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Determination of Innovation and Self-Innovativeness Perceptions in Engineers

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Abstract

Innovation is a crucial subject for a country which tries to be one of the most developed economies in the World. Innovation provides increased efficiency in several areas, enhanced quality of life and competitive advantages. Hence any development within this field should be monitored and well adapted. At the point of adaptation and implementation, one of the key disciplines is engineering. For that reason engineers should be open to innovation and individual innovativeness. The aim of this paper is to find perception of engineers on these subjects. To measure these concepts, a survey was answered by one hundred and twenty engineers who work in different departments and sectors. Calculated Cronbach's alpha coefficient of this study is 0.821. Results of this study show the distribution of innovative approach among engineers and how can be the level of individual innovativeness increased.

Key words: Development, engineering, innovation, self-innovativeness

1. Introduction

Turkey is an economically growing country which aims to be among well developed countries. To achieve such aim, innovation should be monitored and well adapted immediately since this concept is a crucial subject for a country that tries to be one of the most developed economies in the World. It can also be stated that innovation provides increased efficiency in several areas, enhanced quality of life along with competitive advantages. When it comes to adapting innovation to our country, there are many important professions acting as a mechanism and one of the most valued and important parts of that mechanism is engineering.

In other words for a country to excel, it is crucial for engineers in that country to be innovative and keen on self-innovation. Innovation is a process of turning a creative idea into a valuable and tradable product while creating new opportunities for a business within the field [1]. Also it can be emphasized that innovation is a process of creating a successful improvement in intercorporate operations, organizational structure or introducing a significantly improved product, marketing strategy or production line [2]. Innovation is a tool for entrepreneurship and an outcome of series of events which lead to a capacity for creating a welfare [3]. The notion of innovation can also be elaborated as management of combination of numerous events from creating an idea, developing technology, improving a product or a process to the marketing phase of that product. Meanwhile this definition remarks innovation as a management process [4]. Innovation can be seen as a process dedicated to a product, phase or an organization meanwhile self-innovativeness focuses on novelty perception of a human being.

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Personal innovativeness is enthusiasm of a person towards novelty and eagerness to observe and adapt it to his life [5]. Self innovatiness is also the desire to search and find the novelty and to a certain degree every individual can be an innovator since they encounter many new concepts through their lives [6]. From another point of view, self-innovativeness can be expressed as an umbrella which gathers notions such as being open to novelty, not being afraid of taking risks, creativity and leadership [7].

The relation between engineering and innovation concept has always been an important topic both in literature and in industry. Nevertheless, while there are many studies on innovation, there is only limited number of studies about innovation in terms of engineering. So to support our efforts about this subject, a comparative and detailed research about this field is carried out by examining previous works and studies. In their comprehensive work, [8] show that lack of confidence on technical improvements, over-reliance on existing status and avoiding taking risks are inhibitors in engineering innovation. For engineers to be innovative, they should be willing to be open to new ideas and to take risks alongside technical knowledge and confidence. Moreover, [9] focuses on personal skills, education and supporting environment for a human being to have a creative potential and innovative performance. [10] reveals that a majority of behavior, traits and skills have a learned component as opposed to being purely innate qualities. This situation bodes well for engineering and corporate educators in terms of developing programs, curricula and exercises that will encourage greater levels of innovativeness characteristics of engineering. Another study states that engineers with deep knowledge and active curiosity are tend to be innovators. [11] So it can be said that, through this study the level of innovativeness and individual-innovativeness perspectives of Turkish engineers is studied and possible ways to increase that level is discussed.

This paper is formed by multiple parts. To elaborate, the method used in this research is given and discussed in Section 2, Materials and Method. The outcome of the study will be discussed in Section 3, Results and meaning of these findings and possible ways to enhance them will be presented in Section 4, Discussion.

2. Materials and Method

This study aims to find out the engineers' point of view on innovation. To measure this notion, a survey formed by thirty-four questions was directed to one hundred and twenty engineers coming from different backgrounds. The first six questions of the survey aim to gather demographical information about the participants such as their age, level of education, time span that they have been actively working, department they work for and so on. Remaining twenty-eight questions of the survey origins to a questionnaire named "Individual Innovativeness (II)" which was created by Hurt et al. [7] and arranged accordingly to fit for engineers.

The original survey is shared via McCroskey [12] and it is openly stated that there is no need for permission in case of scientific research purposes. Furthermore, original survey is previously translated in Turkish and used for an innovativeness study on nurses by Sarıoğlu [13]. Nevertheless before starting this research necessary permissions are received both from McCroskey [12] and Sarıoğlu [13].

While completing the survey, participants are asked to select the most suited answer among five options that were formed according to Likert Scale. (5-Strongly Agree, 4-Agree, 3-Neither/Nor Agree, 2- Disagree, 1-Strongly Disagree) To reach a wide profile of participants the questionnaire is distributed through a website and shared via social network with potential participants. While transferring questionnaire to virtual platform a requirement for answering each and every question is set hence there is no incomplete or invalid form.

Score of each participant is calculated to see their place in innovative perspective ranking. Same method used by Hurt et al. [7] and Sarıoğlu [13] is used for this study. According to the acquired mark participants are evaluated under five different categories which are innovators, early adaptors, early majority, late majority and traditionalists.

Innovators are the first ones to adopt novelty meanwhile they are keen on taking risks and they have a vision [14]. Early adaptors are the people who embrace innovation rather early. People from this group tend to guide people around them. It can be said that early adopters are eager to accept novelty which provides a solution to themselves [15]. People from early majority are cautious against innovation. They tend to wait for some time and think about the consequences before they adapt any novelty [16] [17]. Late majority is very shy when it comes to innovation. People from this profile wait for majority of the society to experience novelty and see related consequences [16]. Traditionalists are the backmost profile in terms of innovation. Most of the time they act with prejudice when a novelty is confronted [15]. As stated in [7], the ones scored above 68 are considered as highly innovative and people who score below 64 are considered low in innovativeness.

3. Results

Gathered data is analyzed via SPSS 21 according to demographical information, acquired via the first six questions of the survey. By this application whether if there is any alteration according to education level, age, and department and so on could be observed in terms of innovation and self-innovatiness. Distribution of participants according to their personal and occupational properties can be seen in Table 1.

Table 1. Distribution of Participants According to Their Personal and Occupational Properties

Personal and Occupational Properties	**Number**	**(%) Percentage**
Gender		
Female	53	44.16%
Male	67	55.83%
Age		
25-30	71	59.16%
31-36	33	27.5%
37-42	3	2.5%
43-48	4	3.33%
49-54	7	5.83%
55-60	2	1.66%
61 and above	0	0%
Industry		
Public	16	13.33%
Private	104	86.66%

Department		
Research & Development	53	44.16%
Production	5	4.16%
Marketing	7	5.83%
Purchasing	5	4.16%
Other	50	41.66%
Education		
Bachelor's Degree	44	36.66%
Master's Student	23	19.16%
Master's Degree	29	24.16%
PhD Student	15	12.5%
PhD Degree	9	7.5%
Span of Actively Working		
1-5	61	50.83%
6-10	38	31.66%
11-15	7	5.83%
16-20	6	5%
21 and above	8	6.66%

From Table 1 it can be emphasized that participants between 25 and 30 are the majority of the study with 59.16%. 86.66% of the engineers attended to this study work in private sector and 50.83% of the participants have been actively working for 1 to 5 years.

Moreover, a reliability study is carried out over remaining twenty-eight scaling questions. At the end of reliability analysis Cronbach's Alpha is found as 0.757 and it is seen that there are three items which are not in consistence with others. For that reason those items are eliminated so Cronbach's Alpha is calculated one more time and found as 0.821.

Score of each participant is calculated according to rules stated in [7] and [13]. At the end of calculations, every engineer is categorized in a group. In table presented below, distribution of calculated score of each participant and their group in terms of innovativeness can be seen.

Table 2. Scores of Participants and Their Distribution

Categories	**Interval of Score**	**Participants**	
		Number	% Percentage
Innovators	Above 82	48	40%
Early Adopters	Between 75-82	47	39.16%
Early Majority	Between 66-74	18	15%
Late Majority	Between 58-65	7	5.83%
Traditionalists	57 and above	0	0%

Reference to Hurt et al. (1977) and Sarıoğlu (2014).

According to the outcomes presented in Table 2, 40% of the participated engineers are under the classification of innovators. The following majority is early adopters with 39.16%. Early majority has 15% and late majority in this study is only 5.83%. According to analysis, there is no traditionalist within this study's group.

Table 3. Analysis According to Gender

Categories	Female		Male	
	Number	% Percentage	Number	% Percentage
Innovators	19	36%	29	43%
Early Adopters	21	40%	26	39%
Early Majority	8	15%	10	15%
Late Majority	5	9%	2	3%
Traditionalists	0	0%	0	0%

In Table 3, analysis between genders is given. There are 53 female and 67 male participants in this study. Percentage of innovators in female engineers is 36% while percentage in male participants is 43%. So it can be said that in this study, male engineers are more innovative when compared to female engineers.

Table 4a. Analysis According to Education

Categories	Bachelor's Degree		Master's Student		Master's Degree	
	Number	% Percentage	Number	% Percentage	Number	% Percentage
Innovators	19	43%	8	35%	13	45%
Early Adopters	14	32%	9	39%	13	45%
Early Majority	7	16%	4	17%	3	10%
Late Majority	4	9%	2	9%	0	0%
Traditionalists	0	0%	0	0%	0	0%

Table 4b. Analysis According to Education

Categories	PhD Student		PhD Degree	
	Number	% Percentage	Number	% Percentage
Innovators	6	40%	2	22%
Early Adopters	8	53%	3	33%
Early Majority	1	7%	3	33%
Late Majority	0	0%	1	11%
Traditionalists	0	0%	0	0%

Both Table 4a and Table 4b show the results of analysis according to education level and it is seen that participant numbers varies significantly between different choices. From the tables, it can be seen that the highest score in innovators group is from engineers with master's degree.

Table 5a. Analysis According to Age

Categories	25-30		31-36		37-42	
	Number	% Percentage	Number	% Percentage	Number	% Percentage
Innovators	32	45%	10	30%	1	33%
Early Adopters	24	34%	17	52%	0	0%
Early Majority	10	14%	5	15%	2	67%
Late Majority	5	7%	1	3%	0	0%
Traditionalists	0	0%	0	0%	0	0%

Table 5b. Analysis According to Age

Categories	43-48		49-54		55-60	
	Number	% Percentage	Number	% Percentage	Number	% Percentage
Innovators	2	50%	4	57%	1	50%
Early Adopters	0	0%	3	43%	1	50%
Early Majority	1	25%	0	0%	0	0%
Late Majority	1	25%	0	0%	0	0%
Traditionalists	0	0%	0	0%	0	0%

From Table 5a and Table 5b it can be said that from age perspective the majority is engineers between 25 to 30 years old and when they are examined, it is seen that most of the engineers between these ages are innovators. Since there is no participant older than 61 years old, no interpretation can be provided about that age interval.

Table 6. Analysis According to Industry

Categories	Private		Public	
	Number	% Percentage	Number	% Percentage
Innovators	41	39%	7	44%
Early Adopters	41	39%	5	38%
Early Majority	16	15%	2	13%
Late Majority	6	6%	1	6%
Traditionalists	0	0%	0	0%

Most of the participants are from private industry with 87% of the overall participant population. When it is studied for each industry, there is no majority in private industry. In other words, percentage of innovators and early adopters are the same. On the other hand, innovators are the majority in public industry with 44%.

Table 7a. Analysis According to the Department

Categories	Research and Development		Production		Marketing	
	Number	% Percentage	Number	% Percentage	Number	% Percentage
Innovators	26	49%	0	0%	4	57%
Early Adopters	16	30%	4	80%	2	29%
Early Majority	8	15%	1	20%	1	14%
Late Majority	3	6%	0	0%	0	0%
Traditionalists	0	0%	0	0%	0	0%

Table 7b. Analysis According to the Department

Categories	Purchasing		Other	
	Number	% Percentage	Number	% Percentage
Innovators	2	40%	16	32%
Early Adopters	3	60%	22	44%
Early Majority	0	0%	8	16%
Late Majority	0	0%	4	8%
Traditionalists	0	0%	0	0%

Participants are expected to select the most suited answer between Research and Development, Production, Marketing, Purchasing and Other selections. Other option indicates departments in industry other than listed ones alongside with the academic community. It can be said that the most

effective department in terms of innovation is Research and Development (R&D) and this study shows that majority of R&D engineers are innovators.

Table 8a. Analysis According to the Duration of Employment

Categories	1-5		6-10		11-15	
	Number	% Percentage	Number	% Percentage	Number	% Percentage
Innovators	26	43%	14	37%	3	43%
Early Adopters	23	38%	15	39%	3	43%
Early Majority	6	10%	9	24%	0	0%
Late Majority	6	10%	0	0%	1	14%
Traditionalists	0	0%	0	0%	0	0%

Table 8b. Analysis According to the Duration of Employment

Categories	16-20		21 and over	
	Number	% Percentage	Number	% Percentage
Innovators	1	17%	4	50%
Early Adopters	2	33%	4	50%
Early Majority	3	50%	0	0%
Late Majority	0	0%	0	0%
Traditionalists	0	0%	0	0%

From Table 8a and 8b, it can be interpreted that the majority of the participants have been working for 1 to 5 years, with a majority of 51% of the overall participants. Engineers who have been working more than 11 years are few in this study.

4. Discussion

General distribution in this study and other studies from literature can be observed in Table 9.

Table 9. General Distribution

Categories	Hurt et al. (1977)	Kılıçer and Odabaşı (2010)	Sarıoğlu (2014)	Data Retrieved in This Study
Innovators	1.5%	2.9%	2.9%	40%
Early Adaptors	13.5%	13.4%	10.3%	39.16%
Early Majority	34.9%	32.1%	39.9%	15%
Late Majority	34.9%	39.7%	34.8%	5.83%
Traditionalists	15.6%	12.0%	12.1%	0%

Individual Innovatiness (II) scale created by [7] is used multiple times for measuring innovativeness perception of people from different backgrounds. For instance [18], which is a study carried over Turkish university students, shows that the majority of the participants is formed by late majority with 39.7% which leads to a very low novelty and self-innovativeness level.

Additionally, the scale is used in [13] which is a study carried over Turkish nurses. [13] shows that the majority of the participant nurses is early majority with 39.9%. When compared to [18], [13]

shows a better situation in terms of innovation but when this study on engineers is examined it can be easily seen that the majority of the engineer participants is innovators with a 40% percentage. Given researches indicate that, perception of innovation and individual innovativeness alters over time and personal background. As engineers have an important role in innovation, understanding their point of view on these concepts is very crucial. Hence this study shows that Turkish engineers are on a good level of innovation process.

In terms of education, the study shows that level of innovation increases from undergraduate degree through further scientific studies. Conversely, when the results of this study is studied it is seen that participants who have PhD degree have low innovation sense. This situation can be explained with the gained speciality over one specific subject throughout doctoral studies and continuing that topic later on.

When departments of the participants of this study are examined it can be seen that participants from Research and Development are very keen on innovativeness and novelty. This is an important outcome since this department is a pioneer in terms of understanding and implementing innovation to our technology and scientific researches.

When an interpretation is carried over ages of the participants, it is clearly seen that young engineers have higher sense of novelty and personal innovativeness.

Conclusions

For this study, a questionnaire formed by a total of thirty-four questions is directed in order to gather information over perceptions of Turkish engineers on personal innovativeness and innovation over all.

The questionnaire is filled by one hundred and twenty engineers from different backgrounds through a website and the data is analysed via SPSS 21. Additionally, a reliability study is carried out over participants and it seen that the Cronbach's Alpha Coefficient of this study is 0.757. When further examination is carried out among scaling questions, it is seen that three items are not suitable when compared to others hence a re-calculation of Cronbach's Alpha Coefficient is carried out after elimination of these three items and the Cronbach's Alpha Coefficient is found as 0.821.

Score of each participant is calculated and their distribution under different innovativeness groups is carried out. As a result of this step, it is seen that majority of this study is formed by innovator engineers with 40% share. According to the analysis, there is no traditionalist participant is present in this study.

For further studies a study particularly on engineers from Research and Development departments of multiple firms or engineering students from various universities can be carried out.

Consequently, it can be expressed that engineers in Turkey are at a good place in terms of observing and following novelty in their professional and personal areas. To keep this perception level from decreasing an innovation education can be provided to engineering students in their undergraduate education. In other words, selective area courses such as introduction to innovation, innovation

management and innovation in engineering can be added to yearly curriculum in order to keep their knowledge fresh on novelty and to provide an understanding that following innovation throughout their lives is a crucial. Thereby, freshly graduated engineers embraced with innovativeness can be brought both to academic world and to industry.

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