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Functionality and Aesthetics of Furniture - Numerical Expression of Subjective Value

Funkcionalnost i estetika namještaja – metode mjerenja subjektivnog doživljaja

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ABSTRACT • *In the recent years the habits of buying furniture have changed. The fabrication of individual pieces of furniture is increasingly coming to the forefront. A personal contact is being established between the customer and the furniture, which is a relationship of one (product) to one (customer). In order to satisfy the individual demands, higher quality as well as higher prices appeared as a necessity. The competition is beginning on the market, where emotion becomes a significant factor in decision-making process. Therefore, functionality and aesthetic functions, determinative forms and fashionable style play a very important role in furniture design and production. The objective of the paper is to report research results on how functionality and aesthetics of different styles of furniture could be determinated, measured and how they influence customer requirements and demands. To establish the proportion of functionality and aesthetic features, a numerical expression of the functions was defined by using various designers' methods such as Ranking Method Quality Development (RMQD) and Failure Mode and Effects Analysis (FMEA). It is shown that both methods could be used very effectively for designed and marketing oriented furniture, for modelling customer satisfaction as well as in connection with aesthetic functions, assuring the quality of the product in the planning stage.*

Key words: *functionality, aesthetic functions, furniture, designers' methods, customer demands, proportion*

SAŽETAK • *U posljednjih nekoliko godina promijenile su se navike kupovanja namještaja. Naime, u praksi je sve češća izrada pojedinačnih komada namještaja . Uspostavlja se osobni kontakt između kupca i namještaja, što podrazumijeva odnos jedan (proizvod) na jedan (kupac). Kako bi se zadovoljili pojedinačni zahtjevi, kao nužnost se nameće veća kvaliteta, a taj zahtjev prate i više cijene. Konkurentnost na tržištu počinje u trenutku kad emocije postanu važan čimbenik u procesu odlučivanja. Stoga funkcionalnost i estetske funkcije namještaja, kao i određeni oblici odnosno trendovski stil dobivaju vrlo važnu ulogu u dizajniranju i proizvodnji namještaja. Cilj rada bio je prikazati rezultate istraživanja mogućnosti određivanja i mjerenja funkcionalnosti i estetike u različitim stilovima namještaja te o njihovu utjecaju na potražnju i zahtjeve kupaca. Da bi se uspostavio omjer funkcionalnosti i estetskih obilježja namještaja, numerički iskaz funkcije definiran je primjenom različitih dizajnerskih metoda poput Ranking Method Quality Development (RMQD) i Failure Mode and Effects Analysis (FMEA). Utvrđeno je da se*

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obje metode vrlo učinkovito mogu primijeniti za dizajnirani i marketinški orijentiran namještaj, za oblikovanje zadovoljstva kupaca, kao i za povezivanje s estetskim funkcijama i osiguravanje kvalitete proizvoda u fazi planiranja proizvoda.

Ključne riječi: *funkcionalnost, estetska funkcija, namještaj, dizajnerske metode, zahtjevi kupaca, proporcije*

1. INTRODUCTION
1. UVOD

The world of furniture market is getting more complex than it was before. In order to measure consumers needs, preferences and habits, it is important to improve contemporary values of furniture. In recent years, it is evident that the habits of bying and using furniture have been changed (Domljan *et al.*, 2006; Horvat *et al.*, 2008). The fabrication of individual pieces of furniture is increasingly coming to the forefront. A personal contact is being established between the customer and the furniture, which is a relationship of one (product) to one (customer). In order to satisfy the individual demands, higher quality as well as higher prices appeared as a necessity. In the competition that occurs on the market, when choosing furniture, preference is given to individuality and emotions (Domljan and Grbac, 2014). Of course, there are various factors that also influence customer decisions when buying furniture: price, quality, reliability, etc. (Raport DTI, 2005). Therefore, functionality and aesthetic functions, determinative forms and fashionable style play a very important role in furniture design and production. Those parameters, usually connected with visual parameters of the design, are measureable, as well as other designers parameters appearing in the product, by using special designers methods such as Function analysis, Questionnaire research, Ranking Method Quality Development (RMQD) and Failure Mode and Effects Analysis (FMEA) (Antal, 2007; Laurel, 2003).

The objective of this paper is to report research results on how function and aesthetics of different styles of furniture could be determinated, measured and how could they influence the customer requirements and demands by using RMQD and FMEA methods.

1.1. Definition of functionality and aesthetic functions
1.1. Definicija funkcionalnosti i estetskih funkcija

Function can be expressed as the properties related to the use of a product. These properties include the relation between a product and a consumer (Antal, 2007).

On the basis of purchasing motivation, the system of functions can be divided into:
- functionality (e.g. utility and practical function) and
- aesthetic functions (e.g. visual sensation, emotions).

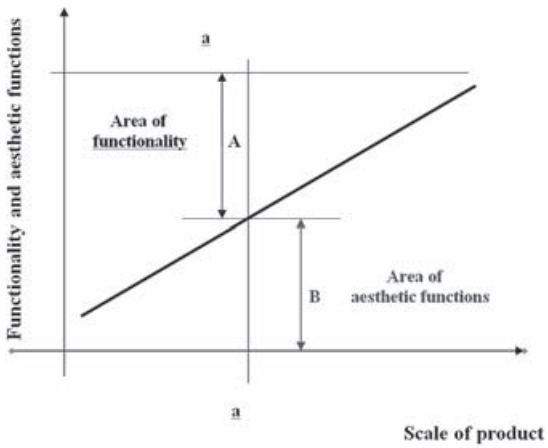
Aesthetic value is considered to be the effect (or style) of objects as to what degree they can teach us to perceive or understand the appeal of beauty (Eco, 2004). Nevertheless a designed object, such as a piece of furniture, can be evaluated regarding whether beauty is involved in it, or not.

Aesthetic value means the complexity of the properties of objects, devices or equipment, which provide appeal, pleasure and good experience when it comes to sensation, action or indirectly, to the general human state of health related to a given object (Antal, 2007).

In industrial design, objects are created with the intention to satisfy not only aesthetic criteria but also criteria of utility and practical function (Papanek, 2005). These features are inseparable. In the products such as furniture they can only appear jointly. "Being useful also means being beautiful. (...) There is no separate usefulness and beauty, but what is useful is considered beautiful as well" (Lissák, 1997). There has to be a suitable combination of usefulness and beauty. In contemporary world, people generally buy furniture in order to use it as well as to take pleasure in it. It is essential, however, to determine the proportion of functionality and aesthetic functions in case of furniture? This proportion has to be determined to satisfy consumer demands. To establish this proportion, both functionality and aesthetic functions have to be measured. It is important to notice that there is still no exact method that could determine precisely the proportion of these functions. A number of experiments have been carried out, but the exact definition of aesthetic functions has been based on modelling consumers' value judgements (Antal, 2007). The quality of two similar products can be measured on the level of function satisfaction. The satisfaction measure determines which product is better, more beautiful and more attractive (Lissák, 1997).

Optimal aesthetic quality of a product depends on the proportion of *A/B*, represented in the section *a-a*. This proportion is to be designed according to customer demand, i.e. in an optimal way.

Figure 1 presents the essence of the success of a product. This idea is being emphasised, regarding all



a-a: position of furniture on the scale
A/B: proportion of functionality and aesthetic value

Figure 1 Representation of proportion of functionality and aesthetic functions (Hegedűs, 1983)
Slika 1. Prikaz udjela funkcionalnosti i estetskih funkcija (Hegedűs, 1983.)

kinds of products, particularly in the current interpretation of a product's value attributed by the customer. It means that the value (V) is the ratio of the function (F) and charge of function (CF);

V (Value) =F/CF (function/charge of function).

If value concerns to the whole product, all functions of the product have to be taken into consideration. If it affected only one or two functions or group of functions, F and CF would have to be determined according to the examined functions.

1.2 Optimization of proportion of functionality and aesthetic functions
1.2. Optimizacija udjela funkcionalnosti i estetskih funkcija

A product consists of subsets of functionality and aesthetic functions, which mostly means the aesthetic quality of the product. The proportion of functionality and aesthetic functions is optimal if it meets the demands of consumers (Antal, 2007).

According to Hegedűs (1994), aesthetic functions are analysed separately from functionality. Both functionality and aesthetic functions have their own values.

As an example, if functionality of a product is taken as:

$H_1, H_2, ...H_i...H_n$;

and the aesthetic functions of a product are:

$E_1, E_2, ...E_j...E_m$;

it follows that:

h_i is the value of H_i; and e_j is the value of E_j

If these functions are linked to the product, which is supposed to satisfy the customers' needs, it can be expressed as follows:

$$\varepsilon_j = \begin{cases} 1, \text{ if } E_j \text{ is carried by the product} \\ 0, \text{ if } E_j \text{ is not carried by the product} \end{cases}$$

$$\delta_i = \begin{cases} 1, \text{ ha } H_i \text{ is carried by the product} \\ 0, \text{ ha } H_i \text{ is not carried by the product} \end{cases}$$

Using these values, the proportion of functionality and aesthetic functions can be expressed by the formula:

$$\frac{\sum_{i=1}^{n} \delta_i h_i}{\sum_{j=1}^{m} \varepsilon_j e_j} = opt. \qquad (1)$$

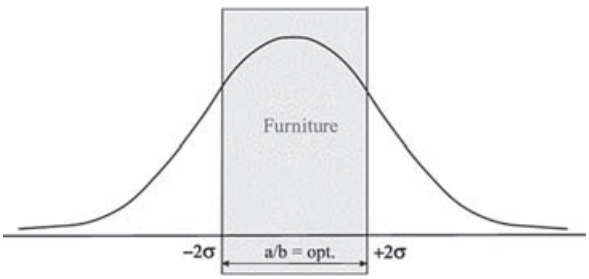


Figure 2 Optimization of criteria in furniture (Antal, 2007)
Slika 2. Optimizacija kriterija vezanih za namještaj (Antal, 2007.)

As an example, Table 1 shows the selected functions of a product that could be observed and analysed.

Using the formula (1) and data presented in Table 1, it can be written as follow:

$$\frac{\delta_2 h_2 + \delta_4 h_4 + \delta_5 h_5 + \delta_6 h_6 + \delta_8 h_8}{\varepsilon_1 e_1 + \varepsilon_2 e_2 + \varepsilon_3 e_3 + \varepsilon_6 e_6 + \varepsilon_7 e_7 + \varepsilon_8 e_8} = \frac{a}{b} = opt. \qquad (2)$$

The optimization means a constriction within an interval on the basis of a criterion. With numerous sampling, a/b rates can be defined and evaluated, as well as the customer satisfaction (rate of satisfaction). The probability value of weighted rate shows the optimum scale (proportion).The type and specifics of distribution can be determined and by means of the bottom and upper limits of confidence intervals of e.g. 95 % (Figure 2).

For example, if the value is: $-2\sigma<a/b<+2\sigma$, it can be declared that

a) furniture is aesthetically acceptable or

b) furniture is exclusive.

Aesthetic numbers for the practical expression of the relation can be suggested and the applicability of the theoretical relation for furniture can be reviewed.

1.3 Designers' methods applied to measure requirements and optimal proportion of the product
1.3. Dizajnerske metode primjenjive za mjerenje zahtjeva i optimalan omjer proizvoda

Customers needs are the first step in defining a number of requirements of the product. It means that it is necessary to establish designers' factors such as functionality, aesthetics, ergonomy, economy, technology and many others for the development of a product (Domljan *et al.,* 2006). Identifying customer needs means creating a high-quality information channel

Table 1 Selected functions of a product that could be analysed
Tablica 1. Odabrane funkcije proizvoda koje se mogu analizirati

Functionality / *Funkcionalnost*	**Aesthetic functions** / *Estetska funkcija*
$H_1 = F_2$ Satisfy of ergonomics needs *zadovoljenje ergonomskih potreba*	$E_1 = F_2$ Satisfy of ergonomics needs / *zadovoljenje ergonomskih potreba*
$H_2 = F_4$ Help for work / *pomoć pri radu*	$E_2 = F_1$ Accommodate to the house / *prikladnost smještanja u kući*
$H_3 = F_5$ Measure up to the medical regulations *udovoljavanje medicinskim propisima*	$E_3 = F_3$ Satisfy aesthetic needs / *zadovoljenje estestkih potreba*
$H_4 = F_6$ Orientate to the ambience / *orijentacija na prostor*	$E_4 = F_6$ Orientate to the ambience / *orijentacija na prostor*
$H_5 = F_8$ Corporate identity / *identitet tvrtke*	$E_5 = F_8$ Corporate identity / *identitet tvrtke*
	$E_6 = F_7$ Carry style / *osnovni stil*

from the customers to the product developers. It will ensure that those who directly control the details of the product, including product designers, understand the needs of a customer. These needs have to be organised into a hierarchical list in order to be more understandable. The methods (for example designer's or manager's methods) that can be used for identifying customer needs are interviews, focus groups, observing the product in use or simmilar.

The customer needs are helpful to define the functions of a product. To achieve it, the needs have to be transformed into functions. Functions are abstractions of what a product should "do". A limited number of elementary or general functions on a high level of abstraction create a function structure. The functions are organised into a hierarchical order, in a so called "tree structure" (Antal, 2007).

From designers' point of view, it is very important to know what kind of methods are used to determine an optimal proportion of the product requirements and for what purposes the proportion could be used. Some of designers' methods are presented below.

1.3.1 Function Analysis
1.3.1. Analiza funkcija

Function analysis is a method for analysing and developing a function structure. A function structure is an abstract model of the new product, without material features such as shape, dimensions and materials used. It describes the functions of the product and its parts and indicates the mutual relations. In function analysis, the product is considered as a technical-physical system. The product functions consist of a number of parts and components, which fulfil sub-functions and the overall function. By choosing the appropriate form and materials, a designer can influence the sub-functions and the overall function. The principle of function analysis is to specify what the product should do and then to infer what the parts - which are yet to be developed - should do as well (Boeijen *et al.,* 2013).

By selecting aesthetic functions from the tree structure and by using them in Failure Mode and Effects Analysis (FMEA), the aesthetic quality of the product in the planning stage can be assured. The measure of the aesthetic functions has become possible by functions value and the weight numbers of determinative style.

1.3.2 Failure Mode and Effects Analysis (FMEA)
1.3.2. Metoda pogrešaka i analiza učinka (FMEA)

Failure Mode and Effects Analysis (FMEA) is a model used to take priority potential defects based on their severity, expected frequency, and likelihood of detection. The FMEA can be integrated into product development or product manufacturing process and used to improve the design or process robustness. The FMEA highlights weaknesses in the current design or process in terms of the customer needs and is an excellent tool to take priority and organise continuous improvement efforts in areas that offer the greatest return. The process is very straightforward and begins by identifying all of the probable failure modes. The analysis is based on experience, review and brainstorming and should use actual data, if possible (MoreSteam, 2014).

The Failure Mode and Effects Analysis model can help teams decrease project scope and complexity by focusing on the primary failure modes of a process. The FMEA can be best created by coordinating a cross-functional team and using objective and subjective knowledge to identify accurate properties about the identified failure modes.

This method can be used by taking into consideration only aesthetic functions combined with function analysis. It means that both the aesthetic functions of furniture could be determined and the aesthetic characteristics and forms of furniture could be analysed. A

Table 2 Severity (Importance of failure)
Tablica 2. Jačina (značenje) neuspjeha

Detection of the value of aesthetic function, % *Otkrivanje vrijednosti estetske funkcije, %*	**Degree of failure's effect** *Stupanj učinka neuspjeha*	**Weight number** *Broj jačine (značenja)*
(The customer completely perceives the value of aesthetic function) / (*Kupac u potpunosti opaža vrijednost estetske funkcije)* 90-100	Very high / *vrlo visok*	10
80-90	Very high / *vrlo visok*	9
70-80	High / *visok*	8
60-70	High / *visok*	7
50-60	Medium / *srednji*	6
40-50	Medium / *srednji*	5
30-40	Medium / *srednji*	4
20-30	Low / *nizak*	3
10-20	Low / *nizak*	2
0-10 (The customer hardly perceives the function value) *(kupac jedva opaža vrijednost funkcije)*	Very low / *vrlo nizak*	1

function structure of the furniture can be created in the FMEA process in order to select the aesthetic functions and to locate the critical characteristics. The functions with failed result are assigned by the elements of the furniture. For these functions the potential failures are identified as well as the effects and reasons of failures. The control is established for preventing all potential failures. The effect and the level of satisfaction of the customer is analysed by the experts team if one of the aesthetic function is not satisfied. In this occasion, the disappointment of the customer is measured. For the aesthetic functions, the measurer relevance numbers are determined. The severity of the failure with these numbers is preferred. Example: if an aesthetic function is not satisfied, this is marked as a failure. The importance of the failure's effect (severity) can be expressed by a weight number. Scoring is made from the customer's perspective, on a scale from 1 to 10 (10 if the customer perceives the aesthetic value 100 %, 1 if the customer hardly perceives the value) (Table 2).

The next step is to assign a value on a 1-10 scale for the probability of occurrence, as well as for the probability of detection for each of the potential failure modes. After assigning a value, the three numbers for each failure mode are multiplied together to yield a Risk Priority Number (RPN). The RPN becomes a priority value to rank the failure modes, with the highest number demanding the most urgent improvement activity.

During the analysis determining the aesthetic functions of furniture and taking into consideration their realization rate, possibility will open to measure aesthetic functions and to improve the aesthetic quality of the furniture. The quality is optimized by eliminating all possible failures, locating their impacts and reasons before getting to the customers.

1.3.3 Ranking Method Quality Development (RMQD)
1.3.3. Metoda rangiranja razvoja kvalitete (RMQD)

The *Ranking Method Quality Development* (RMQD) is a method used for matching and comparison of furniture and concurrency analysis. The realisation of the functions of the determinative forms is defined by this method and ranked by the correspondence percent.

A threshold value can be defined as:

- The pieces of furniture that are situated above this threshold value meet the requirements (e.g. they are exclusive).
- The pieces of furniture that are situated below this threshold value do not meet the requirements (e.g. they are not exclusive).

Through the determining forms, the aim is to detect the proportion of aesthetic and functional properties by certain properties. The *assessment factors* can be measured by using some properties which are not of equal weight, but are ranked by the RMQD. This can help to create a basis for comparison, based on which it can be established whether these properties are included in the furniture and to what degree they are present.

An *assessment method* based on the overall emotions can be created. The method is aimed at determining the range of style properties for a given furniture collection. The algorithm presented below is suitable for applying this assessment method (*Figure 3*).

1.3.4 Questionnaire Research
1.3.4. Istraživanje anketnim upitnikom

The answer to the question: "What kind of furniture properties allow determining the style of a group of furniture" could be obtained with a questionnaire. On the basis of the answers, an order of rank may be formed and

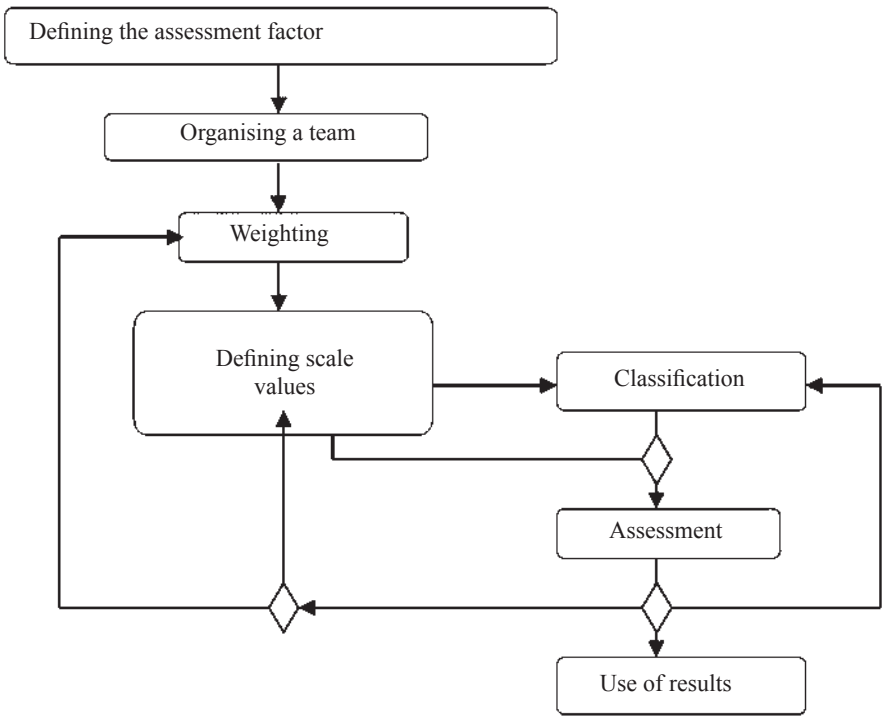


Figure 3 The algorithm for applying the assessment method (Antal, 2007)
Slika 3. Algoritam za primjenu metode procjene (Antal, 2007.)

the first ten properties could be considered. The answers should provide some information on the fact to what degree (what percentage) the given pieces of furniture meet the criteria of a given style and what kind of weighted order should be arranged. The RMQD surveying system is also suitable for this kind of complex measurement.

2 MATERIALS AND METHODS
2. MATERIJALI I METODE

2.1 Samples and team members
2.1. Uzorci i članovi tima

For this research, five groups of furniture were selected as the samples from different points of view. (style, price, materials). The rank of selection was high quality furniture made from solid wood. Quality in this occasion means high aesthetic, construction, technology and economics level of requirements. Groups of furniture samples used for the RMQD analysis were ranked from A to E (Figure 4 – 8).

During the research, a team of five experts (two designers, one wood engineer, one ergonomists and one design manager) from Hungary and Croatia was established with members from 34 to 50 years old.

2.2 Research phase
2.2. Faza istraživanja

The first phase (preparation phase) in the research was to organise a team and determine the parameters.

The agreement coefficient of the team was over 90 %. The distribution of the team members' evaluation was ± 10 %.

The process of the research was determined by the steps as follows:

– determine the task, meeting of team members,
– study the collected documentation of the selected furniture,
– study and accept previous steps of research as input results; e.g. 7 items out of 10 style properties were considered as characteristic of the style,
– classify and weigh - compare properties and requirements,
– select, analyse and compose 5 groups of furniture and rank their value on a 5-1 scale (5 equals the assessment factor of the furniture that complies best with the requirements),
– evaluate the assessment factors individually (each member of the team), by means of the/an assessment list (Table 4)

Figure 4 Seltzfurniture (A). Source: http://www.meubles-seltz.fr
Slika 4. Seltzfurniture (A); izvor: http://www.meubles-seltz.fr

Figure 5 Porada furniture (B). Source: www.porada.it
Slika 5. Namještaj Porada (B); izvor: www.porada.it

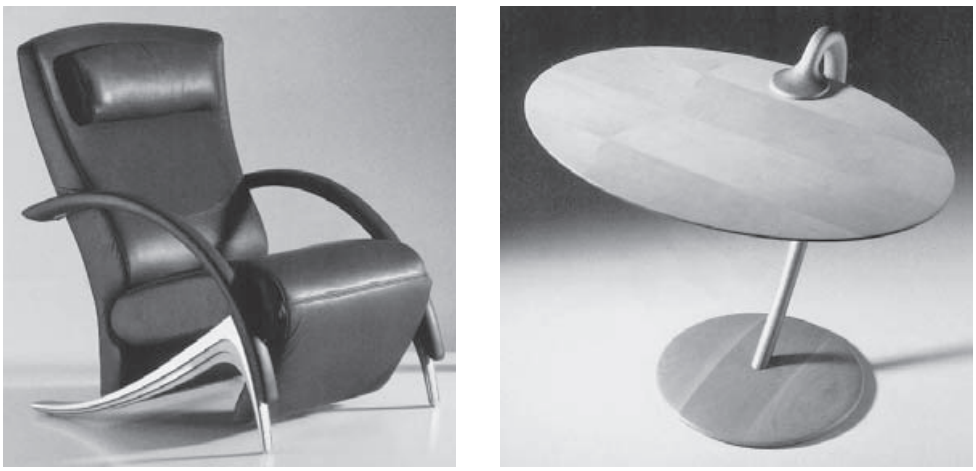


Figure 6 Rolf Benz furniture (C). Source: www.rolf-benz.com
Slika 6. Namještaj Rolf Benz (C); Izvor: www.rolf-benz.com

Figure 7 Ceccotti furniture (D). Source: http://www.ceccotticollezioni.it
Slika 7. Namještaj Ceccotti (D); izvor: http://www.ceccotticollezioni.it

Figure 8 Sixay furniture (E). Source: http://www.sixay.com
Slika 8. Namještaj Sixay (E); izvor: http://www.sixay.com

– analyse all the data by special computer programm of RMQD using CAT (Computer Aided Teamwork), PATTERN (Plaining Assistance Trough Evaluation of Relevance Numbers), COMBINEX (Ranking Method), QPA (Quality Price Analysis), KIPA (Complex Matching Method), presented in tables and diagrams
– analyse partial results and performe common assessment as required.

3 RESULTS AND DISCUSSION
3. REZULTATI I DISKUSIJA

After analytical data processing, the research results appear as follows:

The agreement coefficient is over the required 90 %. The team member whose assessment range was over the standard threshold value was excluded by the computer when arranging the results.

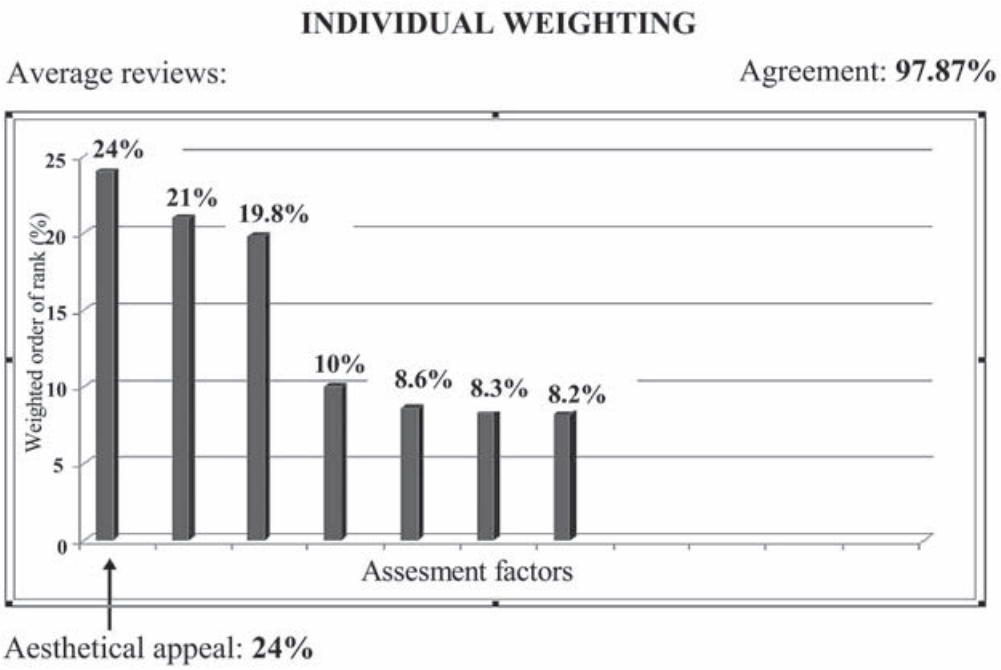


Figure 9 Weighted order of assessment factors
Slika 9. Ponderirani redoslijed faktora procjene

Table 3 Weighted order of assessment factors
Tablica 3. Ponderirani redoslijed faktora procjene

Assessment factors *Faktori procjene*	**Weighted order of rank** *Ponderirani redoslijed ranga*
aesthetic appeal *estetska dopadljivost*	24.00
material-colour harmony *harmoničnost materijala i boja*	21.05
visible style properties *vidljiva obilježja stila*	19.84
harmonious appearance *skladnost izgleda*	9.97
typical rate of proportions *tipična mjera proporcija*	8.65
smartness / *dotjeranost*	8.33
pureness of style / *čistoća stila*	8.16

The weighted order of the assessment factors are presented in Table 3 and Figure 9.

The list of one of the assessing team members is shown as an example in Table 4.

The comparison of alternatives (two groups of furniture) is presented in Figure 10 and 11, taking into consideration the assessment factors.

Table 5 Order of samples from the most exclusive to the least exclusive furniture according to results
Tablica 5. Poredak uzoraka prema rezultatima (od najekskluzivnijih prema manje ekskluzivnima)

Score/number *Rezultat/broj*	**Sample/product** *Uzorak/proizvod*	**Result/percents** *Rezultat/postotak*
1	D (Ceccotti)	94.3 %
2	C (Rolf Benz)	90.6 %
3	E (Sixay)	89 %
4	B (Porada)	82.5 %
5	A (Seltz)	72.7 %

The final results of the survey are shown in Table 5. The five groups of furniture are in compliance with the former established criteria and assesments (Table 4).

Based on the results, a threshold value, e.g. 70 %, was determined. Over this value, the furniture may be considered as exclusive.

6 CONCLUSION
6. ZAKLJUČAK

The demands of costumers are maximally satisfied when the proportion of functionality and aesthetic

Table 4 Assessment list
Tablica 4. Lista procjene

Assessment factors / *Lista procjene*	**Furniture** / *Namještaj*				
	A	B	C	D	E
aesthetic appeal / *estetska dopadljivost*	4	4	4	5	4
material-colour harmony / *harmoničnost materijala i boja*	3	4	4	5	4
visible style properties / *vidljiva obilježja stila*	2	4	3	4	4
harmonious appearance / *skladnost izgleda*	4	4	4	5	4
typical rates of proportions / *tipična mjera proporcija*	3	4	4	4	4
smartness / *dotjeranost*	3	4	3	4	4
pureness of style / čistoća stila	3	5	4	5	4

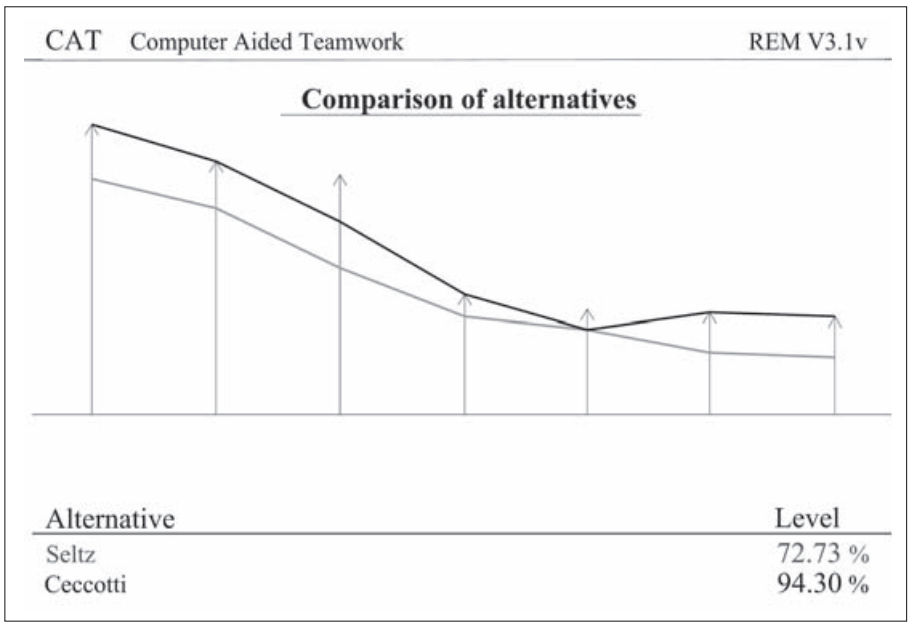


Figure 10 Comparison of groups of furniture; Seltz (A) v.s. Ceccotti (D)
Slika 10. Usporedba grupe namještaja: Seltz (A) prema Ceccotti (D)

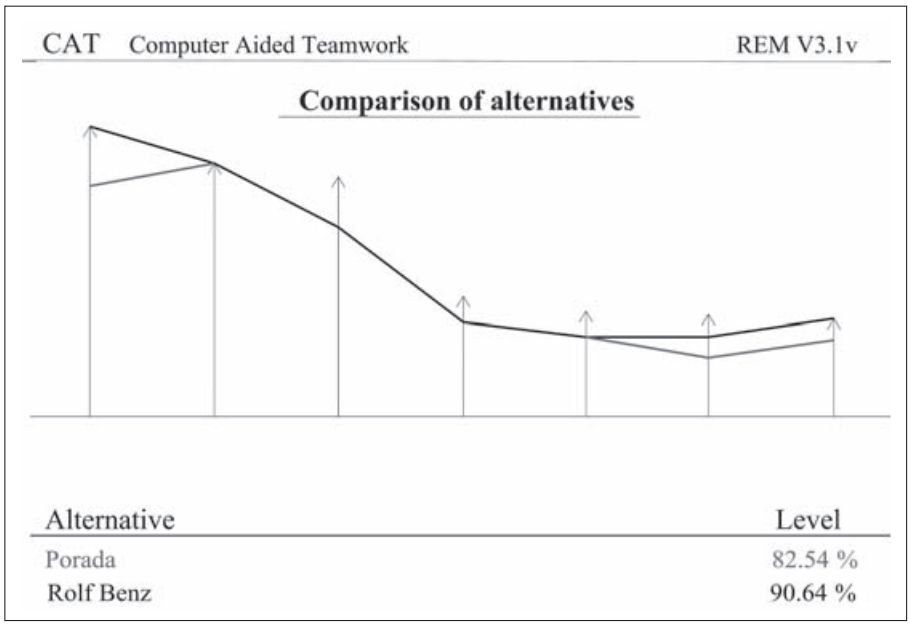


Figure 11 Comparison of groups of furniture; Porada (B) v.s. Rolf Benz (C)
Slika 11. Usporedba grupe namještaja: Porada (B) prema Rolf Benz (C)

functions converge to the expectations of customers. The numerical expression of the subjective value judgment by designing furniture can be used for concurrency analysis and for quality examinations.

An evaluating algorithm can be developed by using the RMQD. This method can be used very effectively for designed and marketing oriented furniture as well as for modelling customer satisfaction. FMEA could also be used in connection with aesthetic functions, assuring the quality of the product in the planning stage.

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