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Perception of Turkish Engineering Students towards Innovation and Self-Innovativeness

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Abstract

Innovation is a concept which sheds a light on scientific and technological improvements in today's world. To keep up with these fast and dynamic changes within the mindset and applications of technology, engineers should be conscious and open to innovation. The purpose of this paper is to study Turkish engineering students from a select university on their perception of novelty and self-innovativeness. To gather data, a survey formed by thirty one questions is directed to students from different engineering disciplines. Acquired data is analyzed via SPSS 21 and detailed according to demographical information provided by the participants such as their department, age and gender. Moreover, to see the reliability of the study Cronbach's Alpha coefficient is calculated. Found results are compared and discussed with sample studies from literature. Also possible ways of increasing innovative knowledge among bachelor's students of engineering faculties are discussed in this paper.

Key words: Engineering, innovation, self-innovativeness, student

1. Introduction

With the improvements in technology and developments in Industry 4.0, openness of an engineer to understand and learn novelties is crucial. To fully understand the importance of the bond between engineering and innovation the overall concept of innovation should be studied in detail since it provides a constant improvement for countries with larger economies [1]. Among 2023 goals, Turkish Scientific and Technological Research Foundation (TUBITAK) has announced that by improving innovative processes up to Industry 4.0 level, Turkey will be able to reach its goal in the area of exportation [2]. From the widest point of view, innovation is the process of turning knowledge into an economically and socially profitable entity. Since innovation increases efficiency and profits of a company, it can be utilized as a very strong advantage [3]. Innovation, a phenomenon created by new entities, draws attention from all over the world and seen as the key to technology guided improvements [4].

When it comes to ability of innovation adaptation, engineers should be keen on concept of self-innovativeness. So for adjusting production planning processes, factories and handling the quality of goods, engineers who work in these areas should be well educated and open to innovation. It is a well-known fact that production units equipped with research and development facilities are the main actors of innovation process [1] and leading players of a research and development laboratories are the engineers. Adapting novelty is determined by the self-innovativeness feature of a person. Innovativeness is the ability and speed of adopting new ideas when compared to other

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members of the society [5]. On the other hand innovativeness in Turkey can be seen as going against traditions [6]. Self-innovativeness level of a person is determined according to his/her willingness to take risks, eagerness to new concepts and openness to novelty [7].

It is a plausible idea that both innovation and self-innovativeness concepts can be learnt at young ages. So the aim of this study is to determine perception of Turkish engineering students towards these concepts. One of the main concerns of this study is to search for possible pedagogies and applications for students to become open to novelty in order to play an active role in innovation process. To measure these topics, a survey is benefitted and participants are grouped under five different categories according to their answers to questions. The groups are innovators, early adopters, early majority, late majority and laggards/traditionalists [8] [9]. Prior to moving to material and method section, each of these categories should be briefly explained. Innovators are known for being curious and adventurous as life style. Innovator people tend to be in harmony with uncertainties that come from a newly introduced concept. Moreover, from time to time innovator people are not seen as ordinary among the society but they are the ones who act actively during the diffusion of novelties [5]. Innovators are the ones who see new in their life, search and find new concepts throughout their lives [1]. Innovator people tend to like taking experimental actions and are very confident in terms of communication [7]. Another meaning to innovators can be provided by defining them as the ones who individually seek and find ways of doing things [10]. Despite the place of innovators among their society, early adopters are the ones who are greatly respected and adored within their groups [7]. Early adopters are not distant from an average innovator. They embody success and respect and have a high sense of novelty. Nevertheless they do not have high sense of uncertainty when they face with novelty. This group of people are known with their central position within the society [5]. Early adopters provide improvement ground for organizational innovations [11]. When it comes to early majority category, despite their higher order in society, members of this group act hesitant when they see a new concept [11]. These people tend to think and deliberate on the novelty before accepting any. Their innovation-decision process chain is a bit longer when compared to innovators and early adopters. But it is important to state that, at the end of the day despite not being able to lead any kind of innovation, they follow it [5]. In literature, individuals from late majority can also be named as skeptical. They meet with novelty right after majority of the society gets accustomed to it [5]. Late majority members tend to get informed about the innovation via mass communication methods and wait for observing decrease in threads that come along with the new concepts [7]. When it comes to traditionalists, they are the last ones to adopt innovation [11]. Traditionalists can also be named as laggards. When traditionalists come to accept novelty, most of the society gets ready for accepting a newer notion or concept to their lives [5]. Traditionalists tend to question the ones who introduce innovation to them. They wait for others to try and experience consequences from related innovation subject [7].

This paper is formed by gathering multiple sections. The methodology used in this study is given and elaborated in section 2, Materials and Method. Data acquired as the outputs of this research are presented in section 3, Results. Meaning of these outcomes are discussed and compared with samples from literature are given in section 4, Discussion.

2. Materials and Method

As stated earlier, this paper aims to find the perception of Turkish engineering students towards innovation and self-innovativeness phenomena. To gather data and to measure these concepts, a survey formed by thirty one questions is directed to one hundred and twenty four students from different departments of a private university in Istanbul, Turkey. In order to gather demographical information about the participants, first five questions of the questionnaire are utilized for gathering insight about age, department, and gender and so on. Remaining twenty six questions of the survey originates to a study done by Hurt et al. [9] in year 1977. The original scale lays a foundation for studies in the field of innovation. The survey created by Hurt et al. [9] is named as Individual Innovativeness (II) and provides a division for participants with varying innovativeness levels. Groups for different levels stated by Hurt et al. [9] and their score limits are given in Table 1, below.

Table 1. Group Labels and Necessary Scores

Group Label	Needed Score
Innovators	Above 80
Early Adopters	Between 69 and 80
Early Majority	Between 57 and 68
Late Majority	Between 46 and 56
Laggards / Traditionalists	Below 46

This survey was translated into Turkish and correlated by Kılıçer and Odabaşı [4] in 2010. After adaptation in Turkish, in 2014 Sarıoğlu [11] adapted the survey to Turkish nurses and published the results. Additionally, the original questionnaire is shared via McCroskey [12], an academic from University of Alabama, through his personal website and it is clearly stated that there is no need for permission in case of scientific researches. In spite of all these things, permissions are retrieved from both McCroskey and Sarıoğlu prior to adaptation of scale to engineering students. After getting related permissions and adjusting the questions, an additional permission for applying it to engineering students is retrieved from board of engineering faculty.

Each participant attends the study anonymously and is asked to select the most suiting choice among five different options that originates to Likert Scale (“5-Strongly Agree”, “4-Agree”, “3-Neutral”, “2-Disagree”, “1-Strongly Disagree”). The survey is distributed to students in person and asked to fill the form without leaving any of the questions out. Unfortunately nineteen of the forms were not filled fully hence they were excluded. Usable filled forms were one hundred and five and all were transformed to SPSS21 software manually in order to carry out reliability tests and execute score calculations. Gathered data and acquired distributions are provided in section 3, Results.

3. Results

Cumulative data is transferred to SPSS 21 software by hand and analyzed according to demographical information provided by the participants such as their department, age and gender. Unfortunately due to great variations among age of participants from nineteen to thirty eight a meaningful analysis under age concept could not be carried out.

Distribution of participant characteristics according to department, class and gender can be observed in Table 2.

Table 2. Distribution of Participant Characteristics

Participant Characteristics	Number (N)	Percentage (%)
Gender		
Female	20	19.05
Male	85	80.95
TOTAL	**105**	**100**
Department		
Computer Sciences Engineering	34	32.38
Electrical Electronics Engineering	50	47.62
Jewellery Engineering	3	2.86
Mechatronics Engineering	18	17.14
TOTAL	**105**	**100**
Class		
Freshmen	6	5.72
Sophomore	46	43.80
Junior	18	17.14
Senior	29	27.62
Longer than 4 Years	6	5.72
TOTAL	**105**	**100**
According to School Entrance Exam		
Student Selection Exam (ÖSS, YGS etc.)	102	97.14
Vertical Transfer Exam (DGS)	3	2.86
TOTAL	**105**	**100**

Table 2 shows that majority of the participants from engineering faculty are male students with 80.95%. Female students are only twenty of the total number and this value corresponds to 19.05%. Most attendees of this study are from electrical and electronics engineering department with 47.62%. Second most participated department is computer sciences department with 32.38%. Since jewellery engineering department is no longer accepting new students, existing number of students is quite low. Nearly all of the participants are accepted via central student selection exam with 97.14%, only three of the participants with 2.86% have come via vertical transfer exam (DGS).

Apart from demographical information analysis, a reliability test for the study is carried out over scaling part of the questionnaire. The reliability test is done via SPSS21 and Cronbach's alpha coefficient is found as 0.758. Cronbach's alpha coefficient is a value utilized to assess the internal consistency of a scale so having an alpha value higher than or equal to 0.8 shows a consistent study [13], hence an additional analysis is carried out to find if there is any inconsistency among scaling questions and it is reached that questions number twelve and thirteen are not in harmony with remaining questions. Consequently, those items are excluded and a new calculation is held over remaining questions. Newly calculated alpha value is 0.805 and it satisfies the limits in literature for a consistent scale.

Following the confirmation of consistency of the questionnaire, score of each participant is calculated according to the formula designated by Hurt et al. [9] and utilized by Sarıoğlu [11]. With

the help of score divisions given in Table 1, each participant is placed under a group. Score distributions among participants with percentages and numbers can be observed in Table 3.

Table 3. Score Distributions

Categories	Score Intervals	Participant	
		Numbers (N)	Percentage (%)
Innovators	Above 80	66	62.85
Early Adopters	Between 69-80	29	27.62
Early Majority	Between 57-68	9	8.58
Late Majority	Between 46-56	1	0.95
Laggards / Traditionalists	Below 46	0	0.00
TOTAL		**105**	**100**

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

According to analysis findings it can be said that, 62.85% of the participated engineering students scored enough points to be categorized under innovators category. The following highest number of participants belong to early adopters category with 27.62% and other following ones are early majority with 8.58% and late majority with 0.94%. Among the outcomes it can be seen that, there is no laggards/traditionalists within this group. In order to get a detailed insight about the outcomes, a breakdown under gender, department and class categories will be provided in following.

Table 4. Analysis According to Gender

Categories	Female		Male	
	Number (N)	Percentage (%)	Number (N)	Percentage (%)
Innovators	16	80	50	58.82
Early Adopters	3	15	26	30.59
Early Majority	0	0.00	9	10.59
Late Majority	1	5	0	0.00
Laggards / Traditionalists	0	0.00	0	0.00
TOTAL	**20**	**100**	**85**	**100**

In Table 4, distribution of attendees according to gender can be seen. In this study, the total number of female participants is twenty and sixteen of them are grouped under innovators with 80%, three are grouped under early adopters with 15%, remaining one is grouped under late majority with 5%. When distribution of male participants is studied, it can be emphasized that most of the male attendees are grouped as innovators with 58.82%. Following highest number of male participants are grouped under early adopters as 30.59%.

Table 5. Analysis According to Departments

Categories	Computer Sciences Engineering		Electrical Electronics Engineering		Jewellery Engineering		Mechatronics Engineering	
	Number (N)	Percentage (%)	Number (N)	Percentage (%)	Number (N)	Percentage (%)	Number (N)	Percentage (%)
Innovators	18	52.94	31	62	2	66.67	15	83.33
Early Adopters	12	35.30	15	30	1	33.33	1	5.56
Early Majority	4	11.76	3	6	0	0.00	2	11.11
Late Majority	0	0.00	1	2	0	0.00	0	0.00
Laggards / Traditionalists	0	0.00	0	0.00	0	0.00	0	0.00
TOTAL	**34**	**100**	**50**	**100**	**3**	**100**	**18**	**100**

In Table 5, it is seen that distributions of attendees differ from one department to another. In all departments, innovators have the highest number. Department of computer sciences has 52.94%, department of electrical and electronics engineering has 62%, department of jewellery engineering has 66.67% and department of mechatronics engineering has 83.33% of innovators among their participants.

Table 6.a. Analysis According to Classes

Categories	Freshmen		Sophomore		Junior	
	Number (N)	Percentage (%)	Number (N)	Percentage (%)	Number (N)	Percentage (%)
Innovators	5	83.33	27	58.70	9	50
Early Adopters	0	0.00	16	34.78	6	33.33
Early Majority	1	16.67	3	6.52	3	16.67
Late Majority	0	0.00	0	0.00	0	0.00
Laggards / Traditionalists	0	0.00	0	0.00	0	0.00
TOTAL	**6**	**100**	**46**	**100**	**18**	**100**

Table 6.b. Analysis According to Classes

Categories	Senior		Longer than 4 Years	
	Number (N)	Percentage (%)	Number (N)	Percentage (%)
Innovators	21	72.42	4	66.67
Early Adopters	5	17.24	2	33.33
Early Majority	2	6.89	0	0.00
Late Majority	1	3.45	0	0.00
Laggards / Traditionalists	0	0.00	0	0.00
TOTAL	**29**	**100**	**6**	**100**

In Tables 6.a. and 6.b. analysis of attendees show that, in all classes innovators are higher in number. In details, freshmen students have 83.33%, sophomore students have 58.70%, junior students have 50%, senior students have 72.42% and students who continue their education longer than four years have 66.67% of innovators.

Table 7. Analysis According to Examination

Categories	Student Selection Exam (ÖSS, YGS etc.)		Vertical Transfer Exam (DGS)	
	Number (N)	Percentage (%)	Number (N)	Percentage (%)
Innovators	64	62.75	2	66.67
Early Adopters	28	27.45	1	33.33
Early Majority	9	8.82	0	0.00
Late Majority	1	0.98	0	0.00
Laggards / Traditionalists	0	0.00	0	0.00
TOTAL	**102**	**100%**	**3**	**100%**

In this study it is understood that students are accepted to university via two different examination methods. The first one is by central student selection exam and the other one is via vertical transfer exam. From Table 7, it can be stated that students from both sections scored high and grouped under innovators.

4. Discussion

In this section, outcomes of this study will be interpreted and compared to selected papers from literature. Distribution within each selected study and from this research is given in details in Table 8, below.

Table 8. Comparison of Findings to Samples from Literature

Categories	Hurt et al. [9]	Kılıçer [7]	Bitkin [14]	Şahin-İzmirli [15]	Albayrak Serin and Yılmaz Yalçıner [8]	Findings of This Study
Innovators	2.5%	8.60%	6.90%	5.68%	40%	62.85%
Early Adaptors	13.5%	37.80%	32.70%	26.59%	39.16%	27.62%
Early Majority	34%	42.20%	43.70%	51.28%	15%	8.58%
Late Majority	34%	10.10%	15.70%	15.05%	5.84%	0.95%
Laggards / Traditionalists	16%	1.30%	1.00%	1.40%	0%	0.00%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

The scale benefitted in this study was created and used by Hurt et al. [9] in 1977 in order to measure innovativeness levels of people from various bases. At the end of research by Hurt et al. [9], 2.5% of their attendees were grouped under innovators. Participants of that study were highest in number under early majority and late majority categories with 34%. Traditionalist within the research of

Hurt et al. is high, they are 16% of the whole participants.

Following the translation and adaptation in 2010, researchers in Turkey applied the questionnaire to Turkish students from different universities and different departments. For instance, Kılıçer [7] applies the survey on pupils of computer technologies teaching department and finds that the most of the participants are ranked as early majority. Traditionalists in this study is quite low when compared to Hurt et al. [9]. Innovators are only the 8.60% of whole participants.

Another example study is held on students from faculty of education of three different universities in Turkey by Bitkin [14]. Study by Bitkin is on students and carried out by handing the scales to participants and asking for attendees to fill them out. After interpretation of the acquired data, it is seen that the highest number of people is under the early majority category with 43.70%, which is nearly half of the whole participants. Yet again, the percentage of traditionalists in this paper is quite low, only 1.00%.

In addition, a study done by Şahin-İzmirli [15] on pupils from faculty of education and found that most of the students are categorized as members of early majority. Among the studies given here, research by Şahin-İzmirli [15] shows the lowest percentage of innovators category in terms of year later than 2000.

The last example is done by Albayrak Serin and Yılmaz Yalçıner [8] in 2017. Researchers focus their study on one hundred and twenty engineers form Turkey. Most of the participants are categorized as innovators with 40%. Second highly participated category is early adopters with 39.16%. Young engineers among participants score highest in terms of innovativeness. Level of innovativeness decreases with increase in age.

On the other hand, when the original study held in this paper is observed, it is seen that innovators category is the one with the highest members, the percentage is 66.00%. There is no traditionalists in this group. The other mostly populated group is early adopters with 29.00%. When this study is broken down into groups according to information provided by the participants it is seen that there are more male participants when compared to female participants. Both female and male participants score high and mostly grouped under innovators.

Additionally, when the analysis is done from the department point of view it is seen that the most innovative department is mechatronics engineering with 83.33% percent innovators. Following department in the ranking of innovation is jewellery engineering with 66.67%. The last one with the level of innovation is computer sciences engineering with 52.94%. From the point of view of the writer, it is a good finding that even the last department in the ranking of innovation, has more than 50% of participants under innovators category.

Conclusions

This study is carried out via implementation of a scale named Individual Innovativeness (II) [9] on students from faculty of engineering in order to measure their perception on innovation and self-innovativeness. The survey is applied on participants after retrieval of necessary permissions from

distributors of the survey and researchers who adapted it into Turkish.

The questionnaire is filled by one hundred and twenty four students but unfortunately nineteen of the forms were not filled correctly hence only one hundred and five of them could be used for the analysis studies. Hand filled forms are transferred to SPSS21 in order to carry out detailed inspection and a reliability test. The firstly calculated alpha coefficient is found as 0. 758. Since that value is not adequate for a scale to be labelled as consistent, a detailed examination among questions is carried out and seen that two of the questions are not in harmony with others. After cancellation of these two questions a new alpha coefficient calculation is held and new Cronbach's alpha is found as 0.805. Score of each attendee is calculated according to formula designated by Hurt et al. [9] and every participant is placed under a group according to their score. At the end of categorization, it is found that there is no traditionalist among the participants and the highest majority is the innovators with 62.85%.

It is important to state that overall level of perception of innovation and self-innovativeness is quite high among participants of this study. So it can be said that, newly graduated engineers from this faculty will have a good knowledge over innovation and entrepreneurship. But it is very important to keep this level away from degrading and furthermore take additional actions to take it to a better place. For instance, adding innovativeness and/or entrepreneurship related courses to curriculums can be a way of keeping students keen on these concepts. After publication of results to this research, researcher aim to hold a more detailed investigation in terms of innovation. Such as elaborating this study over other universities and comparing self-innovativeness levels of engineering students from different universities.

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