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IMPACT OF KNOWLEDGE MANAGEMENT IN TECHNOLOGY TRANSFER PROJECTS FROM R&D CENTERS TO INDUSTRY

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ABSTRACT

According to experts, implementation of knowledge management processes in research organizations is one of the success factors in a competitive environment with increasing technological change. But in research organizations, one of the main activities during research and development projects is to transfer acquired technology during the process of research and development to industry. This technology transfer happens through a process and various factors can be effective on it's success and effectiveness. Therefore, in the research, impact of implementation of knowledge management processes in technology transfer projects from institute to industry were studied. Therefore, the above-mentioned processes in Nonaka and Takeuchi 's model of knowledge management were used as independent variables and the dependent variable " technology pressure for product development " referred to in the final stages Lauren model is selected. To investigate this relationship, correlation and regression methods were used. Eventually it became clear that all knowledge management processes include: socialization, combination, internalization, externalization on phase of technology transfer project in product development is effective.

KEYWORDS: Knowledge Management, Technology Transfer, Research and Development

PREFACE

One of the main activities in organizations, working in the field of R&D, is to transfer the acquired technologies to industrial centers. This activity, from idea to product, is completed just when reaching to the phase of mass production and in other words, it is commercialized. Different factors can influence in completion of above-mentioned process and make it easy and fast such as implementation of knowledge Management (KM) processes during the execution of R&D activities and new product transfer to industry. According to the experts, km implementation is among main factors of success and failure in making a product commercialized and mass produced. In this research it is tried to study the impacts of km processes on technology transfer processes from one specific R&D center to industry. This job is done through literature review of km and domain of management of technology, research conceptual framework design, and finally testing hypotheses.

THEORETICAL FOUNDATIONS

In this section, first of all, we present a definition from knowledge and then, the concepts of km and R&D processes are clarified. Followed by, impact of km on Technology Transfer (TT) process in an R&D project will be represented.

Knowledge Definition

From the conceptual viewpoints, different scholars have proposed diverse definitions for knowledge. Woolf argues that "knowledge" is organized information, applicable to problem solving (Woolf, 1999). In another definition, knowledge is regarded as information that has been organized and analyzed in order to be applicable to problem solving and decision making (Turban, 1992). Knowledge consists of facts and beliefs, concepts and prospects, judgments and expectations, methods and technical perceptions (Wiig, 1993). Rampersad (2002) argues that knowledge is a function of information, culture and skills. In his definition, given function, shows relations among knowledge with culture information from one side and with skills from the other side (Adli, 2005).

Nonaka and Takeuchi argue that knowledge imagination as a set of information, is catching concept from Knowledge life. Knowledge, unlike information stems from beliefs and commitments. Knowledge exist in the user's mental context which act upon. it is just human who can have central role in knowledge creation and computers simply, are tools with marvelous processing power (Nonaka and Takuechi 2004). The variety of knowledge definitions derives from expert's different

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understandings. Each of the provided definitions shows a facet of knowledge dimensions. Some of them emphasize on knowledge subjective substance while some assert its objectivity. In fact, the problem of defining knowledge is as follows: knowledge is created in knower's mind but its application is by those who gain, keep and report it. The points in above definitions can be summarized in conceptual definition by prost in 2000 as follows:

"Knowledge is a full collection of understandings and skills which people use to solve their problems and includes all theories, actions, rules and daily routines. Knowledge is created by people and shows people beliefs and notions regarding cause and effect relations among phenomenon (Gilbert et al., 2006)."

Organizational knowledge is divided into explicit and tacit knowledge. Organizational explicit knowledge consists of knowledge worker's achievements which are kept in the form of reports, papers, designs, plans, notes etc. knowledge-based organizations, swimmingly and orderly, collect and keep explicit knowledge. (Jafari maghaddam, 2005). But the other type of knowledge is objectified in the shape of ideas, facts, assumptions, understandings, questions, decisions, guesswork and speculations, stories and viewpoints. This kind of knowledge is a rebel one which is much difficult to conquer and repossess for organization. This process-oriented knowledge is known as "tacit" knowledge. In other words, organizations own a valuable property, in the shape of their tacit knowledge among their knowledge workers. It is a fact that retaining and keeping organization valued knowledge, faces with considerable cultural and technical barriers. Group awareness tools such as internet, databases etc. usually fails in unfolding tacit knowledge and making accessible organizational memory (Nonaka and Takuchi, 1995). Km processes in organizations are seeking for acquisition and recording tacit and explicit knowledge in organizational processes. More, these processes are explained and finally, R&D processes, in which km implementation leads to identify and recording tacit and codified knowledge are explained.

Km and its processes

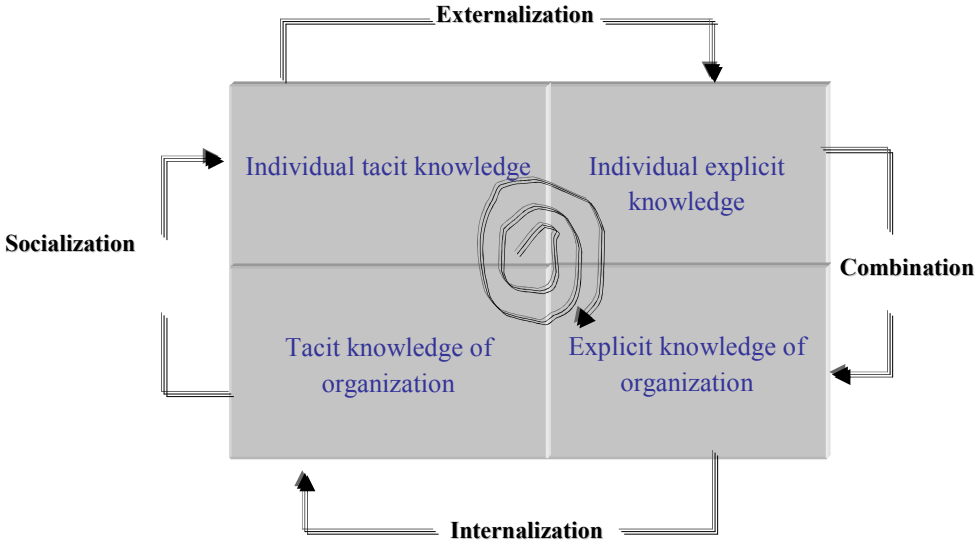
Km is composed of analyzing status quo and needed situation which includes planning and controlling processes to develop knowledge assets to reach to organizational objectives (Afrazeh, 2005). According to Gotcha, km is a commercial model among fields with all facets of knowledge such as knowledge creation, coding and sharing and how these tasks increase innovation and learning (Saeedi, 2009). Formalization and access to experience, knowledge and masterful viewpoints, which accompany new capabilities, higher efficiency power, innovation encouragement and increasing customer's value are main goals of km (Beckman, 2000). But in other definition, efficiency and effectiveness approach has been considered as follows:

Km is doing right things instead of right doing things; effectiveness has been emphasized not efficiency. Efficiency without effectiveness leads to organizational defeat. In long term, a successful company is the one who perceive the next right job and beforehand, prepare itself to ride the next wave (Malhotra, 2003). In all of these definitions, impacts and objectives of using km, such as better planning and controlling, increased organizational learning and innovation, increasing efficiency and effectiveness, and converting tacit to explicit knowledge has been noticed. In order to better introduction of km processes, different frameworks in well-established references have been presented. Nonaka and Takeuchi framework, is one of the most applied of them which has been used in this research. Km framework, for those organizations who are going to implement this management system in their organs, is of great importance. Km framework is a guideline which prevents of making mistake and according to the time and work consumed, would bring benefits for organization.

Nonaka and Takeuchi's km model, has concentrated on 2 types of "explicit" and "codified" knowledge and pays attention to how these 2 types of knowledge change to each other and how they are produced in all organizational levels (personal, group and organizational). In this dynamic model, way of using and converting these 2 types of knowledge and how to knowledge management in this field, according to figure 1, happens like spiral (helical) process.

Also, in above-mentioned thinking, it is assumed that just persons are knowledge creators. so organizational knowledge creation process shall be a continuous process in which, knowledge created by people, in an organized manner is boosted and guided.

Figure 1: Nonaka and Takeuchi model (Afrazeh, 2005)



Socialization (tacit-to-tacit) : hidden knowledge transfer (tacit) from one person to another. (How to solve problem of program-unusual design): in order to effective implementation of this process, shared culture and capability to work group shall be established among people which is possible through social and corporation theories. Group session which explains regarding experiences and discusses about, is a normal activity in which sharing hidden knowledge can happen.

Externalization (tacit-to-explicit) : converting visible knowledge to invisible one. Here, one can offer his or her knowledge in shape of orderly subjects (seminar-educational workshop) to others. Dialogues among members of a group , in response to questions or understating from developments, are among normal activities in which this type of conversion happens.

Combination (explicit-to-explicit) : in this phase, Individual explicit knowledge moves toward group explicit knowledge and it's storage and due to use of existing knowledge, ability to solve problems is provided through group and followed by that, knowledge develops.

Internalization (explicit-to-tacit) : in this phase, acquired explicit knowledge is institutionalized in organization. Also, passing this phase for people, leads to creation a new tacit personal knowledge. (gaining new hidden knowledge from existing explicit knowledge)

Passing 4 above stages shall go on continuously and spiral moves. In this way, each stage completes its previous stage. This will lead to knowledge institutionalization in organization and produces and creates new knowledge. It is noted that each of these 2 types of knowledge, shall be managed in organization and how to use and conversion of these, shall be identified and tapped. Each of these 2 types of knowledge, can make the other one and be developed in personal/group and organizational levels. The other important point is that, when people participate in these processes, organizational learning happens, because in this participation, people's knowledge with others are shared, explained and accessed. Also, knowledge creation happens through processes (Saeedi, 2009).

R&D process

Based on definitions offered in standard references (Fouladi, 2008), R&D is defined as follows: "Successful using of a technology inside a system or product, process, or changing into a system or successful product". But in this process, technology in different phases, is transferred from a department to other. more , this concept has been explained.

Technology transfer in R&D projects

TT is a process through which, desired technology to meet one or multiple specific needs is acquired. So TT is not just buying machinery and equipments or technology license. TT is technology acquisition from every source- whether domestic , overseas or a combination of both-(Hejazi et al., 2010). Management of TT is complete management of technology acquisition and recognition , deployment and

maintenance process .management of TT, means tapping knowledge and skill in order to enable the firm to absorb, match and develop the acquired technology according to firm's needs (hadjihoseini, 2010).

Technology in R&D projects can be defined as a set of all needed factors to change an idea into a profitable product. Here, technology is created. In this process, through doing research projects, technical information and applied research findings are transferred to engineering design and development. Then, in a gradual process, desired technology is created and entered to production process. In order to commercialize research projects, knowledge and technology shall be transferred from universities and research institutions to industry and finally to market. This process is called TT. Numerous mechanisms has been suggested for this kind of TT including licensing existing companies, R&D partnership agreements, training and publications, scientific corporations and reverse engineering. Internal technology acquisition is as a result of endeavors oriented to technology development which starts by organization itself. This can be done by different people including those who knows the technology application well, a foreign group or an equipped R&D division. This kind of internal TT process can be equipped with firm's hidden knowledge. This type of knowledge exists in firm but hasn't been perceived well or used. This knowledge, when discussing and different meetings is identified and tapped. Firm exclusively owns achievements derived from internal technology acquisition and the acquired technology matches with firm's needs but its risk is high and usually takes too long. According to GAO, TT process in R&D projects, specifically consists of 3 stages which are: 1) discovery (discovering ideas and concepts), 2) idea development, 3) TT(from laboratory to production line). Loren, considering to technology push, believes in 5 phases for TT in R&D projects. Product development, with regard to technology push, is differentiated with a specific technology and then through mixing with other technologies, creates new products for meeting market needs. TT starts from defining technology specialties and by reproducing prototypes, considering market pull model, goes on and finally leads to new product (loren, 2004).

Phase1- this phase which consists of defining technology specifications is as follows:

- Collecting technology information
- Grouping technology functional specifications
- Establishment of technology median specifications

Phase2- opportunities identification: output of this stage is projects assessment and prioritization. Alpha and beta prototypes which are results of feedback from product development process, are among other achievements of this phase.

- Identification and organization of wide networks of technology
- Determination of potential applications in different industries
- Identification and organization of expert's network
- Identification, refinement and validating potential applications

Phase3- determination, assessment and prioritization of projects: in this phase, type of product development is defined and organization and assessment of group members and evaluation and prioritization of projects is done.

- Defining type of product development
- Identification and organization of assessor's network
- Projects assessment and prioritization

Phase4- planning before product development and making decision regarding technology push or market pull

Here, like general model of market pull, there is a mission statement for each project and decision maker, considering to assessment and prioritization, shall decide concerning technology push or market pull for product development.

- Resource allocation and preparation of schedule
- Planning for product development
- Project mission statement development

At the end of this phase, final decisions regarding technology push or market pull for product development is made.

Phase5- technology pushes process in product development

This phase starts from identification of customer's needs and goes on with establishment of target coordinates in product development. During this phase, economic analysis, benchmarking from competitive products, and testing models and prototypes is done.

- identification of customer's needs
- target coordinates in product development
- establishment and choosing products concepts(conceptual design)
- product concept test and assessment of alpha sample

Followed by phase 4, if there is any problem, process is reverted to phase 2.

- Setting specifications and product final characters
- System level design , building beta sample (detailed design and testing and troubleshooting)

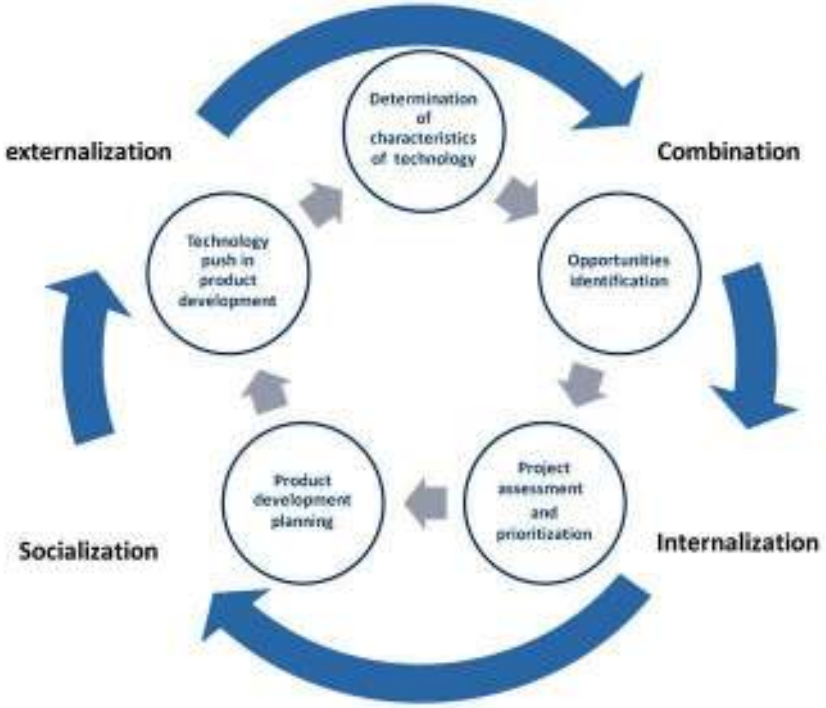
Followed by phase 5, product is launch into the market. In this research, impact of km processes in of Nonaka and Takeuchi model on TT process in loren model will be studied. Below, the conceptual framework which has been designed based on combining Nonaka and Takeuchi model and loren model will be presented.

METHODOLOGY

Research conceptual framework

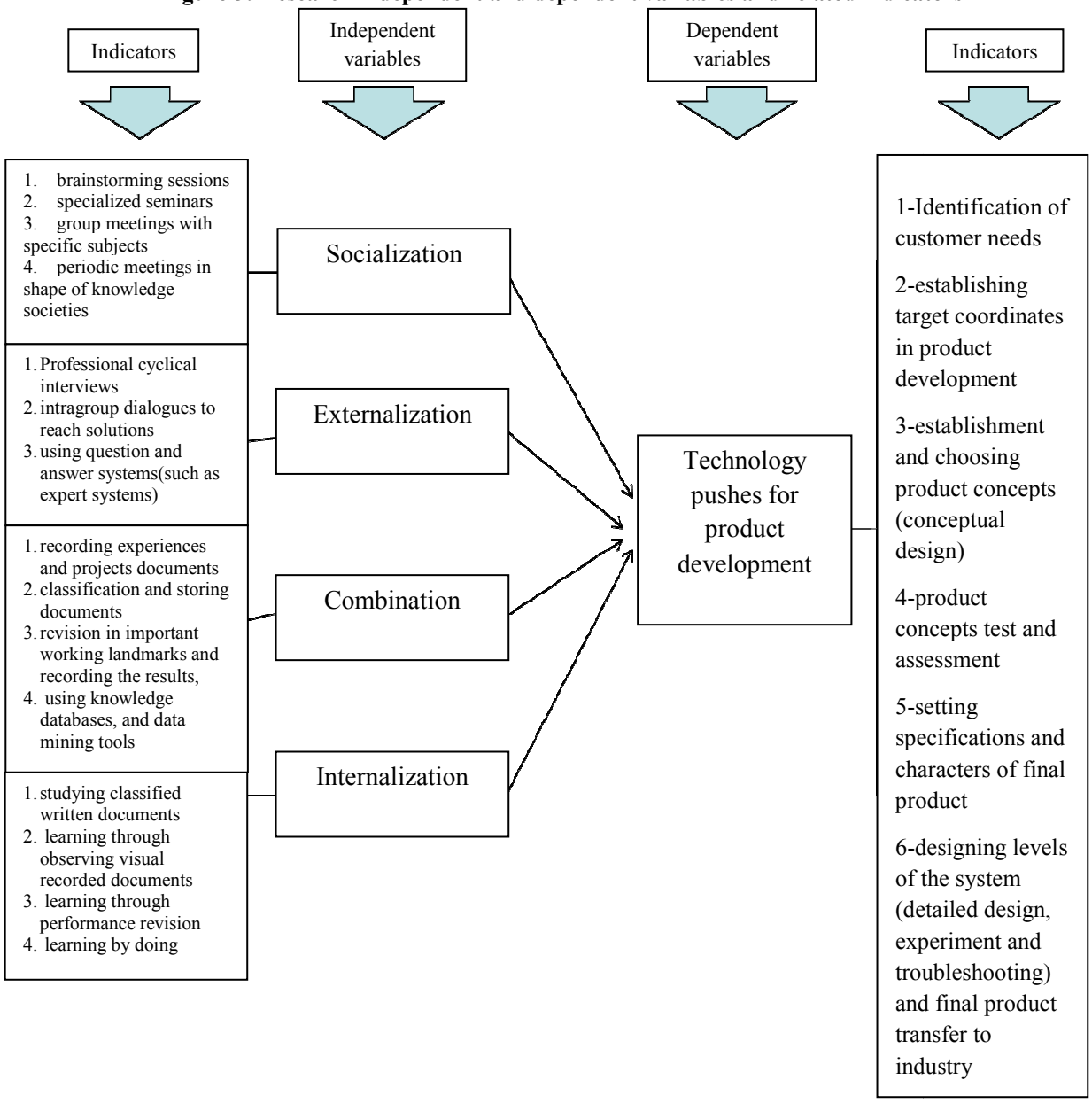
Based on research literature, conceptual framework to questionnaire design and testing research Hypotheses can be seen in figure 2. This framework has came from 2 models of Nonaka and Takeuchi in KM and loren in TT in R&D projects.

Figure 2: Research conceptual framework



According to studies performed, and interview with experts in research institute, the most important phase in TT projects in Sharif university Technology Development Institute, is phase 5, namely technology push process in product development (product commercialization). So, questionnaire questions, and research Hypotheses will be formulated based on this issue. Independent and dependent variables and related indicators are depicted in figure 3.

Figure 3: Research independent and dependent variables and related indicators



Research hypotheses

Considering the research model, in order to answer to research questions, 9 Hypotheses were offered as follows:

Hypothesis 1: in technology push process, phase of socialization, in product development is effective.

- H_0: socialization with technology push process in product development hasn't significant relationship.
- H_1: socialization with technology push process in product development has significant relationship.

Hypothesis 2: phase of externalization with technology push process in product development hasn't significant relationship.

- H_0: phase of externalization with technology push process in product development hasn't significant relationship.
- H_1: phase of externalization with technology push process in product development has significant relationship.

Hypothesis 3: phase of combination with technology push process is product development hasn't significant relationship.

- H_0: phase of combination with technology push process in product development hasn't significant relationship.
- H_1: phase of combination with technology push process in product development has significant relationship.

Hypothesis 4: phase of internalization with technology push process is product development hasn't significant relationship.

- H_0: phase of internalization with technology push process in product development hasn't significant relationship.
- H_1: phase of internalization with technology push process in product development has significant relationship.

Research methodology

Stages of this study are presented in Figure 4.these stages are: expression of research question, theoretical researches, research conceptual framework formulation, designing questionnaire, information collection, testing and conclusion. Regression and correlation methods have been used to test hypotheses and identify the impact of variables.

Figure 4: Process of research

Statistical population and number of samples

In this research, statistical population consists of managers and experts working in TT projects of institute of knowledge and technology development of Iranian Academic Center for Education, Culture & Research - Sharif university branch .sample size is 95 in executive departments. 95 questionnaire containing 22 questions was distributed among 3 statistical population of which 54 questionnaire were filled and returned.

In questionnaire design, in addition to studying researches and similar questionnaires, books, articles and related journals, comments from professors and experts of knowledge management and R&D management were used to have enough reliability in questionnaire. Also, to assess the reliability of the questionnaire Cronbach test was done on the main questions of questionnaire which was equaled to 0.703. because the α value is greater than 0.7, so questionnaire question have appropriate validity.

RESEARCH FINDINGS

Respondents' demographic information

Statistical distribution of 54 respondents is as follows:

- In terms of academic certificate, 14.2% of respondents ,were bachelor's degree, and 60.7% of respondents were doctorate/ Master's degree
- 63% of respondents were part of one technology transfer project and about 37% respondents have been working in more than one project.

Test results

Results of testing hypotheses, using regression methods are listed in Table 1.

Table 1: Results of testing hypotheses

Sig	The coefficient of determination R2	The correlation coefficient	Dependent variable	Independent variable	hypotheses
0.003	0.128	0.385	Technology push for product development	socialization	Hypothesis 1
0.006	0.113	0.341	Technology push for product development	externalization	Hypothesis 2
0.002	0.161	0.483	Technology push for product development	combination	Hypothesis 3
0.0005	0.141	0.423	Technology push for product development	internalization	Hypothesis 4

Hypothesis 1- because the significance level of statistic is 0.003, so H0 is rejected and H1 is accepted. Hence, it can be said that in significance level of 5 percent, "socialization with technology push in product development has significant relationship". Considering The coefficient of determination R2, we can reach to conclusion that independent variable of socialization, determines 0.128% of technology push changes for product development.

Hypothesis 3- because the significance level of statistic is 0.002, so H0 is rejected and H1 is accepted. Hence, it can be said that in significance level of 5 percent, "combination factor with technology push factor in product development has significant relationship". Considering The coefficient of determination R2, we can reach to conclusion that independent variable of socialization, determines 0.161% of technology push changes for product development.

Hypothesis 4- because the significance level of statistic is 0.0053, so H0 is rejected and H1 is accepted. Hence, it can be said that in significance level of 5 percent, "internalization factor with technology push factor in product development has significant relationship". Considering The coefficient of determination R2, we can reach to conclusion that independent variable of internalization, determines 0.141% of technology push changes for product development.

Table 2: Factors comparison with others

The coefficient of determination R2	The correlation coefficient (r)	**Independent variable**
0.128	0.385	socialization
0.113	0.341	externalization
0.161	0.483	combination
0.141	0.423	internalization

According to hypothesis testing, and calculation of constituent factors of knowledge management and its impact on technology push for product development, it can be concluded that combination factor which consists of recording experiences and projects documents, classification and storing documents, revision in important working landmarks and recording the results, using knowledge databases, and data mining tools has more correlation with technology push in products development and has more share in changing this factor.

CONCLUSION

Conclusion of the first hypothesis

Phase of socialization of technology push process in product development is effective.

According to the first hypothesis test and its impact on technology push in effective product development, we can reach to this conclusion that group meetings with specific subjects, specialized seminars, brainstorming sessions and periodic meetings in shape of knowledge societies in technology push process for product development is effective.

Conclusion of the first hypothesis

Phase of externalization of technology push process in product development is effective.

According to the second hypothesis test and its impact on technology push in effective product development, we can reach to this conclusion that professional cyclical interviews, intragroup dialogues to reach solutions and using question and answer systems (like expert systems) in technology push process for product development is effective.

Conclusion of the third hypothesis

Phase of combination of technology push process in product development is effective.

According to the fourth chapter and the third hypothesis test and its impact on technology push in effective product development, we can reach to this conclusion that recording experiences and projects documents, classification and storing documents, revision in important working landmarks and recording the results, using knowledge databases, and data mining tools in technology push process for product development is effective.

Conclusion of the fourth hypothesis

Phase of internalization of technology push process in product development is effective.

According to the fourth chapter and the fourth hypothesis test and it's impact on technology push in effective product development, we can reach to this conclusion that studying classified written documents, learning through observing visual recorded documents, learning through performance revision and learning by doing in technology push process for product development is effective.

CONCLUSION AND SUGGESTIONS

1. Perfect and flawless implementation of KM processes can lead to successful TT process from institute to industry.
2. Using experiences and activities conducted in products development process can help institute in this way, and informs about the past mistakes , and makes products development process less risky and time consuming.
3. Holding group meetings, specialized seminars, brainstorming sessions and and periodic meetings in shape of knowledge societies can facilitate phase of socialization of product development and TT from institute to industry.
4. Specialized interviews, intragroup dialogues and using question and answer systems can conduce to knowledge externalization and converting tacit knowledge to codified knowledge in workforce of TT projects.
5. Recording experiences and projects documents, classification and storing documents, revision in important working landmarks and recording the results, using knowledge databases to record identified explicit knowledge, and using data mining tools can be effective in product development process.
6. Studying written documents, learning through observing documents, and learning by doing can lead to knowledge internalization and finally affects facilitation and expedition of product development and TT from institute to industry.

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