successful technology transfer requires identifying industry goals, required technologies, technological resources, transfer methods, and influencing factors, as well as how to absorb and develop them. Each of these stages necessitates relevant experts. Mokhtarzadeh & Rashidi (2016) state that organizational capability and absorptive capacity enhance product and process innovation, leading to improved technological capability. Manteghi et al. (2015) mention in their research that many elements influence the effectiveness of the technology transfer process. One of these is organizational culture. Organizational culture, influenced by the national culture of countries, can contribute to the success or failure of the technology transfer process. Shah-Abadi & Sajadi (2011) consider technology development and investment in research and development activities as the most important determinants of economic growth.

On the other hand, Kumar et al. (2015) prioritize "regulatory concerns" as the most important dimension in technology transfer. "International institutions," "government officials," and "environmental concerns" are also ranked next. Hosseini Shakib et al. (2014) showed in their research that based on three criteria: capabilities, market and competitors, and the environment, for technology acquisition in the automotive parts industry, the three methods of research and development collaborations, manufacturing, and purchasing are ranked first to third in priority .

Newman et al. (2015), in their research titled "Technology Transfer, Foreign Investment, and High Productivity," investigated the relationship and impact of foreign direct investment and the productivity of domestic companies in Vietnam. The target population was manufacturing companies under the coverage of Vietnam. Based on the results, foreign investment leads to increased productivity due to its direct relationship with technology transfer and its focus on vertical linkages through the supply chain of the researched companies. Furthermore, in the research conducted by Manteghi & Godarz Naseri in 2011, a model with the following six steps was presented for examining technology transfer in the automotive industry: preliminary investigations, analysis of the strengths and weaknesses of the technology recipient, analysis of the strengths and weaknesses of the technology source, examination of the nature of the technology, examination of the transfer process and knowledge accumulation. The sequence of these steps is crucial for successful technology transfer.

Methodology

This research is of an applied nature. Additionally, considering that questionnaires and interviews were utilized to gather the opinions of managers and senior experts from companies related to automotive safety systems, the research also falls into the descriptive survey category. Through a review of the subject literature, conducted research, and interviews with experts in automotive safety systems, the dimensions, and components influencing the improvement of technology transfer capabilities in automotive safety systems were extracted and presented in Table 1. The components were categorized into four dimensions based on the technology transfer process and expert opinions. The research questionnaire was designed based on Table 1, and its validity was confirmed through specialist judgment, while its reliability was verified with a Cronbach's alpha exceeding 0.7.

The statistical population for the ranking section consisted of 11 experts from companies related to automotive safety systems. In the factor analysis section, the opinions of 53 managers and senior experts with postgraduate degrees were used to complete the questionnaires. To ensure further confidence, the adequacy of the sample size was also tested and confirmed using Bartlett's test.

Statistical Analysis

Before analyzing the statistical data, it is necessary to describe them. Descriptive statistics also serve as a step towards identifying the patterns governing them and provide a basis for explaining the relationships between the variables used in the research. As shown in Table 2, the highest frequency in terms of education level is a master's degree, and in terms of work experience, it falls within the range of 11 to 20 years.

Table 1. Dimensions and Components of Improving Technology Transfer Capabilities

Dimensions	Components	Code
I. Technology Identification and Selection (I.S.T)	Identification of technology needs of manufacturers	ist1
	Technology scouting/monitoring	ist2
	Evaluation of technological capabilities in manufacturers	ist3
	Identification of technologies suitable for development within	ist4

	manufacturing companies	
	Identification of technologies leading to product diversification	ist5
	Identification of holders of automotive safety system production technology globally	ist6
	Selection of countries and technology-owning enterprises for choosing suitable technologies	ist7
II. Negotiation and Technology Acquisition (N.A.T)	Formation of a suitable technology transfer team	nat1
	Determination of technology transfer method considering barriers and limitations	nat2
	Training and simulation of meetings, and extraction of different scenarios	nat3
	Preparation of a draft contract for scenarios and alignment with national and industrial development laws	nat4
	Valuation of the transferred technology	nat5
	Conducting effective negotiations and concluding contracts for technology acquisition	nat6
	Inclusion of clauses in the contract that protect the interests of companies under sanctions	nat7
III. Technology Development and Commercialization (D.C.T)	Establishment/modification of an R&D unit structure for process review and identification of newer technologies	dct1
	Upgrading and updating companies' technical knowledge through appropriate technology transfer contracts with leading technology owners	dct2
	Reverse engineering to increase the absorption capacity of technology components	dct3
	Achieving clean technologies for product manufacturing in parts manufacturing companies	dct4
	Development of financing methods for the production of up-to-date products and safety systems	dct5
	Public dissemination and awareness in society regarding imported technologies and product improvements	dct6
	Dissemination of imported technology across all relevant enterprises in the country's industries	dct7
	Commercialization by transferring improved technology to other countries through various methods	dct8
	Protection of intellectual property rights for developed technologies	dct9
	Updating safety system production technology in line with the class of new cars produced in the country	dct10
IV. Localization and Technology Deployment (L.E.T)	Educational planning and upgrading knowledge, awareness, technical, and managerial skills for the localization of imported technology	let1
	Revising organizational structures and necessary processes in accordance with imported technology	let2
	Examining the compliance of imported technology with criteria, standards, and regulations of supervisory organizations in the	let3

	country	
	Examining the compatibility of required raw materials for production in comparison to imported technology and adapting them	let4
	Localizing production knowledge and utilizing appropriate technology in companies	let5
	Enhancing companies' capabilities in production aligned with the class of manufactured cars and diverse product applications	let6
	Developing soft and hard technologies in comparison to the functional and process characteristics of imported technology	let7
	Launching and equipping production lines and related systems	let8
	Managing and developing the supply chain and networking suppliers	let9
	Establishing quality management, calibration, and factory management systems at the level of manufacturers and the supply chain	let10
	Attracting and employing specialized personnel for optimal utilization of new technology capacities	let11
	Developing new marketing methods	let12
	Creating a suitable systematic structure for identifying and evaluating suppliers	let13

Table 2: Respondent Demographics

Frequency	Frequency	Work	Frequency	Frequency	Degree
1.87%	1	1 to 3	20.75%	11	Bachelor's
26.41%	14	4 to 7	45.28%	24	Master's
32.08%	17	8 to 10	33.96%	18	Doctorate
39.62%	21	11 to 20	100%	53	Total
100%	53	Total			

To determine the adequacy of the sample size, the KMO and Bartlett's test was utilized. If the KMO value is above 0.7, it indicates that our sample is sufficient in terms of size.

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.746
Bartlett's Test of Sphericity	Approx. Chi-Square	2230.803
	Df	666
	Sig.	.000

In Table 3, since the KMO value is above 0.7 and Bartlett's test is significant, the adequacy of our sample size is confirmed. To test the validity of the theoretical model of the research and calculate the impact coefficients, the Structural Equation Modeling (SEM) method using PLS software has been utilized.

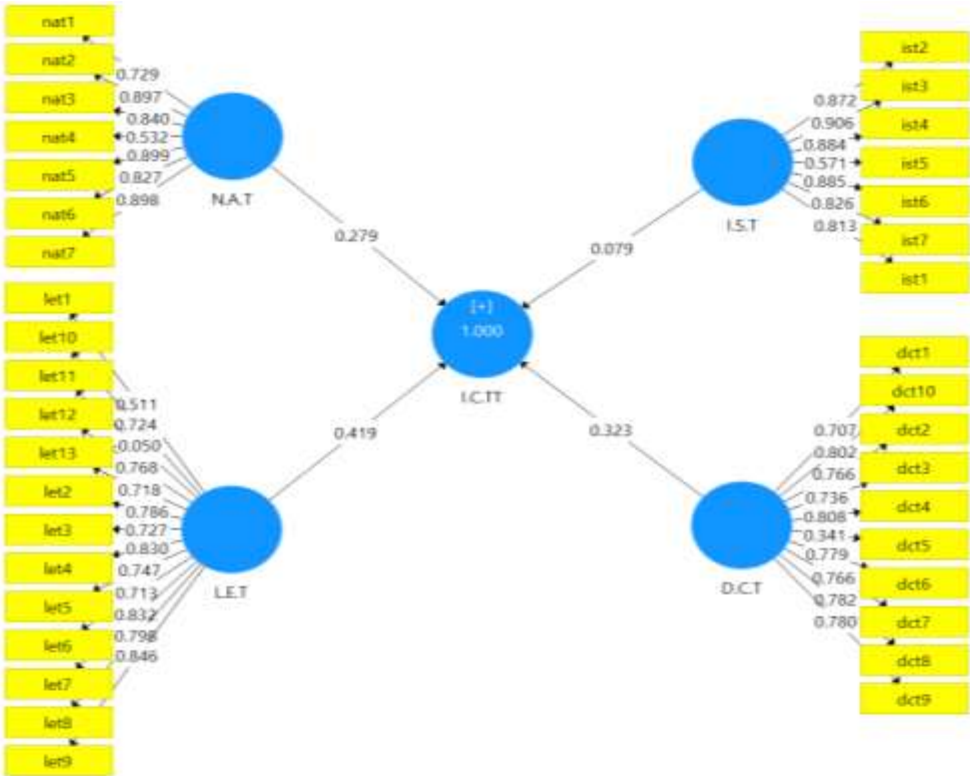

Figure 1. Initial Measurement Model with Standardized Coefficient Estimates

Considering Figure 1, questions in the model with factor loadings less than 0.7 are removed from the model. PLS structural equation modeling software determined that out of 37 indicators related to the research, 5 indicators (dct5, ist5, let1, let11, nat4) had factor loadings less than 0.7 and were removed from the model. The corresponding questions were eliminated to enhance the reliability of the research and ensure convergent validity in the model. Figure 2 illustrates the modified measurement model.

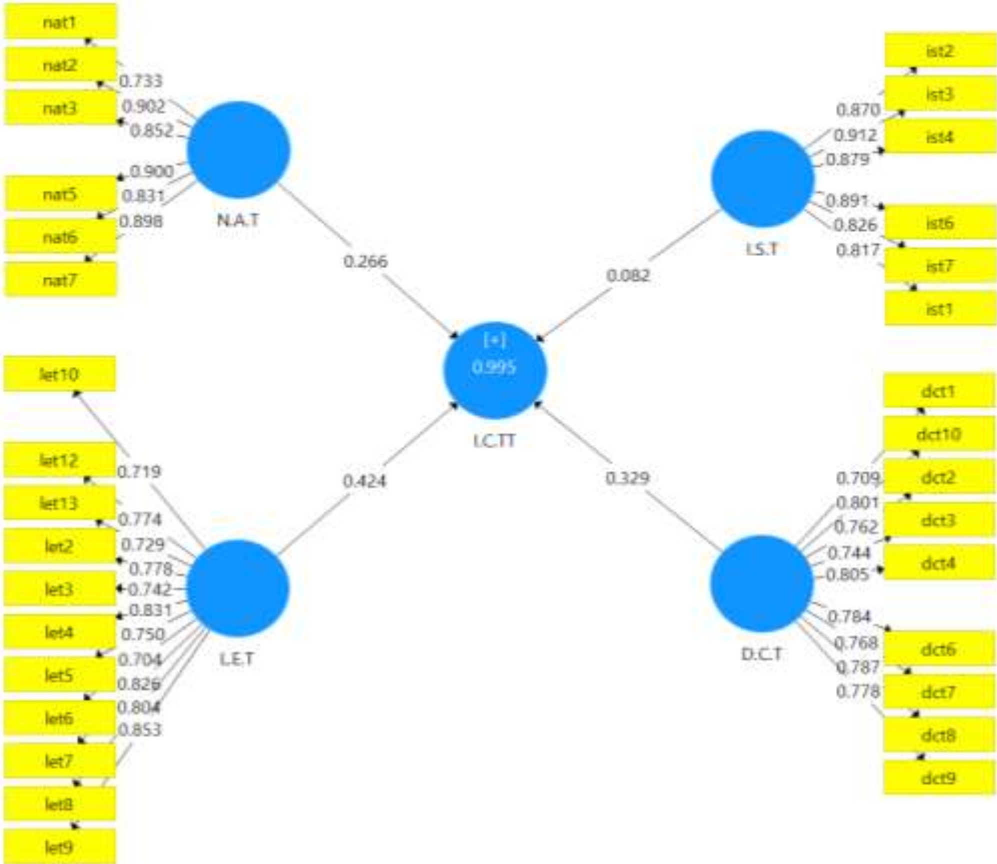

Figure 2. Modified Measurement Model with Standardized Coefficient Estimates

Reliability Test of the Reflective Measurement Model

In accordance with the data analysis algorithm in PLS, after assessing the factor loadings of the indicators, we need to calculate and report the composite reliability, Cronbach's alpha, and average variance extracted (AVE). The results are presented in the table below.

Cronbach's alpha and composite reliability for all factors are above 0.7, and the AVE for all variables is greater than 0.5. Based on these results, the reliability conditions of the research model are met.

Table 4: Cronbach's alpha, Composite Reliability, and Average Variance Extracted (AVE) values for the variables

Dimensions	Cronbach's Alpha	Composite Reliability	communality
D.C.T	0/915	0/930	0/595
I.S.T	0/810	0/948	0/751
L.E.T	0/833	0/943	0/601
N.A.T	0/825	0/942	0/731

Convergent Validity Test of the Reflective Model

To assess convergent validity in this research, indicators such as the significance of factor loadings, average variance extracted (AVE), and comparison between composite reliability (CR) and AVE were used. In this study, all indicators in the modified model have absolute values higher than 2.58 and are significant at a 99% probability level, confirming the convergent validity of the research model. Additionally, all factors have an AVE greater than 0.5, further validating the correctness of the convergent validity results using this indicator. The final criterion for confirming convergent validity is the comparison between CR and AVE. To confirm convergent validity, CR should be greater than AVE. (CR>AVE)

Table 5: Comparison of CR and AVE for Latent Variables

Dimensions	AVE	CR	CR>AVE
D.C.T	0/595	0/930	OK
I.S.T	0/751	0/948	OK
L.E.T	0/601	0/943	OK
N.A.T	0/731	0/942	OK

As observed in Table 5, we conclude that for all latent variables, CR is greater than AVE (CR>AVE). This indicates that the research model possesses adequate convergent validity.

To examine discriminant validity in this research, indicators such as the cross-loadings test, Fornell-Larcker criterion, and the communality index were utilized. In the cross-loadings test, all indicators within their respective factors exhibit factor loadings at least 0.1 higher than the factor loadings of the same indicator in other factors. In the Fornell-Larcker test, the correlation coefficient of a construct with its own indicators is greater than the correlation coefficient of that construct with other constructs.

The communality index measures the model's ability to predict observed variables through the values of their corresponding latent variables. Positive values of the CV-Com index indicate the good quality of the reflective measurement model. According to Hair (2006), the established criteria for this index are 0.02 for weak, 0.15 for moderate, and 0.35 for strong. The values of this index are presented in Table 6.

Table 5: Comparison of CR and AVE for Latent Variables

Dimensions	(=1-SSE/SSO)
D.C.T	0/427
I.C.TT	0/330
I.S.T	0/536
L.E.T	0/434
N.A.T	0/537

- Considering the values obtained from Table 6, we observe that the quality of the research measurement model, based on the criteria, is at a strong level, indicating the good quality of the research measurement model. Therefore, based on the tests related to discriminant validity and the results obtained, discriminant validity in this research is confirmed.

Structural Model Analysis

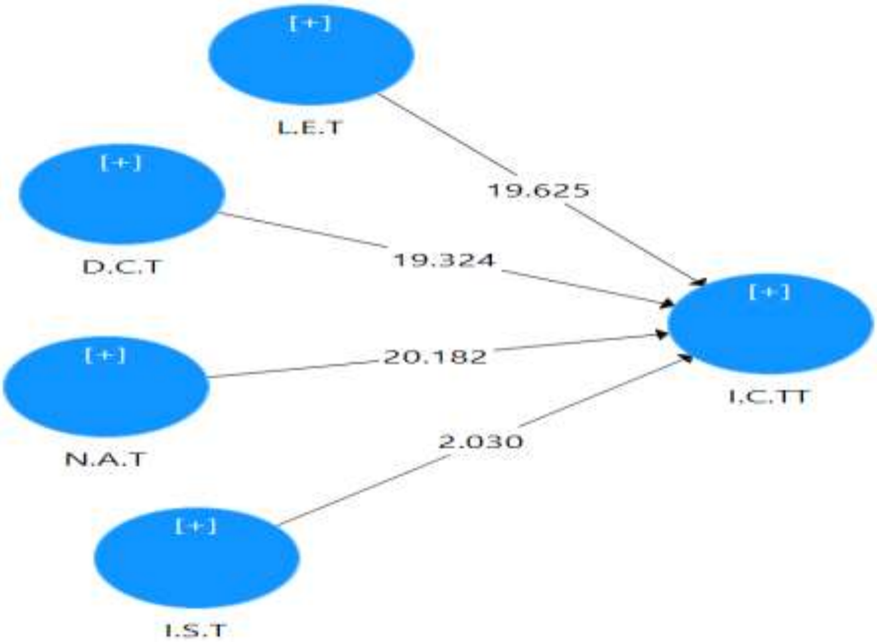

Figure 3: Structural Model with Significant Path Coefficients

After forming the structural model, it must be tested for analysis, a process that underscores the significance of your research. This is done by assessing the significance of relationships.

Testing the Significance of Relationships in the Research

When the relationship between two variables surpasses the absolute value of 1.96, it signifies a significant relationship with a 95% probability. If this number exceeds 2.58, the two variables have a substantial relationship with a 99% probability, a reliable criterion (Hair, 2006). Based on Figure 3, as observed, 3 relationships are significant with 99% confidence, and one relationship (identification and selection of technology) is substantial with 95% confidence.

Adjusted Coefficient of Determination (R Square or R^2) Criterion

The adjusted coefficient of determination is a measure that indicates the relationship between an exogenous variable and an endogenous variable. The three values of 0.67, 0.33, and 0.19 are considered as benchmarks for weak, medium, and strong R^2 values, respectively (Hair, 2006). In this research, this value is 0.995, which falls into the strong category.

Predictive Relevance (Q^2)

The predictive relevance test assesses the quality of the structural model. The three values of 0.02 (weak), 0.15 (medium), and 0.35 (strong) are the benchmarks for this test (Henseler & Chin, 2010). This value for the research model is calculated as 0.334. Based on the obtained value, it indicates the predictive power of the model.

Confirmation of the Final Model Quality with the GOF Criterion

To assess the overall quality of a model, a single criterion called GOF (Goodness-of-Fit) is used. The three values of 0.01, 0.25, and 0.36 are introduced as weak, medium, and strong values for GOF, respectively (Wetzels et al., 2009). This criterion is calculated through the following formula:

$$GOF = \sqrt{\overline{communalities} \times \overline{R^2}}$$

$$GOF = \sqrt{0.669 \times 0.995} = 0.815$$

Considering the obtained GOF value of 0.815, the very good quality of the overall model is confirmed.

Ranking the Dimensions of Improving Technology Transfer Capability in Automotive Safety Systems

Given the internal relationships between the obtained criteria and sub-criteria, the ANP method was used in this research for ranking. In Figure 4, the network pattern of relationships between the criteria (technology transfer objectives) and sub-criteria (confirmed indicators), or the network tree, can be observed, which was drawn based on expert opinions. Additionally, the pairwise comparison questionnaire was completed using the panel formation method with 11 experts. Since the inconsistency coefficient in the SUPER DECISIONS software output is less than 0.1, the reliability of the pairwise comparison questionnaire is confirmed.

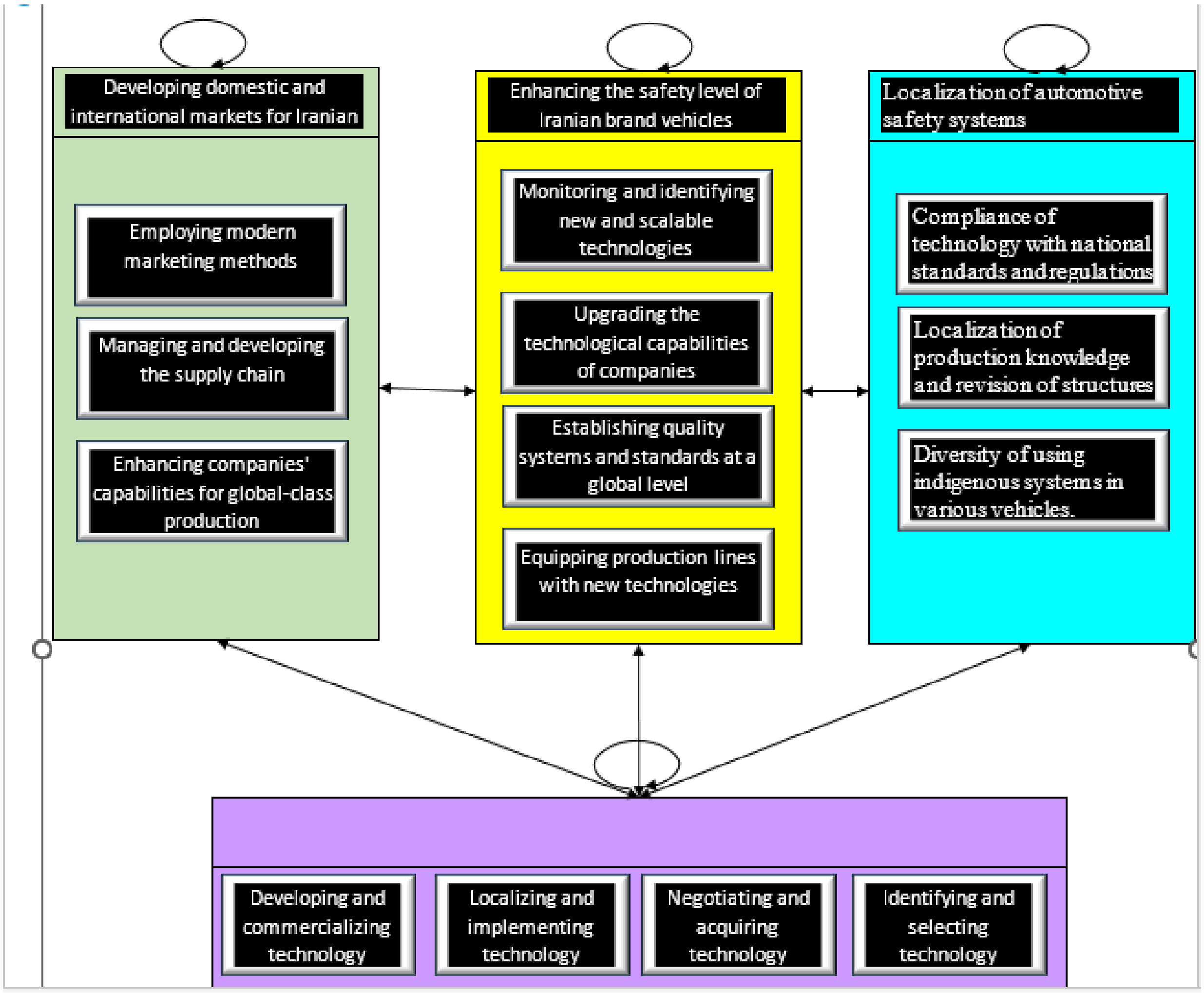

Figure 4: ANP Network Tree

Accordingly, Chart 1 illustrates the ranking of factors derived from the ANP output.

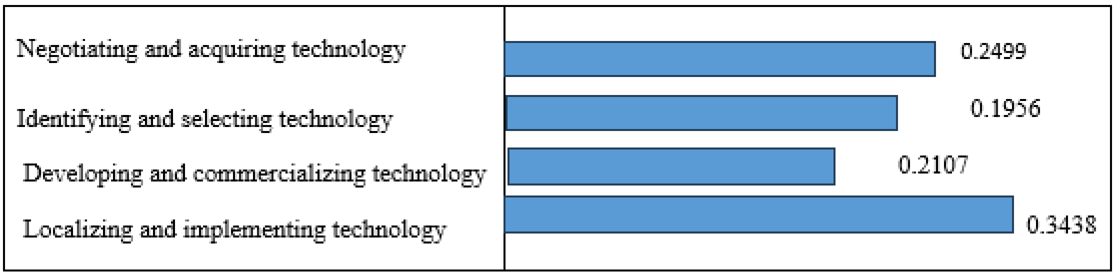

Chart 1: Ranking of Factors Influencing Technology Transfer in Automotive Safety Systems

Results and Discussion

This research aimed to identify the dimensions and components influencing the improvement of technology transfer capabilities in companies related to automotive safety systems.

The technology transfer capabilities in these companies were derived from a literature review, research, and interviews with experts from these companies. Ultimately, 37 capability indicators were identified and categorized into four dimensions, forming the basis for the research questionnaire. Experts examined the questionnaire's validity, and the finalized questionnaire was distributed and collected among the statistical population. To assess the accuracy of the research model, factor analysis with structural equation modeling and SMART PLS software was employed, eliminating 5 indicators with factor loadings less than 0.7.

The research findings indicate that the 4 dimensions and their components influence the improvement of the technology transfer process in automotive safety system companies, and the impact of all 4 dimensions is statistically significant. Furthermore, the ranking of dimensions for improving technology transfer capabilities was conducted using the Analytic Network Process (ANP) method and Super Decisions software. To construct the ANP network, three major objectives of technology transfer in automotive safety systems were utilized: localization of automotive safety systems, enhancing the safety level of Iranian-branded cars and expanding domestic and foreign markets for Iranian-branded cars. The ranking results indicate that the capability for technology localization and deployment holds the highest priority. This result signifies that the capability for technology localization and deployment plays a crucial role in the technological development of automotive safety systems and can significantly contribute to increasing the absorptive capacity of related companies. Therefore, senior managers and decision-makers in the automotive industry should pay special attention to the indicators within technology localization and deployment capability.

On the other hand, considering that within the dimension of technology identification and selection, the indicator of evaluating technological capability in manufacturers has the highest factor loading and influence, it is recommended to establish a technology management system in companies producing automotive safety systems and conduct annual technological capability assessments to identify their technological strengths and areas for improvement. Suitable improvement projects should then be defined and implemented to enhance the level of technological capability in these companies. Additionally, within the dimension of negotiation and technology acquisition, the indicators of determining the technology transfer method considering barriers and limitations and the valuation of transferred technology have the highest factor loading and influence. To strengthen these indicators, it is recommended to conduct training courses on technology transfer methods and technology valuation for technology transfer teams. Furthermore, within the dimension of localization and technology deployment, the indicator of supply chain management and supplier networking has the highest factor loading and influence. To strengthen and improve this indicator, it is suggested that, in addition to including representatives from strategic suppliers in technology transfer teams, knowledge and innovation management, as well as the creation of technological intelligence within them, be implemented by strengthening information technology infrastructures.

Finally, within the dimension of technology development and commercialization, the indicators of achieving clean technologies and updating production technology for safety systems in line with new car models have the highest factor loading and influence. To strengthen these indicators, in addition to transferring sustainable and environmentally friendly technologies that are in a suitable position within the technology lifecycle, it is also necessary to utilize up-to-date global standards for automotive safety systems.

It is recommended that researchers conduct further studies on models for clean technology transfer, technological capability assessment, and world-class technology transfer in companies manufacturing automotive safety systems, considering the results and findings of the present research.

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