Professional competences of Surveying (Geodetic) Engineers




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Abstract

Globalisation, as a process and a condition of the space for higher education, dictates the guidelines for development of study programmes. A special challenge has appeared in the fields depending on the fast developing information technology, including spatial information science, and in the fields of licensed disciplines such as land surveying. Due historical reasons, surveying, geodesy and cartography have been often part of a common academic study programme in the most European countries. The competences of classical surveying, geodetic, and cartographic higher educational programmes have been changing and new areas are developing rapidly. In the article, we focused on competences of the surveying (geodetic) higher education in today's society, where findings of actual international discussions are summarised. Furthermore, the renovation of higher study programmes of surveying in Slovenia is presented (official translation is geodesy), which has been partly influenced by historical facts, and current European and international guidelines in higher education of surveying and geodesy. In this respect, the competences of the new higher educational programmes of surveying (geodesy) in Slovenia are presented.

Keywords: Surveying, geodesy, higher education, competence, Slovenia

1. Introduction

The new, fast developing technologies and methodological approaches in different professions are inevitably entering the everyday practice, which dictates the guidelines for study programmes in the higher education area all over the world. There is not only development in technology but also social-economic conditions and guidelines in higher education, research and science are changing, which demands the renovation of current curricula [1]. Therefore, the technological development is not the only driver in developing professions and their competences. A special problem for developing or renovating higher educational programmes has appeared in the fields depending on the fast developing (information) technology, and in the fields of regulatory (licensed) disciplines, where surveying is characterized by both challenges. In general, the surveying profession has to adopt and follow the spatial information revolution and at the same time endeavour to maintain traditional services. Since surveying has been traditionally related to the land, additional phenomena are shaping the surveying professional competences, such as need for sustainable spatial development and sustainable development in general.

The study objects in surveying, geodetic, other spatial and land related studies have changed and broadened a lot during the last decades. There have been several discussions on the topic of surveying (also geodetic, geomatics) higher education in the last years on national, European level as well as worldwide (see [2], [3], [4], [5]). Because of historical reasons, and because of methodological and technological dependence, surveying, geodesy, cartography and spatial information science are often included into a common study programme of surveying, geodesy, geomatics, geoinformatics or similar. The fields covered by the surveying (geodetic) study programmes are diverse among the countries. In addition, surveyors, geodetic engineers in some countries provide professional services, which are provided by different professionals in other countries. However, the list of functions, activities carried out by them is common to most countries, at least in Europe.

2. Surveying profession and competences

The history of surveying goes back to the centuries when man permanently settled the land. The importance of this crucial natural resource forced the human to develop technical and methodological solution for evidencing and registering the land, and consequently protecting of rights on land. On the other side, man has been interested in learning about the Earth from the old. Geodesy was developed in order to understand natural phenomena which are related to the size,

shape, gravity field of the Earth. Terrestrial surveys and geodetic measurements have been the fundaments for determining size and shape of the Earth and position of spatial phenomena. Together with astronomy, geodesy is among the oldest sciences and is the oldest geoscience. However, surveying and geodesy were based on the same principles – even more, the relative local and absolute positioning was usually performed with the same instruments and both disciplines complemented each other. Furthermore, surveying and geodesy provided the basis for modern mapping. These three disciplines got a common higher educational curriculum, at least in the most European countries [6].

The nature of surveying, geodesy, cartography and related fields has been changing because of new technologies, methodologies and growing demands of the society for spatial data and information related to the geographical location. Consequently, the competences of the surveying, geodetic engineers, and cartographer have been changed in the last decades and the new definitions of surveying profession were formed. The international trends of surveying educational profile is much more focused on land management and administration than it used to be, where the areas of measurement science and land management is supported/associated by interdisciplinary paradigm of spatial information management. Such a professional profile aims to be able to design/build/manage the natural and built environment and connected spatial/legal rights and restrictions (see [7]).

2.1 Competency standards and challenges for surveying profession

Competency can be defined as the ability to apply knowledge and skills to produce a required outcome [8]. It is the ability to perform activities within an occupation; to function as expected for employment; and ability to do a job under a variety of conditions, including the ability to cope with contingency. Competency is expected to develop from the three components over an employee's lifetime, comprising education, training and experiences. Certifying a certain level of competency is separate from what is described variously in different countries as legal registration or licensure, which is legally enforceable registration of an individual by a regional jurisdiction. Competency cannot be directly observed; hence it has to be inferred from indirect evidence and is therefore performance based. Competency is defined by a set of standards, which define the level of attainment at various levels [8].

The benefits of professional competency standards are that they can test the effectiveness of professional education and training, improve recruitment, identify training gaps, lead to improve efficiency, worker safety and employee retention. In addition, the competency standards can be understood as the answer to professional organizations, where the intention of the European Commission for securing the free movement of professionals within the single market place of the EU has to be emphasized on the European level. Furthermore, the World Trade Organization (WTO) aims to support the global market place for services, for which mutual recognition of qualifications is of big importance (see [9]).

Focusing on surveying profession, the tasks of the surveyor's profession vary in the different European countries, just as in other parts of the world, but the profession can be said to originate in mapping and in the definition of boundaries for real estate units and other spatially based rights. The emphasis on these activities varies between countries and from the historical perspective. The interesting point, though, is that an original knowledge of real estate has enabled the surveyors to develop new activities such as legal counselling, planning, land development, property valuation and property management. Meanwhile technical progress has been rapid. Internationally, then, the surveying profession, as a whole, has a wide range of professional practices that can change according to how readily new tasks can be assimilated [10]. According to FIG definition, the surveying profession is not focused only to the technical aspects. On the international level (FIG) it is argued that any future educational profile of surveying should comprise measurement science and land management, and that it should be supported by and embedding in a broad interdisciplinary paradigm of spatial information management [3].

2.2 Higher education in surveying (geodesy) – European contents

The past years have been a time for preparation and implementation of new curricula in the history of the European higher education. The main concern has been on the reformation of the structure of national higher education systems in a convergent way in accordance to the Bologna Declaration [11]. The main goal of the Bologna

Declaration has been to create a European space for higher education in order to enhance the employability and mobility of citizens and to increase the international competitiveness of European higher education. Three main priorities of the Bologna process are [12]:

- introduction of the three cycle system (bachelor, master and doctorate),
- quality assurance, and
- recognition of qualifications and periods of study.

Although the higher educational programmes have to be flexible and follow the newest technological trends and needs of the society, and are therefore denoted with the constant called "change", the transition to three tire system of the academic education according to Bologna provided an opportunity to introduce novelties or at least changes in a larger scale, which was also the case in Slovenia. Based on competences of the higher educational programmes, which were defined on questionnaires for graduates in surveying (geodetic) engineering and employers in Slovenia, and following the main guidelines of the surveying profession on the international level, the new study programmes have been introduced at Department of Geodesy, Faculty of Civil and Geodetic Engineering, University of Ljubljana.

3. Higher educational programmes of surveying (geodesy) in Slovenia

3.1 Historical background

The profession of surveyor in Slovenia has its roots in the far 18th century where Slovenia was part of Habsburg monarchy. The professional education programme of surveying in former Carniola was adjusted to the need of technical support in Idrija mercury mine. Towards the end of the 18th century, the initiatives for establishment of the university in Ljubljana on the model of Vienna University were getting very strong. In that time, some study programmes were performed in Ljubljana, and in the framework of the humanistic educational programmes also surveying was included; but the contents was dependent on lecturers. The surveying course was mainly carried out in the framework of the tradesman's education, adjusted to the needs of the society (land measurement and surveying mapping). Study of surveying in Ljubljana was again introduced in the period of Ilirian provinces (1810) but remained only for two years. Since then, only periodic educational programmes of cadastral surveyors and cartographers were organized in Ljubljana, while for higher degree Slovenes had to study at foreign higher schools and universities [13].

In 1919 the University of Ljubljana was founded. In the framework of the university, the permanent higher education of surveying (geodesy) was introduced. There were some changes and also interruption of performing this study programme in the following 25 years. However the German (Austrian) influence shaped the study programmes at the university. Right after the World War II (1945/46), the Department of Geodesy was established at the University of Ljubljana, which introduced 9-semester study programme of surveying, mainly dedicated to the needs of the post-war economy. Already in 1956 the narrow oriented study programme changed and courses from public infrastructure, urban planning and spatial development were included, and in 1957 the higher educational study programmes of surveying (geodesy) got part of university study programme at the new Faculty of Architecture, Civil and Geodetic Engineering [13].

Today, the academic education of surveying (geodetic) engineering is still carried out in Slovenia only at the University of Ljubljana, Faculty of Civil and Geodetic Engineering. Mainly because of historical reasons, but also due needs of the society, the study programmes of surveying (geodesy) in Slovenia cover the fields from geodesy, land surveying, to spatial data management and land management. Since the Slovenian world "geodezija" usually represents all these fields, some dilemmas appear when translating these study programmes in English. In the paper, these fields are mentioned as "surveying (geodesy)", except the official translation of the programmes, where the world "geodesy" is used. At the moment, the study programme is in transition from the old study programmes to tree tires study programmes following the Bologna guidelines. Recently, the study programmes have been based on German higher educational system. The graduates at the "University study programme of Geodesy" (9 semesters, the last enrolment in the 1st semester in 2008/09) have got title "university diploma engineer of geodesy", which is comparable to a master's degree in countries that use consecutive system of higher education. The "Higher professional study programme of Geodesy" (6 semesters, the last enrolment in the 1st semester in 2007/08) is comparable to study programmes at Universities or Colleges of Applied Sciences (in Germany: Fachhochschule). Its diploma may be compared to the degree of a bachelor at honours

level. Diploma at this study programme entitles the graduate ("diploma engineer of geodesy") to practice in nearly all fields of surveying with the exception of certain fields of geodesy and surveying [14].

The above mentioned programmes are not old, because the previous higher educational study programmes of surveying (geodesy) were renewed in the framework of Phare-Tempus Programme (1996-1999). The main changes in the study programme at that time were incorporation of new courses of the principles of law and economics as well as land management and real estate valuation. However, already at the end of the project in 1999, it became obvious that changes of curricula were in fact the start of a permanent process of changing. The rapid development of science and technology, and new dimension of the surveying profession demanded that the started process should rather be a cyclical one. Therefore, as a more intangible outcome of the Phare-Tempus project, the agreement prevailed at the Department of Geodesy that the continuous attendance of surveying study programmes are necessary. In this context, the last Bologna changes make a logical continuation and the study programmes of surveying (geodesy) are having been replaced by Bologna study programmes. However, contrary to experiences in some Western European countries, in Slovenia there has been solid interest in surveying (geodetic) study programmes in the last decades and the number mainly varied because of changing enrolment regulation – the limitation of number of students in the first semester, which has been becoming stricter recently (Fig. 1).

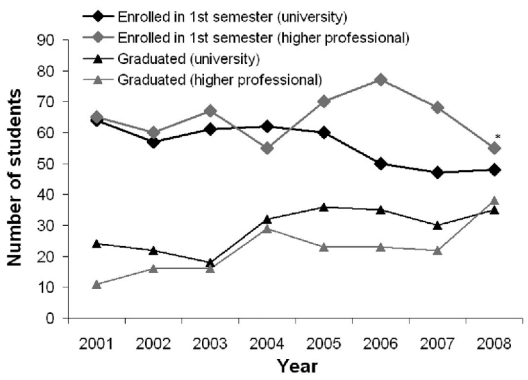

*Fig. 1: Number of students in the 1st semester and graduated at the University of Ljubljana (Slovenia) at the university- and higher professional study programmes of surveying (geodesy) in 2001-2008 (*in the academic year 2008/09, the new professional bachelor study programme was introduced instead of the old higher educational programme).*

3.2 Renovation of higher education of surveying (geodesy) in Slovenia

The adoption of Bologna declaration at the Faculty of Civil and Geodetic Engineering, University of Ljubljana, which is the only institution in Slovenia that carries out the academic education in surveying (geodesy), started in 2004 with preparation of new study programmes at all three levels: Bachelor, Master and PhD. This gave an additional opportunity to adjust the higher educational study programmes to the needs of the society. The main idea of new study programmes follows the Bologna guidelines where learning outcomes are instruments that make studies more compatible and comparable. However, one of the most important factors in renovating study programmes was to follow the need of the society.

For this purpose, the analysis of the situation about the surveying (geodetic) profession in Slovenia was performed, based on two questionnaires: for graduates (in 2005; see [15]) and employers (in 2006; see [16]). All of 98 graduates at Department of Geodesy in Ljubljana, who answered questionnaire, had no problem to find a job after they graduated and were employed at that time. Fig. 2 shows fields of work of graduates in surveying (geodesy) (graduates at the University study programme of Geodesy and graduates at the Higher professional study programme of Geodesy) in Slovenia. In general, diploma engineers of both study programmes suggested that the topics of real estate registration, real estate management, spatial informatics, law and business economics should be included in the new surveying study programmes in the future (see also [14], [15]). The general opinion of Slovene employers (50 answers) was that graduates in surveying (geodesy) are rather prepared for work in their company regarding their professional knowledge and skills. The main subjects of critique of employers in private companies were regarding graduates' knowledge and skills in business management, organization and ability to be self-critical and critical in general (see also [14], [16]).

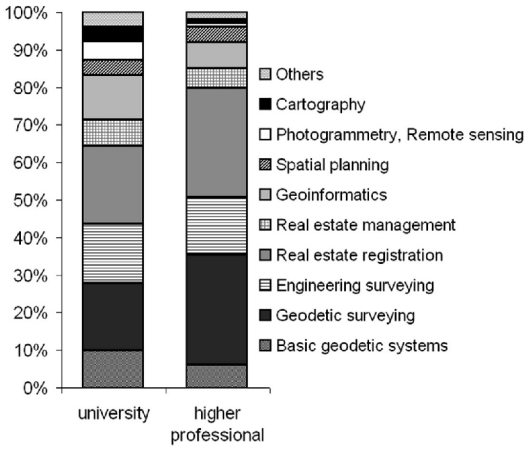

Fig. 2: Field of work of geodetic (university) diploma engineers in Slovenia [13].

As characteristic in the most European countries, the need to change the focus in surveying education from predominantly an engineering focus to a more managerial and interdisciplinary education was shown also in Slovenia. Based on the results of the research (questionnaires) and therefore taking into consideration national needs beside the global trends in surveying (geodetic) profession, the study competences of new Bologna study programmes in Slovenia has been introduced. This provided the main basis for formation of new study programmes at the Faculty of Civil and Geodetic Engineering of University of Ljubljana. It was decided to introduce four study programmes at the Department of Geodesy at the first and second level:

(1) "Professional Bachelor degree study programme Technical Real Estate Management" (introduced in 2008),

(2) "University Bachelor degree study programme Geodesy and Geoinformation" (will be introduced in 2009),

(3) "Master degree study programme Geodesy and Geoinformation" (planned in 2010), and

(4) "Master degree study programme Spatial Planning" (planned in 2010).

In addition, a special attention was given to the doctoral study programme (3rd level) where advanced student will get opportunity to join advance courses in two of three branches in the framework of common PhD study programme "Built Environment" at the University of Ljubljana, Faculty of Civil and Geodetic Engineering. Three study and research branches of PhD study programme "Built Environment" are "Civil Engineering", "Geodesy" and "Spatial Planning and Land Management", where the last two makes a direct upgrading of both above mentioned master degree study programmes at the Department of Geodesy.

Names of new study programmes were selected to reflect the last situation in profession (new technologies) and society, what can contribute to promote the profession and increase the affirmation of the profession [14].

3.3 Proposed competences of the Surveying (Geodetic) Engineer in Slovenia

As already ascertained, the educational competences represent only part of the professional competences, which are resulting from life-long learning and practice. However, the society (employer) demands some certain knowledge and skills already from the higher education in order to get the profile of graduates to be able to develop and upgrade his/her professional quality. The competences of introduced Bologna study programmes (at the first two levels) at the Department of Geodesy, Faculty of Civil and Geodetic Engineering, University of Ljubljana were defined by knowledge and several skills, the graduates should acquire during study period through learning and practice. In general, the competences can be summarised as described in Table 1.

	PROFESSIONAL COMPETENCES	BA TUN	BA GG	MA GG	MA SP
	GENERAL COMPETENCES				
	Understanding and solving technical and/or business related problems using high level thinking skills (applying theory into praxis); the capabilities for individual learning, critical evaluation of learning sources;	X	X	X	X
	The possession of appropriate personal and professional values, behaviours and responsibilities; the abilities to make sound judgements in a professional and ethical context;	X	X	X	X
	Advanced language, numerical and IT literacy; communication skills and appropriate public appearance; comprehensive knowledge of related fields and the ability for interdisciplinary work;	X	X	X	X
	Understanding and using scientific methods; the abilities to define, research, understand and advanced solve practical and theoretical problems, principles;			X	X
	Understanding and critical evaluation and use of professional/scientific literature; the abilities to critical, analytical and synthetic thinking; the abilities to professional and scientific expression;			X	X
	KNOWLEDGE (PROFESSIONAL SPECIFIC) COMPETENCES				
	Understanding the role of surveying, geodesy, spatial data in the society; the familiarity with spatial data acquisition, data sources, data quality.	x	X	X	x
	Understanding the role of technical real estate management for the sustainable development; the familiarity with spatial data acquisition, data sources and its quality as support for spatial planning and spatial policy.	X	x	x	X
LAND MEASUREMENT	Comprehension and professional use of advanced technology and methodology in surveying measurements;	X	X	X	
LAND MEASUREMENT	Maintaining the basic geodetic systems; designing, organizing, managing, implementing less exacting measurements; land cadastre measurements;	x	X	X	
LAND MEASUREMENT	Designing, establishing, maintaining, renewing of basic geodetic system; performing of advanced, precise geodetic measurements; developing advanced geodetic technology and methodology; monitoring the position of natural and man-made objects in space and time.			X	
LAND MEASUREMENT	Advanced comprehension and critical monitoring of geographical and human environment, understanding of graphical presentation of the space;	X	X	X	X
SPATIAL DATA MANAGEMENT	Understanding of conceptual modelling and model presentations of the geographical environment, including intangible entities;	x	X	X	x
SPATIAL DATA MANAGEMENT	Designing, managing, maintaining geographical, cartographic, land information systems; advanced problem solving and research in the fields of topography, cartography, photogrammetry and remote sensing.			X	
SPATIAL DATA MANAGEMENT	Solving practical problems from the fields of spatial and land related data acquisition, valuation, presentation and maintenance; use of surveying and other spatial/land related data independently (also in GIS);	x	X	X	x
SPATIAL DATA MANAGEMENT	Understanding, planning, implementing advanced spatial data acquisition; developing advanced solutions in spatial data management, IT solutions;		X	X	
SPATIAL DATA MANAGEMENT	Understanding, designing and maintaining real estate recording/multipurpose land information systems;	X	X	X	
SPATIAL DATA MANAGEMENT	Registering the real estate: determining, presenting and recording technical characteristics of real estate and rights referring to the real estate (land).	X	X	X	

LAND MANAGEMENT	The familiarity with legal framework of surveying, spatial data acquisition, real estate recording and management; Professional participating in planning and implementing spatial interventions, spatial planning, urban and rural development; and in land management;	X	X	X	X
	Valuation and appraisal of different values of real property (market value, investment value, cost value, property rent etc.	X	x	x	X
	Studying natural and social environments and surveying of land resources; critical use of spatial and land related data (physical, economic, environmental, social attributes etc.) in spatial planning (urban and rural);	x		x	X
	Policy making in spatial planning (local, regional, national), urban/rural and land development; considering also public opinion;				X

Table 1: Educational competences of new study programmes at the Department of Geodesy, Faculty of Civil and Geodetic Engineering, University of Ljubljana (Legend: BA TUN – Bachelor study programme of the first degree Technical Real Estate Management, BA GG – Bachelor study programme of the first degree Geodesy and Geoinformation, MA GG – Master study programme of the second degree Geodesy and Geoinformation, MA SP – Master degree study programme Spatial Planning; X *– full competence, x – limited competence).*

In performing in the Table 1 mentioned competences, the graduates of new study programmes take relevant legal, economic, ecological and social viewpoints affecting different projects in surveying (land management, land measurement and spatial data management) projects. The common competences of graduates in the study programmes are also capability for gathering and evaluating land information and other spatial data, and to apply this information for the purpose of planning and managing the land, sea and structures, as well as the objects on them. Furthermore, the graduate will be qualified for developing geospatial services adapted to various users' groups.

4. Conclusions

The term professional competence relates to the status of expert and cannot be achieved only through university graduation as well as it cannot be achieved solely through professional practice [7]. However, the higher education is one of the important parts in developing professional competences.

Based on experiences in Slovenia, we would like to emphasize that the structure and the content of the higher educational curriculum have to be flexible in order to quickly adapt to developing technology and changing demands of the society, profession. The study outcomes, competences of graduates, seem to play an important role in developing the profession in the future. It is widely recognised that the adequate competences of the higher education are crucial not only to the renovation of study programmes but also to the future of international mobility of students, researchers and teachers in every profession.

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