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Research Article

ANALYSIS THE GEOMATICS DISCIPLINE IN TURKEY

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ABSTRACT

The trained labour force in the Geomatics sector includes graduates from institutions providing secondary school, undergraduate, graduate and post graduate education and are developing rapidly. Most of the schools are state schools that contribute human resources to the sector. However, the presence of the private sector in this field has remained very limited. Studies are being conducted by professional non-governmental organizations, leading with the Geomatics and Cadastre Engineers Association and also by other prominent associations and foundations. Moreover, these non-governmental organizations, working in an international context, contribute to the efforts to further institutionalize the professional and organizational structure. A body structured to cover all institutions providing education in the profession and also all civil society representatives hasn't yet been established. The need stands out in particular for a civil society umbrella organization that includes graduates of educational institutions at different professional levels.
Keywords: Geomatics sector, engineering activity, educational analyse, state school.

1. INTRODUCTION

These days, the education-employment relationship and professional standards are gaining prominence and especially with globalization, the quality of employees has become quite important due to the development of business arenas and competition in this field. In addition, for successful management in today's growing enterprises, it has become mandatory to utilize information and communication techniques effectively. This requires employees to understand and be able to use technology efficiently, while continuously advancing themselves qualitatively (Morkoç et al., 2014).

The discipline of Geomatics involves producing maps for all or part of the earth, topographic maps at a desired scale, cadastral maps, thematic maps, etc. More specifically, this is a field of engineering science that carries out four-dimensional measurement of the earth, executes production and modelling of maps, installs and measures geodesy networks, establishes information systems, determines continental movements, records the ownership or possession of land, makes rural and urban land arrangements and forms the infrastructure of all investment and engineering services. All these activities are carried out using terrestrial and photogrammetric methods and satellite and computer technologies. The purpose of Geomatics is to obtain useful

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geospatial information for decision makers through data collection, data analysis and visualization (Teo et all., 2014). The discipline of Geomatics is known at the international level as Geomatics Engineering, Surveying Engineering and Geodesy and Photogrammetry Engineering. In Turkey, it goes by three different names (in Turkish): *Harita Mühendisliği, Jeodezi ve Fotogrametri Mühendisliği* and *Geomatik Mühendisliği*. FIG acts as the premier international organization representing the interests of surveyors worldwide. It is a federation of national member associations and covers the whole range of professional fields within the global surveying, geomatics, and geodesy and also geo-information community. It provides an international forum for discussion and development aiming to promote professional practice and standards (URL-7, 2018). The equivalent in Turkey is the Turkish Engineers and Architects Association (in Turkish *Türk Mühendis ve Mimar Odaları Birliği - TMMOB*) in alliance with the Geomatics and Cadastre Engineers Association (*HKMO*) (Yildiz and Coruhlu, 2017).

The satellite technology which has been developing rapidly of late has made map production activities faster, especially for geodetic infrastructure. With *Global Navigation Satellite System* (GNSS) technology and techniques, positioning work can be done more quickly and with great accuracy. The process of converting remotely sensed images to maps is also used in other disciplines. On the other hand, activities also carried out by the Geomatics Engineering discipline include land management for cadastre and the zoning and planning of urban and rural areas (Uzun, 2009). It contributes to the registration of property and other limited real rights under state guarantee (Demir et al., 2008 and 2015; Yildiz and Coruhlu, 2017). In this way, it can be considered as an active and important component in the development of the land market. Rapid urban transformation projects (Uzun and Şimşek, 2015) and real estate valuation studies have been conducted in Turkey in recent years and spatial analysis for proper site selection is frequently used in these studies (Yildirim, 2012; Uyan, 2014 and 2017; Yildiz and Arslan, 2015; Uslu et al., 2017; Yildirim et al., 2018). Geomatics is related to many other areas such as conservation of cultural and natural assets for future generations (Coruhlu, 2016) and management of foundation lands (Coruhlu and Demir, 2015). The realization of such applications requires technical knowledge as well as legal knowledge.

Recently, more sophisticated cameras and sensors have also been employed to enhance data acquisition capabilities in photogrammetry and remote sensing (Gong et al., 2017). New theories and methodologies are being applied for image interpretation and information extraction. Emerging technologies such as cloud computing, large-scale array databases, and the Internet of Things have expanded the reach of spatial information science, allowing us to answer previously unanswerable questions that often traverse diverse scientific domains (Yue et al., 2016). The areas of interest of the Geomatics Engineering discipline at this point can be visualized as in Fig. 1 below.

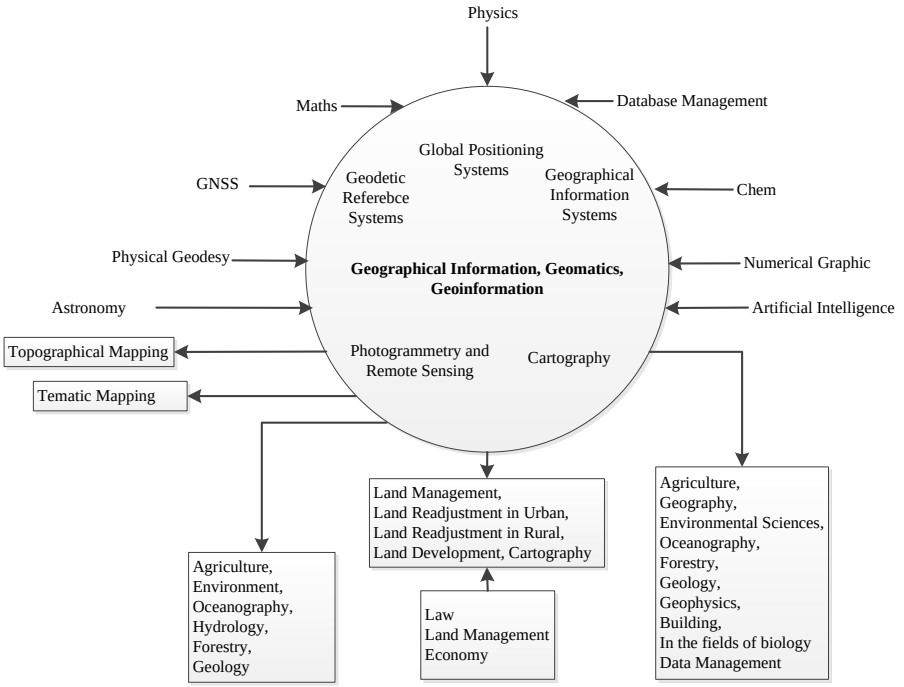

Figure 1. Geomatics / Geoinformatics content (Adapted from (Konency, 2002).

Considering this diversity in the Geomatics sector, it is obvious that well-trained human resources are needed. This requirement should be analysed and met in a proper way. However, in practice, new departments and programs are opened in educational institutions without such an analysis having been performed. Education-teaching problems in the sector begin at the secondary level and expand to cover a wide range. Positive or negative developments in the education process affect the profession from a sectoral perspective (Köktürk et al., 2005). In this study, the extent of the Geomatics Engineering discipline in Turkey is dealt with and recommendations are presented in accordance with the findings.

2. MATERIAL AND METHODS

The case study method was used in this study. In analysing the current situation, in addition to the particulars given in the Introduction, a dimensional analysis of Geomatics studies was carried out. Thus, it was observed that Geomatics had been added as an academic subject at the secondary and higher education levels. Academic human resources, qualifications, accreditation, institutionalization and quality-oriented activities related undergraduate and graduate studies in Geomatics are covered in the Results section of the study. Finally, the Discussion section and Conclusions and Recommendations constitute the last part of the study.

2.1. Educational dimensional analysis of Geomatics Engineering

When the vocational and technical education systems around the world are examined, significant differences can be seen among developed countries such as those of the European Union, USA, Japan and Australia. In Germany, France and the UK, which are known as the

driving force of the European Union, there are important differences in terms of vocational and technical education systems. In Asia, Turkey, Israel, Korea and Jordan, the number of students enrolled in vocational and technical education has increased significantly, compared to the 1970's (Keating et al., 2002; Uçar and Özerbaş, 2013).

In Turkey, the education and business sectors have quite different qualifications that are widely recognized and applied. The objective is to incorporate these qualifications, which are prepared from different approaches, into an integrated framework and to create a single structure. In this context, the European Qualification Framework (EQF), which defines professional competency levels, indicates eight different levels of proficiency (Table 1). Each level of competency includes specific knowledge, skills and expertise. Accordingly, the higher the level, the more advanced are the knowledge, skills and proficiencies that are expected. In determining the level, the criteria taken into consideration include the breadth and depth of theoretical and practical knowledge, the complex skills related to comprehension, creativity and practice, the complex intellectual skills, the individual degree of taking responsibility, problem solving and/or creativity, the extent of teamwork contribution and the scope of individual leadership and accountability. The EQF ensures that competences are more compatible among the different countries and systems in Europe. Thus, the EQF is a common benchmarking tool that enables the qualification systems of countries to relate to each other (URL-1, 2019).

Table 1. Examples of professional levels and qualifications.

Level	Level Descriptors	Qualification Examples
1.	Work is done according to specific rules under direct supervision	Pre-vocational qualifications (Elementary Diploma).
2.	Work is done with limited autonomy under supervision.	Basic professional qualifications (Non-Formal Education Certificate).
3.	The employee takes responsibility for the completion of the tasks and adapts behaviour to the environment in solving problems.	Semi-competent intermediate qualifications (Non-Formal Education Certificate).
4.	The work is mostly predictable, but self-initiative is used when doing a job that is subject to change. The employee takes some responsibility for the evaluation and development of business activities and supervises the routine work of others.	Full proficiency qualifications (Non-Formal Education Certificate, Vocational / Technical High School Diploma).
5.	The employee manages and supervises business activities where unpredictable changes exist. Evaluates and improves the performance of self and others.	Under Graduate Degree. Advanced Vocational Qualifications.
6.	The employee manages complex technical or professional activities or projects. Takes responsibility for decision making in unpredictable business activities. Takes responsibility for managing the professional development of individuals and groups.	Bachelor Degree. Professional and Executive Vocational Qualifications.
7.	The employees manages and changes business activities that require unpredictable, complex and new strategic approaches. Takes responsibility for contributing to the professional knowledge and practice of working groups or for evaluating their strategic performance.	Master Degree. Professional Competencies, Senior Executive Qualifications.
8.	The employee exhibits a high level of competence, innovation, and autonomy, academic and professional integrity. Carries out research and demonstrates responsibility (commitment) in the development of new ideas and processes.	Doctorate Degree

In terms of professional levels, Geomatics studies in Turkey start from Level 4. At this level, vocational/technical high schools provide education for four years. Education is then given in university vocational colleges (two years) and engineering faculties (four years). Apart from these, for professional in-depth knowledge and research, there are various master and doctoral

programs in higher-education institutions. The institutions offering studies in Geomatics are discussed in detail below.

2.2. Institutions offering studies in Geomatics

a. High School Level Geomatics Studies

In Turkey, within the system of the Geomatics sector, the first step is the basic education given in high schools. In order to develop professionals who have competency in the Geomatics sector, there are Geomatics, Land Registry and Cadastre programs in the Vocational and Technical Anatolian High Schools (in Turkish *Mesleki ve Teknik Anadolu Liseleri - MTAL*s). Today there are 78 *MTAL*s offering a four-year education. Students who graduate from these high schools receive the title 'Map Technician' (in Turkish *Harita Teknisyeni*).

b. Higher Education Level Geomatics Studies

This training consists of under graduate, bachelor, master and doctorate levels of education.

(1) Under Graduate Studies

Under graduate studies in the field of Geomatics are offered in two-year Geomatics and Cadastre programs in the university vocational colleges. Students graduate from these schools with the title of 'Map Engineer' (in Turkish *Harita Teknikeri*) and are considered as intermediate-level employees. Under graduate studies in the field of geomatics are given in a total of 57 university vocational colleges across Turkey, with more than 5000 graduates annually (Fig. 2).

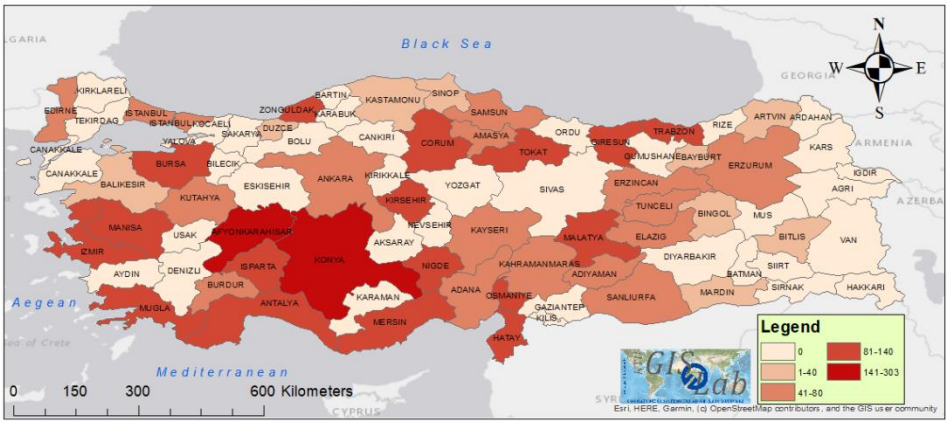

Figure 2. Number of students settled in map-cadastre departments in 2018 (province-based)

(2) Graduate (Bachelor) Studies

Due to the expanding requirements of development activities and technical services, the Ministry of Education in its decree of 07 June 1949, for the first time in Turkey, established a Department of Geomatics Engineering at Yildiz Technical University. In following years, Geomatics departments were established in other universities including Istanbul Technical University and Karadeniz Technical University. The names of the departments in which Geomatics was offered were previously referred to as Geodesy and Photogrammetry Engineering, Geodesy Engineering and Map and Cadastre Engineering. Nowadays, this discipline is referred to Geomatics Engineering. Today, throughout the country there are 33 graduate programs in the

field of Geomatics Engineering which are affiliated with various faculties. In total, there are officially 40 departments, including 10 departments that are not educationally active due to the lack of academic staff or other reasons (Table 2 and).

Table 2. Geomatics Engineering departments in Turkey by years (URL-6, 2019).

Year	Number of Geomatics Engineering Departments			
	(Active)			(Passive)
	Normal Program	Secondary Program	100% English	
2000	7	-	-	-
2005	9	2	-	-
2010	12	8	1	-
2014	19	9	1	-
2018	23	7	3	14
2019	23	4	3	10

(3) Post Graduate Studies

In the master thesis programs, advanced theoretical and practical information is offered to students in the sub-fields of Geodesy, Measurement Technique, Photogrammetry and Remote Sensing, Cartography, Geographical Information Systems (GIS) and Land Management. Training is provided to advance the students' problem-solving skills and to give them opportunity to improve research and development skills. The graduates of these programs are employed in the public and private sectors as 'Geomatics Engineers M.Sc.'. After completion of the doctoral studies, it is possible to become an academic. The aim of non-thesis master programs is to educate and enable the graduates to gain thorough knowledge and become experts in the subject and to be able to demonstrate the use of existing knowledge by putting it into practice.

The situation of the high school, under graduate, undergraduate and postgraduate levels of education in Turkey is presented in Fig. 3 and Fig. 4 below. As can be seen, education at the high school and vocational college levels has expanded throughout the country, and the number of udergraduate programs has risen in parallel with the rapid increase in the number of universities, especially in recent years (Table 2). However, postgraduate-level education is being carried out in universities with long-established programs.

Figure 3. Current status of map engineering departments

Figure 4. Numbers of vocational high schools with map-cadastre section

3. RESULTS

In the study, the educational dimension of the discipline of Geomatics in Turkey is discussed and the findings are presented below.

3.1. Academic human resource qualifications for undergraduate and graduate studies

Table 3 shows the number of students studying in the field of Geomatics in Turkey, according to Higher Education Council (in Turkish *YÖK*) data as of 2017. Faculty/staff numbers are shown in Table 4 and their ratios are presented in Table 5. When Table 5 is examined, it can be observed that the instruction in the under graduate programs is being carried out mainly by teaching staff, while faculty members are doing most of the teaching at the undergraduate and higher levels and there is a numerical balance among the academic titles of these faculty members (Fig. 5).

Table 3. Number of students studying Geomatics in Turkey (URL-6, 2018).

Program	Number of Students	State University		Foundation University
		Number of Students per Faculty Member	Number of Students per Instructor	Number of Students per Instructor
Under Graduate	13560	713	86	50
Bachelor	8606	51	29	18
Master (with Thesis)	1246	7	4	-
Master (without Thesis)	137			-
Doctorate	242	1.3	0.7	-

Table 4. Geomatics Engineering departments and number of faculty members/teaching staff (URL-6, 2019).

University (State: S / Foundation: F)	Prof. Dr.	Assoc. Prof.	Assist. Prof.	Lecturer	Research Assist.
Afyon Kocatepe(S)	2	5	1	-	3
Aksaray (S)	3	1	5	-	3
Avrasya (F)	3	-	-	-	-
Artvin Çoruh (S)		2	1		6
Zonguldak Bülent Ecevit (S)	1	2	8	1	6
Cumhuriyet (S)	-	3	3	-	2
Çanakkale Onsekiz Mart (S)	-	3	2	-	1
Erciyes (S)	3	-	3	1	9
Gaziosmanpaşa (S)	2	1	1	-	4
Gebze Technical (S)	3	4	2	1	6
Gümüşhane (S)	-	1	8	-	11
Hacettepe (S)	3	3	5	1	7
Harran (S)	1	-	4	-	4
İstanbul Technical (S)	18	10	4	1	22
İzmir Kâtip Çelebi (S)	1	1	4	2	1
Karadeniz Technical (S)	7	6	6	1	14
Kocaeli (S)	-	5	2	-	5
Necmettin Erbakan (S)	2	1	4	-	1
Mersin (S)	1	-	2	1	1
Okan (F)	2	-	3	-	-
Ondokuz Mayıs (S)	1	5	3	-	7
Osmaniye Korkut Ata (S)	-	1	4	-	3
Ömer Halisdemir (S)	1	1	2	-	6
Selçuk/Konya Technical (S)	10	5	4	1	5
Uşak (S)	-	1	2	-	-
Yıldız Technical (S)	11	11	9	2	25
Total	74	72	84	13	161

Table 5. Ratios of teaching staff/faculty members in departments offering Geomatics (URL-6, 2019).

Program	Teaching Staff (%)	Faculty Members (%)	Total (%)	Prof. Dr. (%)	Assoc. Prof. (%)	Assist. Prof. (%)	Lecturer (%)	Research Assist. (%)	Total (%)
Under Graduate	88	12	100	2	1	10	87		100
Bachelor	43	57	100	19	19	21	1	40	100
Master	43	57	100	19	21	20	1	40	100
Doctorate	40	60	100	23	19	18	2	38	100

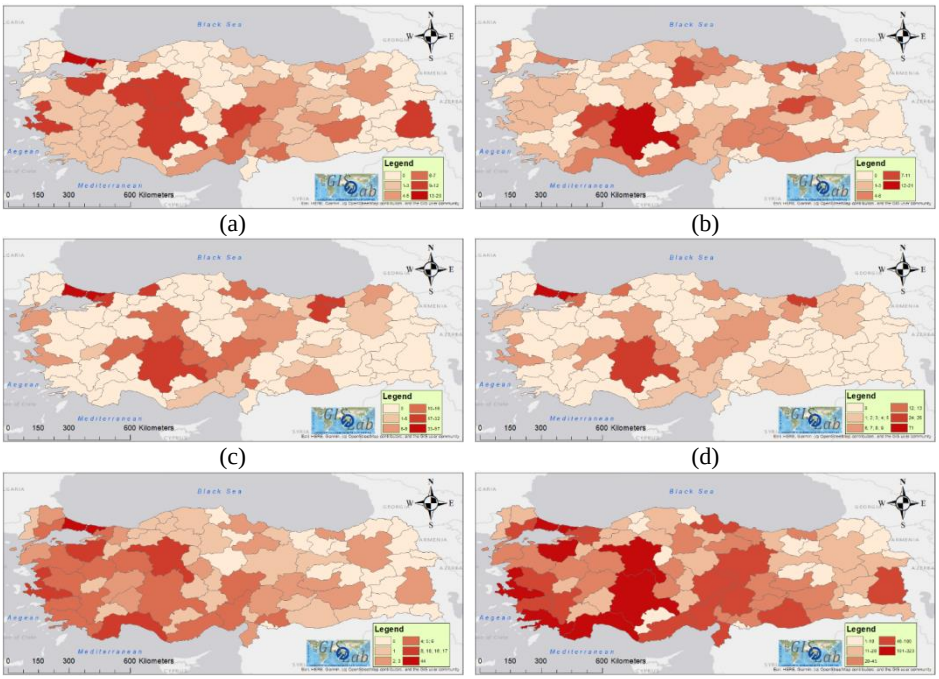

Figure 5. (a) Number of teachers in vocational high schools with map-cadastre department, (b) Number of academicians in vocational schools with map-cadastre department, (c) Number of academicians in universities with a map engineering department, (d) Number of academicians in universities with a map engineering department (research assistants not included), (e) Distribution of licensed map cadastral offices by province, (f) Number of map-cadastre engineering and consultancy offices

An important factor affecting the sector in undergraduate programs is the number of students per instructor. In Turkey, the departmental quotas in this field have continuously increased, adversely affecting the number of students per faculty member, while second-session programs have brought an almost two-fold increase in the current quotas. On the other hand, although the number of faculty members was high in some programs, the quota was fixed, while in other programs the quota was increased despite the inadequate number of faculty members. Second-session (evening) programs were opened in departments already having an inadequate number of faculty members. This situation continued until the 2018 Higher Education Qualification Examination (*YKS*) placement period. As a result of the placements in 2018, some normal session and second session program quotas remained unfilled and the enrolment rates decreased (Table 6 and Fig. 6). For this reason, the Higher Education Council applied the same standard for teaching to the regular, appointed faculty members, in order to balance their distribution in the universities. In addition, some departments approved the closure of their second-session programs.

Table 6. Geomatics Engineering quotas and enrolment rates by years (URL-6, 2019).

University / Department Name	Year	Quota*	Number Enrolled	Enrollment Rate (%)	University / Department Name	Year	Quota*	Number Enrolled	Enrollment Rate (%)
Yıldız Technical University Geomatics Eng.	2019	100 + 1	101	100	Harran University Geomatics Eng.	2019	30	6	20
	2018	100 + 1	101	100		2018	50	25	50
	2017	100 + 3	103	100		2017	40 + 1	41	100
	2016	100 + 3	103	100		2016	0 + 0	0	0
	2015	105 + 3	108	100		2015	0 + 0	0	0
Kocaeli University Geomatics Eng.	2019	60 + 2	62	100	Niğde Ömer Halisdemir University Geomatics Eng.	2019	30 + 2	1	3.12
	2018	60 + 1	61	100		2018	60 + 2	20	32.26
	2017	60 + 2	62	100		2017	60 + 2	62	100
	2016	50 + 2	52	100		2016	50 + 2	52	100
	2015	40 + 1	41	100		2015	40 + 1	41	100
Izmir Kâtip Çelebi University Geomatics Eng. (taught in english)	2019	70 + 2	72	100	Osmaniye Korkut Ata University Geomatics Eng.	2019	30 + 2	9	28.12
	2018	60 + 2	62	100		2018	50 + 2	15	28.85
	2017	60 + 2	62	100		2017	50 + 2	52	100
	2016	50 + 2	52	100		2016	40 + 1	41	100
	2015	40 + 1	41	100		2015	0 + 0	0	0
Karadeniz Technical University Geomatics Eng.	2019	80 + 2	82	100	Gaziosmanpaşa University Geomatics Eng.	2019	30 + 2	6	18.75
	2018	90 + 3	93	100		2018	60 + 2	15	24.19
	2017	90 + 3	93	100		2017	60 + 2	62	100
	2016	90 + 3	93	100		2016	60 + 2	62	100
	2015	90 + 3	93	100		2015	50 + 2	52	100
Ondokuz Mayis University Geomatics Eng.	2019	50 + 2	52	100	Gümüşhane University Geomatics Eng.	2019	40 + 2	2	4,76
	2018	60 + 2	62	100		2018	60 + 2	19	30.65
	2017	60 + 2	62	100		2017	60 + 2	62	100
	2016	60 + 2	62	100		2016	60 + 2	62	100
	2015	60 + 2	62	100		2015	50 + 2	52	100
Gebze Technical University Geomatics Eng.	2019	60 + 2	62	100	Aksaray University Geomatics Eng. (2nd Ses.)**	2019	0	0	0
	2018	60 + 2	62	100		2018	60 + 2	5	8.06
Konya Technical Selçuk University Geomatics Eng.	2019	90 + 2	50	54.35		2017	60 + 2	62	100
	2018	90 + 3	93	100		2016	60 + 2	62	100
	2017	90 + 3	93	100		2015	60 + 2	62	100
	2016	90 + 3	93	100	Avrasya University Geomatics Eng.	2019	30	0	0
	2015	90 + 3	93	100		2018	24	6	25.00
Karadeniz Technical University Geomatics Eng. (2nd Ses.)**	2019	0	0	0		2017	24	6	25.00
	2018	0 + 0	0	0		2016	24	13	54.17
	2017	90 + 3	93	100		2015	4 + 0	4	100
	2016	90 + 3	93	100	Harran University Geomatics Eng. (2nd Ses.)**	2019	0	0	0
	2015	90 + 3	93	100		2018	50	8	16.00
Çanakkale Onsekiz Mart University Geomatics Eng.	2019	50 + 2	52	100		2017	40 + 1	37	90.24
	2018	50 + 2	52	100		2016	0 + 0	0	
	2017	50 + 2	52	100		2015	0 + 0	0	
Erciyes University Geomatics Eng.	2019	65 + 2	60	89.55	Gümüşhane University Geomatics Eng. (2nd Ses.)**	2019	0	0	0
	2018	65 + 2	67	100		2018	60 + 2	3	4.84
	2017	65 + 2	67	100		2017	60 + 2	62	100
	2016	65 + 2	67	100		2016	60 + 2	62	100
	2015	60 + 2	62	100		2015	50 + 2	52	100
Necmettin Erbakan University Geomatics Eng.	2019	60 + 2	9	14.52	İstanbul Technical University Geomatics Eng. (Taught in English)	2019	60	60	100
	2018	60 + 2	62	100		2018	60	60	100
	2017	60 + 2	62	100		2017	50 + 2	52	100
	2016	50 + 2	52	100		2016	40 + 1	41	100
	2015	40 + 1	41	100		2015	35 + 1	36	100

Afyon Kocatepe University Geomatics Eng.	2019	60 + 2	14	22.58	İstanbul Technical University Geomatics Eng.	2019	60	60	100
	2018	60 + 2	62	100		2018	60	60	100
	2017	60 + 2	62	100		2017	60 + 2	62	100
	2016	60 + 2	62	100		2016	55 + 2	57	100
	2015	60 + 2	62	100		2015	45 + 2	47	100
Konya Technical Selçuk University Geomatics Eng. (2nd Ses.)**	2019	0	0	0	Hacettepe University Geomatics Eng. (Taught in English)	2019	60	60	100
	2018	90 + 3	55	59.14		2018	60 + 1	61	100
	2017	90 + 3	93	100		2017	60 + 2	62	100
	2016	90 + 3	93	100		2016	50 + 2	52	100
	2015	90 + 3	93	100		2015	40 + 1	41	100
Çanakkale Onsekiz Mart University Geomatics Eng. (2nd Ses.)**	2019	40 + 2	32	76,19	Okan University Geomatics Eng.	2019	15	2	13.33
	2018	50 + 2	52	100		2018	15	3	20.00
	2017	50 + 2	52	100		2017	23	3	13.04
Erciyes University Geomatics Eng. (2nd Ses.)**	2019	40 + 2	4	9.52		2016	20	3	15.00
	2018	65 + 2	46	68.66		2015	20	10	50.00
	2017	65 + 2	67	100	Bülent Ecevit University Geomatics Eng.	2019	70 + 2	7	9.72
	2016	65 + 2	67	100		2018	70 + 2	16	22.22
	2015	60 + 2	62	100		2017	70 + 2	72	100
Aksaray University Geomatics Eng.	2019	40 + 2	3	7.14		2016	70 + 2	72	100
	2018	60 + 2	36	58.06		2015	70 + 2	72	100
	2017	60 + 2	62	100	Cumhuriyet University Geomatics Eng.	2019	40	5	12.50
	2016	60 + 2	62	100		2018	60	19	31.67
	2015	60 + 2	62	100		2017	50 + 2	46	88.46
Afyon Kocatepe University Geomatics Eng. (2nd Ses.)**	2019	40 + 2	0	0		2016	55 + 2	46	80.70
	2018	60 + 2	26	41.94		2015	55 + 2	57	100
	2017	60 + 2	62	100	Bülent Ecevit University Geomatics Eng. (2nd Ses.)**	2019	0	0	0
	2016	60 + 2	62	100		2018	40 + 1	4	10.00
	2015	60 + 2	62	100		2017	70 + 2	17	23.61
Artvin Coruh University Geomatics Eng.	2019	20 + 2	3	7.33	Mersin University Geomatics Eng.	2019	20 + 1	21	100
Usak University Geomatics Eng.	2019	40 + 2	2	4.76					

*+ Indicate data for normal program quotas
** Second session (Evening class) programs

Figure 6. Number of students who settled in map engineering departments in 2018 (province based)

In the light of all these data, the ratio of students per faculty member/teaching staff in the undergraduate programs was compared to the figures of the OECD (Organisation for Economic Co-operation and Development) (Table 7). Older universities established before 2000 and newer universities existing for less than twenty years were classified separately. As seen in Table 7, the number of students per faculty member in universities established for more than 20 years is close to the OECD rate. There can easily be understood from the table the enrolment rate has been decreasing since 2018. This situation may be gone on because of limited employment rate in construction industry and a lot of departments and geomatics engineers and also secondary educational programme and finally also economic crisis and situation in the world.

Table 7. Number of students per faculty member/instructor (URL-6, 2019).

Program	Student number per Instructor	Student Number per Faculty Member
Doctorate	1	1
Master	4	7
Bachelor (S) (normal + 2nd session)	29	51
Bachelor (S) (normal)	16	29
Bachelor (S) (normal + 40 quota)	9	16
Bachelor (S) beginning studies <2000	18	28
Bachelor (S) beginning studies >2000	31	64
Bachelor (F)	18	18
Under graduate	99	740
Japan	7	
USA	13	
China	20	
Russia	11	
OECD	17	

S: State university, F: Foundation university

3.2. Institutionalization and quality-oriented activities

The most important institutionalization activity at the higher education level in Turkey was the establishment of the Higher Education Council. The lack of effective and coordinated central planning at the tertiary level in the country, especially in the 1960s and 1970s, caused the higher education system to fail due to the the rapid increase in the number of higher educational institutions and students and many other issues. In addition, the political, social and economic problems between 1960 and 1980 accelerated the deterioration of higher education. Therefore, a radical reform had become inevitable by the end of the 1970s, and so in 1981, reform was finally put into effect, when with Higher Education Law No. 2547, higher education entered a process of restructuring in academic, institutional and administrative terms. With this law, all higher educational institutions were gathered under the umbrella of the Higher Education Council, which, as an autonomous public legal entity, became the institution solely responsible for all higher education issues. In addition, non-profit foundations were allowed to establish private higher educational institutions. After the 1981 reform, the number of universities increased during certain periods and new faculties and departments were opened in parallel. As a result, since 2006, the total number of universities in Turkey has surpassed 200 (URL-4, 2018).

Another institutional structure is the Vocational Qualifications Authority (in Turkish *Mesleki Yeterlilik Kurumu - MYK*), aimed at improving the quality in vocational education. This institution is associated with the Ministry of Labour and Social Security and has administrative and financial autonomy. The organization is managed with the equal participation of representatives of the state, workers, employers and professional organizations. The purpose of

the *MYK* is to establish and operate a national vocational qualification system compatible with the EU. The role of the *MYK* in the professional qualification system is to determine professional standards, to carry out examination and certification procedures and to provide accreditation services (Atasoy, 2011). Accreditation is the assessment of an institution or program in terms of compliance with pre-determined standards (Oakes, 1999). The goal is to contribute to improving the quality of engineering education in Turkey by engaging current emerging technologies and better training activities in order to graduate top-quality engineers. Evaluation is done by institutions that carry out the accreditation process. Two of these are the European Network for Accreditation of Engineering Education (ENAEE) and the Accreditation Board for Engineering and Technology (ABET).

In this context, "For more than 80 years, accreditation has provided quality control for engineering education in the United States, seeking to assure that graduates of accredited programs are prepared for professional practice thanks to ABET"(Prados et al., 2005),

And "ABET has recommended a revised set of accreditation criteria that is designed to assure that graduates of accredited programs are prepared to enter the practice of engineering" (Koehn, 1997).

Accreditation studies have been carried out not only in the USA, but in Europe and also in other parts of the world. For example, accreditation of engineering programs has been applied in Taiwan for ten years. In this respect, accreditation ensures that the quality of engineering education is upgraded. Undoubtedly, quality is closely related to the satisfaction of internal and external stakeholders. Accreditation has been undertaken in this regard, and also includes consideration of the quality of the accreditation services of the stakeholders (Lee et al., 2017).

In 2002, the Council of Engineering Deans, composed of deans of engineering faculties in Turkey and the Turkish Republic of Northern Cyprus (TRNC), organized a detailed program for the evaluation of undergraduate engineering programs, and the Engineering Review Board (in Turkish *Mühendislik Eğitim Programları Değerlendirme ve Akreditasyon Derneği - MÜDEK*) was established as an independent platform for organizing and implementing detailed programs. The Engineering Review Board became an association in 2007. Later, the Higher Education Council decided to recognize it as a quality assurance organization for engineering programs, and awarded it a five-year validity period. Thus, *MÜDEK* was the first organization certified for Quality Assessment and Registration in Turkey. Nowadays, *MÜDEK* is an independent quality assessment organization whose work contributes to raising the quality of engineering education in Turkey by carrying out accreditation, evaluation and notification activities for various engineering education programs. Thus, the aim is to build a prosperous society by better educating engineers who are more qualified and aware of current and developing technologies (URL-2, 2017).

The Higher Education Quality Board (*Yükseköğretim Kalite Kurulu*) is regulated by Article 35, which was added to Higher Education Law no. 2547 via Law no. 7033. The Higher Education Quality Board is a public legal entity with administrative and financial autonomy and a private budget. The organization carries out internal and external quality assurance and accreditation processes and authorizes independent external evaluation institutions to evaluate the quality levels of higher educational institutions, educational and research activities and administrative services according to national and international quality standards. The main duties of the Higher Education Quality Board are to conduct external assessments of higher educational institutions, to conduct the recognition processes of accreditation bodies and to ensure the internalization and dissemination of the culture of quality assurance in higher educational institutions (URL-5, 2018).

The *MÜDEK* became a member of the ENAEE on 17 November 2006 and was authorized by ENAEE for the period from 21 January 2009 until 31 December 2018 to issue the EUR-ACE® (European Accredited Engineer) label for accredited engineering studies programs. In addition, *MÜDEK* achieved provisional status as a candidate for the International Engineering Alliance (IEA) on 25 June, 2010, and became a full member signatory to the IEA -Washington Accord on 15 June 2011 (URL-2, 2018).

The ABET operates as a non-governmental organization that accredits programs in the fields of applied science, engineering, technology and informatics in higher educational institutions in the United States. Approval is given for "substantial equivalency" within faculties outside the United States (URL-3). As *MÜDEK* complies with both the ENAEE in the European Union and the IEA in the USA, hence, *MÜDEK* is also compatible with ABET (Turhan et al., 2015). Geomatics Engineering departments in Turkey with *MÜDEK* and ABET accreditation are given in Table 8.

Table 8. Departments of Geomatics Engineering with *MÜDEK* and ABET accreditation (URL-2, 2019; URL-3, 2019).

University Name	Program Type	Accredited by	Validity Period
Karadeniz Technical U.	Normal	MÜDEK	01.05.2010-30.09.2020
Karadeniz Technical U.	2nd (Evening) Session*	MÜDEK	01.05.2010-30.09.2020
Kocaeli U.	Normal	MÜDEK	01.05.2014-30.09.2024
Selçuk U.**	Normal	MÜDEK	01.05.2008-30.09.2020
Selçuk U.**	2nd (Evening) Session	MÜDEK	01.05.2008-30.09.2020
Yıldız Technical U.	Normal	MÜDEK	01.05.2007-30.09.2020
Yıldız Technical U.	2nd (Evening) Session*	MÜDEK	01.05.2007-30.09.2018
Zonguldak Bülent Ecevit U.	Normal	MÜDEK	01.05.2015-30.09.2021
Ondokuz Mayis U.	Normal	MÜDEK	01.05.2019-30.09.2021
Çanakkale Onsekiz Mart U.	Normal	MÜDEK	01.05.2019-30.09.2025
Çanakkale Onsekiz Mart U.	2nd (Evening) Session*	MÜDEK	01.05.2019-30.09.2025
İstanbul Technical U.	Normal Session	ABET	01.10.2005-Continuing

***** were cancelled the 2nd (Evening) Session

****** Selçuk U. has trasferred the geomatics department to the Konya Technical U.

4. DISCUSSION

In under graduate degree and undergraduate Geomatics Engineering studies programs, the student/teacher ratios are higher than those in the OECD (OECD, 2017) and other developed countries (Eğitim Birsen, 2017).

The number of students per faculty member or instructor is very high in under graduate degree programs. Including second-session programs, 91 under graduate degree programs are offered throughout Turkey. The proportion of faculty members in these programs is 12%. In all these programs, teaching is carried out on average with two instructors. On the other hand, data on the number of graduated map technicians and map engineers is not available. The information accessed for 5228 graduates from 2007 to 2015 included only the data issued by the e-school information system of the General Directorate of Vocational and Technical Education of the Ministry of National Education.

The main problems in under graduate degree studies, which are also valid in their Geomatics and Cadastre programs, include the absence of pedagogical training, the great inadequacy of student infrastructures, and the disorganization of vocational courses, post-graduation employment problems and the imbalance in quota increases (URL-8, 2018).

One of the main problems in undergraduate education is that in the OECD and developed countries, basic science courses are completed at the high school level, while in Turkey, these are

included in the undergraduate studies course-load, thus compromising basic vocational studies. Other problems include the lack of sufficient student exposure to the latest applications in technological development and the low levels of student foreign language proficiency and oral communication skills, along with the failure to prepare vocational courses according to criteria such as national requirements, ethical standards, social responsibility and environmental sensitivity. Employment problems faced by graduates and imbalance in quota increases also add to the difficulties (Çetinsaya 2014; Eğitim Birsen, 2017).

Since the early1980s, a significant increase in the number of faculty members and teaching staff has been seen in Turkey. Nevertheless, this rate of increase has remained below the rate of increase in student numbers (Çetinsaya, 2014). The conditions for student recruitment for Geomatics Engineering undergraduate programs require that the program have at least three faculty members. Apart from this, the presence of facilities, equipment, laboratories, etc. are not compulsory. There are 14 departments already in Turkey that cannot fulfill the requirement. The universities providing undergraduate Geomatics Engineering education (Table 2) and student quotas (Table 6) have increased rapidly since the early 2000s (Coruhlu and Uzun, 2018). As with the teaching profession in Turkey, the need for the number of Geomatics engineers may already have been exceeded (Yildiz and Coruhlu, 2017).

Foreign language proficiency is undoubtedly important for internationally qualified engineering graduates. In addition, accreditation by independent international evaluation institutions is one of the criteria of the undergraduate programs which graduate engineers. Thus, employers engaged in international commerce have begun to question whether, as prospective employees, these engineers have graduated from accredited programs (Coruhlu and Uzun, 2018). It appears that the accreditation process is not being adequately promoted by the Higher Education Council and that accredited departments are not given the necessary support. The professional rank of bachelor graduates is at level 6 according to *MYK* standard. This level 6 education is expected to be given on an equal basis in all Geomatics Engineering programs in the country. However, in practice this is unlikely because of the differences in the history of the departments, the number of faculty members and teaching staff, the competency of academic staff, the physical facilities of the departments, the number of laboratories and amount of equipment and the adequacy of all this equipment, and the level of participation in scientific research in national and international fields. It is essential to minimize all these differences on the basis of model programs. Of course, the emphasis is on achieving minimum quality criteria. In recent years, the accreditation processes initiated in engineering education have become the most important tools in achieving this quality because the leading Geomatics engineering programs are assertive in providing these factors, prepare themselves for independent evaluation processes and encourage accreditation. Nine of the 33 programs (including second-session programs) that provide active undergraduate education are accredited by *MÜDEK* or ABET.

The rate of master and doctoral graduates in Turkey is quite low compared to OECD countries. Support and incentives such as various research programs and scholarships should be diversified and further developed to encourage master and PhD students. Here, the necessity for increasing the research capacity of universities in Turkey is indicated. This includes taking steps to adapt to international scientific and technological developments and to urgently increase the number and quality of academicians. Failure to encourage and supervise dissertation topics focusing on solutions to national issues and problems based on existing realities in the country, failure to cooperate with the public and private sectors, failure to create an environment where dissertations can be publicly promoted, and failure to sufficiently take into account the results and recommendations obtained from these all affect student demand (Çetinsaya 2014; Eğitim Birsen, 2017).

5. CONCLUSION AND RECOMMENDATIONS

In Turkey, the number of institutions referred to as intermediate educational institutions providing studies in in the field of Geomatics includes 78 high schools, and 57 university vocational colleges. Twenty-five universities offer undergraduate studies in Geomatics Engineering, with this number reaching 33 when the second-session programs and English education programs in these same universities are counted. There are 14 university Geomatics Engineering departments that have not yet begun their undergraduate studies. The universities providing graduate education number 18, 12 of which also offer doctoral studies. Eight of the 33 programs that provide undergraduate studies are *MÜDEK*-accredited and one of them is accredited by ABET.

Geomatics studies are offered at under graduate degree, undergraduate and graduate levels. The number of university vocational colleges and undergraduate programs as well as the number of students and faculty members are below the average of the OECD and other developed countries. The high student/teacher ratio forces the instructors to devote more time to the students and the courses and spend less time on research.

The conditions for accepting students into university vocational college and undergraduate programs are determined by the Higher Education Council. The number of students versus the number of faculty members and teaching staff must be re-evaluated. The data of OECD and other developed countries should be taken into account when opening new programs and determining quotas. In order to increase the number of graduate students, support and incentives such as various research programs and scholarships should be diversified and further developed in order to encourage master and PhD students.

Mechanisms should be developed to ensure the continuity of student education and training in order to prevent the decline in educational quality and competence. Classes must be taught in a practical manner aimed toward career paths. In particular, it is of utmost importance to direct students to interdisciplinary fields and to develop new fields of application in the profession. In recent years, the real estate appraisal/development market, urban transformation systems, and especially, the engineering and architecture disciplines have been rapidly expanding. Here, in the name of increasing the human resource of Geomatics engineers, updating the course content at the undergraduate level and directing students to this field can bring new business arenas to the profession in the years following their graduation.

In Turkey, more than 16,141 Geomatics engineers are known to be registered in the non-governmental organization *HKMO*. However, it is obvious that there are engineers who have graduated but not registered with *HKMO*. In the next five years, these numbers will increase along with any new departments that are opened. The data of the employees in the sector should be obtained from the institutions that offer workforce to the Geomatic sector. A human resource management system should be established.

In this way, study areas scheduled to open can be provided for the Ministry of National Education, the Council of Higher Education and the private sector in a more controlled way and according to need. This can be accomplished by the Union of Chambers of Turkish Engineers and Architects (*TMMOB*) together with a ministry designated by the public sector. Moreover, a collaboration made up of all categories at the top of the scale, i.e., instructors, students and graduates (technicians, specialists, engineers) can be utilized in the planning. In this context, there is obviously a need for an umbrella civil society organization which includes graduates of vocational studies at institutions of various levels. Furthermore, the fact that no data were available which could enable all the stakeholders working in the sector to be analysed together was considered as one of the remarkable findings of the study.

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