

The Influence of (beta) Technology Intensity and Evaluating TCC Using AHP Model in Iran Tractor Manufacturing Company (ITMCO)

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Due to the strategists in business World, the most important strategic consideration in international economic and industrial competition is in managing innovation and technology context. Increasing the competitive advantage of each economic institution needs the increase of technologic content improvement applied in production process of that institution. The present paper aims to study and evaluate the technology intensity and TCC in Iran Tractor Manufacturing Company (ITMCO). According to the results of research work, the authors have offered proposals to improve the technology by introducing the turning points and defects existed in technology parts in the company.

Field of Research: Management

1. Introduction

Due to doctrines of technology improvement theories, the first step in improving the status of technology and planning for more efflorescence in the future is recognition and awareness of the content and current status of technology. After recognition of all aspects factors of current technology and analyzing the defects and turning points in industry, the next step is to determine the goals regarding the local condition and special technologic status, in which the best possible status and strategies to achieve desirable technology is recognized, evaluated and analyzed and finally optimal strategy to improve industries is selected (Chi & Kent; 1990).

So without recognition the current level of technology and knowing defect, training points and main technologic problems of industry each strategy of technology improvement will go to fail. The paper organized as follow; in section two the importance of technology explained. Research questions stated in section three. In section four literature of technology is referred. In sections five, six and seven Methodology of

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research and how the research is conducted, discussions and results and conclusion are explained respectively.

2. The necessity and importance of the issue

The necessity and importance of measuring technology level in industry can be evaluated in two parts: small economy and huge one. Considering the small economy, technology category in studied in two branches small economy and efficacious management studies in production function have shown that production elements (labor forces ,capital,...) only explain half of the production size, and economist believe that this indefinite problem which is applied with technology level is recognizable. So to improve the condition and amount of production, it is important to consider technology element (Brown, 2000). on the other hand one of the core requirement of strategic management is current measuring of technology level to make a decision and to recognize the defects and turning points is one of the basic stages in this procedure measuring technology level provides documented information of defects and turning points for management, and considers it .

As an information entry for strategic management of the company considering the huge economy, regardless to discussions related to human improvement and institutionalism which derives from technology an producers many different ideas, we will refer just two phenomena to convey technology and technology improvement. Measuring technology level in ITMCO introduces defects and turning points of industry technology as well as proper scales to lead and focus investment and studies to solve the defects and support turning points of industry within the country.

There are two reasons for the importance of technology (Fluid, 1996). First technology is the base of success in business and also in many services and without effective use of technology. It is not possible to put oneself in competitive position. So in this view, technology is the main and determinant cause of main course to:

- Differentiation of product
- Reduction in costs.
- Creating new chances in business (or to confront with treaties of replacing)
- To facilitate and support essential changes.
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Second technology based innovations are the only course of long-term growth and improvement in industry and economy, so the management in usage of technology in long-term managing and policy making is necessary.

3. Research questions

The main question is what is the level of existing technology in ITMCO? The similar and more specific questions are:

- 1- How is the position of each technology element?
- 2- What is the influence degree of technology elements in (β) of company and what are their roles?
- 3- What are the existing problems and training points of technology elements?
- 4- Is there a proper balance between technology elements?
- 5- What elements of technology have the most and the least prominence?
- 6- How can the level of technology be improved?

To answer these questions on the base of research gains, first we introduce different models to measure technology level. Then describing the research methodology based on technology ATLAS model, we provide the most important findings of research and proposed procedures of project to improve technology in the company.

4. Literature review of theoretic principles

The term technology is originally a combination of Greek terms "TECHNO" That means art and industry and "logy" means science cognition, which is known in English as a derivation of Logica and Technique.

So termological meaning is "TECHNOGRAPHY". Based on the researchers has done about it, we can claim that as the same number of theorists in technology context ,there are different definitions for technology ,which have many common aspects .although they have superficial differences. In this section we will provide just three definitions without analyzing their dimensions:

- 1- Technology is the knowledge and necessary skills to produce a production and service which are the results of thought might and understanding human and combination of existing rates in nature and in extended concept it also involves applying science in industry using ordered studies and procedures (UNIDO, technology management ,1995).
- 2- Technology is introduced as a transformer factor of natural, soil, capital, labor-force sources to produced stuffs, so we can consider it as a combination of hardware and software for production which is included of four main factors: technical implement, human implement, institutional implement and informational implement (Technology ATLAS, 1990).
- 3- Technology is a set of knowledge, products, process, tools, procedures, structures and systems which are applied in creation of value in a system (Porter, 1990).

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4.1. *Classifying different kind of technology*

Technology can be classified for different purpose .this classifications are relative and identifying an accurate boundary for classes is not possible. In this section we name just some of the most important classes in technology (Yousefpoor, 1988 and Hajfathalipoor, 1993).

- 1- Classifying technology according to existing abilities: includes exploitation and usage technology, adoption technology, designing and constructing technology, production power of new technology (research and improvement for innovation),the basic researches.
- 2- Classifying based on the origin of technology includes: imported. Local, traditional and combined technology.
- 3- Classifying based on complexity included: acceptable and unacceptable technology.
- 4- Classifying applicatory and the amount of investment it takes:

Includes applied technology and the one which takes investment.

- 5- Classifying based on the nature includes: hardware and software technology
- 6- Classifying based on application includes: consuming and producing.
- 7- Classifying technology in strategic aspect includes: basic technology, key technology, emerging technology, pioneer technology,
- 8- Classifying technology based on final productions includes :the technology to produce capital products ,the technology to produce intermediate products and to

Produce essential products.

- 9- Classifying based on lifetime includes: technology in introduction phase, Technology in distribution and growth phase, technology fullness phase, technology in obsolescence phase.
- 10- Classifying based on the kind of industry includes: heavy industry technology, light industry technology and handicraft technology.

4.2. *The levels of technology*

The technology existing in each industry and in products and services has some special levels of ability and knowledge .industrial research center UNIDO has classified the level of technology by studies in ten levels, which are:

- 1- The lack of knowledge of technology.
- 2- Knowing about the existence of technology and its application.
- 3- Having knowledge about leadership, management and utilization.
- 4- Having knowledge about maintenance and repair.
- 5- Knowledge of assembling.
- 6- Knowledge of renewal and reduplication procedures.

- 7- Knowledge of adopting procedures.
- 8- Knowledge of designing and improvement.
- 9- Knowledge of industrial and applied researches Institution, or in national level, each of them evaluates technology in different aspects .Each of them has its special defects and turning points.

For determining the level of technology there are different approach which we mention here and then we explain just ATLAS approach because of its applying in this research. These approaches are as follow:

- 1- Economic assessment of status of technology
- 2- Disaggregated measurement of status of technology.
- 3- Strategic analysis approach
- 4- Multiple indicator approach
- 5- Technology indicators
- 6- Technology fitness audit.
- 7- Porters approach.
- 8- Technology Atlas.

5. Methodology and Research Design

The research aimed to study the influence of (beta) Technology intensity and evaluating technology components in Iran Tractor Manufacturing Company (ITMCo). For determining the levels of technology, the researchers used technology Atlas method. This approach is the result of four years assessment and research in Asia Pacific Center for Technology Transmission (APCTT).

One of the dependent organizations on economic social commission of Asia and Pacific is the draft of which has written in 1988(APCTT, 1988).

The technology atlas which is new and in evaluation, is a applicative approach for developing countries and the results are almost reliable. specialty of this approach not only is it is applicability in different economic levels but also recognize the existing defects and turning points so it provides the possibility to plan and to make strategy and policy to improve, empower and for achieving them (Industrial Management Organization 1995).

- 1- **Techno-ware** :that's the means with technology has been set in them and include all necessary physical possibilities to achieve transmission ,such as tools ,equipment ,machinery, building and etc...
- 2- **Human-ware**: That's technology lied in human who includes the necessary abilities to implement production, such as: proficiency, skill, agility, innovation initiative, etc....
- 3- **Info-ware**: That's the technology lied in documents which includes all necessary information and figures in production ,such as plans, characteristics, observations, Relations, mathematical calculation ,graphs and scientific theories.

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- 4- **Orga-ware:** That's technology laid in an organization which includes all necessary frames a structures in production such as: systemize, organize, networking and marketing.

To reach the strategic plan based on technology in company, system and subsystems in massive level, we can apply these four categories and create balance and effective relation between them.

Measuring technology level in the firm based on technology ATLAS, in research which has done in the firm and it is used to measure technology level.

In this section the methodology to assess technology level is provided.

Indicators to determine technology level:

As mentioned before, there are four categories based on technology to determine additive technology and technology level, techno-ware, info-ware, human-ware, orga-ware. Determining the prominence and share of each category and combining them through calculating. Technology Contribution Coefficient (TCC) indicates the technology level of an industrial unit.

To measure technology level of industrial units, the following stages have been done:

- 1- Determining the statistical information and proper individuals to fill the questionnaire with MIS in the firm.
- 2- Determining indicators to assess the level of techno-ware in the first stage of production.
- 3- Determining maximum and minimum level of complexity in every stage of production.
- 4- Determining indicators to assess human-ware, info-ware, orga-ware.
- 5- Determining maximum and minimum level of complexity in each category of human-ware, info-ware, orga-ware.
- 6- Reference to different people and sectors of the firm and determining the degree of each indicator by questionnaire.
- 7- Determining the importance of each stage in production and specifying proper weightiness according to the importance of every stage.
- 8- Calculation the intensity of the influence of each component of technology based on the information obtained from questionnaires
- 9- Determining the importance of technology component in comparison with each other in the firm.
- 10- Calculate of technology contribution coefficient (TCC) in the company.

5.1. *Determining the proportion of each technology components*

5.1.1. Techno-ware (T)

- Determining and separation the basic production stages in the firm.

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- Determining the complexity level of equipment and machinery (maximum, minimum) in each stage.
- comparing the characteristics of machinery and equipment in each stage to compare with SOA (normal condition)
- Determining the weightiness or importance of each stage.
- Making proper tables to collect information and calculate the share of techno-ware by following formula:

$$T_i = \frac{1}{9} \left[LL + \frac{ST(UL - LL)}{10} \right]$$

$$T = \sum T_i w_i$$

Where T is the proportion of techno ware, LL is the minimum complexity of techno ware in I stage, UL is the maximum level of complexity in I stage, ST is the average of indicators prominence in I stage, W is weightiness of I stage.

5.1.2. Human-ware (H)

- Determining and separation human force groups (production workers, supportive workers, production supervisor.....)
- Determining the complexity levels of human ware (maximum, minimum) in each group.
- Determining comparative indicators for human force.
- Determining the weightiness of each group related to human force.
- Making paper tables to collect data of human force and calculating their shares by this formula:

$$H_i = \frac{1}{9} \left[LL + \frac{SH(UL - LL)}{10} \right]$$

$$T = \sum H_i w_i$$

Where H is the proportion of human-ware, in each group, LL is the minimum of complexity in human-ware in I group, UL is the Maximum complexity in human ware in I group, SH is the average of indicators prominence in I group and W is the weightiness of I group. Indicators of human-ware include the degree of tendency to success, tendency to be serious, tendency to be on time, tendency to leans and capacity to take risk.

5.1.3. Info-ware (I)

- Determining indicators.
 - Determining the complexity levels of info-ware (maximum, minimum)
 - Making tables to collect data of information and calculating its.
- Share by the following formula:

$$I_i = \frac{1}{9} \left[LL + \frac{SI(UL - LL)}{10} \right]$$

Where I is info ware proportion, LL is minimum complexity of info-ware, UL is the maximum complexity of info ware and SI is the average of indicators prominence determined for info-ware.

5.1.4. Orga-ware (O)

- Determining the complexity levels of orga-ware (maximum and minimum).
- Determining indicators prominence of orga-ware.
- Making proper tables to collect data of orga-ware and to calculate their share by the following formula.

$$O = \frac{1}{9} \left[LL + \frac{S_o(UL_o - LL_o)}{10} \right]$$

Where O is the proportion of orga-ware, LL is the minimum complexity of orga-ware, UL is the maximum complexity of orga-ware, S is the average of indicators prominence determined for orga-ware.

The indicators of orga-ware include leadership to create motivation, the incentive for orientation, the tendency to strategic management, internal independence and proper space to innovate.

5.2. Calculating of Technology Contribution Coefficient (TCC)

After calculating each component T , H , I , O , we use them to combine their role of power function called technology contribution coefficient function:

$$TCC = T^{\beta_t} \cdot H^{\beta_h} \cdot I^{\beta_i} \cdot O^{\beta_o}$$

Where T , H , I , O are the scores of each component of technology and β relates the role of each component on TCC . The value of β can be calculated by different ways and expert opinion. In this study hierarchical analysis was used to determine preference of β . And the related calculation was done in "expert choice" a software. Note that the minimum possible value for aforesaid indicators is zero and the maximum is one.

5.3. THIO graph in the company

Considering the prominence average of each technology component

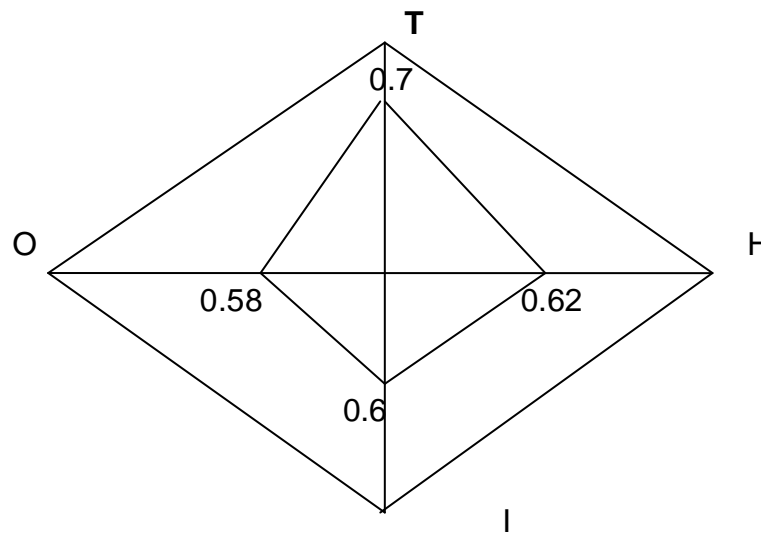


Figure 1: THIO graph in the company

The figure indicate the split between existing condition and optimal condition of share of technology component, also it shows the degree of balance or lack of balance between these components in the company.

6. Discussions and Results

The result of technology level in the firm using ATLAS model has shown that:

1. Assessing values of technology component in the firm shows that the share of techno-ware with value of 0.71 is the highest value in comparison with other components share and human-ware, info-ware are 0.62,0.6 respectively .the orga-ware With value of 0.58 has the least value in the firm. As general we can set their order as $T > H > I > O$.
2. Considering the maximum of each element, all technology component of the firm are higher than the mean. Therefore technology contribution coefficient in additive value of the firm with $TCC = 0.64$ is higher than mean level. In other words the level of technology of the firm in comparison with the best possible level in industry is higher than mean level.
3. Considering the balance between elements of technology in the firm, the values don't have considerable difference so the balance is in a desirable level.
4. Technology Contribution Coefficient (TCC) of Iran Tractor manufacturing firm is higher than mean level. This coefficient is a combination of values of elements, indicates the difference of

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technology level of the firm with desirable level. In other words in comparison with the best level, the technology level of the firm is higher than mean level.

5. Considering intensity of effectiveness and role of each component based on Hierarchic analysis process algorithm shows that techno-ware with weight of $\beta=0.393$ And info-ware with $\beta=0.145$ respectively have the most and the least intensity of Effectiveness in the firm and human-ware and orga-ware have respectively the subsequent levels.
6. The findings of research in techno-ware shows that ,the most average value of product stages is related to center housing ,front excel and assembling the engine. The least value also is related to gearbox.
7. findings of research in human-ware of technology of the firm shows that:
 - 7.1 Among different indicators of human-ware in different human groups of the firm,
Tendency to learn and tendency to success have the highest values and the capacity to take risk and tendency to be on time have least values.
 - 7.2. Assessing the average of indicators by separation of human force classes shows that supervisors of product group have the highest value in comparison with other human-ware indicators and workers group of production has the least value.
8. Finding of research in info-ware of the firm shows that:
 - 8.1. Between existing information systems in the firm , strategic planning information System and research and improvement information system ,have the most and the least value, respectively.
 - 8.2. Based on the information system to be up to date ,strategic planning information System of the firm is quite using up to date mechanism and four information system of marketing ,management calculating ,engineering and technology improvement , And information system of research and improvement are up to date in 50 percent of cases.
 - 8.3. As general the average of generality of information in the firm with the value of 8.36 shows the high level of generality in existing information in different contexts.
 - 8.4. The average of indicators of existence and being up to date of information systems are respectively 6.78 and 6.64 which by considering the maximum of 10, the minimum of zero and the average of 5, the levels of these indicators are higher than mean level.
9. Research in orga-ware technology shows that:
 - 9.1. Among the orga-ware technology indicates, the highest value relates to the degree of involvement and leadership of creating motivation and tendency to orientation has the least value.
 - 9.2. The total average of indicators of orga-ware is 5.54, which considering the minimum of zero the maximum of 10 and the mean of five, the average of indicators of orga-ware are in a mean level.

Although assessment of different aspects and elements of technology and values indicates desirable values higher than mean level and also changing current level of technology and improving the technology indicators need considerable efforts the current research accepting. It is defects indifferent aspects of technology assessment offers the followings in its methodology frame to improve the level of technology and reach to optimal level.

7. Conclusion

In this paper we have tried to illustrate the existing condition of technology in Iran Tractor Manufacturing Company (ITMCO) according to one of the known models to measure technology level. First the necessity and importance of measuring technology was presented and then research Production question were offered by conspectus review of theoretical principals of technology and measuring models, the methodology ATLAS, the level of technology in An institution, a country, or a sector is a function of four elements: techno ware, human-ware, info-ware, orga-ware. For empowering of THIO, the authors made suggestions as follow:

1- Empowering Orga-ware through empowering and improving the management organization abilities in different units of the firm.The key to improve technology throughout institutions is depending on effectiveness of management and organization capacities. This aspect of technology has the serious and important duty of management and organizing of other elements of technology due to the finding of research about orga-ware indicators of technology in the firm, the Following sentences are offered to empower the orga-ware technology:

- Increasing the proficiency of managers to apply management and strategic planning and to equip them with systematic thought in managing units.
- Defining accurate long term goals, midterm goals and short term goals of firms units.
- Identifying general plans to improve manager's proficiency in different organizational levels in the company.

2- To empower Info-ware of technology

As the existence of necessary information systems, one of the most important elements of technology in industrial units is the information to be update and comprehensive in different production processes.

So based on research findings the following offers are:

- The necessity of notice of different units of the firm to design and improving necessary information system and efforts to apply modern style in managing information systems.
- The necessity of notice to research and improvement and accurate definition of its place in organizational structure and to

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collect and complete information and knowledge which is necessary in research and improvement of similar successful units throughout the world:

- Improving technical knowledge of managers and technical and engineering experts of the firm in modern technology ground related to processes and existing activities.

3- Empowering Human-ware in the company

Human resources in an institutional level not only is a product tool, but also is an intelligent element by its proficiency and innovation, so they have been considered and in recent decades humans predominate role has been transformed to efficiency and then to use The intelligence of them. As a result one of the important and determining tools of Technology improvement in the firm is improving mental abilities and human sources.

But to the finding of research the following sentences is offered to empower human-ware of technology:

- investment in improving organizational entrepreneurial which considering ,it will improve and extensive spectrum of human-ware indicators:
- Improving knowledge and skills of human resource to have proper productivity of equipments.
- Creating motivation and responsibility taking in all levels of human force according to the goals of the firm and creating innovation through applying associative managing principle.
- Increasing the organizational learning abilities of human resource, improving abilities to manage time and increasing the capacities to take risk and lack of confidence.

4- Empowering Techno-ware of the company through studying the possibility of transmission of technologies with advanced techno aspect along with considering other elements of technology and studying and determining of procedures to increase technical efficiency for better use of machinery and equipment as much as possible.

5- Technology ATLAS which was provided by ESCAP is a proper way to determine technology level of industrial units in developing countries. So applying this approach in assessing technology level of industrial units and services in our country and especially in the provenance is recommended and making the research center in this subject can be useful.

6- The lack of knowledge in some managers and employers of different units of the firm about new aspects of technology makes it necessary to have some short term curriculums for management.

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