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Identifying the optimal strategy for technology development in the Information Communication Technology (ICT) industry in Telecommunication Infrastructure Company

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Abstract

The present study's primary objective is to identify the optimal strategy for technology development in the ICT industry in Telecommunication Infrastructure Companies based on the direct technical competency model. To do so, the study's theoretical foundations and the domestic and foreign-related works have been investigated. The model, the variables, the conceptual model's framework, and the research questionnaire were designed in the next step. The study questionnaire was administered to 169 individuals, including the managers and experts of Iran's ICT industry, after which they were subjected to analysis and preliminary and final examinations in statistical terms for testing the research hypotheses. The results indicated the confirmation of the study's primary hypothesis as well as all three secondary beliefs in such a way that, according to the results of the secondary hypotheses suggesting the existence of significant relationships between the variables, namely "absolute power scale" and "relative power scale and being the key factor," and the dependent variable (Little's strategy competencies for technology development in Iran's ICT industry), it can be eventually concluded that there is a significant relationship between the evaluation scales in the main technical competencies and Little's strategy competencies for technology development in Iran's ICT industry and the primary hypothesis is consequently affirmed for a Little's model stronger than the other models. In the end, suggestions have been presented in line with the study results for the technology development in Iran's ICT industry in line with the scales in Little's model.

Keywords: ICT industry, Main technical competencies model, Optimal strategy, Technology development, Telecommunication Infrastructure Company.

Introduction

The ICT industry is one of the superior industrial resources, and it has a substantial quotient in the emission of greenhouse gases and energy consumption. On the other hand, technology is a primary weapon for competition between companies nowadays, so success in today's world is vividly dependent on technology. On the other hand, inappropriate technology selection may result in irreparable outcomes. This way, technology selection is an essential topic in decision-making about technology transfer. In order to be able to manage the technology optimally, an expanded image and a panorama of its future horizons should be

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attained to the maximum possible extent. In recent studies, the technology development has been divided in comfort research terms into three generations. In the higher generations, the primary scale of the technology development becomes more comprehensive so that the side effects of the technology are reduced. In the fourth generation of technology, comfort is the primary scale of the designing process. Although it might be possibly not necessary to say that the goal of most of the technologies is implicitly comfort, is the main competency of a technology sort is just based on the creation of comfort? Alternatively, is it that the broad sense thereof, i.e., physical, psychological, and social aspects, can be considered the ultimate goal of the technology development in the designing process instead of paying separate attention to the values and well-being (Wei Gu et al., 2021).

The current "Infrastructure Telecommunications Company" was established as an independent company from the Telecommunication Company of Iran during a process between 2004 and 2008, following the policies and macro-plans of the Islamic Republic in order to communicate the policies of Article 44 of the Constitution. In legal terms, as well, the subject “technology development” is one of the pivotal issues of the sixth five-year development plan, which has been pointed out in paragraph C of article 2 of the same law by the rule of which the government is obliged to insert plans related to technology development in the annual budget. The statements of the main competency incorporate an abstract of the technology and trade strategy of the companies. Of course, they are separate and succinct to a large extent, and it seems that they are not useful for the determination of the following: the determination of this that what should be done for taking advantage of competency so that one can enter the new areas of activity. To strengthen the competitive power in various extant products or centralize the investments in technology and R&D, the companies’ managers should perceive the complex streams of technology and work activities constructing these technical competencies. In order to evaluate their companies’ abilities, these details should be provided to them in a more useful and effective manner. They prefer to create a common perception in their organizations to make better decisions about the strategy and investments. Herein, we have also been able to do such things very well (Xin Guo et al., 2021).

Main competencies possess special properties. They bring about superiority and create a competitive advantage. The other feature of them is that this excellence and superiority are translated and turned into perceived value by the customers, and its imitation would become difficult for the rivals, and it can be generalized to new markets for it causes stimulation in the market (Rezvani Tabar et al., 2021).

In general, there are two general sets of competencies definable; based on these two sets, a group of competencies excel the other capabilities existing in the collection of competencies; the first set is the main technical competencies: this is when the majority of the ground-setting key

capabilities are technological (when the primary determinative technology is superiority) and the second set includes the primary marketing competencies; here, the term "marketing" has been used for highlighting the product management, pricing, communications, sales, and distribution (when most of the vital competencies are of the type of ability to communicate with the market). This set of competencies is occasionally termed primary non-technical competencies. On the other hand, the review of the literature on competency signifies that even if training and development of managers' competency is found of importance for the organizations, it is difficult to obtain an applied suitable instrument in this regard, and there is still this question that how an organization can become sure that it has trained its managers in an optimal manner and with the use of suitable tools? Do the applied instrument and method of competency enhancement have the required effectiveness and efficiency? Is this empowerment in line with the organization's objectives, strategy, and mission? Thus, it is necessary to identify, prioritize, design, and implement the competency model for increasing the managers' abilities and creating a meritocratic system in the organization (Kazemi et al., 2022).

The power of the competencies in every set and of any type can be identical. However, the main technical competencies are particularly important for they can repeatedly pass through the market's borders and prepare a basis for the considerable superiority of the product. The rest of this discussion is concentrated on the main technical competencies, for overlooking them would be riskier (Khosroabadi et al., 2021).

The competency model's development process in the organizations can be defined in three stages: preliminary, developmental, and executive. The first stage includes determining the strategy and the goals of the model's implementation and definition of an operational program. The second stage encompasses determining the methodology of the plan's implementation, extraction of the competencies, and construction of a model, and the third stage embraces implementation, evaluation, and updating of the model (Khosroabadi et al., 2021).

Thus, the main issue of the research is that which of the strategies from amongst the ones offered for technology development are optimal based on the indicators of the main technical competencies' model (absolute power scales, relative power, and being a key factor) for the development of technology in Iran's ICT industry in Telecommunication Infrastructure Company? This is the question we are trying to answer in this research paper.

Theoretical Foundations:

Technology Development:

Technology seeks to contribute to the world's change in the hope of a better life. From the perspective of development, the distinction between advanced technology and low-level technology is not important. The thing that matters is the usefulness of the processed products and services resulting from society and the environment to assist economic growth, social equality and justice, and supply of essential needs (Cheng et al., 2021).

In the modern order of the world's economy, the creation of knowledge and technology and proper use thereof are the preconditions for the economic-social systems to keep on striving. This calls on the developing countries, Iran included, to a new and essential challenge. The hasty global changes rule that Iran, as well, should as soon as possible provide itself with the capacities required for entering this phase of development (Gkoumas et al., 2021).

For the governments in the developing countries, the re-designing of the structure of the research-technology organizations that are funded by the general budget as well as the improvement of the facilitation and enhancement of more activities for the researchers and technologists are of much importance for their participation and their obtaining of a higher performance rate and also their paying of more attention to the national needs. In Iran, with the entry of every technology into the country's scientific arena, many job opportunities are subsequently created in the country. Therefore, to preserve dynamicity and keep pace with technological growth worldwide, there is a need for systematic research, creativity, innovation, building trust, discovering the proper and economic ways of production and wealth-creation, and setting the proper work grounds. The youngness of the country's population and increase in the growth rate of university students during recent years made the executive branches and organizations think of developing the sciences and novel technologies parallel to the development of the universally advanced technologies. Furthermore, the high-level documents, including Iran's comprehensive scientific document, the fifth five-year development plan, the commands of the supreme leadership of the Islamic Revolution, and the enactment by the knowledge-based companies for the preparation and setting of the grounds required for the development of the technology and innovation system have all offered strategies and solutions that are per se reflective of the advanced technological topics and institutionalization of their utilization in Iran.

Investigation of the Models of technology Strategy Codification:

During the two recent decades, the elaboration of the technology development strategy has been considered as one of the most vital needs of the various business entities/industries, and many of the experts in this area have categorized it in a level higher than the other operational strategies due to its subtle effect on the other operational strategies adopted by the business entities and industries. The codification of technology development strategy in an organization/ business entity aims at obtaining a superior competitive position and defining the quality with which the long-term and technological objectives can be actualized, and this can take place through the determination of the investment priorities as well as the method of attaining and developing the selected technologies (Gkoumas et al., 2021). Table (1) shows the strategies of technology development and their attributes:

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Table 1: technology development strategies and their properties

Row	Technology development model	Model's properties
1	Porter's model, 1998	- This model has been defined for obtaining the competitive position - The relationships between the collection of activities (value chain) cause a higher profit amount. - In this method, the infrastructure of the human resources management entity, technology development, and procurements are noted. - In this method, the business entity level is considered, with the national level being disregarded (Porter, 1998)
2	Hax and Majluf's model, 1996	- Technology strategy is defined as an operational strategy helping the business entity put its competitive strategy into practice. - Macro-level strategies determine the technological needs, and the strategic technological units are identified based on the technological needs (position-finding approach) (Hax and Majluf, 1996)
3	Mc Kinsey's model, 2010	- A portfolio analysis matrix has been suggested for technology strategy. - This matrix has been laid on the foundation of two pivots, production enhancement vista, and investment output enhancement panorama. - The position of the technologies in the aforesaid matrix includes an investment with a large deal of emphasis, investment with a developmental approach, and investment with a limited defensive support approach (Mc Kinsey, 2010)
4	Little's Model, 2001	- The essential step of the model incorporates the identification of the market sectors - Identification of the required technologies: this is done based on strategic programs, strategic products, and key success factors in every section of the market - Determination of the technologies' strategic importance and selection of the important technologies for the actualization of the key success factors; in this step, the technologies are divided based on their competitive effect into four groups: base technologies (that are vital for the survival and striving of the business), key strategies (having a large deal of competitive effect), recently entering the market strategies (some competitors are testing hat) and newly emerging technologies (having an unknown but promising competitive effect) - Weak and strong points of the business entity: the strong points of the business entity can be classified into five categories: absolute leader, strong leader, favorable leader, defendable leader, and weak leader - Codification of the technology strategy: technology strategy can be codified based on the simultaneous analysis of the weaknesses and strengths of the business entity, on the one hand, and technologies' competitive effect, on the other hand (Little, 2001)

5	Ford and Saren's model, 1996	- A theoretical framework wherein two decisions, namely obtaining technology (endogenous development of technology or its transferring from outside)" and "technology application" (inside or outside the organization), have been dealt with.
6	Chiea's model, 2001	- A dynamic model for the technology development in the business entity's level - Based on Chiea's model, the technology matrix of the function should be determined - This matrix expresses five general strategies, including deepening of the competency, fertilization of the competency, renovation of the competency, completion of competency, and destruction of competency (Chiea, 2001)

Models for Evaluating the Technology Competencies:

Various models are related to the evaluation of technology competencies, and these perspectives and models can be categorized into three general parts, as explained below (Khamseh, 2011)

Table 2: classification of the models for evaluating technology competencies (Khamseh, 2011)

Row	Evaluating the technology competencies models	Properties
1	Technology atlas model	- In this evaluation method, the evaluation of the technology content matters. - The evaluation relies on four components of technology (technoware, infoware, humanware, and orgaware) (Gkoumas et al., 2010)
2	Ford's model,	- It deals with the technology evaluation based on the ability of technology management - This model points to aspects like the development and innovativeness of the technology's level, the strategic importance, and technology's applications and performances (Ford and Saren, 1996)
3	Main technology competency model[4]	- Based on three indicators (indices), namely absolute power, relative power, and being a key factor, the optimal strategy is chosen (Mark R. Gallon, 1995)
4	TIME model	- TIME method evaluates the extant technologies to ease the process of optimal technology transfer

[4] Mark R. Gallon, was the management consultant in the technology committee of PI consultation group in Cambridge, UK, at the time of this article's writing. As a specialist and in designing the strategies based on main pivotal competencies, he played a key role in the designing of PI method and, simultaneously, provided consulting services to large manufacturing companies worldwide from the entire Europe to the US and southeast Asia. He succeeded in acquiring an honor degree in chemistry from York University.

		- In this method, technology is evaluated in four aspects: 1) level of technology development; 2) innovative potential and capability; 3) market potential; and 4) strategic importance of technology (Mendez, 2000)
5	Lall's model, 1992	- In order to assess the technology competency, four primary aspects, namely investment capability, production ability, engineering ability, and communication capability, are proposed (Lall, 1992)

Main Technology Competency Model

The competencies are evaluated through the use of 5-point scales. One useful method for investigating the main competencies is the sum of capabilities and, based on this method, synergy is created, and it features sustainable value and vast capability (see diagram 2). Based on this method of competencies sum, there are always two complementary key competencies; these key competencies are the source of the competency's power, and it is at this point the ability of a company is rendered distinct from the competencies of the other companies. As for 3M, this company has several key competencies at the heart of its primary competency. For example, the technical knowledge in the rheological domain and 3M's competencies in surface coating formulas and constant covering processes, various capabilities, and main competencies can be usefully divided into several types as pointed out beneath:

- Market-relationship competencies: competencies that are used in the market or are completely evident for it: sales, advertisement, counseling, issuance of sale invoices, or monitoring customer satisfaction are amongst these competencies.
- Infrastructural competencies: competencies that are pertinent to the companies' internal operations and are evident to the individuals outside the companies, such as the management information systems or internal training.
- Technological competencies: technical competencies that directly support the status of the goods or services.

This set of competencies can be divided into several groups:

1) Applied sciences competencies: the technical knowledge stemmed from technical knowledge; for instance, the technical knowledge of fields like genetics, life adaptation, demographic factors, nuclear physics, applied statistics, or ceramic materials.
2) Designing and development competencies: various scientific fields used for the transformation of a project: construction of preliminary samples, industrial engineering or software designing
3) Manufacturing competencies: competencies directly support manufacturing or operations such as internal quality control systems,

environmental control or inspection, and final test.

Gellen states that we have noticed that many vital competencies for organizations are technological competencies or communication capabilities with the market. Thus, most of the primary competencies rely on the technological capabilities and communication with the market; we have defined two general sets of competencies and, based on these two sets, a group of competencies gains superiority over the other competencies existing in the collection of capabilities:

- Main technical competencies (CTCs): Most ground-setting key competencies are technological in nature (when the primary determinative technology is superiority).
- Main marketing competencies (CMCs): marketing has been used here for considering product management, pricing, communications, sales, and distribution (when most of the vital competencies are of the type of the ability to communicate with the market). This set of competencies is sometimes termed main non-technical competencies. Thus, based on its three indicators as detailed in Table (3), Gellen's model can be the foundation for choosing the optimal strategy for developing technology. The three indicators of this model encompass most of the properties of technology development strategies.

The power of the competencies in every set and of every type can be identical, but the main technical competencies are particularly important because they can repeatedly pass the market's borders and provide a basis for considerable product superiority. The rest of this discussion is concentrated on the main technical competencies because ignoring them is riskier.

Considering the abovementioned materials and the concept of this model, the indicators of this model can be introduced and encoded based on the table beneath.

Table 3: the model of main technology competencies and the encoding of its indicators

	Indicators of main technology competencies' model		
	Absolute power	**Relative power**	**Being a key factor**
Score	The extent of the competency's optimality inside the company	The amount of the competency's role in offering the best industrial method	The amount of a competency's direct effect on the competitive power
5	It has been completely monitored; there is a trivial and limited possibility for its corroboration	Being notably and undisputedly pioneer	The main determinative of the competitive advantage

4	It is well-developed, but the improvement realm is intermediate	It is equivalent to the best industrial model, but it is not clear whether it will become a pioneer or not	It exerts much direct effect on the competitive power
3	Part of it has been developed, and there is enough room for improvement	It has been developed to the average limit of the industry	It is indirectly significant for the competitive power
2	It is in the beginning stage of development	There is a lot of a road to be taken to the best method	It is not so much important for the competitive power, but it has an indirect effect
1	It is in the newborn stage with an opportunity for being improved	In comparison to the industry's norms, it is intensively underdeveloped	It nearly does not affect the competitive power.

Method and Methodology

The study method is of descriptive type based on data collection. To assess the study's variables, a sample volume of 169 individuals was chosen out of a 300-person population (using Morgan's table); then, questionnaires were administered, and the preliminary and final tests were carried out to examine the hypotheses. Therefore, the present study is of survey type based on the descriptive researches' classification, and it is of applied type in terms of the study objectives.

Data Analysis (Hypothesis Test)

In order to assess the study variables, use was made herein of a researcher-constructed questionnaire containing 20 questions out of which five questions deal with each of the three indicators of the main technical competency model for selecting the optimal technology development strategy in Iran's ICTindustry and five other questions assess the competencies of each of the six technology above development strategies' model (table 4). After testing the convergent and divergent validities as well as testing the reliability and combined reliability (for all of the questions in the questionnaire, Cronbach's alpha coefficient and combined reliability were obtained above 0.7) and following the completion of the sample volume's adequacy test and determining the method of determining the factor load, use was subsequently made of the structural equations method and partial least squares for analyzing the interrelationships of the study variables in order to test the hypothesis using Smart PLS 2.0 and SPSS, version 22. In the end, Little's model was selected as the most optimal and the best technology development strategy for Iran'sICT industry. Thus, the statistical analyses inserted in this article have been offered based on the selected model.

Study's Descriptive Analysis:

Based on the data inserted in Table (4), it is clear that 169 correct data have been gathered

regarding the study's variables. The mean value of the variables' scores ranges between 3.9 and 4.2, with the "being a key factor" having the highest mean. The scattering rate is large in terms of the index of the variations range, and it is between 1.2 and 5. The variable "relative power" has the highest scattering in the standard deviation index.

Table 4: descriptive statistics of the three indicators related to the main technical competency model

Variables	Number	Range of variations	Minimum	Maximum	Mean	Standard error	Standard deviation	Variance
Absolute power	169	3.60	1.40	5.00	3.9207	0.5253	0.68286	0.466
Relative power	169	3.60	1.40	5.00	3.9006	0.5311	0.69045	0.477
Being a key factor	169	3.60	1.40	5.00	4.1716	0.05274	0.68567	0.470
Little strategy's competencies for technology development	169	3.80	1.20	5.00	4.1148	0.05227	0.67952	0.462

(Source: Study Findings)

Testing the Normality, Sample Adequacy, and Model's Quality:

Based on the results of the variables; the normality test, the skewness is in a range from -2 to 2 for all of the variables; also, the kurtosis statistics fall in a range between -3 and 3; the standard error of them is in a range between -2 and 2. Therefore, the condition of non-violation of the data distribution normality has been preserved. Moreover, in order to determine the proper variables, the data would not be suitable for factor analysis if KMO is found below 0.5 and, in case that its amount is found between 0.5 and 0.69, factor analysis can be conducted with more caution; however, in case that its amount is found larger than 0.7, the correlations existing between the data would not fit factor analysis. The output of this test can be seen in the table below. Since KMO has been found equal to 0.834, the study sample volume is adequate for factor analysis. Furthermore, the significant rate of Bartlett's test has been found below 0.05, which indicates that the factor analysis is suitable for identifying the structure of the factor model.

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Table 5: measuring the sample volume's adequacy

Test	Statistics	
Kaiser-Meyer-Olkin (KMO)	Measuring the adequacy of the study sample volume	0.834
Bartlett's sphericity test	Chi-square approximation	2970.042
	Degree of freedom	190
	Significance	0.000

(Source: study findings)

In order to investigate the quality or credibility of the model, use has been made of the commonality credibility index test and redundant credibility index test. Based thereon, since the indices are positive and larger than zero, it can be stated that the model enjoys an acceptable quality and credibility. In addition, based on the calculation of the general fit index (that is obtained based on the calculation of the geometrical mean, commonality values, and determination coefficient (R^2)), the GOF index has been obtained equal to 0.793, which is a strong index indicating the high quality of the model.

Study Hypotheses Test

The relationships of the studied variables in each of the study hypotheses have been tested based on a causative structure using the partial least squares (PLS) technique. In the general model of the study that has been depicted in figure (1), the measurement model (the relationship between each of the observed variables and the latent variable) and the structural model (relationships between the latent variables with one another) have been computed. In order to assess the significance of the relationships, the t-statistic has been offered through the bootstrapping technique, as shown in figure (2).

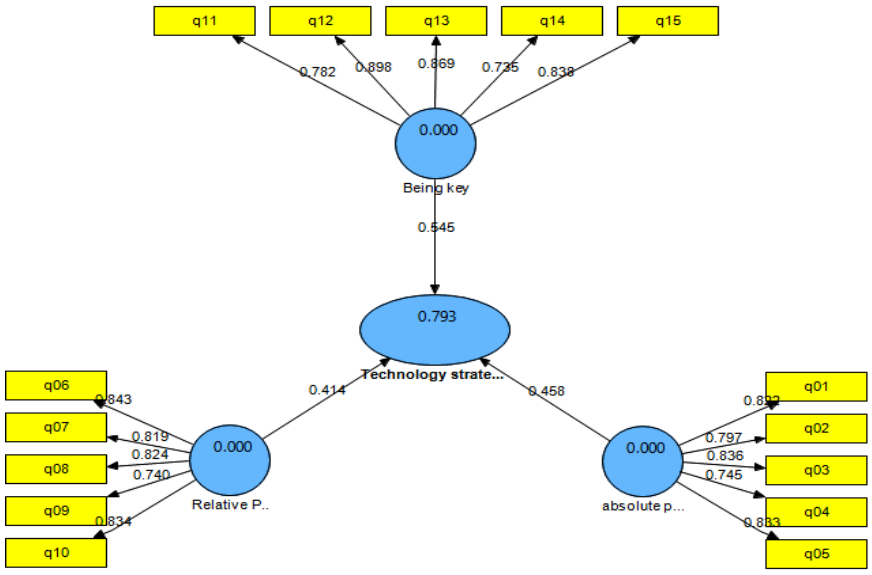

Figure 1: the general study model using partial least squares technique

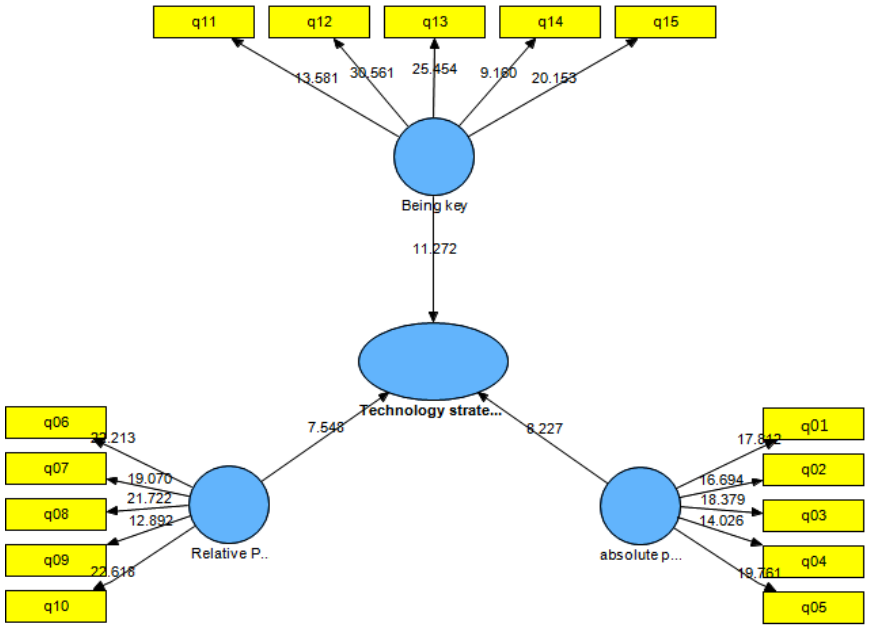

Figure 2. t-statistic of the study's general model using bootstrapping technique

In this model, the output of smart PLS software, the summary of the results pertinent to the significance of the standard factor analysis, and the significance of the study variables' interrelationships have been offered. The path coefficients and their significance, as well, have been given in table (6).

Primary Hypothesis: there is a significant relationship between the three evaluation indicators of the main technical competencies model and the technology development strategy competencies for Iran'sICT industry.

Table 6. path coefficients for Little's model

Path direction	Effect	t-statistic
Technology strategy←being a key factor	0.545	11.272
Technology strategy←relative power	0.414	7.548
Technology strategy←absolute power	0.458	8.227

(Source: study findings)

Secondary Hypothesis One: there is a significant relationship between the absolute power in the model of the main technical competencies and the technology development strategies' competency for Iran'sICT industry.

The intensity of the absolute power scale's effect on Little's strategy competencies for the development of technology in Iran's ICTindustry is equal to 0.458, and the test's probability statistic has also been obtained equal to 8.227, which is larger than the

critical t amount in a 5% error level, i.e., 1.96, and this indicates that the observed effect is significant. Therefore, it can be stated with a 95% confidence level that there is a significant relationship between absolute power scale in the model of the main technical competencies and Little's strategy competencies for the development of technology in Iran's ICT industry, so the first secondary hypothesis is confirmed.

Secondary Hypothesis Two: there is a significant relationship between the relative power in the model of main technical competencies and the technology development strategies' competencies for Iran's ICT industry. In the end, the intensity of the relative power scale's effect on the technology strategy competencies has been found higher than the other technology development strategies and equal to 0.414, and the test probability statistic, as well, has been obtained equal to 7.548, which is larger than the amount of critical tin a 5% error level, i.e., 1.96, which indicates that the observed effect is significant. Therefore, it can be stated with a 95% confidence level that there is a significant relationship between "being a key factor" in the model of the main technical competencies and Little's strategy competencies for technology development in Iran's ICT industry, so the second secondary hypothesis is confirmed.

Results and Suggestions:

Results

Considering the results of the secondary hypotheses that confirm the existence of significant relationships between the variables "absolute power" and "relative power" and "being a key factor" with the dependent variable (Little's strategy competencies for technology development in Iran's ICT industry), it can be in sum concluded that there is a significant relationship between the evaluation scales in the model of main technical competencies and Little's strategy competencies for the technology development in Iran's ICT industry, so the primary hypothesis for Little's model is stronger than that for the other models. The summary of the study results can be seen in Table (7).

Table 7: summary and summation (for Little's model)

Result	Hypothesis		Direction	Impact	t-statistic	Result
Confirmation	Primary hypothesis	Secondary hypothesis	Development strategy←absolute power Little's technology model	0.458	8.227	Confirmed
		Secondary hypothesis	Little's technology strategy←relative power	0.414	7.548	Confirmed
		Secondary hypothesis	Little's technology strategy←being a key factor	0.545	11.272	confirmed

Recommendation

One useful way to investigate the main competencies is, to sum up, the competencies based on which synergy is created, enjoying the sustainable value and extensive capability. Based on the competencies sum method, there are always two supplementary key competencies; these key competencies source the competency power, and it is at this point that a company's ability becomes distinct from that of the other companies. Considering the study results, the following suggestions have been made:

Based on the significant relationship between the absolute power and Little's strategy for technology development in Iran's ICTindustry, it is suggested that sales, advertisement, consultation, and supervision on customer satisfaction can improve these competencies, so strategies complying with these competencies should be regulated. Based on the significant relationship between the relative power and Little's strategy for technology development in Iran'sICT industry, it is suggested that the management information system or internal training should be improved so that the staff members can have the skills and competencies required for offering high-quality services to the organization.

Considering the significant relationship between the scale "being a key factor" and Little's strategy for technology development in Iran'sICT industry, it is suggested that the internal quality control systems, environmental control systems or inspection systems, and final test systems should be very well investigated and reviewed to be able to offer high-quality products to the market.

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