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Presenting a Suitable Pattern to Transfer Technology from Armed Forces to Defense Industries for Mass Production

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ABSTRACT: One of the concerns in research organizations is to convert the research projects to production procedures, since the prophecy, nature and mission of these organizations is, to convert an idea to research plan and to carry out research cycle from Needs assessment to develop a research sample and as the lack of industrialization and production infrastructure, so the managers of these organizations always face the concern of why the research plans will not be produced and what the obstacles are. This has resulted in problems for most organizations. In the literature of this research, first, it is tried to study the principles and bases of technology , the principles and concepts of technology transmission, acquaintance with industrial products manufacturing methods in industrialized countries (the US and Russia) , familiarity with the technology transmission models, current problems on technology transmission of research projects to industry, explaining the technology transfer obligations in armed research organizations including type of sample definition in industrial research and executive phases of a research project. Then, according to the recognized problems and theoretical studies, with study (survey) of the types of technology transfer patterns in industrialized countries and Iran, and the successful investigation of research centers, a model is proposed consistent with national research organizations, and is validated by using viewpoints of 40 experts in the form of questionnaire and through analyzing the collected data in two ways. The Cornbrash's Alpha obtained for the model was 0.901. The model was then finalized and presented by adding two new procedures.

KEYWORDS: Technology, Technology Transfer, Technology Transfer Vertical.

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1. INTRODUCTION

Technical knowledge (or technology) is a main component in results of every research project. It involves information on planning and designing stages including preliminary, conceptual and engineering steps, fabrication and montage methods and employing and maintenance instructions. Each research project is basically defined with mass production view and has to have a certain framework in the form of a pattern to achieve this goal. There is a wrong conception that technical knowledge is only transferred at the end of a project life span and the resulted knowledge must be transmitted to industry as a full package to enable information-based production.

Knowledge of a research project must be managed from starting point. This management begins from identifying producer industry and interacting with it during project implementation and proceeds to making use of industry's ideas on the type of knowledge to be produced, its size and other required factors in production area. At the beginning steps of receiving an idea production and knowledge transfer should be considered while processing that idea. This indicates the importance of technical knowledge transfer. Therefore, the pattern of technology transfer is a document specifying the routes of technology transfer which assigns functions of each section involved. The pattern has a considerable and necessary impact and prevents personal interests. Consequently, research results come into practice instead of being archived and this prevents wasting research costs. Some of important outcomes of conducting this pattern are growth in industry, supplying country's internal needs, independence from foreign countries, improving researchers' incentive, etc.

Nowadays, industrial growth of most developing countries is highly dependent upon technology transfer and there is a direct relationship between technology transfer and a country's economic, social, political and cultural advances so that technology is considered as a necessary factor in creating wealth, capability and knowledge in most countries and a strong tool for national development. Technology is a set of interrelated factors and elements. Moreover, technology transfer means employing technology in a location other than the initial one. In other words, a procedure which results in flowing technology from the source to the receiver is called "technology transfer" (Ali Ahmadi, 2000).

2. THEORETICAL PRINCIPLES OF TECHNOLOGY

2.1. Definition of Technology

Technology is targeted and structuralized composition of "human, informational and organizational" capabilities which leads to production of a valuable product (Ali Ahmadi, 2000).

2.2. Technology Components

Based on above definition, technology is composed of four following components:

(1) Human-ware (creative, experienced, knowledgeable and skillful human resources)
(2) Hardware (tools, vehicles and equipment)
(3) Software (all information, documentations, theories and plans)
(4) Management or organization-ware (including managerial skills, flexible organizational structure, developing a proper environment for growth and effectiveness of the other three components).

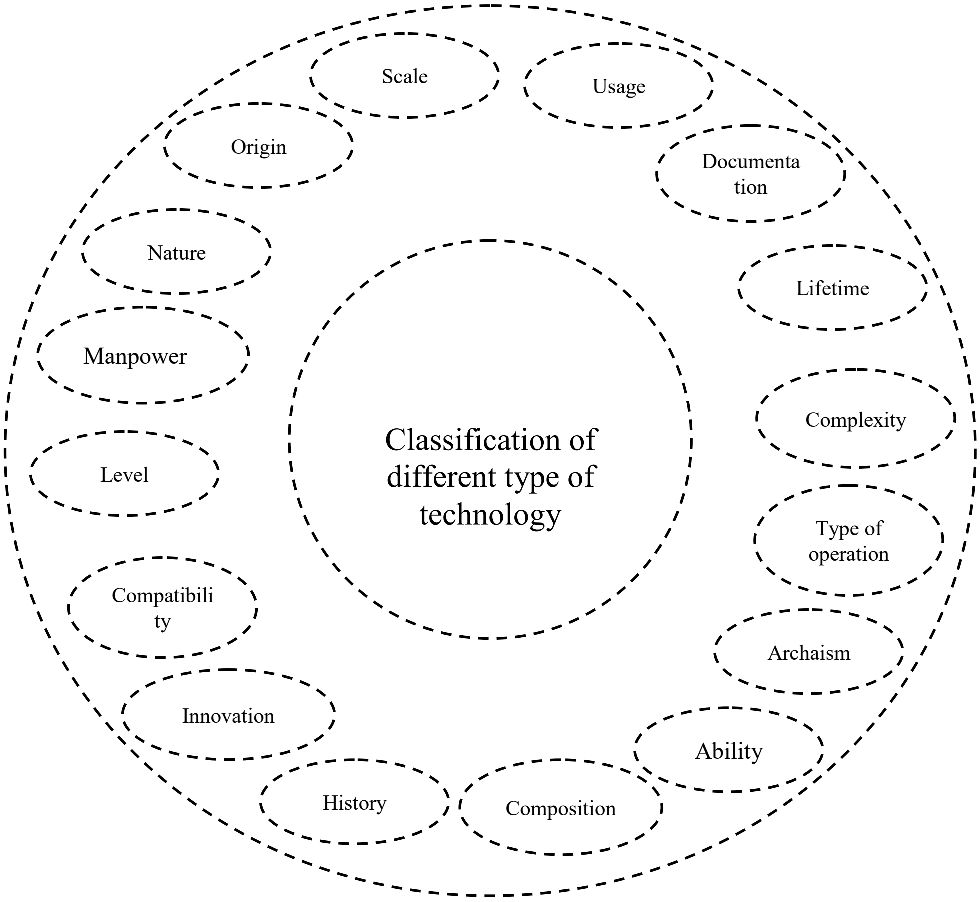
In most cases, technology is subcategorized into different types to describe the compound word of its name (Ali Ahmadi, 2000)

2.3. Types of Technology

Figure 1: different types of technology

Classification of technology types is based on: origin, nature, human forces, complexity, innovation, composition, historical career, capability, age, type of exploitation, life cycle, level, documentations, types of use, consistency, measure(Ali Ahmadi, 2000).

Figure1. Classification of different types of technology



3. THE CONCEPT OF TECHNOLOGY TRANSFER

Technology involves all knowledge, products, processes, tools, methodologies and systems being used in producing a product or service. One of the fields of technology management is technology transfer which requires a comprehensive, deep look. Today, industrialization is highly dependent on technology transfer. As mentioned earlier, there is a direct relationship between technology transfer and a country's economic, social, political and cultural advances in the present world so that technology is considered as a necessary factor in creating wealth, capability and knowledge in most countries and a strong tool for national development. This is why military war is globally replaced by technological economic. Therefore, adopting technological development strategies in different economic sections is a main requirement for economic reconstruction of a country. Besides, this is a factor without which it is not possible to achieve goals such as self- sufficiency, national development and improvement of life standards.

Technology transfer is a complicated, difficult procedure. If technology is purchased or transferred without prior examinations and investigations, it is not useful and leads to weakening of national technology beside wasting time and costs. Having a look on technology transfer is a procedure through which imported technology is acquired in a way that is employed to produce products and develops a background for creating new technology. Technology is usually transferred in two manners: vertical and horizontal. In vertical transfer or transfer of research and development, technical data and findings of applied research are transferred to engineering development and planning levels and then is commercialized to enter production process. In horizontal technology transfer, technology is transferred from an empowerment level in one country to the same level in another location. In this case, the higher the level of technology receiver, the lower the transfer costs (and technology is being received more effectively)(Tavakoli,2008). Table 1 presents nature and concept of technology transfer in every level and its costs compared to other levels (Arabi, 2009).

Table 1: A comparison of concept and costs of technology transfer in technology and empowerment levels

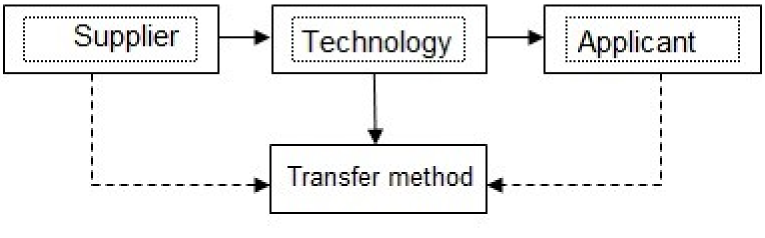
Costs of technology transfer	Concept of technology transfer	Nature of research activity	Level
Very low	Knowledge transfer	Research	Applied research
Low	Knowledge transfer	Research and development	Incremental research
Proper	Capability transfer	Engineering activities	Planning engineering
Acceptable	Capability transfer	Engineering activities	Fabrication engineering
High	Machinery transfer	Management	Production
Very high	Product transfer	Business	product

3.1. Essential Points in Technology Transfer

3.1.1. Principles of Technology Transfer

Technology transfer is a procedure through which technology receiver (applicant) achieves required hardware, a desired level of software, technical knowledge and skills hidden in technology transferred by the sender (supplier) and hence it can reach better methods of production or serving by paying the costs of relative technology. Therefore, it is of great importance to determine and separate principles of technology transfer in transfer procedure. The principles are presented in Fig.2 (Manteghi, 2010).

Figure 2: Principles of technology transfer



3.1.2. Technology Transfer Method

Technology transfer method is a set of predefined activities during which the required technology is transferred to the applicant. Technology transfer methods differ depending on technology type and status of receiver and sender (a huge variety in most cases). Among all books and articles on the subject there are various classifications indicating direct and indirect, internal and external, official and unofficial, commercial and noncommercial, packed and unpacked, depicted and non-depicted methods (Hadavand, 2004). The present paper considers the official method of technology transfer.

3.1.3. Models OF Technology Transfer

Technology transfer models are divided into two groups:

3.1.3.1. Horizontal models

The following five models are among the most well-known vertical transfer models:

A) Chiza and Mansini's model (Chiesa.V and Manzini. R,1998)
B) Ford's model (Ford, David,1988)
C) Roberts and Berry's model (Roberts.E and Berry,1985)
D) Gilbert's model (Gilbert, A.lee,1995)
E) Stock's model (Stock's,1996)

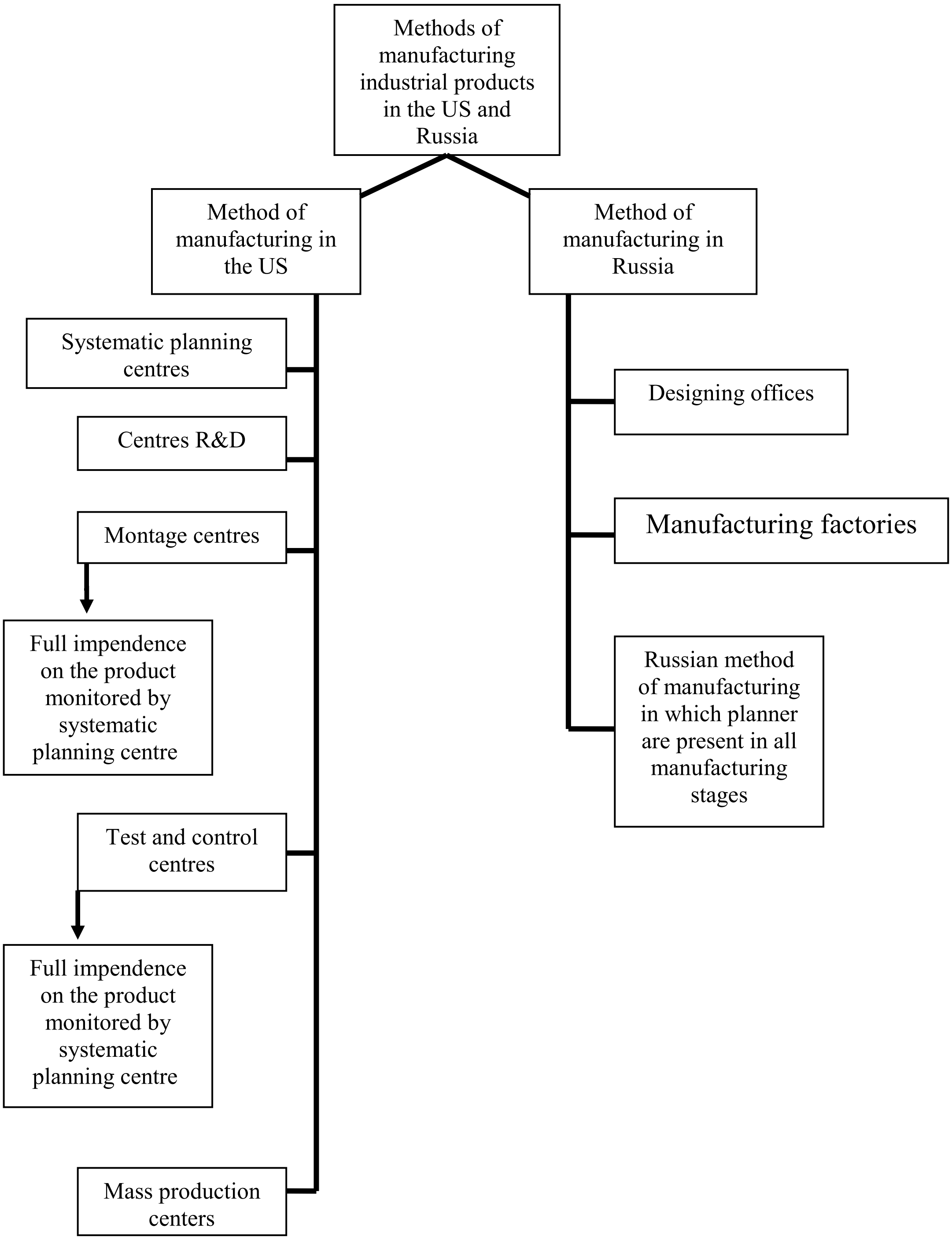
3.1.3.2. Vertical models

Among all available horizontal models, the present paper mentions models proposed in some industrial countries such as the US and Russia which are more consistent with Iranian research organizations and, also, two models presented in Iran.

A) Methods Of Producing Industrial Products In The Us And Russia

Based on earlier investigations, the US and Russia manufacture industrial products according to Fig. 3.

Figure 3: Methods of manufacturing industrial products in the US and Russia



Triangular patterns presented in figures 4 and 5 are related to activities required to define the route from project to production line of a product in the US and Russia (and some other countries) which are depicted as follows (Saad, Mohammad,2002).

Figure 4: Triangular model of Russia

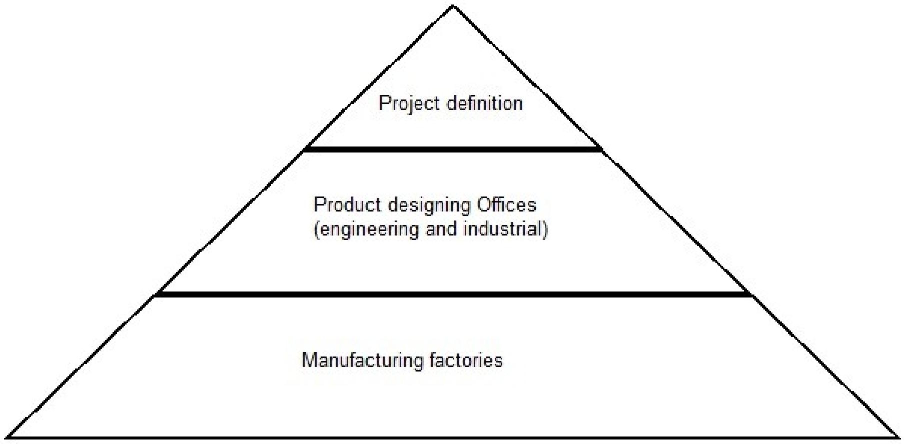
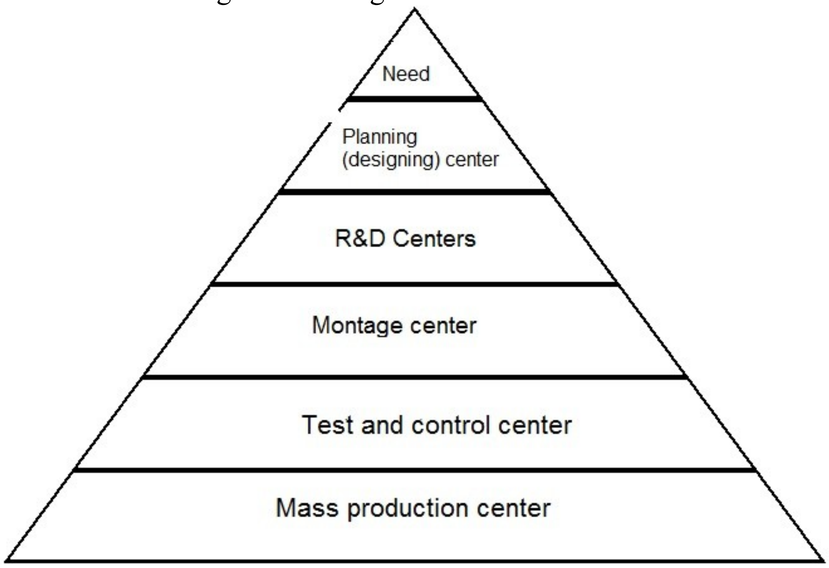


Figure 5: Triangular model of the US



B) Vertical Model Of Technology Transfer In Iranian Defense Industries

In the vertical method (procedure to production), there is still no standard or comprehensive model in Iran and every organization or research center acts on a pattern consistent with its environment. The statistics of research project leading not to technology transfer to production suggest that vertical transfer of technology lacks a universal pattern. Blow is the model used in Iranian defense industries **(**Industrial research vice-presidency of armed forces, 2012)**.**

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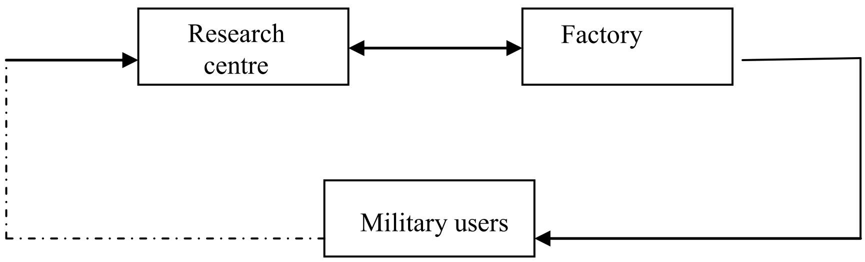
Figure 6: The patterns used in Iranian defense industries



A research center is developed in every industry and collects needs of armed forces and converts them into research, designing and fabrication projects of research, engineering and production standard samples with the help of factory's experts. It is noteworthy that the presented pattern used in Iranian defense industry is a novel and young one.

- **Advantages of the pattern**

(1) Close relationship between research center and the factory
(2) Preparation of production requirements along with the project life cycle
(3) Consistency of planners with fabrication and production procedures
(4) Presence in the factory because of familiarity and close relations to industrial section
(5) Lack of need to conduct additional and unnecessary documentation

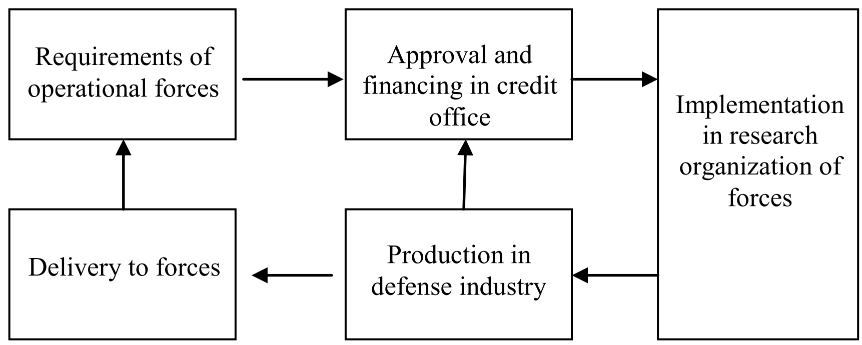
- **Disadvantages**

(1) Research center usually predicts military users' needs and does not met their exact requirements
(2) Lack of close relationship between research center and users
(3) Weakness in technical attachment of research projects because of users' inability in defining their needs with technical language
(4) More attention paid by industries to commercial products instead of military ones (higher profitability of commercial section)
(5) Insignificant tendency of defense industry toward military section as a result of limited number of new technologies demanded by military forces.

C) The (present) pattern used in research organizations of armed forces(Industrial research vice-presidency of armed forces, 2012)

In this pattern (Fig. 8), research organizations, first, collect operational requirements of all forces and accordingly define research projects. In the next step, defined projects are approved in the Headquarters of industrial research and abandoned to specialized centers of research organizations for implementation. Having the project implemented and confirmed by operational users the specialized centers transfer its documentations to the manufacturer industry in the form of a letter of understanding (approved by headquarters of industrial research).

Figure 8: The (present) pattern used in research centers and organizations



- **Advantages**

In this pattern, research organizations of armed forces are the main references of adopting operational requirements and defining and approving research projects. Interaction and close relationship between research organizations and operational users and recognizing and defining precisely in technical language lead to define and approve accurate research projects. Therefore, the pattern is more advantageous than the present presently used defense industries. Moreover, technology is transferred to industry through the letter of understanding and hence military forces (owners of project knowledge) can supply their requirements with lowers costs and getting higher discounts from defense industries.

- **Disadvantages**

(1) Lack of standard documentations of industrial production
(2) Inconsistency between projects' research stages and fabrication and manufacturing stages; elongated time of transferring technology to industry
(3) Lack of incentives in defense industries to receive technology of research projects because of low number of orders and consequently uneconomic production
(4) Lack of proper interaction between research and manufacturing chains
(5) Lack of trust in research organizations to transfer technology to manufacturing industries because of deficient definition of project's ownership rights.

3.2. Problems of Available Models of Technology Transfer From Research Organizations of Armed Forces to Defense Industries For The Sake Of Production

1) Lack of proper standards to prepare documentations of a product in each step (engineering, industrial, manufacturing)
2) Lack of suitable management and leadership in research projects
3) Lack of incentive in research centers and among researchers to transfer project knowledge from one project to another (ownership rights)
4) Lack of defined and approved credits to accomplish and improve research projects from engineering model to industrial product
5) Long time required to transfer technology and technical knowledge from research to production
6) Keeping project secrets in research centers as a result of lack of trust (required for transferring technology to production)
7) Denying research results by operational users (The engineering model which is considered as the product or result of research does not meet users' real requirements and hence it must turn into industrial product and presented to users after approval)
8) Lack of incentive in defense industries to receive technology of research products (reasons: unprofitability of production, lack of foreign and local companies to compete and challenge the industry, lack of trust of the industry in continual research result production)
9) Lack of proper interaction between research and manufacturing chains
10) Permanent and unpredictable changes in the structure of research categories leading to discrete planning
11) Lack of sufficient focus of researchers and research centers on probable problems in post-research steps resulting in doubt in long-term production of research results
12) Lack of sufficient predicted credits for purchasing products of research projects in long-term plans. This leads to suppressed industrialization and production
13) Lack of integration and proper interaction between authorities and practitioners of research, production and equipment field which results in lack of support from local research and manufacturing projects
14) Weak definition on engineering, industrial and manufacturing products among research and manufacturing categories and users (for instance, users expect an engineering product to be responsive in every operational condition)

4. Requirements of Transferring Technology from Research Organizations to Defense Manufacturing Industries

4.1. Developing a Common Technical Language among Researchers in All Implementation Stages (From Idea to Production) and Defining Model Type in Industrial Research

4.1.1. Lab Model

This model (sample) is:

1) A research sample (model) of major and unknown parts of the main sample being examined in vitro.
2) A sample similar to the main sample in which the three main components (from, size, function) are typically respected. Besides, its characteristics are determined based on requirements of the research team and to demonstrate effectiveness of employed theories and technologies.
3) A model development of which aims to create a sample which ensures validity of main decisions with lowest costs. In some cases, hence, standard life cycle or repeatability are not necessary for samples.

4.1.2. Engineering Sample / Pilot

The product is finalized in terms of engineering characteristics and ultimate performance but its life cycle, supplied items and production procedures. Sample characteristics include:

1) A one-to-one model of the final product so that it is finalized (respecting engineering sample) respecting operational sample. The model can be used to evaluate expected key capabilities and test them in their related operational environment.
2) It is a final model in system's real dimensions and involves all subsystems and ultimate characteristics of the product. Still, it lacks expensive equipment (with military standards) irrelative of activity principles and authorities of
3) Most operational – technical capabilities of the system are expressed. For example, the task can be performed during an experimental exploitation period by the customer with direct and indirect monitoring and cooperation of representatives of the research organization.
4) It is necessary to control and approve integrated performance of main interacting subsystems in an acceptable level.
5) Performance of subsystems is directly controlled and its stages are confirmed.

4.1.3. Operational Model / Production Standard Model / Advanced Engineering

The model is entirely similar to the engineering model in terms of operational and technical features. It may not be practice in research procedure. In other words, operational model is a sample with finalized engineering and performance characteristics and main system items. But, it has not been stabilized in terms of lifecycle and production procedures. Characteristics of such a model are as follows:

1) It is capable of responding to general operational expectations of users
2) Product fitness (in terms of sample and documentations) is enough to initiate technology transfer in order to enter production phase

3) The model is highly a representative of the final system but it still lacks characteristics of a manufactured product (such as price, supportiveness, mounting main parts, production repeatability, etc.).
4) All experiments (in the factory, at work and field experiments) should be performed and probable problems solved
5) Customer documents (maintenance, fixing, operation, etc.) are provided and used by the customer, except in some limited cases
6) Operations are performed in a successful and repeatable manner
7) Users and operational experts must successfully acquire enough experience and skill to employ the system
8) In this model, all technical / operational capabilities of the system are expressed. The task can be performed during an experimental period by the customer with direct and indirect monitoring and cooperation of representatives of the research organization.

4.1.4. Semi Industrial Model / Limited Production / Pilot Plan

Semi industrial or limited production (Pilot Plan) is a step prior to industrial production or even foundation of the factory. It is, in fact, the limit between research production and industrial production with a production rate smaller than that of industrial and greater than that of experimental productions. Research on semi industrial production is a kind of investigation on production in micro scales compared to industrial manufacturing so that required data is gathered through test and error on sample fabrication and production method correction (this means what is needed to build and initiate an industrial factory). Pilot Production enables planners, researchers and investors to revise their ideas and estimations in order to optimize production methods and characteristics of products and procedures. It is possible to present products, while accomplishing and examining production period, in order to perform an experimental marketing and finalize market feedbacks. Meanwhile, users' feedback is considered in ultimate evaluation of production and its scales. When a laboratory sample product successfully passes through initial stages it is carried to Pilot Plan production step where production limit is low. Here, the Pilot Plan analyzes deficiencies, loss and profit, capacity, accuracy, facilities and equipment.

A) Objectives of the Pilot Plan

1) To optimize production procedure
2) To gain technical knowledge on production procedure and realize research results
3) To train employees and develop trust in management
4) To estimate production expenditures prior to industrial production with a close approximation to the real estimations of industrial production
5) To investigate product application in the market
6) To test capacity and sensitivity of machinery and equipment to determine their properties for mass production
7) To find the best transportation mode
8) To access technology data. This enables identifying effective production factors and parameters and developing an industry for that product.

B) Characteristics of Pilot Plan sample

1) A sample or model all features of which are finalized and all equipment used in it have standards of a real system
2) It has sufficient life cycle, maintenance support services, extensive training services, competent operational power and durability in vivo and limited production. It also is generally responsive to all operational expectations of customers
3) Because of limited orders and demands, the product is manufactures only in a certain period of the year. Hence, production capacity of other industrial lines is usually used to manufacture the product (and vice versa)

4) In order to economize the product some parts (subsets) are provided from external sources
5) All factory/on work/operational experiments are implemented successfully and probable deficiencies removed
6) Entire technical documentations including maintenance, operation, etc. are completely produced and accessible by customers
7) Logistic items and their production procedures are finalized with economic components. In other words, the sample is ultimately stabilized in terms of performance, age, production, item supply and finished costs.

4.2. Common Definition Of Implementation Phases Of A Research Project (industrial research vice-presidency of armed forces, 2012)

First phase: possibility evaluation (evaluating requirements and conceptual designing)

Second phase: preliminary designing

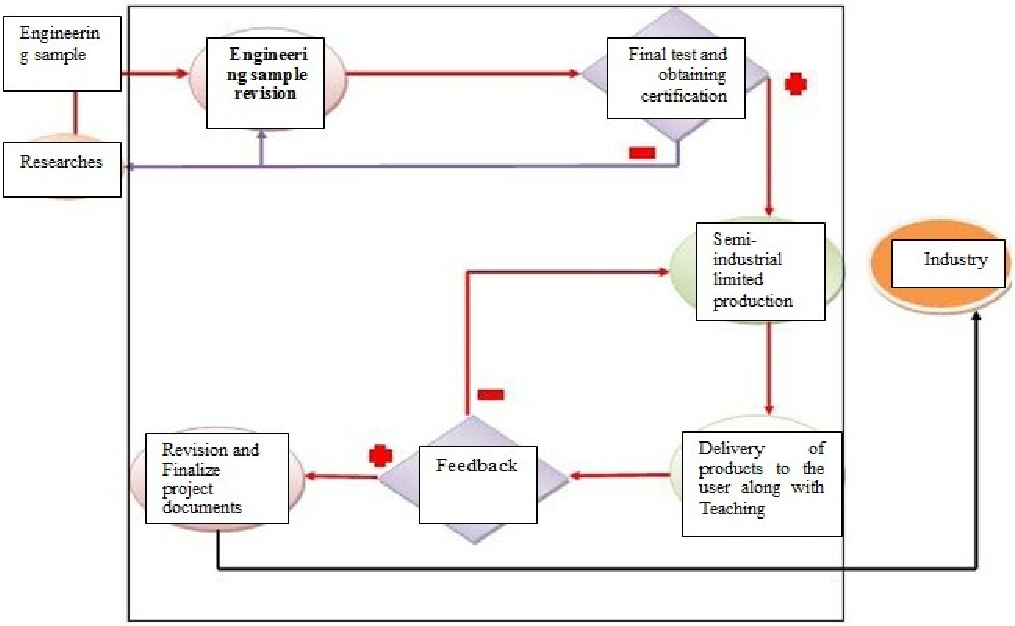
Third phase: detailed designing and sample examination

5. THE PROPOSED PATTERN

The proposed pattern of the present research is suggested (Fig. 9) respecting mentioned problems of available patterns and according to items below:

- Performing theoretical studies
- Investigating different types of available models of technology transfer and identifying their strengths and weaknesses
- Exploring the procedures used by successful research centers and organizations
- The 20-year experience of researchers on technology transfer

Figure 9: The proposed pattern



According to the proposed pattern the beginning sections of which are similar to the pattern depicted in figure 8, research organizations of armed forces, collect operational requirements of all forces and accordingly define research projects. In the next step, defined projects are approved in the Headquarters of industrial research and abandoned to specialized centers of research organizations for implementation. Then, the engineering sample is transferred to the Center of Self-sufficiency and Industrial Affairs (CSIA) of research organizations along with research documentations of project management sample phase.

The mentioned Center revises the engineering sample performs an operational test. If the test result is desirable, the Center issues an inquiry for a (limited) number of required products. Having approval procedure accomplished by commanders and receiving the final certificate, the credit required for limited production is financed and technical capacities and available equipment are used to plan for production of that limited number of products. While limited production is accomplished, required documentations are conducted according to imparted standards and samples are fabricated based upon the documentations and delivered to supplying centers (Preparations Unit) to be handed over to selected sections according to distribution tables. The CSIA is responsible for educations on employing produced samples and user sections send their feedbacks after a period of six months or 1 year.

If the required number exceeds a certain limit (for example, a number of 10 samples; a number which depends on the nature and type of the product), a model of produced samples along with its technical data is sent to a manufacturing industry through CSIA management in the form a Letter of Understanding among four authorities (Headquarters of Industrial Research, Vice-president of Preparations and Logistic, Director of the Executive Research Organization and the President of Organization of Defense Industries). Defense industry cooperates with CSIA and, first, produces "production criterion" sample having exerted required modifications and then, launches mass production after the final approval of criterion sample.

5.1. Tool-Making (Validity Test) And Collecting Data From Experts (Questionnaire Design) To Evaluate And Modify The Proposed Model And Present The Final Model

5.1.1. Research tools

Because of weak documentations in projects and lack of access to recorded data individual experience is considered as one of the richest and most reliable information sources. But this source is somewhat dispersed and requires a scientific research tool and method to gather the raw data and process them.

Therefore, questionnaire and interview are used as research tools respecting various articles on the subject and other scientific methodologies. The applied questionnaire is designed using Likert Scale. Answer items of this scale usually represent agreement or disagreement of the respondent on a certain subject. Moreover, a total number of 27 interviews are conducted in order to establish a direct relationship with experts. The interviews were performed on the following topics:

1- Necessity and importance of producing research projects
2- Implementation methods and procedures of technology transfer from research organizations
3- A proper model for technology transfer

5.1.2. Questionnaire Design

A questionnaire containing 54 questions was conducted to collect experts' ideas on technology transfer. Every question represents a measure of proposed patterns. The respondent should express his/her rate of agreement or disagreement on every measure (in the form Likert Scale).

5.1.3. Questionnaire Validity

A questionnaire is valid which its content exactly evaluates studied subject. First, a questionnaire is designed based on the subject and its questions were evaluated in different steps. Ten experts were surveyed on questions comprehensiveness, relativity of test objective to proposed questions and omission of irrelative ones. Finally, required modifications were exerted on the questionnaire and its questions (according to ideas and viewpoints of advisor professor). Thus, the questionnaire possesses sufficient content validity.

5.1.4. Population Selection And Sampling

Research population consists of individuals with different education levels in the field of manufacturing, fabrication and management of technology transfer. Around 1000 researchers work in the mentioned population of which approximately 25% are directly practicing in manufacturing and technology transfer. Therefore, the sample was selected from 250 experts of technology transfer among whom 40 questionnaires were distributed. Thus, respecting completed questionnaires, omitting uncompleted and deficient ones, the total number of 30 questionnaires was selected to be analyzed. Effort was made to select the population from those organizations having research process of technology transfer.

Random sampling was used in the present research. A list of experienced managers and experts in manufacturing, documentation and technology transfer was prepared and, then, some individuals (40 individuals) were selected randomly.

5.1.5. Determining Reliability Of Questionnaire Data Using Cronbach's Alpha Method

Cronbach's Alpha is one of the methods used to estimate reliability. It is a coefficient representing positive correlation between members of a collection. The closer the Alpha to 1, the greater is the internal consistency reliability.

Having 30 questionnaires completed, their Cronbach's Alpha (0.901) was estimated using SPSS 19 (Table 2). Hence, the used questionnaire is reliable. Results are presented in tables below.

Table 2: Determining questionnaire reliability using Cronbach's Alpha

Case Processing Summary			
Cases	--	N	%
	Valid	30	100.0
	Excluded०	0	0
	Total	30	100.0
A. list wise deletion on All variables in the procedure.			

Reliability Statistics	
Cronbach's Alpha	N of Items
.901	54

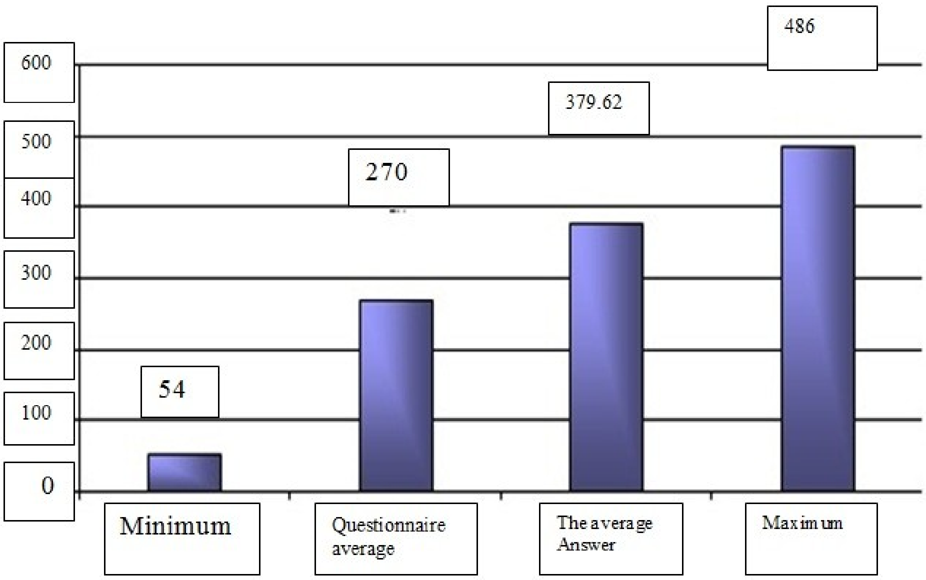
5.2. Data Analysis

Following statistics and test were used to analyze data statistically, having collected experts' viewpoints and determining questionnaire reliability using Cronbach's Alpha.

5.2.1. Data analysis using mean value

In order to compare results of completed questionnaires to mean and maximum scores, aggregate scores of each questionnaire and its mean score was calculated. The resulting mean value (379.62) is greater than questionnaire mean (270) indicating desirability of experts' ideas framework (the mean of questionnaire is 5 and that of answers is 7.03).

Chart 1: Comparison of mean value of experts' ideas to the mean of questionnaire



5.2.2 Data Analysis Using Binomial Test

Likert Scale is used here. The reason (objective) is to convert respondents' qualitative ideas to quantitative numbers intelligible for a machine. Since the numbers lack quantitative meaning, nonparametric methods should be employed to analyze them.

Item	Very low	Low	Medium	High	Very high
Score	1	3	5	7	9

Since descriptive methodology and quantitative data were used to perform the present research, binomial test is used for data statistical analysis. Binomial analysis has following characteristics:

- The test has only two states (success, failure)
- Success probability is constant (p and q are probabilities of success and failure, respectively so that $p + q = 1$).
- Experiments are independent from each other
- Experiments are repeated for n times

If the binomial distribution leads to success with probability of p and failure with probability of $q = 1 - p$, then the probability distribution of variable x, number of success in n independent experiments, is obtained as follows:

$$b(x,n,p) = \binom{n}{x} p^x q^{n-x} \qquad x = 0,1,2,3,\ldots,n$$

To analyze data pertaining to completed questionnaires, hypotheses were defined for all questions. Moreover, in all questions $\mu \leq 6$ and $\mu > 6$ were considered as H_0 and H_1, respectively.

Examples of binomial test on some questions:

Question one: having enough number of procedures

H_0: number of procedures is not enough

H_1: number of procedures is enough

Question five: economic justification of model implementation

H_0: model implementation is not economically justified

H_1: model implementation is economically justified

Question fifty four: necessity of presence and supervision of research center/organization until the end of mass production phase in industry

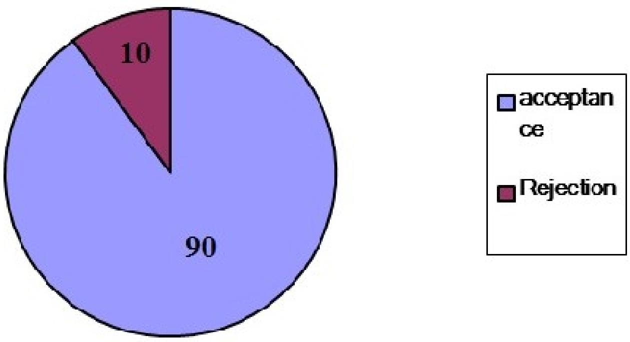
H_0: presence and supervision of research center/organization until the end of mass production phase in industry is not necessary

H_1: presence and supervision of research center/organization until the end of mass production phase in industry is necessary

Analysis is performed through a strict hypothesis in this test. This means that means smaller than (or equal to) 6 are rejected and those greater than 6 are accepted. Except for questions 12, 35, 36, 38, 39, 45, 50 and 54, the null hypotheses of all questions are rejected. Respecting questionnaires' results and performed analyses, two results are mentioned here:

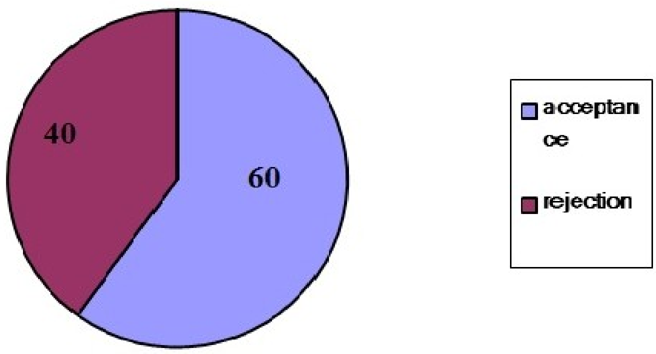
Question 8: 90% of experts confirmed the necessity of predicted procedures in the pattern.

Chart 2: Percentage of respondents to Question 8



Question 12: 60% of experts confirmed the necessity of revision on standards of documentation in revision procedure of the engineering sample.

Chart 3: Percentage of respondents to Question 12



The same methodology was used for other questions.

5. Conclusion

The most important factor suppressing production of industrial research projects of armed forces' research centers is the lack of proper structure or pattern in research-to-production procedure. A primary pattern (Fig. 9) is presented in this research reliability and is modified and turned to model presented in Fig. 10 after validation and collecting experts' viewpoints. The following items were added to the preliminary pattern (according to experts' ideas):

1) Fabrication of operational sample after revising engineering sample and before limited production
2) Fabrication of operational sample based upon experts of provisions, operations and industry
3) Establishing a mutual interaction during production procedure between manufacturer research organization and technology-receiving industry (on fabrication processes and completing documentations according to the pattern accepted by the industry).

The important point of the pattern is creation of an intermediate between research and production so that engineering sample resulting from implementation of research projects is improved and converted to operational sample. Then, having the Pilot Plan implemented and feedbacks of operational sections collected, the technology is transferred to defense industry in the for a Letter of Understanding and comes to mass production after finalizing production criterion sample.

Therefore, consequences and achievements of the present research are of great significance and prevent exerting personal interests. It seems that by implementing the proposed pattern research results come into practice instead of being archived and this prevents wasting research costs. Other outcome of this pattern include the growth in country's industry, meeting needed of armed forces locally and independence from foreign countries, development of incentive in researchers, etc.

Figure 10: the Final pattern of technology transfer from research organizations of armed forced to defense industries for mass production (Ali Ahmadi, 2000).

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None.

ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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