

## Scientific Studies in the Area of Mechanical Engineering: A Descriptive Analysis Related To Researches in Turkey

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**ABSTRACT:** Studies related to engineering area in our country and in the world have increased day by day. Progress in national economy depends research and development (R&D) investment. The increase of number and quality of studies performed in engineering area has a big importance for our country. The purpose of this study is to introduce general situation by investigating studies about mechanical engineering performed in Turkey with regard to content and scientific research method used. In this context, international studies about mechanical engineering were investigated, and then, mechanical engineering studies in Turkey were analyzed according to purpose, method, and the place that the analyses were done. For this purpose, three different data sets were created by scanning with Master of Science and PhD theses in the research scope published after 2000 and articles published five different academic journals in the area of mechanical engineering in Turkey. Performed studies was approached according to their purposes as basic or applied, according to their methods as experimental or descriptive, according to place performed as area or laboratory. In the light of obtained findings, it was discussed the weak side of area with how it can contribute to literature. In this context, when studies were investigated according to place performed, that researches were generally done by experimental methods and that they were done in laboratory environment are among the results of research. It was concluded that area studies are pretty less than those performed in laboratory environment. Theses that have access permission and registered National Thesis Center were included in the research, while theses restricted by its author, and having no access permission were included only general evaluation.

**KEYWORDS:** Experimental Study, Academic Study, Mechanical Engineering, Descriptive Analysis

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### I. INTRODUCTION

Science can be explained as getting basic laws depending on observations and experiments by basing on human life, collecting applicable and reliable data, and period to explain these.

Scientific research is done to discover and contribute literature [1]. Purpose of science are to introduce to humankind himself and his environment, to make him understand what's happening, and to investigate reasons of these and take control of environment and society events [2]. Science is a broad concept that includes a variety of human activities, such as biologists viewing bacteria using microscopes, chemists conducting reaction experiments in a lab, astronomers peering through telescopes to observe galaxies, and physicists solving the equations on a blackboard. Essentially, it is a form of accumulated knowledge through the effort of human in understanding the universe in which we are living. Different from the past, when only a small number of people had the opportunity to work as scientists, modern science is advanced by many researchers from different disciplines. Meanwhile, much effort is being made to accelerate the publication of research findings. As a result, hundreds of new journals have been created in the past decade, and thousands of scientific papers are published every day [3].

Science is the one of important factors in order that society guarantee their future, proceed, and continue their life. When science is evaluated with regards to its basic properties, it uses a methodology based on experiment and observation together with investigating cause-effect relations [4]. We can classify scientific method in engineering researches as documental researches and experimental researches. Experimental studies can be applied as scanning and experimental design, as well [5]. Research is fact of seeking right and true.

Scientific research can be described as research made by using specific rules in collecting data, analyzing, and evaluating. Undoubtedly, applying solutions experimentally and reaching accurate result are more important besides describing problems.

Engineering is the process of presenting products that can satisfy the needs of people by putting science, mathematics, and experience into practice. Engineers can introduce new ideas for industry and technology and can improve life standard of humanity by directing ideas [6]. Engineering job is an important job requiring special and application weighted, and directly affecting national economy and human life at the same time. For this reason, it is an obligation to teach and raise members of this profession very well [7]. Engineering criteria prepared by Accreditation Board for Engineering and Technology (ABET) describes properties that programs training engineering education is required to improve as following:

- ✓ Practice ability of mathematics, basic sciences, and engineering information.
- ✓ Ability of experimental design, making experiment, and data interpretation.
- ✓ Design ability of a system, its components, and solution methods having desired properties.
- ✓ Ability to work within an interdisciplinary group.
- ✓ Ability of introducing engineering problems, modeling, and solving.
- ✓ Awareness ability of professional and ethical responsibilities.
- ✓ Ability of communicating efficiently.
- ✓ Creating wide perspective that can apprehend engineering solutions in universal and social context.
- ✓ Ability of introducing requirements and trying lifelong learning.
- ✓ Having knowledge about prevailing legislation.
- ✓ Ability of using engineering tools, skills, and techniques required for engineering applications [8].

Increasing experimental study rate is one of method giving way to possible developments and new discoveries in the field of machine engineering. Progress of creativity depends on use of new methods and techniques. Research and development use are directly proportional with patent number in developed countries, as well. It should not be forgotten that Thomas Alva Edison invented bulb as a result of approximately 2000 results, and he got numerous patents in this field. The purpose of this study is to remark connection between research and development investments of performed studies and methodology of academical studies. Conversion of theoretical studies to experimental studies presents importance of financial assistance given studies in process starting from education.

### **1. Engineering Education in Turkey and Increasing Education Quality**

Engineering education started in our country by 1800s. It has been made many steps in engineering education until today. There are engineering faculties training engineers in international qualities in our country as well as there are faculties teaching with a structure not having sufficient equipment [9].

It isn't desired an engineering profile that performs same studies every time, doesn't follow technology, doesn't present new ideas and doesn't open to improve oneself. Therefore, it should be aimed at earning properties such as opening to progress, and following technology in universities thanks to equipment and faculty members.

### **2. Relation between Research and Development and Economic Growth**

Developments in the world economy and competition depending on developments have increased interest to subject of "innovation" day by day. New growth theory (Endogenous Growth Theory) emerged in 1980s defends technological developments and human capital as key determinants of growth. Economic growth model based on Research and Development, which emphasize importance of Research and Development activities as supportive power growth, suggested by Romer (1990) for the first time. While technological growth and innovation causes economic growth of country in the macro level, it causes increase of business income and market share in micro level. Innovation comes to exist thanks to expenses reserved to Research and Development. This also contributes national economy [10].

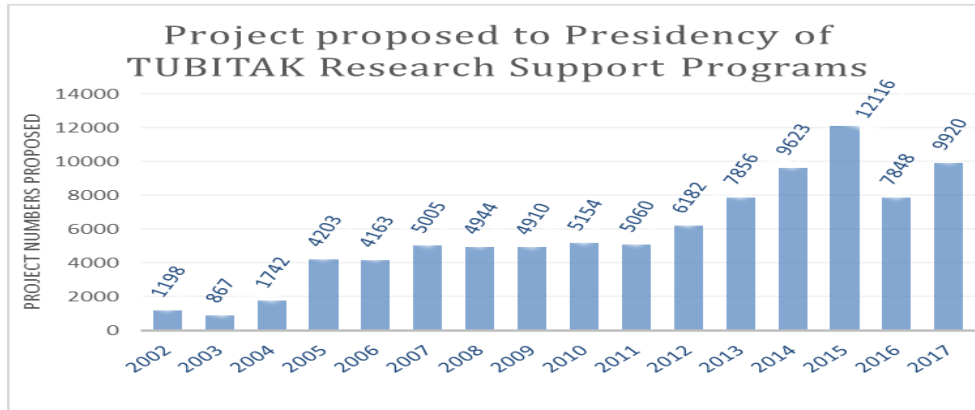


Figure 1. Project proposed to Presidency of TUBITAK Research Support Programs distributed by years[11].

When Figure 1 is investigated, it is observed that project numbers proposed to Presidency of TUBITAK Research Support Programs showed an increase distribution by years in general, the highest project proposal was in 2015, and it was seen a little decrease in proposed project number after 2015.

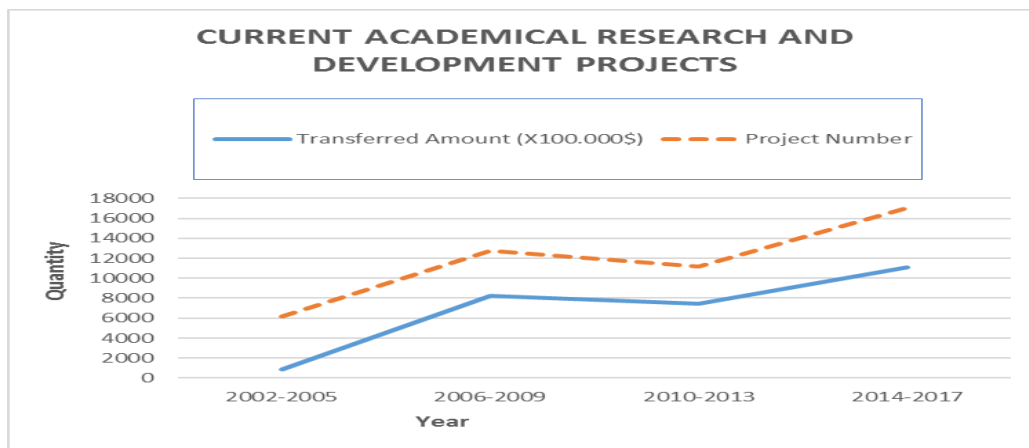


Figure 2. Current Academic Research and Development Projects (Including Public Projects) [11].

Project number and amount transferred yearly showed an increase until 2007 in general, showed a falling tendency from 2007 to 2010, after that, it was seen an increase until 2015, when Figure 2 is investigated. After 2015, it was seen a little decrease in project number and transferred amount. It was reached the highest project number in 2015, and the highest support amount in 2017.

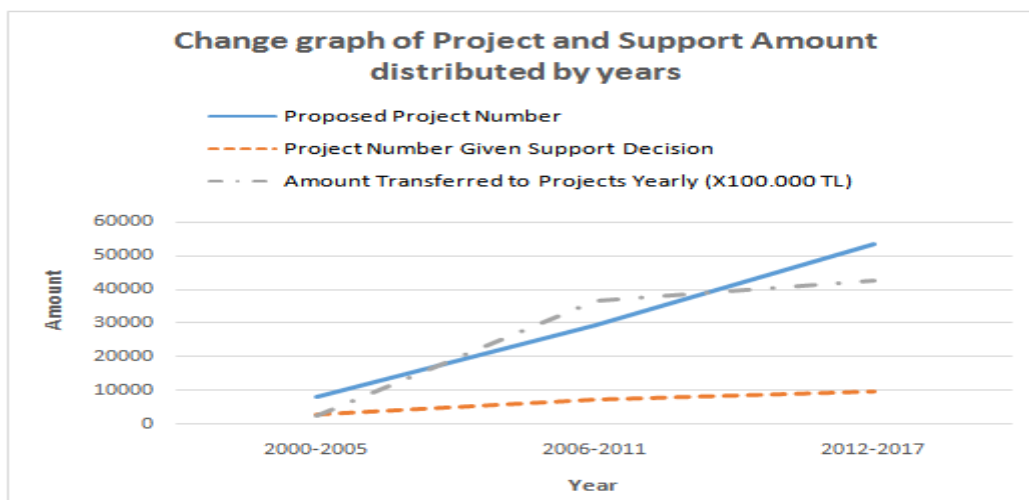


Figure 3. Change graph of Project and Support Amount distributed by years.

When the graph is investigated in Figure 3, it is seen that proposed project number, project number given support decision, and amount transferred to projects yearly as directly proportional. While proposed project number rapidly increased from 2000 to 2017, rate of project number given support decision, and amount transferred to projects yearly showed a little decrease from 2011 to 2017.

### 3. Role and Importance of Techno Parks in Engineering Studies in

According to description of The International Association of Science Parks, (IASP), techno parks are an enterprise whose main purpose is to increase the wealth of society by supporting and putting forward competitiveness and inventiveness culture of incorporated companies. In order to provide these purposes, a techno park manages and promotes flow of information and technology, paves the way for comprising and growing innovative companies by the help of incubation centers; provides places and opportunity in high quality, and gives other value-added services.

Since global competition have rapidly increased, and demand and desire of humanity have quickly changed today, having science and technology and making innovations have become inescapable obligation for countries. Developed countries having conscious of this convert information and technology to social and economic contribution by improving university and industry collaboration, producing technology, making innovation and producing high value-added products, and they use techno parks as an important tool to provide these [12].

Benefits providing universities of techno parks:

- ✓ Providing more and efficient collaboration with industry
- ✓ Creating basic and applied opportunities in new subjects presenting as a result of efficient communication with companies.
- ✓ Using funds reserved research substructure of universities more efficient and productive.
- ✓ Converting research results in universities to economic profit.
- ✓ Universities create new resources such as land improving, office renting, and contribution income
- ✓ Creating new resources in universities by transferring funds providing founded techno parks to research.
- ✓ Creating more research and better education environment
- ✓ Providing new employment opportunities to university graduates and students.

### 4. Importance of Experimental Studies in the Field of Machine Engineering

Practicability in education will be proportionately increased by making experiments, which are done in laboratories today, with the help of interfaces and simulations in internet environment, though not as much as real environment. In order to be made a job, expresses an opinion first, creates mentally, writes down, and project is presented after making calculation. Faults in this part being completely theory of job is uncovered after job puts into practice. Even if everything is correct in theory, it can be some problems in practice. It is pretty important to apply considered and planned things theoretically in practice. This kind of problems can occur since all changeable that will be show up won't come to mind and calculate. Therefore, only knowing theory of job is not sufficient when making a job. Important one is to combine theory and practice, to perceive later problems showing up, to detect and to solve [13]. Mengi and Schreglmann asked to academicians as "I can provide financial support for scientific research (fund, scholarship, promotion etc.) in their study, and they got the response of "I rather agree" as the most preferred choice [14]. Even if evaluations performed with theoretical studies or analyze programs are sufficient for scientific comments, they stay meaningless as long as they don't support with experimental studies. Moreover, analyze programs also based upon databases created by experimental studies.

### 5. Evaluation of Academical Studies Done in the Field of Machine Engineering in Turkey

Before studies in the field of machine engineering in Turkey were started to investigate, international studies in the field of machine engineering were analyzed. Studies performed in Turkey were classified according to their purposes and their methodologies. In this sense, academical articles registered DergiParkAcademical Database and allowed Master of Science and PhD thesis under machine engineering department registered Council of Higher Education (YOK) National Thesis Center were investigated. Master of Science and PhD Theses and articles were chosen by using "select random" properties located in formulate bar of Microsoft Excel Program.

**Table1.** Allowed-not allowed Master of Science theses number under machine engineering department registered Council of Higher Education (YOK) National Thesis Center and investigated thesis number

YEAR	ALLOWED THESIS NUMBER	NOT-ALLOWED THESIS NUMBER	TOTAL PERFORMED THESIS	RANDOM CHOSEN AND INVESTIGATED THESIS NUMBER
2000	19	4	23	5
2001	28	6	34	5
2002	24	10	34	5
2003	20	19	39	5
2004	43	178	221	5
2005	97	116	213	5
2006	240	13	253	10
2007	373	2	375	10
2008	383	3	386	10
2009	428	0	428	10
2010	507	2	509	10
2011	442	2	444	10
2012	453	1	454	10
2013	455	2	457	10
2014	480	1	481	10
2015	389	158	547	10
2016	310	222	532	10
2017	261	285	546	10

**Table2.** Allowed-not allowed PhD theses number under machine engineering department registered Council of Higher Education (YOK) National Thesis Center and investigated thesis number

YEAR	ALLOWED THESIS NUMBER	NOT-ALLOWED THESIS NUMBER	TOTAL PERFORMED THESIS	RANDOM CHOSEN AND INVESTIGATED THESIS NUMBER
2000	10	2	12	5
2001	6	4	10	5
2002	10	5	15	5
2003	16	6	22	5
2004	21	22	43	5
2005	26	12	38	5
2006	39	6	45	10
2007	73	0	73	10
2008	78	0	78	10
2009	85	0	85	10
2010	80	1	81	10
2011	75	1	76	10
2012	78	1	79	10
2013	94	2	96	10
2014	89	1	90	10
2015	75	41	116	10
2016	67	76	143	10
2017	21	97	118	10

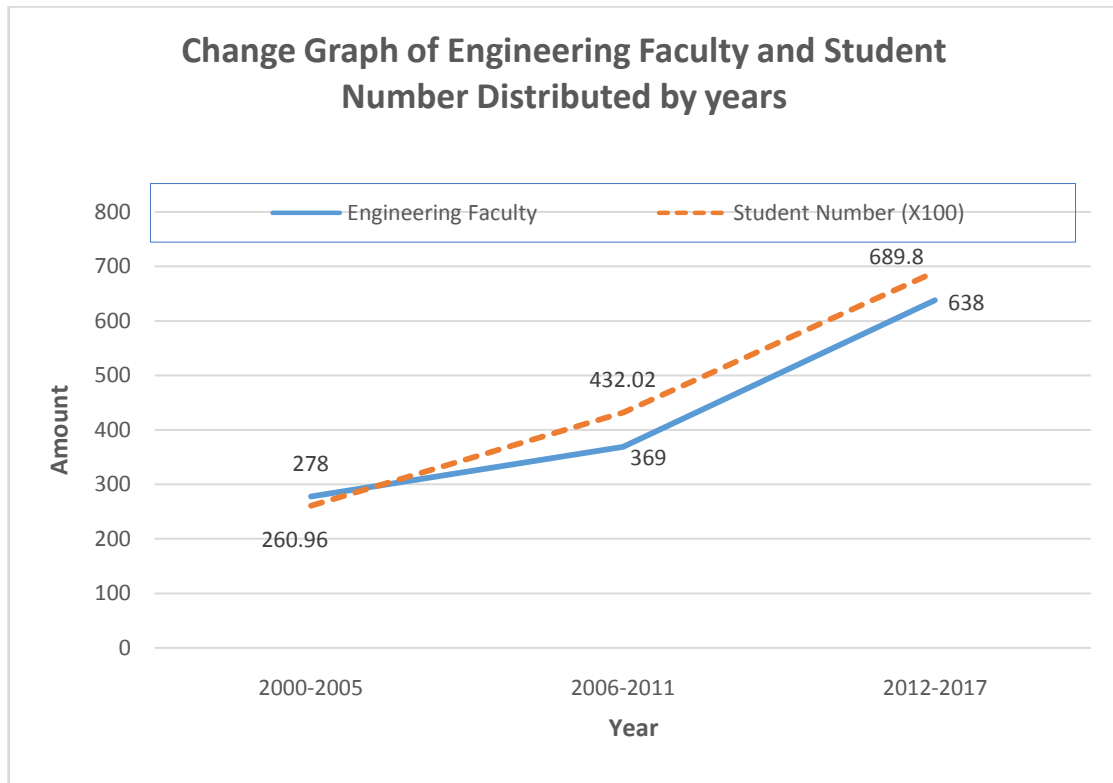


Figure 4. Change Graph of Engineering Faculty and Student Number Distributed by years

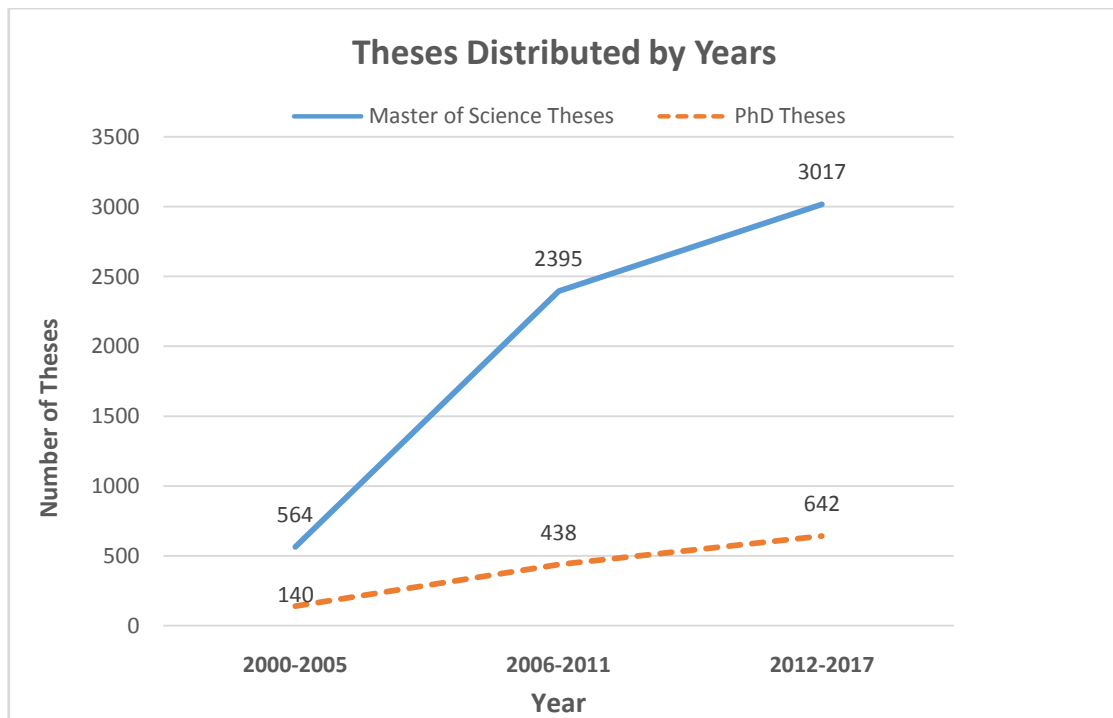


Figure 5. Theses distributed by years

When we view Figure 4, student number has increased by increasing machine engineering faculty number. It was seen that increase rate of student number is lower than increase rate of machine engineering program between 2000-2005 and increase rate of student number passed increase rate of machine engineering in later years. This can be attributed with increase in contingent of faculties located in choice guide of Student Selection and Placement Center (OSYM). As to Figure 5, students number studying Master of Science and PhD between 2000-2017 increased depending on increase number of machine engineering program and student

number. It was seen a rapid increase in Master of Science and PhD theses from 2000 to 2011, and it was seen a little decrease in thesis number increase rate from 2011 to 2017.

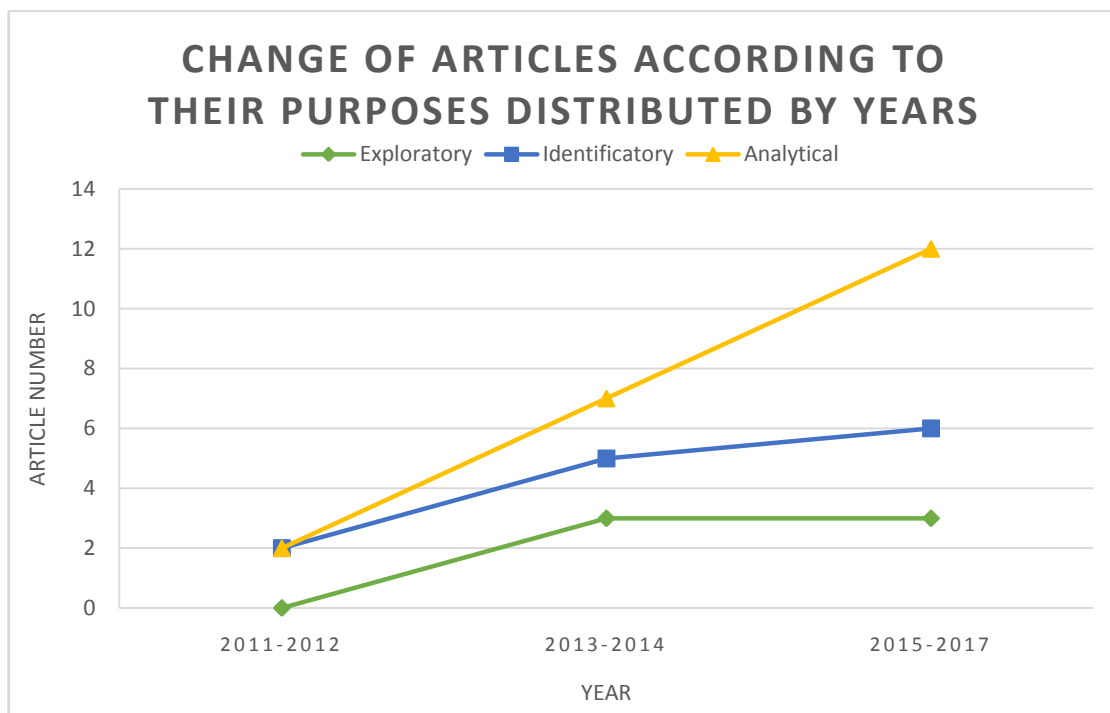
**6. Machine Engineering in Terms of Scientific Method in Turkey**

Theses and articles investigated in this study were approached according to their purposes and research methodologies. Chosen articles and theses in this concept were investigated as exploratory, identificatory, analytical, descriptive, experimental scanning, and experimental design. According to this classification, new innovations and field works was involved in exploratory and experimental scanning, making experiment design by preparing specimen in laboratory environment was involved in analytical and experimental design, research and comparison studies were involved in identificatory and descriptive studies. At the same time, if exploratory, analytical, identificatory studies were included in same thesis, these theses were involved in more than one method located in their content.

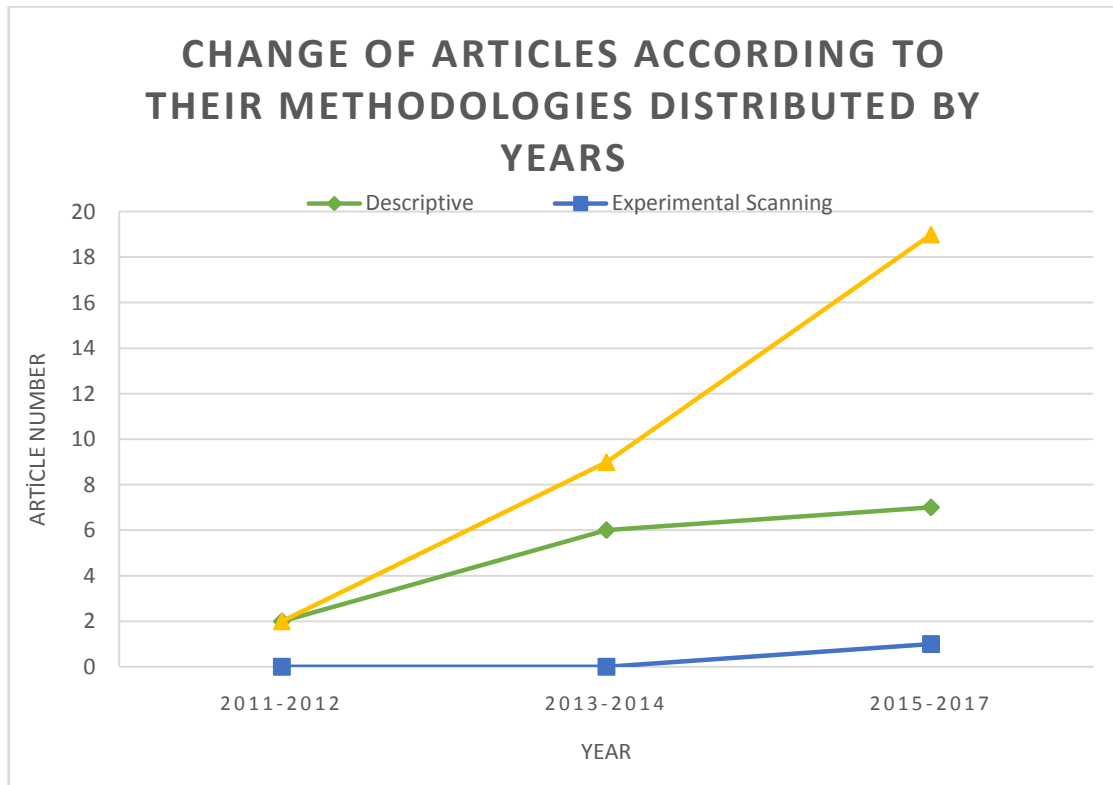
**Table 3.**Distribution of Theses and Articles According to type of research methods

Type of Research Method		Master of Science Thesis		PhD Thesis		Article	
		Number(N=150)	Percentage Distribution (%)	Number(N=150)	Percentage Distribution (%)	Number(N=50)	Percentage Distribution (%)
According to Purpose	Exploratory	36	24	35	23	6	4
	Identificatory	45	30	65	43	14	9
	Analytical	116	78	95	63	25	17
According to Research Method	Descriptive	41	27	38	25	13	9
	Experimental Scanning	19	13	23	15	2	1
	Experimental Design	100	67	111	74	31	21

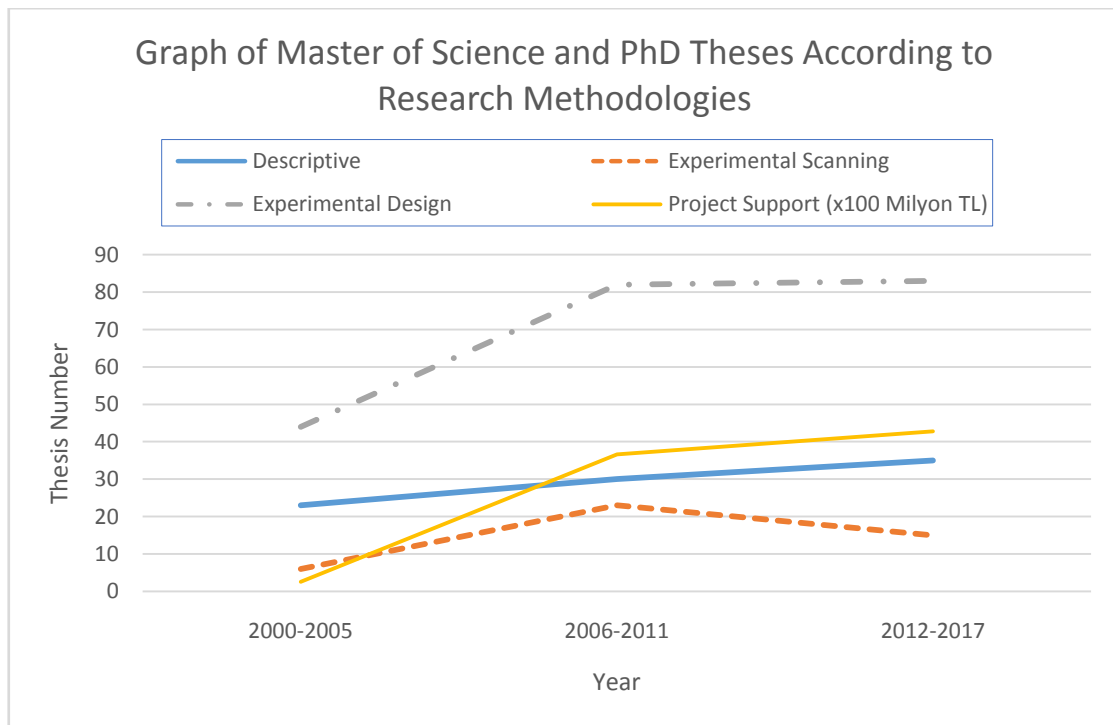
When Table 3 is analyzed, it is understood that research methods are parallel to each other, and researches were performed in laboratory environment by making experiment design in general manners.



**Figure 6.**Change of Articles According to Their Purposes Distributed by Years



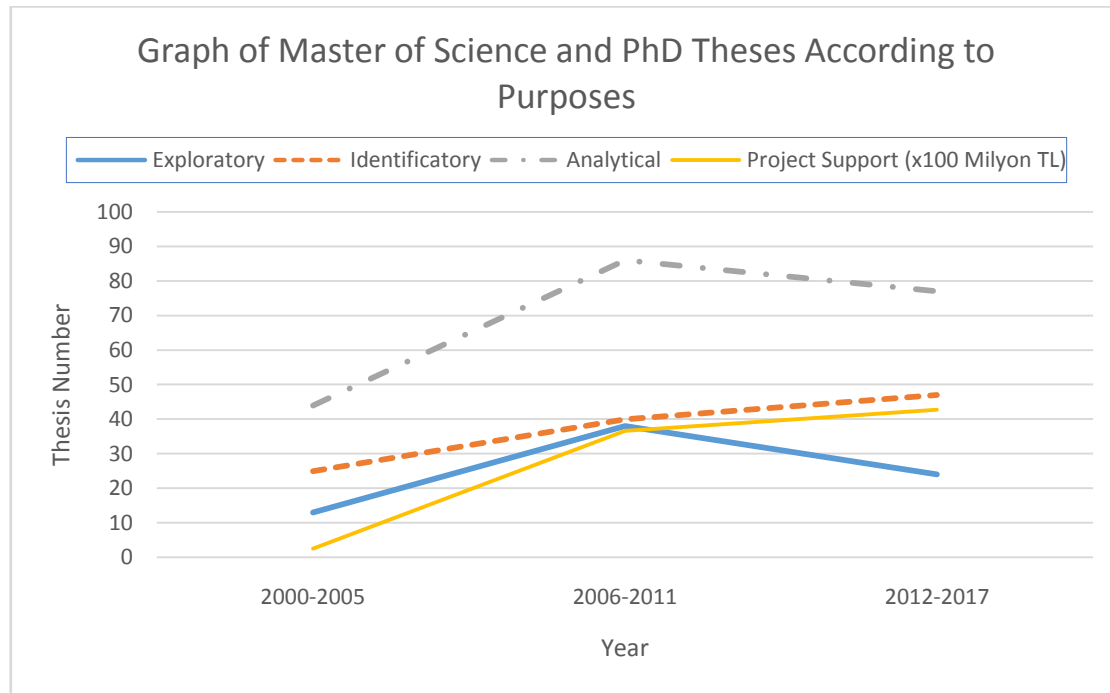
**Figure7.** Change of Articles According to Their Methodologies Distributed by Years



**Figure8.** Graph of Master of Science and PhD Theses According to Research Methodologies

It is seen that a big ratio of theses was performed in laboratory environment according to experimental design methodology when Figure 8 is investigated. In general, all research methodologies showed an increase until 2011, two methodologies except experimental scanning methodology increased after 2011 but it was seen a little decrease in increase rate. However, it was seen a decrease in experimental scanning methodology from 2011 to 2017. Also, project support has showed an increase in direct proportion to increase rate of these three research methodologies.





**Figure 9.** Graph of Master of Science and PhD Theses According to Purposes

It was seen that a big ratio of theses was analytical purposed in Figure 9. In general, exploratory, identificatory, and analytical researches showed an increase until 2011. It was seen a decrease in exploratory and analytical researches after 2011, while it was seen an a little increase in identificatory researcher. Also, project support has showed an increase in direct proportion to increase rate of these three research methodologies.

## II. RESULTS

International studies performed in the field of machine engineering were investigated and machine engineering studies in Turkey were analyzed one by one according to purposes, methods, and places performed in this study. three different data sets were created by scanning with Master of Science and PhD theses in the research scope published after 2000 and articles published five different academic journals in the area of mechanical engineering in Turkey. When researches were investigated according to places performed, it was seen that they were performed with experimental methods in laboratory environment in general. When Research and Development projects are investigated, it was observed that project number increased in direct proportion to transferred financial source. Although there has been decrease in financial sources recently, created project making culture has proceeded and increased. Also, it was concluded that field works is quite a little compared with studies performed in laboratory environment. It was seen an increase in machine engineering program number and student number from 2000 to 2017. Depending on faculty and student number, there was a parallel increase in research number. It was observed an increase in performed research number with increasing supported project number and amount transferred to project.

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