Azgaldov G. G., Kostin A. V. Quality - as the most important object of quantitative analysis

In 20th century experts of different countries faced a severe problem of defining reliable techniques for quality evaluation, applied to outcome of creative team and individual work, products, services etc. As a result a new branch of science called qualimetry was established around the world in 1968. It has become considerably in demand recently along with rapid development of internet and with growth of human activities characterized with quantification of research techniques, means and ways [1].

It is commonly known that everything produced by humans, including what they face in their everyday life, can be expressed as a combination of four elements: products, services, information and energy. Each of these elements can be fully described by three fundamental values:

- ***quantity,*** in conventional units of measure;
- ***cost*** of production, distribution and consumption–use-operation-application, per quantity unit;
- ***quality*** of quantity unit.

The first of these values, the *quantity*, has been the basis for applied science calculations for centuries. The second one, the *cost*, also has been studied and accounted for by economy science. As for the third value, the *quality*, it almost never has been taken into account neither in applied or economy science, nor in management.

But its numerical accounting today is very important.

First of all, any team leader or researcher in everyday activity needs to measure quality numerically to evaluate, for instance, results of work (*products and services); planning; production or social process; staff activity.*

Second, quality has to be measured in those rather frequent situations when one needs to decide on the best quality solution out of a number of options. For instance, one needs to select the best quality product sample, or an organization structure type, or a vacancy candidate; or a project solution; or an equipment set etc. Clearly, to accomplish these types of tasks an ability to evaluate quality numerically is necessary.

And, finally, measuring quality is required to solve such social and economic problems, where accounting for qualitative, not just quantitative, factors, like, social, ecological, ergonomic, aesthetic and other ones, improves the estimate accuracy.

The above considerations predetermined appearance of qualimetry – a science studying methodology and problems of all-inclusive quantitative assessment of the quality of any objects and their qualitative values presently not expressed in any measurement units [2].

Slightly rephrasing Winston Churchill's quote, qualimetry is the best way of giving inaccurate evaluations in a situation where any other means give even worse evaluations.

Given the limited scope of the publication, let us present just the very basic information on qualimetry.

As an illustration, let's consider a simplified quality model for an object like a conference talk. Suppose, we have to quantitatively measure the quality of the conference participants' talks using six agreed-on criteria (property tree in fig.1), and then to

award three highest quality talk authors: 10000 € to the winner, 5000 € to the second author and 1000 € to the third one.

This problem can be solved in different ways, but since the error price is high and can lead to the award organizer reputation failure and real losses it was decided to involve qualimetrologists (1) to develop methods of the talk quality evaluation; (2) to conduct estimates based on the developed methods; (3) to select tree talks jf the best quality.

We use this example to introduce the respectable participants of the conference to the science of qualimetry which has been in use in different countries for forty years. Dozens of papers on qualimetry have been published and are published yearly. Seminars and conferences are held. National and international quality awards in many counties are conducted using qualimetry techniques, although sometimes even the organizers don't know the name of the science providing theoretical basis for the competition and award methodology.

Let's start with the key terms used in qualimetry.

Object – is any object or process within the topic of this conference, and it may be:

- animate or inanimate;
- a product of labor or a product of nature;
- material or virtual;
- natural or artificial;
- a product or a service;
- an object or a process.

Comment on the term "***Object***" In our case the research and evaluation object is a result of the conference participant creative work (an software version of the talk), and the process of its communicating to the audience (the talk presentation: voicing, audio and video effects. For the purpose of simplicity let's evaluate five participants.

In this task the properties are defined from the problem setting. In general, definition of properties for an object quality evaluation is a separate complicated task. Let's present the object (conference talk) properties as a property tree:

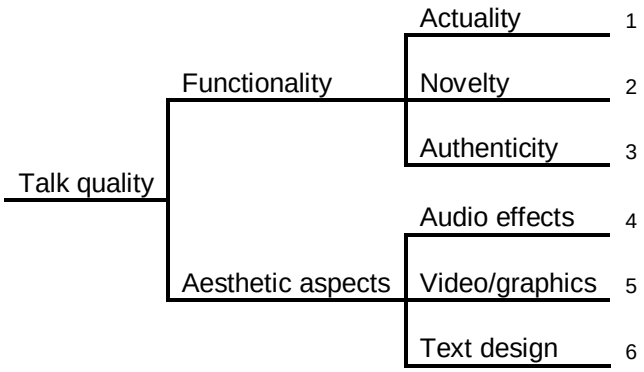

Fig. 1. A simplified model an object quality presented as a property tree

Property is a feature, characteristic or peculiarity of an object that shows itself in the course of consumption or operation, use or application, according to its purpose.

Comment on the term "***Property***" In our case there are six properties of a conference talk: actuality (1), novelty (2), talk content authenticity, (3), audio effects (4), visual and graphical effects (5), text design (6).

Quality – is a complex property combining such and only such properties that characterize results of object consumption, both desirable/positive and undesirable/negative, excluding the costs of its production and consumption.

Comment on the term "***Quality***"

In our example only six complex properties are used for the talk quality object. Although in practice significantly more qualities are used for real object quality model. For instance, in our case one can mention the means of material presentation; the talk correlation with the conference purpose, audience and topicality; type quality; references to information sources (other authors, examples etc.)

Cost efficiency is a combination of object properties that refer to its production and consumption costs.

Integral quality is an object property that combines its quality and cost efficiency.

Comment on the term "***Cost efficiency***" and "***Integral quality"***

In our example there is no task to determine integral quality of the conference talk, so we do not analyze its production and presentation costs. The latter may include, for instance, the costs of artist, copywriter, designer, translator/interpreter, stylist, image-maker work etc.

Property (quality, integral quality) measure is a numeric characteristic of a property (quality, integral quality).

Comment on the term "***Property measure***"

Let's assume that all talk properties are measured with analytical or expert techniques, and their values are put into the Table 1.

For every property a benchmark and a rejection values can be set using analytical and expert techniques. For simplicity let's assume that for all property values a percentage rate can be measured, so that their values are within the range from 0% to 100%.

Value of a property measure is a numeric value of a property measure.

Comment on the term "***Value of a property measure***"

For instance, for "Novelty" property the measured values are within the range from 20 to 70, according to Table 1.

Table 1. Values of property measures for the conference talks

Talk properties	Value of a property measure Q_i				
	Speaker 1	Speaker 2	Speaker 3	Speaker 4	Speaker 5
Actuality	10	40	30	80	20
Novelty	70	20	50	40	30
Authenticity	60	30	70	30	40
Audio effects	30	90	70	50	50
Video/graphics	80	20	60	10	50
Text design	50	30	90	20	70

In addition to an absolute property measure Q_i, every property is also characterized with a **relative measure K_i** , which shows the level of property measure with respect to some **benchmark Q^{ref}_i** and **rejection Q^{rej}_i** values of property measure:

$$K_i = \frac{Q_i - Q_i^{\text{rej}}}{Q_i^{ref} - Q_i^{\text{rej}}} \qquad (1)$$

Taking into account that benchmark and rejection values in our example are equal to $Q^{ref}_i = 100\%$ and $Q^{rej}_i = 0\%$ (for estimate simplicity), the relative measures calculated using Formula 1 are presented in Table 2.

Table 2. Relative measures of properties

Talk properties	Calculated value of a relative measure K_i				
	Speaker 1	Speaker 2	Speaker 3	Speaker 4	Speaker 5
Actuality	0,1	0,4	0,3	0,8	0,2
Novelty	0,7	0,2	0,5	0,4	0,3
Authenticity	0,6	0,3	0,7	0,3	0,4
Audio effects	0,3	0,9	0,7	0,5	0,5
Video/graphics	0,8	0,2	0,6	0,1	0,5
Text design	0,5	0,3	0,9	0,2	0,7

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Every object property can be quantitavely characterized with a property weight G_i. To determine the values of these weights two groups of techniques are applied: expert and analytical ones. In our case the property weights determined using expert techniques are presented in Table 3:

Table 3. Talk quality property weights

Talk properties	Property weight Gi
Actuality	0,235
Novelty	0,435
Authenticity	0,115
Audio effects	0,096
Video/graphics	0,032
Text design	0,087
Total	1,000

To express quality numerically let's define combined quality as a relative measure K_Q, expressed in our simplified example by the function $K_Q = f(K_i, G_i) = \Sigma K_i G_i$, $i = 1,...,n$, where n is the number of the object properties (in our case n=6). In general case, the function f can be arbitrary and can be expressed, for instance, with polynomials and various averages.

The estimate results, showing the numerical values of every talk combined quality, are presented in Table 4.

Using the results of the analysis, the best talks were selected, based on the highest three values of the quality. In our case, the top three speakers are: 3 (K_Q^3 = 0,53320), 1 (K_Q^1 = 0,49490) и 4 (K_Q^4 = 0,46510).

Conclusions:

- **Important**. Using qualimetric techniques, we made a justified selection of the three highest quality talks and honor the speakers with well-deserved awards;
- **Useful**. All measurements in qualimetry are made with respect to the world level, so its application is useful both in the process of verifying an innovation and in its selection (evaluation) procedures;
- **New**. In collaboration with Bolivian colleagues we presently plan to publish a qualimetry teaching aid (for education purposes) in ibero-american language.

References

1. Azgaldov, G.G. and Kostin, A.V. (2011) "Applied qualimetry: its origins, errors and misconceptions", Benchmarking: An International Journal, Vol. 18 Iss: 3, pp.428 – 444.

2. Azgaldov, G.G. (1981), "Development of the theoretical basis of qualimetry", doctoral dissertation, Kuibyshev Military Engineering Academy, Moscow (in Russian).

Table 4. Estiamte of the conference talk combined quality values and award assignment

Talk properties	Weights Gi	Speaker 1	Speaker 2	Speaker 3	Speaker 4	Speaker 5
Actuality	0,235	0,100	0,400	0,300	0,800	0,200
Novelty	0,435	0,700	0,200	0,500	0,400	0,300
Authenticity	0,115	0,600	0,300	0,700	0,300	0,400
Audio effects	0,096	0,300	0,900	0,700	0,500	0,500
Video/graphics	0,032	0,800	0,200	0,600	0,100	0,500
Text design	0,087	0,500	0,300	0,900	0,200	0,700
Combined quality value (K_Q^i) of a talk		0,49490	0,33440	0,53320	0,46510	0,34840
Rating		2	5	1	3	4
Award, €		5000		10000	1000	

Appendix

Table 5

Areas for possible use of quality assessment (qualimetry analysis) to make usable information more accurate

Quality assessment for accurate definition of usable information, which is:	Interim information on quality necessary to obtain more information (about products, services, energy, etc.)				While analyzing price
					While analyzing utility
	Final information on quality required in any case	Quality of objects	Resources	natural products: water, land, plants, animals, air, etc.	
				products of labor: construction, machinery, equipment, raw materials	
				human resources	
			Fnished commodity	Information for domestic market	for vendor (to determine sales opportunities)
					for consumer (choosing the best product option)
				Information for foreign market	for export (the definition of competitiveness)
					for import (choosing the best product option)
		Quality of processes or events	Quality of work	Individual expert (in science, medicine, manufacturing, etc.)	
				Team (crew, division, department, shop, etc.)	
				Field or branch of national economy	
			Quality of state or condition	Level of development of national economy branches and fields	
				Level and quality of life of population (including regional and social group aspects)	
				Ecological conditions (including regional aspects and features of national economy branch)	

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Table 6

Areas for possible use of quality assessment (qualimetry analysis) in the best option selection for the basic types of multi-criteria decision

<table>
<tr><td rowspan="8">Quality assessment (qualimetry analysis) in the best option selection for the basic types of multi-criteria decision</td><td rowspan="6">Conventional project planning and engineering solutions</td><td rowspan="5">Project planning</td><td rowspan="3">Objects</td><td>Construction projects</td></tr>
<tr><td>Architectural objects</td></tr>
<tr><td>Designer objects</td></tr>
<tr><td rowspan="3">Processes</td><td>Projects on construction and production work setup</td></tr>
<tr><td>Projects on technological process setup in industry</td></tr>
<tr><td>Projects on information flow setup</td></tr>
<tr><td colspan="3">Engineering: machinery, tools, equipment, etc.</td></tr>
<tr><td colspan="2" rowspan="2">Unconventional economic and socio-economic solutions</td><td colspan="3">Major economic solution projects (for example, country supply with home-produced grain</td></tr>
<tr><td colspan="3">Major social and economic solution projects (such as certification of scientific personnel (KPI choice, etc.)</td></tr>
<tr><td colspan="5">Contests, ratings, rankings</td></tr>
</table>

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