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Full Length Research Paper

Standardisation in engineering surveys in Turkey

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Buying, selling and changing goods and services easily in today's world, where economic, social and cultural relations are very complicated, are related to standards that determine the qualities of them. Although there are standards for every kind of goods and services produced in the European Community that we still try to become a member of it, no detailed study had been done on this subject. Unfortunately, conformity packages, which can help us almost in every subject, will force us to work on this subject imperatively. Since the engineering surveys are also based on technological service and its production, getting a better quality in a production process and the quality of the personnel (surveying engineers, surveying technicians etc), who works in production process, depend on standardisation of the methods and the equipment used for survey. The subject of the qualification and the quality of personnel, who work in surveying sector, determination of standards related to survey methods and instruments has not been developed into consideration in detail. Only some legal regulations have been made until now. Quality problem on the production of goods and services must not change from country to country. This subject is very important and cannot be solved by legal regulations made in different countries. Free circulation of goods and services is possible if they are standardised globally.

Key words: Standards, standardisation, standardisation in engineering surveys, International Organization for Standardisation (ISO) standards, International Federation of Surveyors (FIG) standardisation committee.

INTRODUCTION

Free circulation of capital, goods and services is increased globally by free trade agreements and international unions like the European Union. This circulation is not indiscriminate. It is applied conveniently to some legal arrangements. Quality is more important than the arrangements especially in the circulation of goods and services. When the rules of free circulation have been formatted, detailed arrangements concerned with the quality of these goods and services must be taken into consideration. The quality of a good or a service must be of similar standards in global or in national sense. This is very important for the producers and services. Having a good position, which is steady, of the international market depends on the quality of the goods and services produced. Determination and measurement of the quality of services and goods is a very important topic here. This question leads us to the standards of standardisation. The most important details of the subject include the following questions:

a. How will these standards be determined?
b. Under what conditions will these standards bedetermined?
c. Who will determine the standards?

The International Organization for Standardisation (ISO), established in Geneva in 1947, is the basic body for facilitating the change of goods and services globally, in the formation of international standards. Some important international standardisation bodies such as DIN (Germany), BSI (England), AFNOR (France) and ANSI (America) are members of ISO. There are 135 countries that are members of ISO. Promoting the standardisation and related activities in the world with a view to facilitate international exchange of goods and services, and to develop cooperation in the spheres of intellectual, scientific, technological and economic activity is determined as the mission of ISO (Greenway, 2003). Acceptance of the standards is determined by ISO, voluntarily. Since users and persons who buy services and things, trust the firms, which are being suitable to international standards, this voluntary became forced

situation nowadays. Trust of the suitability of a thing or a service to the standards is supplied by the declaration of procedures and the controls made by independent bodies. Standards are determined and published in varieties of subjects such as specification of electronic distance meters and sizes of fruit juice boxes in today's world. Being totally 12524 ISO standards at the end of 1999 is important for understanding the importance of the topic. The well-known ISO 9000 standards related to quality management are very important in production processes. Since our profession is a service production, profession standards such as ISO 9000 and some official standards are becoming increasingly important for our colleagues (surveyors). A survey firm, which does ISO quality certificate, has more advantages than the firm, which has not process the ISO quality certificate for getting orders on national or international level. Since standardisation activity is becoming move important to surveyors, International Federation of Surveyors (FIG) decided to establish a Task Force on Standardisation in 1997 congress (Greenway, 2002a, b). This established task force on standardisation started work in earnest in 1998. FIG maintains relations with 3 technical committees in ISO at present:

1. TC 59 Sub-Committee 4 – dimensional tolerances and measurements;
2. TC 172 Sub-Committee 6 – geodetic and surveying instruments;
3. TC 211 – Geographic Information/Geomatics.

The task-force established in FIG is to give technical support to ISO being related to activities of surveyors. This task is also supported by the FIG members (Greenway, 2001a, b).

STANDARDISATION IN SURVEY WORK

Advantages of the standardisation in producing and presenting things and services are very big for a country in an economic sense. The following outcomes related to economic advantages of the standardisation have been obtained as a result of a research made by The Technical University of Dresden and the Fraunhofer Institute for Systems and Innovations in Germany (Hawerk, 2001).

1. The benefit to the German economy from standardisation amounts to more than US $15 billion per year.
2. Standards contribute more to economic growth than patents and licences.
3. Companies that participate actively in standards work have a head start on their competitors in adapting market demands and new technologies.
4. Transaction costs are lower when European and International standards are used.
5. Research risk and development costs are reduced for companies contributing to the standardisation process.

The following parameters and standards can be taken into consideration in determining the standards related to a surveying firm (www.tsps.org).

Standards concerned to surveying instruments and office equipments

These standards can be concerned with surveying instruments and office equipments, which belong to a surveying firm, such as total stations, distance meters, theodolites, levels, hydrography ship, sonar, photogrammetric aircraft and its camera, satellite receiver, computer, printer, plotter, scanner and software etc. (www.tsps.org). The following interrogations can be performed during the determination of these standards:

1. Do technical specifications of the instruments belonging to a surveying firm convenient to determine standards?
2. Are calibration and test of the instrument performed periodically?
3. Is the software used by the firm adequate to get precise and accurate outputs?

Standards concerned to the used survey method and evaluation techniques

Different studies are to be performed by FIG, FIG members and other important bodies. Then these studies must be put together and a convenient surveying method and evaluation techniques must be determined on a project base. Regional conditions must be taken into consideration in this determination. The results must be accepted as ISO standards (Greenway, 2000a, b).

Continued education and certification of the personel

Survey works are performed by the cooperation of an engineer, technician, and other persons. A person who has got an engineering diploma and lacks some experience is accepted as sufficient in joining an order in some countries. Only the engineer's title is not sufficient for performing a survey project. After some years and some proficiency tests, a person must get a licence to perform survey projects. Every member of the surveying personnel must go to a professional course periodically. He must learn new survey methods and techniques. He must be certificated periodically by professional bodies. Such bodies are brought into existence by universities and professional chambers in local or global sense. A continued education is to be taken into consideration. Think of a person who has got diploma in medical science and has not obtained enough experience, and

we think that we are a patient of his. Nobody wants to think of the result of this situation. We can also think of a situation in an engineering project. Think of an engineer who has not got enough experience and imagine that he works in a tunnel project. No doubts, there will be faults in direction and level of the tunnel. Education quality is different from country to country. This is also a problem in global sense. The quality of a professional education of a university must be credited by independent bodies periodically. Nobody has to get engineer title easily, because he will contract not only locally (Steve et al., 2000).

STANDARDS IN LARGE SCALE MAP REGULATIONS IN TURKEY

Regulations of production of large scale maps and map information have been published in 1988. Map has been produced according to these regulations until year 2005. This regulation has been rearranged in 2005 (Regulation of Producing of Large Scale Map and Knowledge of Large Scale Map, 2005) because of new technical developments such as satellite techniques, remote sensing and geographic information systems in surveying engineering. This regulation has supplied professional agreement in standardization. Standardization has been supplied in map production and geographical data production.

Some comparison has been made between the regulations that have been produced in 1988 and 2005 in Turkey. Some standards related to surveying engineering have been explained and the suitability of the maps produced in Turkey to international standards has been researched in this article.

COMPARISON OF OLD AND NEW REGULATIONS

The renovations that came with the last regulations produced in 2005 can be listed. Due to the standardization in the sector there will be no repetition of the works.

In addition to public utilities, corporate bodies and private persons have to conform to these technical rules.

Position information in large scale maps have been based on horizontal and vertical Networks that have been established by conventional measurement methods three dimensional before the establishment of National GPS Network of Turkey (TUTGA). Nowadays, three dimensional cartesian coordinates of points are tied to TUTGA by the aid of satellite and space techniques.

Since information of points on the map are gotten in national data change format, visualization of information using cartographic techniques is supplied.

It maps are produced by public institutions, public corporations and real person or corporate bodies; there must be a surveying engineer who will get authority and responsibility.

Classification of points that are established on the field at new and old regulations

The classification of points that are established on the field at new and old regulations is shown in Table 1.

NEW STANDARDS FOR GEODESIC WORKS

Coordinates of horizontal control points determined with three degrees grid essential at Universal Transversal Mercator (UTM) projection and Geodesic Reference System 1980 (GRS-80) defines with having equal potential ellipsoid that have the parameters which are appropriated by international Geodesy and Geophysics cooperations in 1979 associated with last updated Turkey National main GPS Network (TUTGA-99) (Regulation of Producing of Large Scale Map and Knowledge of Large Scale Map, 2008).

a = 6378137.0 m;
f = 1 / 298,257222101
J_2 = 0.00108263;
W = 7292115 $\times 10^{-11}$ rad $.s^{-1}$;
GM = 398600.5 $\times$ 10^9 m^3 s^{-2}

Standard deviation values which is intended with the result of measurement at main and densification points made by Satellite and Space Techniques are shown in Tables 1 and 2.

Intended standards at densification points for measurement (map production) are as follows:

Measurement accuracy for distances: ± (5 mm + 5 ppm);
Measurement accuracy for direction observations: for DIN 18723;
Measurement accuracy for horizontal direction: 6^{cc} or 2"
Point position accuracies: ± 5 cm ≤ mx, my ≤ ± 7 cm

At traverse measurement (rapid static and static measurement) made by GPS technique; Point position accuracies: ± 8 cm.

Standards at traverse measurement made by conventional techniques are as follows:

Measurement accuracy for distances: ± (5 mm + 5 ppm); Measurement accuracy for direction observations: for DIN 18723; Measurement accuracy for horizontal direction: 10^{cc} or 3"; Point position accuracies: Should be ≤ ± 8 cm.

Helmert orthometric heights of accuracies

Helmert orthometric heights of accuracies was determine by one of the methods of geometric levelling, trigonometric levelling or GPS levelling tied with updated Turkey National Vertical Control Network-1999 (TUDKA-99) points. The difference between Helmert orthometric height

Table 1. Classification of points that are established on the field at new and old regulations.

Year 1988 regulation	Year 2005 regulation
Classification of the produced points with classical measurement methods 1. Ground control point: Triangulation, Polygon and Levelling points based on National Geodesic Network 2. Horizontal control points: First and second degree triangulation points and third degree polygon points tied with National Geodetic Network. 3. Densification points for map production mid points, complementary and arranged triangulation points taken with photogrametrical methods. 4. Vertical control points: Levelling points at different degrees of National Levelling Network	Classification of the points produced with space and satellite methods 1. Global International Terrestrial Reference Network (ITRF) points 2. European Terrestrial Reference Network (ETRF) points. 3. Turkey National GPS Network (TUTGA) points tied with ITRF and ETRF networks 4. Main GPS network (AGA) points tied with TUTGA 5. Densification network (SGA) points tied with AGA 6. Turkey National Vertical Control Network (TUDGA) points: a. Horizontal control points: AGA and SGA points that's base distances between 35-40 km tied with TUTGA b. Densification points for map production: Midpoints, complementary arranged triangulation, polygon and photogrametric points that is, base distances are under 4 km tried with AGA and SGA c. Vertical control points: Main levelling networks points closed with maximum 40 km loops and main levelling networks points closed with maximum 10 km loops tied with TUDGA

Table 2. Standard deviation values.

At main GPS network points	$\sigma_{\Delta X}$, $\sigma_{\Delta X}$, $\sigma_{\Delta X} \leq \pm$ (10 mm + 1 ppm)
At geodesic points after adjustment	σ_{φ}, $\sigma_{\lambda} \leq \pm$ 3.0 cm, $\sigma_{h} \leq \pm$ 5.0 cm, 1- $\lambda \leq \pm$ 3 ppm, Statistical reliability 1- $\acute{\alpha}$ = 0.95

height difference was determined by the usage of Turkey Geoid (TG99A) and GPS and Helmert Orthometric Height difference between the accuracies should prove:

$\Delta H_{mm} \leq 12$ mm $\sqrt{S_{km}}$ condition

During levelling measurement, levelling equipments (like level and rod) which can determine height differences of double measurement ±1.5 mm/km or better sensitivity, should be used. Helmert orthometric heights are determined and adjustment with equipment that has this intended sensitivity standard deviation of unit weighted measurement (Standard deviation of height difference at 1 km road) should not be bigger than ±10 mm as the result of free net adjustment.

STANDARDS BETWEEN TRANSFORMATIONS

At the production of geographical knowledge on large scaled maps in Turkey and point position information at maps, Cartesien coordinates (X,Y,Z) which is based on coordinate system of Turkey National Basic GPS network or horizontal position information at the form at (φ,λ,h) geodesic coordinates at GRS-80 ellipsoid are obtained. Helmert orthometric height (H) which includes vertical point positions is gained based on Turkey National Vertical Control Network 1999 (TUDGA-99) (Regulations of Producing of Large Scale Map and Knowledge of Large Scale Map, 2005). 1950 European Datum (ED-50) is a datum which is based on Hayford Ellipsoid and its parameters;

a = 6378388.0;
f = 1 / 297.0

So that the transformation is made by two or three dimensional method or one of the resemblance transformation methods in the condition of at least 4 common points between TUTGA and ED-50. Conformity test is made between the coordinates, 1-ά = 0.95 is taken as statistical reliability interval. Accommodative common transformation points should cover 60% of project area. Accuracy of conformity test should be smaller than σ_0. The biggest coordinate corrections should be smaller than ±14 cm.

STANDARDS AT DETAIL SURVEYS

During projection coordinates of detail points, horizontal points accuracy should be bigger than $(\sigma_x^2 + \sigma_y^2)^{1/2} = \pm 7$ cm and Helmert Orthometric Height Accuracy should be bigger than $\sigma_H = \pm 7$ cm Kinematic point determination

methods detail measurements can be made with Electronic Tacheometer, Prismatic measurement, Levelling and GPS. Observation distance should not pass 500 m at measurement method with Electronic Tacheometer (Regulation of Producing of Large Scale Map and Knowledge of Large Scale Map, 2008).

PHOTOGRAMMETRIC STANDARTS FOR PRODUCING LARGE SCALE MAP REGULATION

Photogrammetric standards for producing large scale map regulation depending on scales of map and orthophoto scales of vertical photos are as follows:

1. Scale of a photograph is not smaller than 1/6000 in the map scaled 1/5000;
2. Scale of a photograph is not smaller than 1/100000 in the map scaled 1/2000;
3. Scale of a photograph is not smaller than 1/5000 in the map scaled 1/1000;
4. Scale of a photograph is not smaller than 1/3500 in the map scaled 1/500

Obtuse angled cameras having average 15 cm focus length and 23 cm × 23 cm photograph sizes are used in taking photo of air photos and maps scaled 1/5000 and bigger than 1/5000.

Photogrammetric triangulation surveys are performed full or half automatically (Regulation of Producing of Large Scale Map and Knowledge of Large Scale Map, 2008). These surveys are adjusted in blocks. After this adjustment;

1. Mean coordinate errors should not be bigger than 8 μm;
2. Mean position error should not be bigger than 10 μm.
3. Mean level error should not be bigger than 15 μm.

Conclusions

There are a lot of rules called standards related to a lot of topics in our life. We have to understand the importance of the standardisation in nowadays world. If we want to develop our country and our firms economically, we must think of our profession globally. We are not alone in the world. If someone wants to get more economic income, he has to realise the meaning of standardisation and he has to form all things suitably up to be present standards on the global market. As a result, if the standards defined for Turkey in this article are accepted over the world, it will be inevitable for opening of engineering survey projects to be applied in Turkey to international competition.

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