A NEW MODEL FOR ANALYZING AND MEASURING THE SUCCESS OF INTERNATIONAL TECHNOLOGY TRANSFER (ITT) IN DEFENSE JOINT VENTURES - A CASE STUDY FROM TURKEY

M. Atilla Öner[*], Hamdi Kaygusuz[**],

ABSTRACT

Due to the differences between defense industry and civilian industry, International Technology Transfer (ITT) success measurement models that are being applied to civilian joint ventures may prove difficult to be used in defense ITT. In this study a new model has been developed in order to measure and analyze the success of ITT in defense joint ventures in Turkey from the transferee government and firm point of view. This model has been offered as an alternative to the added-value model that is being used by the Government of Turkey as a local content indicator in order to measure the success of ITT in defense joint ventures. The model is applied in one case. The weights of the proposed model components were determined by AHP as people 0.303, system 0.322, organization 0.184 and knowledge 0.190.

Keywords: *AHP, international technology transfer, model, defense industry, Turkey*

---

[*]Assist. Prof., Yeditepe University, Dept. of Bus. Admin., 34755 Kayisdagi, Istanbul, Turkey
[**] MS Student, Yeditepe University, Dept. of Systems Engin, 34755 Kayışdağı, Istanbul, Turkey

1. INTRODUCTION

The accelerated technological change has become a fact and will continue to challenge industrial and societal development in the 21st century [1]. Technology is becoming more important and necessary than that of past day by day. One of the main reasons of technology adoption is the globalization of the world. As the world globalizes, the science and technology also globalize. The globalization of science and technology describes the international technology transfer (ITT) process beyond the borders of nations. The concept of globalization of technology results with ITT.

Due to the differences in the technological levels of countries, they may be classified as developed, developing and underdeveloped. There is always a technological gap between these countries. Transfer of technology aims to close this gap [2, 3]. Sharif [4] actually prefers to use the term "technology transaction or exchange" in place of "technology transfer" in order to avoid "misunderstanding" and "unnecessary north-south polarization".

The underdeveloped and developing countries are willing to obtain high technologies through ITT with the goal of improving their technological infrastructure. The acquisition of technology takes place in one of the technology transfer modes such as license, joint venture, foreign direct investment, franchising, etc. ITT is a very complex process because the investment sizes, the infrastructures of firms, the phases of product life cycle (PLC), the aims of firms, the phases of technologies, the nature of contracts and types of transferee and transferor are all different in each ITT process. In such an environment it is very difficult to measure the success of ITT.

In this study a new methodology has been developed in order to measure and analyze the success of ITT in defense joint ventures in Turkey from the transferee government and firm point of view. The next section reviews literature on international technology transfer. Section 3 introduces and evaluates the current international technology transfer model used in defense joint ventures in Turkey. Section 4 gives the methodology of the present study. The new proposed model is given in Section 5. Section 6 gives the model application and discussion of results.

2. LITERATURE REVIEW

The vast literature on international technology transfer may be grouped and discussed under different headings.

Pre-ITT success approach

Pre-ITT term has been used for the period before signing the deal of ITT. In this period "partner selection" assessments, "possible transfer returns and costs" assessments, assessments of "manufacturing fitness for technology transfer", "gap" assessments etc. are performed in order to decide ITT [5, 6, 7].

The literature review on pre-ITT success approach focuses on ''assessment of relative cost and feasibility of ITT'' that is based on four criteria [8]:

1. The complexity of product and production of techniques being transferred
2. The transfer environment in the transferor and transferee countries
3. The absorptive capabilities of the transferee
4. The transfer capability and profit maximization strategy of transferor.

Among the four criteria listed above

''*assessment of the absorptive capabilities of transferee*'' seems to be the hardcore issue of the Pre-ITT period that is substantially based on forecasting and foreseeing the future. Capacity to assimilate advanced technology is generally described as the combination of [9]:

1. The capacity to recognize what can be transferred directly and what might be adapted for transference

2. Adapting advanced technology for application in the transferee's economy

3. Restructuring the context of operations to provide a more hospitable environment for the advanced technology.

Negotiation success

Negotiation by two sides to affect the items of deal in their favor is a key issue in ITT. Some authors believe that a successful ITT can be achieved through a negotiation phase executed successfully between transferors and transferees although transferors seem to be the advantageous ones [5, 10, 11]. However, this phase should not be considered independently. If the Pre-ITT assessments are evaluated precisely, and the prerequisites are foreseen wisely, the negotiation phase is to be achieved successfully.

Negotiation process is generally conjured up as a dialog in order to influence the other party, using the power in each party's hands. As mentioned above, the most powerful resource is the 'technology that is to be transferred'. Transferor firm will have great haggling power if it is capable of providing the transferee firms with [11]:

1. An export channel

2. Hard currency earning potential

3. A technology that is not locally available

4. An ITT channel that has more advantages than others

5. A reasonably priced technology

6. A long term arrangement that can feed technological enhancements

7. A prestigious brand name

8. Prior experience in ITT

On the other hand transferee firm has a strong haggling position when [11]:

1. It has strong technological absorption capability

2. It has strong domestic marketing capability and reputation.

3. It is a big user of product produced by supplier firm

4. It has a convenient geographic location or access

5. It has a direct contact in a governmental agency

6. It is profitable

7. It has a strong position in the procurement of local raw material

8. It is not a direct competitor of the supplier firm

9. It can provide the transferor firm with complementary technology

10. It has strong ties to a financial institution.

It's a well-known fact that the success of ITT activities in each phase of ITT is heavily influenced by the extent of personal contact and mutual respect between the groups involved [12].

Literature review shows that negotiation phase is full of traps among the complexity fashioned by problems related with copyrights, royalties, rentals on equipment, technical assistance, know-how, off-set, barter, management contracts, donations, unilateral transfers, loans, ITT modes and balance of

payments. Most of the developing countries having huge budget deficits acknowledge that these deficits are because of ''the flaws in the transaction period of ITT'' [13].

Implementation success approach

Implementation is the period that starts after signing the deal. The success of ITT during the ongoing ITT process is generally assessed by the transferee country based on the degree of *localization of technology* or *product* especially in defense industry.

Localization term so far has been used for the localization of material forming the product.

In fact, the most frequently used variables in the technology studies were the "degree of mechanization, flexibility, operationality of sub-goals and the amount of technical knowledge required by the job". More recent studies have been classified according to whether technology is operationally defined in terms of materials, operations, or knowledge [14].

Success approach of transferor and transferee firms

ITT success can be thought both from the point of view of transferee and transferor firms. The success indicators of ITT changes according to benefits transferor and transferee firms.

Literature review on success of ITT from transferor and transferee firms shows that 'success' can be reached through having an 'effective business organization' (private or governmental) while overcoming the barriers listed below[15]:

1. Demand barriers (There may not be sufficient demand to national production)

2. Capital barriers (Local producers may not have or be able to obtain the capital to utilize the technology)

3. National resource barriers (a nation's commercially-developed natural resources may be inappropriate for effective utilization of technology)

4. Labor-cost barriers (Low labor cost relative to the other costs may discourage the application of a particular technology)

5. Technological barriers (Local producers may not have the skills or education to absorb the incremental technological know-how)

6. Scale barriers (Foreign producers may have economies of scale that cheapen costs vis-à-vis host nation producers; without government protection, national producers may have no possibility of meeting foreign competition)

7. Infrastructure barriers (There may not be sufficient supporting services or complementary techniques to warrant diffusion)

8. Cultural barriers (There must be values and norms of behavior conducive to the absorption of technology)

9. Language barriers that can slow technology absorption.

The transfer of technology between transferor and transferee firms evolves in three phases and clearly last phase – the phase of learning how to learn as well as to use what others have learned is quite different and difficult from the earlier phases and costly to achieve [16]:

1st step : Material transfer

2nd step : Design transfer (transfer of design, blueprints, and the ability to manufacture the new product in the recipient country)

3rd step: Capacity transfer which occurs when the capacity to adopt the new item to local conditions is transferred.

Government's success approach

From the transferee government point of view (especially in defense industry) implementation period requires fulfilling the 'controlling' responsibility of government after signing the deal. Transferee government's carte blanche of controlling entails fulfilling the negotiation terms by two sides throughout the process of ITT although the word of 'audit' sometimes annoys transferor and transferee firms which have already 'close' relations with each other.

The success indicators change in all phases of ITT according to benefits of the transferor and transferee government. The transferee government's benefits focus on these items [10, 17]:

1. Reduced energy consumption
2. Contribution to local technology or energy efficiency of the production
3. Job creation in the country
4. Foreign currency savings, eventual earning, exportation.
5. Performance of the product
6. Localization of technology
7. Investment increase of the transferor
8. Minimum dependence on foreign companies and countries, technical independence
9. Decreased control of transferor over the ITT process
10. Non-existence of political threats of the transferor country
11. Commitment to contracts

The above review proves the multi-dimensionality of international technology transfer. In the next section, we will briefly examine the nature of defense industry and the existing model for international technology transfer in Turkish defense ministry.

3. DEFENSE JOINT VENTURES IN TURKEY

3.1. Nature of defense industry

The civilian industry and defense industry are different from each other because of the differences between the market of defense industry and civilian industry. These differences are listed in Table 1.

Because of these differences in these two markets, ITT in defense industry shows different features from the civilian industry. On the other hand, transferor government's expectations from defense-oriented ITT focus on these items [8]:

1. Political effect and control
2. Strategy of expanding market
3. Cheap labor force in the recipient country.

Although some theorists argued that ITT affects the transferor country's economy negatively, in terms of overall benefits, employment and lead, recent studies, however, indicated growing support for the notion that ITT benefits the transferor country economically and technically through gaining access to the world's scientific and technical capacity. Furthermore other studies also claimed that technology leakage during ITT process had no adverse effect on competitiveness of transferor countries [19]

TABLE 1: DIFFERENCES BETWEEN CIVILIAN AND DEFENSE MARKET [18]

CIVILIAN MARKET	DEFENSE MARKET
There are too many firms.	There are a few firms. These are usually large in size.
Prices are determined based on marginal costs	Prices are determined based on total costs.
Prices are determined based on marginal benefits.	Prices are determined based on required military performances
Market reaches the balance steadily.	There may be unsteady attitudes in the market.
There are no governmental restrictions.	Decision maker is government
The volume of market is determined by the seller or customer.	The volume of market is determined by government through laws.
There are too many customers.	There is a single customer, that is, government.
Sellers develop new products based on potential market analysis.	Customer defines its needs. Then seller initiates product development and production activities.

Transferee government's expectations from defense-oriented ITT focus on the term of "localization of technology" because of the following reasons [8]:

1. To close the gap
2. To take the measures in case of embargo, in other words, will of self sufficiency in technology.
3. To prevent the capital flow to foreign countries.

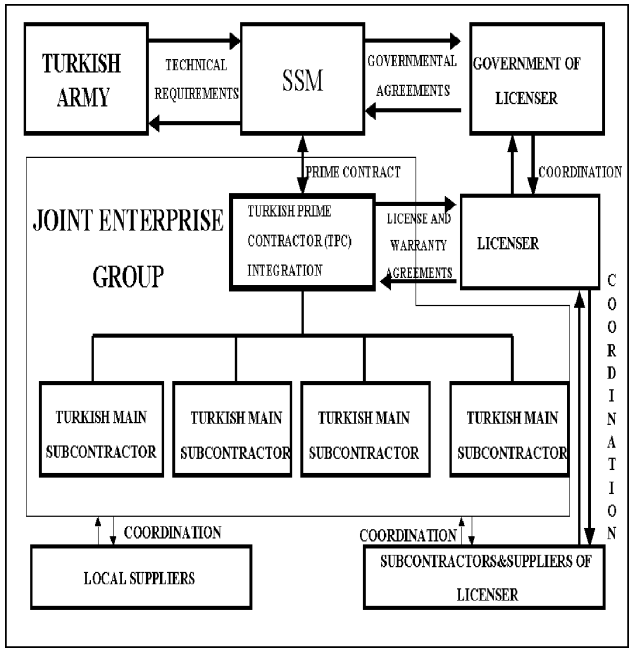
3.2. Current ITT Model

Turkish Defense Industry is an industry in which ITT is taking place according to International Defense Industry Model rather than Self-Sufficient Industry Model. The ITT affairs of Turkish Defense Industry are being executed by Undersecretariat for Defense Industries (SSM) on behalf of the Turkish Government. Weapon production system of Turkey includes mostly joint-enterprise groups. Weapon system production of Turkey is being executed according to Joint-Enterprise Group Model (Figure 1).

According to Joint-Enterprise Group Model, Turkish Prime Contractor (TPC) is generally the joint venture which is responsible for all activities of the joint-enterprise group. The relationships between TPC, Turkish main subcontractors, licenser, government of licenser, SSM, local and foreign suppliers and Turkish army have been demonstrated in Figure 1.

According to Joint-enterprise group model

FIGURE 1: JOINT ENTERPRISE GROUP MODEL OF TURKEY [18]



the joint venture only produces a specific part of the weapon system. Other main parts such as night vision system, communication system, weapon system, etc are produced by Turkish Main Subcontractors. Local and foreign suppliers support joint-enterprise group.

The *localization activities* are performed by TPC and Turkish Main Subcontractors according to the contracts signed between SSM and the joint-enterprise group. The local content is targeted for each program year (PY) of contract package. Contract package is the number of the weapon systems that is to be delivered by the joint venture in the period that is decided in the contract.

The *local content* of product for each PY is defined as the *localization degree* of the technology by SSM. To find out the localization degree, the *added-value* of the products delivered for each PY is assessed based on the formula below:

Contract price = Number of delivered systems* Base Price

Added-value = Contract Price – (The cost of material, equipment, labor and services of non-Turkish origin purchased by the joint venture + Profits transferred outside + expenses of foreign employees + interest paid on foreign credits)

As explained above added-value model is being used by SSM as a local content indicator and a technology transfer success indicator. Added-value model is a limited model to access the success of ITT because:

1. It is a model that shows only *economic indicators.*

2. Added-value model only aims to measure *the local content of product.*

3. Added-value model does not focus on localization of hardware, software, people, organization dimensions of technology transfer.

4. Added-value model does not deal with other technology transfer success indicators.

5. Added-value model is based on numerical data about the economic indicators it does not focus on qualitative success factors.

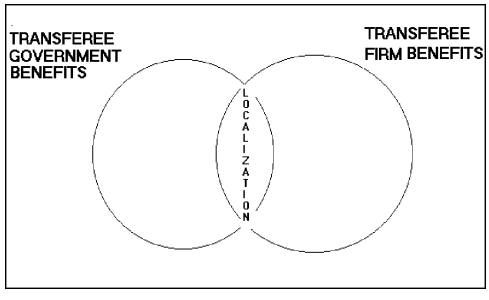
Because of these reasons, a new methodology to access the success of defense-oriented ITT from the transferee government point of view has been developed as explained below.

4. METHODOLOGY

Based on the literature review cited above it has been noticed that the cross-section of the expectations of transferee government and transferee firm is the term of "*localizatio*n" (Figure 2).

In order to develop a methodology for the measurement of ITT, first the span of localization term has been expanded. Technology and technology transfer are all people- embodied, system-embodied and organization-embodied. This classification is the same as classification of People, System, Organization (PSO) classification of Goal Directed Project Management (GDPM) [20]. Rather than the localization of product, localization of people, system and organization have been thought. At the same time transfer of knowledge infrastructure has been thought under the heading of K (knowledge) [21]. The steps of the methodology developed are explained below:

FIGURE 2: THE CROSS-SECTION OF TRANSFEREE GOVERNMENT AND FIRM BENEFIST AND EXPECTATIONS FROM ITT.



1ST STEP: Technology transfer success indicators and localization indicators have been picked up from different sources and previous success measurement models.

2ND STEP: These success indicators have been modified according to the nature of Turkish Defense Industry.

3RD STEP: The success indicators have been grouped under the heading of Knowledge, People, System and Organization (KPSO).

4TH STEP: These indicators have been weighted by both joint venture managers and other workers of government according to pair-wise comparisons of Analytical Hierarchic Process (AHP)[1].

5TH STEP: These indicators have been put in to a form of Audit and Scoring Table. The developed Audit and Scoring Table is a multifunctional table that shows:

1. ITT success indicators

2. Scoring coefficients (Yes-No questions, localization degree (LD), Ratio (R), Questionnaire results (QR))

3. Weights allocated by AHP

4. Score and total score of the joint venture.

[1] Analytic Hierarchy Process of Saaty and Vargas [22] is used to assist decision-makers by decomposing information into a hierarchy of criteria and alternatives. It is synthesized to determine relative rankings of alternatives [23, 24]. The questionnaire shows the numerical pair-wise comparison between factors; equality between two factors corresponds to 1, if one criteria is moderately more important than the second criteria, then the answer is 3, if strongly more important then 5, if very strongly more important then 7, and if extremely more important then 9. The results of the assessments are given as weights of factors in the model adding to 1,00 or 100 %.

TABLE 2: RELIABILITY ANALYSIS OF QUESTIONNAIRES 1-3

	Sample Size	Groups that have eigenvalues over 1	General Cronbach's Alpha	Cronbach's alphas of groups					
				1	2	3	4	5	6
Q1	30	3	0.84	0.87	0.89	0.84			
Q2	43	2	0.79	0.84	0.84				
Q3	30	6	0.74	0.95	0.81	0.91	0.89	0.76	0.74

In the study 4 questionnaires have been administered:

1. AHP Questionnaire (120 questions), in which pair-wise comparison of ITT success indicators have been performed by 32 individuals (15 army officers, 17 managers from the company)

2. Questionnaire-1 (8 questions) is about "maintainability of product by local users" indicator of model. The questionnaire has been applied to 30 local technicians in Turkish Land Forces.

3. Questionnaire-2 (5 questions) is about "customer satisfaction" indicator of the model. This questionnaire has been applied to 22 mechanized company/squad/platoon commandors and 21 vehicle and turret operators.

4. Questionnaire-3 (19 questions) is about "communication, cordination and motivation" items of the model. This questionnaire has been applied to 30 company workers in different hiearchic positions.

Reliability analysis of the questionnaires 1-3 are given in Table 2. All are relieable because all Cronbach Alphas are greater than 0.7.

Expert Choice software was used to get the AHP results. The calculated inconsistency ratios were all below 0.1 as shown in Table 3.

TABLE 3: AHP INCONSISTENCY RATIOS

Subject Area	Inconsistency Ratio
K-P-S-O	0.05
PEOPLE	0.01
LOCALIZATION OF EMPLOYEES AND MANAGERS	0.00
FOREIGN TRAINING	0.02
INTERNAL TRAINING	0.01
SYSTEM	0.00
LOCALIZATION OF HARDWARE	0.03
LOCALIZATION OF SOTFWARE	0.07
LOCALIZATION OF PRODUCT	0.00
ORGANIZATION	0.05
COMMUNICATION	0.05
COORDINATION	0.00
MOTIVATION	0.03
ADOPTION OF CONTEMPORARY TECHNIQUES AND APPLICATIONS	0.00
KNOWLEDGE	0.00
SYSTEM-BASED KNOWLEDGE INFRASTRUCTURE	0.00
ORGANIZATION-BASED KNOWLEDGE INFRASTRUCTURE	0.03
HUMAN-BASED KNOWLEDGE INFRASTRUCTURE	0.00

5. PROPOSED MODEL

5.1 People-dimensional ITT Success And Localization Indicators

Localization of foreign personnel

Transferee government is willing to save the local capital. The less foreign personnel in the joint venture the less money transferred from the transferee country. The second reason is the self-sufficiency in the technology [7]. The third reason is the will of controlling the decision-making process in the joint venture by the transferee firm. This is established through local CEOs in the joint ventures[25]. Localization of foreign personnel has been investigated through these indicators in the methodology developed:

1. Existence of local CEO

2. Decrease in the number of foreign employees and technicians: The measurement of this criteria can be assessed due to localization degree assessed based on the formula below:

3. LD = (1- (current number of foreign employees and technicians / number of foreign employees and technicians at the very beginning of the establishment of the joint venture))

4. Decrease in the number of foreign managers: The measurement of this indicator should be made also according to the localization degree (LD) formulation above.

Foreign training

One of the expectations of the recipient or transferee country is training. Training can be thought under the term of know-how. Foreign training can be carried out in two ways:

1. Foreign training can be carried out in the transferor or another country. Especially managers, process leaders or a few critical employees can be sent to foreign countries to be trained.

2. Foreign training can be carried out in the host country. Especially because of the high cost of sending all employees to any foreign country, most firms or joint ventures are willing to train their employees in the host country by foreign instructors.

Generally at the very early stages of ITT the number of people sent for foreign courses is higher than that of others. As the technology is adopted the number of foreign courses may decrease. This decrease is not a success indicator. Also the foreign training needs decrease or increase according to flexibility of production [26]. Based on these facts the success measurement criteria of foreign training can be defined due to percentages of people sent to foreign courses in the joint venture as explained below:

1. The ratio of managers sent for foreign courses to the total number of managers in the joint venture.

2. The ratio of manufacturing process leaders sent for foreign courses to the total number of manufacturing process leaders in the joint venture.

3. The ratio of employees who received foreign training in the host country to the total number of employees.

Internal Training

The training activities are not limited by only foreign training. Internal training activities help diffusion of technology. Internal training activities are generally thought according to the trained personnel. These are:

1. Training of joint venture personnel.
2. Training of customer.
3. Training of supplier.

The existence of a training unit in a firm is a necessity of internal training in a joint venture. Without a training unit in a joint venture the diffusion of technology and the application of know how is impossible. The diffusion mentioned here stems from the joint venture and reaches to workers, customers and suppliers of joint venture as demonstrated in Figure 3.

The "*internal training*" part of the methodology has been prepared according to TQM and ISO audits as explained below:

1. Average number of courses: This indicator reflects the increment in the quality and quantity of the training activities. As years pass the number of course types increases or decreases in a joint venture because of the flexibility of production. But the number of courses should be higher than a specific number. As a result, the measurement of this indicator should be performed based on average number of courses. Average number of courses should be found by summing the course types conducted each year and dividing this value by age of the joint venture (in defense industry instead of age, contract period should be used). Scoring should be made by comparing this value with the values of other joint ventures according to a specific table.

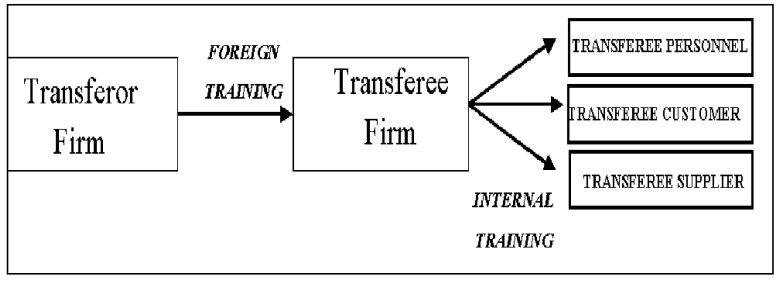
2. The percentages of joint venture personnel who received internal training: One of target of a training program year is to provide training for all workers including management and employees in a firm. This indicator should be assessed by summing up the percentages for each year and dividing the total value by the age of joint venture (in defense industry instead of age, contract period should be used). Average percentage or ratio is the indicator of efficiency of the internal training.

3. Existence of impact measurement of training: This indicator shows whether the impact of training is measured and evaluated in the joint venture. Impact measurement of training performed through Training Follow-up Forms and Training Evaluating Forms.

4. Existence of supplier and customer training: The training of supplier and customer as important as the training of joint venture personnel as explained in Figure 3.

5. Existence of collaboration with universities in training: The joint ventures'

FIGURE 3. DIFFUSION OF TECHNOLOGY THROUGH FOREIGN AND INTERNAL TRAINING.



training programs are sometimes conducted with universities. The contribution of universities to the training may take place in three ways generally. These are:

- Technical consultation in training.
- Instructor supports.
- Joint-programs established by two sides.

5.2. System-Dimensional ITT Success and Localization Indicators

Transfer of hardware

Transfer of hardware explains the transfer of machines [25]. The transferred machines should be of good quality and they should be functional. From this starting point, transfer of hardware have been through under three ITT success indicators. The success indicators about the transfer of hardware are:

1. Non-existence of second-hand machines: Transferor firms generally establish plants according to period of contract. After the termination of time they carry the machines to another country for a new contract period. It can be said that joint ventures are *temporary* and plants are *mobile*. In most of the defense-oriented firms the machines are second hand. Because of this reason the quality of the machines is lower than that of original machines. In this indicator the ratio of machines that are not second hand to the total number of machines should be investigated in joint ventures.

2. Frequency of out-of-order of machines: The frequencies of breakdown of machines show the quality of machines. The measurement of this indicator should be assessed according to maintenance records of the machines.

3. Existence of substitutions during big breakdowns: This indicator is necessary to expose the continuity degree of the manufacturing processes. The machines should be transferred in order to be used instead of the others in case of a breakdown. The ratio of machines that have substitutions to the total number of machines has been thought as the measurement criteria of this indicator.

Transfer of software

In transfer of software, the existence of the transfer of user and maintenance instructions of machines and transfer of process guiding books have been reckoned to find out the passage of these factors. Also existences of products' maintenance and user guides are included in the ITT success indicators. Transfer of software has been thought as :

1. Existence of user instruction of machines: "The ratio of machines that have user instructions to the total number machines" has been thought as the measurement criteria of this indicator.

2. Existence of maintenance instructions of machines: "The ratio of machines that have maintenance instructions to the total number of machines" is the measurement criteria of this indicator

3. Existence of process guiding books: "The ratio of the processes that have guiding books to the total number of processes" is the measurement criteria of this indicator.

4. Existence of product user instructions: "The ratio of product types that have user instructions to the total number of product types" is the measurement criteria.

5. Existence of product maintenance instructions: "The ratio of product types that have maintenance instructions to the total

number of products" has been thought as the measurement criteria.

Localization of software

Localization of software has been thought as the translation of the software elements mentioned above into the language of the host country. The measurement criteria has been thought as the same as the measurement criteria above. These indicators are:

1. Existence of user instructions of machines translated into the language of the host country.

2. Existence of maintenance instructions of machines translated into the language of the host country.

3. Existence of process guiding books translated into the language of the host country.

4. Existence of product user instructions translated into the language of the host country.

5. Existence of product maintenance instructions translated into the language of the host country.

Localization of the product

As well as the increase in the local content, the maintainability of product by local technicians and customer satisfaction should be thought under the term of "localization of product":

1.Increase in the local content: Localization of product is generally expressed as the "increase in the local content". The methodologies to find the local content may be various according to each transferee country. In this methodology for Turkey the Added-value Model's result has been used as the local content indicator neglecting the money paid for personnel.

2. Maintainability of product by local technicians: Local content shows the qualitative side of product localization. The quantitative side of the extent of usage of product is determined by the "maintainability of the product by local users". In this part, a questionnaire should be applied to a sample of local technicians to explore whether the product is maintainable or not.

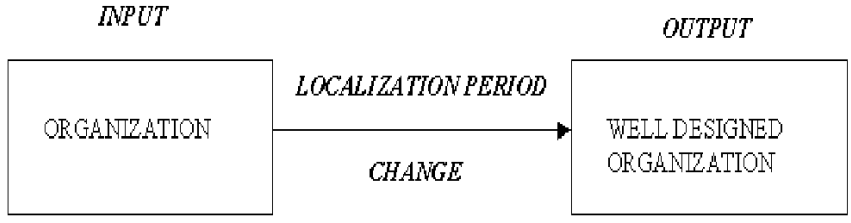
3. Customer satisfaction: The efficiency of product is very important in defense sector. Because of this reason a questionnaire should be developed and applied to the users of product in order to explore the efficiency. This questionnaire also should be designed including the efficiencies of the main sub-systems of the product.

5.3. Organizational ITT Success and Localization Indicators

In an organization during the ITT implementation phase some changes may occur positively or negatively. The organizational ITT success indicators from the point of view of transferee firm and government are undoubtedly based on the localization of organization as well as other organizational ITT success indicators. In the time interval between the foundation time of the joint venture and the current time, the organization of the joint venture should reach a perfect position. Based on the assumption of a perfect organization, it can be said that well designed organization is the one in which there is a perfect communication, coordination and motivation. Also well designed organization is the one that applies modern and advanced managerial techniques and applications such as TQM, ISO etc.

The organizational ITT success indicators are grouped under the following headings:

FIGURE 4. EXPECTED ORGANIZATION



Localization of the organizational structure

This ITT success indicator implies the decrease in the number of units which have been managed by foreign managers. The assessment of this indicator should be made based on the ratio of the number of local units to the number of total units. This indicator shows the density of the local units in all organizational units.

Communication in the organization

"Technology transfer has many technical dimensions, but it is first and foremost a communication issue"[27]. At the beginning of the ITT, throughout ITT, as well as communication is very important. Communication in the organization should be measured according to these sub-indicators:

1. Communication abilities of superiors in the organization
2. Suitability of organization for communication
3. Non-existence of time pressure in the organization
4. Non-existence of foreign language problems in the organization.

In order to measure communication indicator a questionnaire should be prepared and applied to the personnel of the joint venture.

Coordination in the organization

Coordination implies an environment in which complexity does not exist. The level of coordination should be measured in the organization according to these indicators through a questionnaire applied to joint venture personnel:

1. Existence of encouragement to voluntary coordination (team spirit)
2. Attendance of employees to the decision-making process
3. Non-existence of complexity in the working environment.

Motivation in the organization

A technology transfer is performed through a motivation in the organization. In the first periods of the ITT, this motivation can be called as ITT motivation. But in later periods of ITT, this motivation can be called as the *organizational motivation*. The sub-indicators of motivation are:

1. Satisfaction of the personnel with the reward system of the organization
2. Satisfaction of the personnel with the promotion system of the organization
3. Satisfaction of the personnel with the wage system of the organization
4. Satisfaction of the personnel with the leave system of the organization

5. Satisfaction of the personnel with the ITT activities of the organization

6. Satisfaction of the personnel with the initiative given.

These indicators also should be measured according to a questionnaire applied to the personnel of the joint venture.

Adoption of contemporary managerial techniques and applications

A well designed organization is the one that adopts and applies the contemporary managerial techniques and applications. In this part of the methodology only adoption of TQM and ISO have been investigated for defense-oriented joint ventures of Turkey. These managerial techniques and applications may be increased in other studies.

Before explaining knowledge-dimensional ITT success indicators it will be helpful to demonstrate the relationships between data, information, knowledge and wisdom [28].

Knowledge is related with people, system and organization dimensions of the processes. The People, System, Organization (PSO) concept of Goal Directed Project Management (GDPM) Methodology [20] has been used under the heading of Knowledge, People, System and Organization (KPSO) by Özkan, Başoğlu and Oner [21] in project management, so in ITT, existence of a knowledge dimension can be mentioned.

In such a competitive environment, knowledge management is so important that most of the joint ventures and firms are establishing *knowledge infrastructure*

TABLE 4: THE RELATIONSHIPS BETWEEN DATA-INFORMATION-KNOWLEDGE-WISDOM

DATA	INFORMATION	KNOWLEDGE	WISDOM
Pure data	Formatted data	Using formatted data for a purpose	Using accumulated knowledge to detect emerging pattern

5.4. Knowledge-Dimensional ITT Success Indicators

With the new developments in data processing technology, the industrial economies are being replaced by information economies [28]. As this replacement takes place, the infrastructure of economy which is composed of production, consumption and distribution is being restructured based on the knowledge. The knowledge is becoming basic element of competition [29, 30, 31]. Knowledge also creates increasing returns [32].

FIGURE 5: KPSO CONCEPT

in order to use it in knowledge management. Because of these reasons in ITT the transfer or establishment of such an infrastructure in the organization is becoming necessary and existence of such an infrastructure is being desired by transferee government or firm.

As mentioned above the infrastructure of knowledge is the existence of an information system. Knowledge infrastructure is composed of :

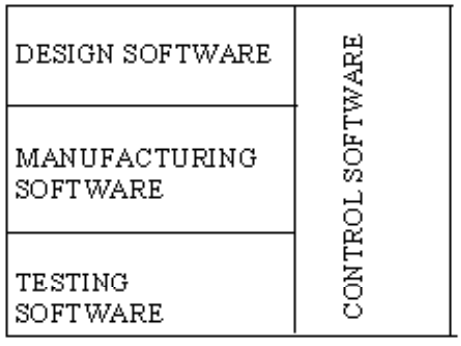
System-based knowledge infrastructure

The system-based knowledge infrastructure should be composed of the software related with design, manufacturing, testing and control [33] (see Figure 6). Existence or transfer of these manufacturing and design software should be investigated while measuring the success of ITT.

For Turkish Defense industry these software types have been chosen to investigate their existence:

1. Computer-aided design (CAD)
2. Computer-aided manufacturing (CAM)
3. Computer numerical control (CNC)
4. Computer-aided testing (CAT)
5. Direct numerical control (DNC)

FIGURE 6: SYSTEM-BASED SOFTWARE [34]



These are critical elements that are to be constructed in a production system that is ornamented by such a knowledge infrastructure. As well as know how these software should be transferred or established later in order to establish a well designed manufacturing system. These software is also necessary for *flexible* production [33]. Blanchard and Fabrycky [34] point out that product, process and support life cycles are not composed of only a manufacturing phase but also composed of design and development phases. Because of this reason, it is highly essential that design & development factors should be transferred as well as the other elements of ITT.

1. There should be also a *network* between the computer-aided machines for data flow.

2. Finally, the work instructions of manufacturing should be available in the software for a perfect knowledge management.

People-based knowledge infrastructure.

Sharing information requires a network between people. People should be forced to generate knowledge. The people dealing with knowledge should be trained about the software and processes of the firm [28]. In summary these success indicators should be found in people-based knowledge infrastructure:

1. Existence of PC operator training in the joint venture.

2. Existence of software training in the joint venture.

3. Existence of network training in the joint venture.

Organization-based knowledge infrastructure

Inceler [28] mentions about the existence of *Management Information System*

(MIS) in an organization for a knowledge infrastructure. Modern management requires benefiting from MIS which is the product of advanced technology.

Özkan, Basoğlu and Oner [21] mention about the connection of people with each other and connection of people with the outside of the organization for a perfect knowledge management. These connections can only be performed due to *intranet* and *www connections*. The people or organizations can reach the joint venture due to *web pages.* In summary organization-based knowledge infrastructure can be achieved through:

1. Existence of intranet in the joint venture.
2. Existence of web page of the joint venture.
3. Existence of www connection of the joint venture.
4. Existence of MIS applications in the joint venture.

6. MODEL APPLICATION AND DISCUSSION OF RESULTS

All success indicators mentioned above have been grouped under the headings of Knowledge, People, System and Organization and embodied into a form of audit table that is composed of 55 indicators. The AHP results of the weights of these indicators are given in Tables A1 – A4 in the appendix.

The localization and technology transfer success indicators have been measured in a defense-oriented joint venture which is responsible for producing Armored Vehicle System for the Turkish Land Forces. Results of the audit model can be seen in Table 5.

Localization is undoubtedly the function of sophistication of technology and time. Because of this reason it has been proposed to use this methodology for only contract period. Application of this methodology will undoubtedly force the joint venture to increase the localization efforts in this period. In this methodology we have proposed that as well as time and sophistication of technology, organizational efforts are the determinants of the localization. In this methodology the term of localization has been used for people, system and organization. Product localization can not be considered only as the increase in the local content. At the same time, maintainability and efficiency of product has been considered under the term of product localization.

This methodology has been constructed for defense-oriented or weapon-system-producing joint ventures. In other civilian joint ventures it can be used partially, that

TABLE 5: ITT MODEL AUDIT RESULTS OF THE COMPANY

	TOTAL	PEOPLE	SYSTEM	ORGANIZATION	KNOWLEDGE
Company Score	91.3	29.0	27.0	16.3	19.0
Total Score	100.0	30.4	32.2	18.4	19.0
Success Level %	91.3	96.0	84.0	88.0	100.0

is, it must be modified while applying it in civilian joint-ventures. This methodology should be used in mature technology transferring. In order to be used in high-tech joint ventures it should be modified with *innovative* success indicators.

This methodology should be applied for period of each contract package in order to see positive or negative changes in the joint venture. The software is developing in all areas very fast, hence, the knowledge-dimension of the methodology can be modified according to these changes.

This study is first of its kind in assessing the success level of international technology transfer in defense joint ventures in Turkey. The authors hope that its continuing use and resulting feedback from the related parties will help in improving the model.

APPENDIX: AHP WEIGHTS OF MODEL COMPONENTS

TABLE A1.: PEOPLE PART OF THE AUDIT AND SCORING TABLE

			Coefficients (C)					Weight Allocated by AHP(W)	Score of Company (W * C)*100
			YES	NO	Loc Degree (LD)	Ratio	Questionnaire results (Average/5)		
PEOPLE	Localization of employees and managers	1. Existence of local CEO	1	0				0.049	SCORE
		2. Decrease in the number of employees and technicians?			LD			0.023	SCORE
		3. Decrease in the number of the foreign managers.			LD			0.040	SCORE
	Foreign Training	4. The ratio of managers sent to foreign courses to the total managers.				R		0.051	SCORE
		5. The ratio of process leaders sent to foreign courses to total number of leaders.				R		0.027	SCORE
		6. The ratio of the employees who received foreign training in host country to the total number of employees.				R		0.023	SCORE
	Internal Training	7. Increase in average number of courses.	cf. Scoring Table					0.025	SCORE
		8. Whether all of the workers in the firm have benefited from training.				R		0.026	SCORE
		9. Existence of the measurement of the impact of training	1	0				0.012	SCORE
		10. Existence of supplier and customer training.	1	0				0.013	SCORE
		11. Existence of collaboration with universities in training.	1	0				0.014	SCORE
							TOTAL	0.303	TOTAL SCORE

LD = LOCALIZATION DEGREE

R= RATIO

QR= QUESTIONNAIRE RESULTS

W= WEIGHT ALLOCATED BY AHP

TABLE A2.: SYSTEM PART OF THE AUDIT AND SCORING TABLE

			Coefficients (C)					Weight Allocated by AHP(W)	Score of Company (W * C)*100
			YES	NO	Loc Degree (LD)	Ratio	Questionnaire results (Average/5)		
SYSTEM	Localization of Transfer of hardware	12. Whether the machines are second hand or not?				R		0.026	SCORE
		13. Frequency of out-of-order of the machines.	cf. Scoring Table					0.038	SCORE
		14. Existence of substitutions during big defects?	1	0				0.042	SCORE
	Localization of the Transfer of Software	15. Existence of user instructions of machines?				R		0.011	SCORE
		16. Existence of user instructions of machines in the language of the host country.				R		0.008	SCORE
		17. Existence of maintenance instructions of machines?				R		0.013	SCORE
		18. Existence of maintenance instructions of machines in the language of the host country.				R		0.007	SCORE
		19. Existence of user instructions of product.				R		0.009	SCORE
		20. Existence of user instructions of product in the language of the host country				R		0.007	SCORE
		21. Existence of product maintenance instructions.				R		0.011	SCORE
		22. Existence of product maintenance instructions in the language of the host country.				R		0.007	SCORE
		23. Existence of process guiding books.				R		0.035	SCORE
	Localization of Products	24. Increase in the value-added of firm				R		0.054	SCORE
		25. Maintainability of product by local technicians.					QR	0.027	SCORE
		26. Efficient usage of the product by local technicians.					QR	0.027	SCORE
							TOTAL	0.322	TOTAL SCORE

LD = LOCALIZATION DEGREE

R= RATIO

QR= QUESTIONNAIRE RESULTS

W= WEIGHT ALLOCATED BY AHP

TABLE A3.: ORGANIZATION PART OF THE AUDIT AND SCORING TABLE

			Coefficients (C)					Weight Allocated by AHP(W)	Score of Company (W * C)*100
			YES	NO	Loc Degree (LD)	Ratio	Questionnaire results (Average/5)		
ORGANIZATION	Localization of the Organizational Structure	27. Localization of the units of the organization and change in the organizational structure				R		0.059	SCORE
	Communication in the Organization	28. Communication abilities of superiors.					QR	0.007	SCORE
		29. Suitability of organization for communication.					QR	0.005	SCORE
		30. Non-existence of time pressure					QR	0.003	SCORE
		31. Non-existence of foreign language problems.					QR	0.004	SCORE
	Coordination in the Organization	32. Existence of Encouragement for voluntary coordination (Team spirit).					QR	0.005	SCORE
		33. Attendance of employees to the decision-making processes.					QR	0.010	SCORE
		34. Non-existence of complexity in the working environment.					QR	0.005	SCORE
	Motivation in the Organization	35. Satisfaction of personnel with reward system of organization					QR	0.005	SCORE
		36. Satisfaction of personnel with promotion system of the organization.					QR	0.006	SCORE
		37. Satisfaction of personnel with wage system of the organization.					QR	0.010	SCORE
		38. Satisfaction of personnel with leave system of the organization.					QR	0.004	SCORE
		39. Satisfaction of personnel with the activities of ITT.					QR	0.003	SCORE
		40. Satisfaction of the personnel with the initiative given					QR	0.007	SCORE
	Adoption of contemporary techniques and applications	41. Adoption of TQM	1	0				0.034	SCORE
		42. Adoption of ISO	1	0				0.017	SCORE
		LD = LOCALIZATION DEGREE					TOTAL	0.184	
		R= RATIO							
		QR= QUESTIONNAIRE RESULTS							
		W= WEIGHT ALLOCATED BY AHP							

TABLE A4.: KNOWLEDGE PART OF THE AUDIT AND SCORING TABLE

				Coefficients (C)					Weight Allocated by AHP(W)	Score of Company (W * C)*100
				YES	NO	Loc Degree (LD)	Ratio	Questionnaire results (Average/5)		
KNOWLEDGE	SYSTEM-BASED KNOWLEDGE INFRASTRUCTURE	Existence of manufacturing & design software	43. Existence of CAD	1	0				0.006	SCORE
			44. Existence of CAM	1	0				0.006	SCORE
			45. Existence of DNC	1	0				0.006	SCORE
			46. Existence of CNC	1	0				0.006	SCORE
		47.Existence of network between the machines in the manufacturing department.		1	0				0.022	SCORE
		48. Existence of work instructions in the software		1	0				0.014	SCORE
	ORGANIZATION-BASED KNOWLEDGE INFRASTRUCTURE	49. Existence of intranet in the organization.		1	0				0.021	SCORE
		50. Existence of web page of organization.		1	0				0.015	SCORE
		51. Existence of continuous WWW connection.		1	0				0.015	SCORE
		52. Existence of MIS application in the organization.		1	0				0.024	SCORE
	HUMAN-BASED KNOWLEDGE INFRASTRUC	53. Existence of PC operator training.		1	0				0.016	SCORE
		54. Existence of software training.		1	0				0.025	SCORE
		55. Existence of network training.		1	0				0.014	SCORE
		LD = LOCALIZATION DEGREE						TOTAL	0.190	TOTAL SCORE
		R= RATIO								
		QR= QUESTIONNAIRE RESULTS								
		W= WEIGHT ALLOCATED BY AHP								

REFERENCES

[1] Tschirky H., Bringing Technology into Management: The Call of Reality Going Beyond Industrial Management at the ETH, Paper presented at PICMET97, PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA (1997)

[2] Jarayama V., Agrawal R.K., and Seethamraju R.J., "International Technology Transfer Model" paper presented at PICMET97, PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA (1997)

[3] Sharif N., Reengineering Technology Governance for Philippines 2000, Technological Forecasting and Social Change 54 (1997) 37 – 55.

[4] Sharif N, Book Review – "Development Techniques for International Technology Transfer, M. LeGoc, Westport, CT: Quorum Books, 2002", Technological Forecasting and Social Change 70 (2003) 923 – 927.

[5] Ramanathan, A Normative Model for Planning and Implementing International Technology Transfer, Paper presented at PICMET99, PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA (1999).

[6] Franza R.M and Srivastava R., Measuring ROI for Military to Private sector Technology Transfer, Paper presented at PICMET99, PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA, 1999.

[7] Şimsek S., Lisans Anlaşmaları Yoluyla Teknoloji Transferi, T.O.B.B., Ankara, 1999.

[8] Baranson J., Technology Transfer Through the International Firm, The American Economic Review 60 (2) (1970) 435-440.

[9] Solo R., The Capacity to Assimilate an Advanced Technology, The American Economic Review 56 (1-2) (1966) 91-97.

[10] Glinow M.A.V, Schnepp O, Bhambri A., Assessing Success in the United States-China Technology Transfer in "Technology Transfer in International Business", edits. Agmon T. and Glinow M.A.V, Oxford University Press, New York, 1991.

[11] Reddy N. M. And Zhao L., Managing International Technology Transfer Negotiation, Technovation 13 (6) (1993) 383 – 397.

[12] Kohler B.M & Rubenstein A.H.& Douds C.F., A Behavioral Study of International Technology Transfer Between the United States and West Germany, Research Policy 2 (1973), 160-184.

[13] Mason R. H., Masson F. G., Balance of Payments Costs and Conditions of Technology Transfer to Latin America, Journal of International Business Studies 5 (1) (1974) 73-85.

[14] Lynch B.P., An Empirical Assessment of Perrow's Technology Construct, Administrative Science Quarterly 19 (3) (1974) 338-356.

[15] Wilking M., The Role of Private Business in the International Diffusion of Technology, The Journal of Economic History 34 (1) (1974) 166-168.

[16] Mansfield E., International Technology Transfer: Forms, Resources, Requirements and Policies, The American Economic Review, 65 (2) (1975) 372-376.

[17] Aharoni Y., Education and technology Transfer: Recipient Point of View, in Technology Transfer in International Business, Oxford Press, New York, 1991.

[18] Şimşek M., Üçüncü Dünya Ülkelerinde ve Türkiye'de Savunma Sanayii, T.O.B.B., Yayın no: SAGEB-3, AR-GE-1, 1989.

[19] Reddy N. M. And Zhao L., International Technology Transfer: A Review, Research Policy 10 (1990) 285-307.

[20] Andersen S.E, Grude K.V. and Haug T., Goal Directed Project Management, Kogan Page London, 1996.

[21] Özkan, İ. M., Başoğlu, A. N., Öner, M. A., Web-Based Knowledge Management Systems: A Field Study of "MORN" in R&D Project Management, Defense Sciences Journal 1 (1) (2002) 29 – 75.

[22] Saaty, T. L., Vargas, L. G., The Logic of Priorities – Applications in Business, Energy, Health, and Transportation, Kluwer-Nijhoff Publishing, Boston, 1982.

[23] Israeli, A. A., Mehrez, A., Bochen, D., Hakim, D., Justification of global positioning systems purchase using the analytic hierarchical process – The case of the Israeli Defense Force, Technovation 18 (6/7) (1998) 409 – 424.

[24] Cheng, C-H, Yang, K-L, Hwang, C-L, Evaluating attack helicopters by AHP based on linguistic variable weight, European Journal of Operational Research 116 (1999), 423 – 435.

[25] Ding D..Z. and Taylor B., Technology Transfer in Japanese Ventures in PRC, Paper presented PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA, 1997.

[26] Çelikyürek T, Flexibility, Technology Diffusion and Modernization in Turkish Defense Industry Firms, MS Thesis, Yeditepe University, Istanbul, 2000.

[27] Aharoni Y.,1991, Education and technology Transfer: Recipient Point of View in Technology Transfer in International Business, Agmon T & Glinow M.A.V., edits, Oxford Press, New York, 1991.

[28] Inceler H.S., Rekabette Başarının Yolu Teknoloji Yönetimi, Desnet Yayınları, İstanbul, 1998.

[29] Pelc K.I., Patterns of Knowledge Generating Networks, paper presented at PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA, 1997.

[30] Peters L.S., Inter-firm Knowledge Management and Technology Development in Radical Innovation, paper presented at PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA, 1999..

[31] Takahashi S, Knowledge Integrated Management, paper presented at PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA, 1999.

[32] Sutoh T., Suzuki H. and Baba J., Strategic Knowledge Management Creates Increasing Returns, paper presented at PORTLAND International Conference on Management of Engineering and Technology, Portland, Oregon, USA, 1999.

[33] Ferraz J.C., Rush H., Miles I., "Development Technology and Flexibility: Brazil faces industrial divide", London, UK, 1992.

[34] Blanchhard B.S. and Fabrycky W.J., System Engineering and Analysis, Prentice Hall, Englewood Cliffs, New Jersey, 1990.