

# Anthropometry and the Comparison of Garment Size Systems in Some European Countries

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## ABSTRACT

*This work points to the relevance of regional and state systems of garment sizes. High quality, garment size systems, garment design and economy are currently the focal points, which belie the outdated strategy of competitiveness based on product cost. The average body dimensions have considerably changed in the last decades. We have investigated these differences in a number of European countries and compared the garment size systems. A concrete example is provided by the hind part of women's trousers and comparisons have been made. The conclusion is that most countries still possess their own official garment size systems, which differ in many aspects from the others. In addition, larger firms in some countries use their internal standards, which vary to some extent. The conclusion based on research is that they depend on the function and purpose of the garment, on trends in fashion, on the design and on the economy of production.*

**Key words:** anthropometry, body sizes, garments, garment size systems, quality, European countries

## Introduction

In the current moment, which is marked by increasing internationalization and globalization of selling power with new markets for selling clothes expanding over the Balkans, the East-European and Asian countries, it is seminal for this branch of industry not only to know the selling markets, the specific features of different religions, cultures, mentalities and the purchasing power of the population but also to be acquainted with the quality standards and the body sizes of the prospective buyers. That is why it seems interesting not only to investigate the existing systems of garment sizes e.g. in Germany, Italy, England regarding their influence and transferability to other population groups but also to reveal them and apply the results in a resourceful way to the performance and comparison of different garment parts. In this manner it will be possible to meet the ever-increasing requirements for an optimal size. The same requirements are also maintained in the trend of cutting to measure, which can obviously be carried out only in specific sectors. Cutting and sewing clothes to measure is a rather demanding job in spite of the existence of different electronic aids for taking body measures and for transforming the obtained data into garment parts of

required dimensions and sizes. This problem will be treated more in detail later on in the text<sup>1-5</sup>.

Since there is a requirement to supply the new markets with top-quality products, the conditions expected on these markets ought to be thoroughly investigated<sup>1,2</sup>. It has been proven that quality represents a crucial factor of successful production and running a business. This has been confirmed by numerous exact analyses of successful ways of conducting business in many firms, more particularly those whose products have become world-known and appreciated for their quality. Only the clothing item, in which an optimal relationship between quality, good fit, design, kind and volume of offer and price has been reached, can be considered successful; and successful products are the chief guarantee for a successful business firm. In order to make the clothes production economical one ought to primarily consider the wishes and needs of the consumer i.e. the user and try to find a way of meeting his expectations as promptly and successfully as possible. Therefore, controlling the quality has both a strategic and an operational level, and setting norms and standards has proven indispens-

able for their application in firms. High quality, anthropometry and anthropological measurements, systems of garment sizes and the design of clothing are currently the focal points belying the outdated strategy of competitiveness based on the cost of the product. They rank among the most relevant conditions for joining the forthcoming international labor division and, in the long run, the only possible manner of establishing a closer economic link between the clothing industry of developing countries and the European market. If the new markets are to be supplied with top-quality clothing products, the conditions expected on these markets have to be thoroughly investigated<sup>4,6-8</sup>.

### Theory

The investigating endeavor regarding the establishment of volumetric shapes of the human body is carried on in several directions. Both men and women are increasingly interested in well-fitting and comfortable clothes. The average body dimensions have considerably changed in the last decades, primarily owing to higher quality diet and better nutritional norms<sup>3</sup>. Besides, the older population groups, especially in highly developed countries, which are also the most important clothes consumers, are staying increasingly active in spite of old age and bodily deformities. That part of the population is becoming increasingly relevant and since it also represents an important market segment, it justifiably poses demands for convenient, well-fitting and functional clothes. That is the reason why the interest in taking individual body measurements at garment selling points and in the industrial production of clothes as unique items has been enhanced. Developmental investigations are particularly in full swing in Japan, America, England and Germany: their main object is to – by taking measurements – facilitate and ensure, via computer network, a complete transfer to garment factories where the adaptation of standard patterns, the production of the garment and the delivery to the purchaser is to be carried out within 24 hours. For that purpose there are convenient laser techniques and analyses of video films as well as computer graphically processed data connecting three-dimensional volumetric body data with two-dimensional patterns of garment cuts<sup>4,9-11</sup>. Figure 1 illustrates the principle of taking body measurements without contact, the transfer of those data and the computer design of the human body according to the filmed measurement data as well as the execution of the cut pattern for an original garment as a unique item.

The development has so far taken two directions: computer design of the human body in motion (Synthetic Humans), and taking no-contact measurements of the garment purchaser, adaptation of the measures to the design of the human body and finally the execution of cut patterns for garments as unique items.

The two-dimensional system for taking no-contact body measurements is based on taking two-dimensional frontal and lateral shots of the measured person's sha-

dow, a procedure, which is performed by means of conventional black-and-white cameras against a well-lit background. The picture-taking is based on photogram-

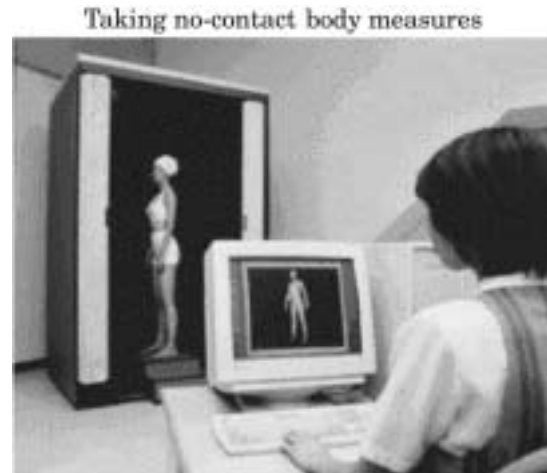


Fig. 1. Principles of taking body measurements without contact for the purpose of sewing a lady's costume as a unique item.

metric cognitions and measuring by separating the body outline and subsequently its three-dimensional anthropometric adaptation to the human body. This system makes possible the taking of body measurements of 100% of the population, from children to old people. The measurements are taken in very short intervals so that errors due to the movements of the body are excluded. The application of the binary system rules out the possibility of errors due to uneven lighting. From the outlines obtained by application of the binary system it is possible to derive and work out the basic body measures. Along with these it is also possible to establish the stature of the person, his/her body rise and carriage. Based on these data it is possible to work out a computer representation of the human body and then the so-called »wire« model of the body. Thus even rather modest measuring equipment enables us to establish the body measurements indispensable for executing a garment while a more complex computer technique can provide a picture of the human body and its »wire« model<sup>4–11</sup>. Three-dimensional no-contact measurements are based on the method of active optical triangulation using four miniature lasers (power 10mW) and diffraction linear optics. Two special cameras with an integrated system for processing the picture on a CCD chip are used for taking pictures. The precision of the system is between 1 and 4 mm and the time needed for taking pictures is 1.2 sec. Within this time 10.000 measuring points become available. For a three-dimensional representation of the human body it is necessary to have 80.000 to 90.000 3D measurement points. By using a 3D representation it is also possible to obtain a »wire« model of a male or female body. The basic obstacle not to be underrated is the fact that many countries do not undertake their own anthropological measuring, so they do not possess their own national standards and have no established tables of body sizes for men's, women's or children's clothes. On the other hand, some countries use old standards e.g. the JUS standard from former Yugoslavia the anthropological measurements for which were carried out in Vojvodina in the early sixties and are still applied in present-day Croatia, Slovenia, Bosnia and Herzegovina, Macedonia and Serbia. Further examples are found in Turkey, which uses foreign (German, Italian) tables of garment sizes, and Malaysia and Sri Lanka, which use the English tables. Kuwait uses the English, German, Italian and French tables of garment sizes and Egypt the tables of USA garment sizes, whereas Croatia employs German, Italian and English tables. The use of tables belonging to neighboring or even distant countries (sometimes situated on the opposite side of the globe) is based, on the one hand, on economic and political connections or business relationships between the garment industries of those countries and their most important clients (Turkey, Kuwait, Egypt, Romania, Bulgaria) and, on the other hand, on traditionally good relations between e.g. Great Britain and a number of European, African and Asian countries.

In order to determine the optimal national garment size systems it is necessary to take into consideration

both the proportions of the human body and its anthropometric measures as well as the international garment size systems and the systems of designating those sizes.

In this paper an investigation of garment size systems has been carried out and certain differences between the systems and the proportional measures in different countries have been found. The determination of the proportions of the human body is based on anatomy, which also studies the scheme of the human body and its proportions. Anthropometry is an anthropological method dealing with measuring and investigating the human body and the relationship between the dimensions of its parts. In clothing engineering the anthropometric measures are applied in the domain of garment construction. The execution of clothing requires typical body measures as well as their mutual proportions. The results of anthropometric measurements of a sufficiently vast population can be used for determining the national garment size systems. The international organization for setting norms ISO passed in 1989 the norm ISO 8559 for anthropometric examinations provided with a list and description of body measures in view of constructing garments<sup>1,4,12–15</sup>.

## Experiment

In order to be able to carry out a quality investigation of different garment size systems and compare them, it was first necessary to define the corresponding CONTROL points. The designation of sizes according to ISO systems, i.e. Mondoform system, encompasses 1 to 3 designated body measures which can be found in the pictogram or represented by the numerical value of designated body measures along with the description e.g.: chest girth 96, body rise 176, waist girth 82 etc. The pictogram is a symbolic representation of the silhouette of the human body on which positions and designated body measures can be shown<sup>13</sup>. For representing these measures a standard pictogram is used, whereas for some other body measures a modified pictogram is applied e.g. for the lower breast girth in women. Designations according to ISO systems are shown on pictograms in Figures 2 and 3, in which the measures are expressed in centimeters<sup>14,15</sup>.

This investigation has shown that many countries still use their own systems. Thus in former Yugoslavia a JUS standard was passed for these systems which are still applied in Croatia (HRN) and, with slight alterations, in other successors of the former state, like Slovenia, Bosnia and Herzegovina, Serbia and Macedonia<sup>15</sup>. All garment size systems are based on body rise and the types of human body established by means of anthropometric measures adapted to the established systems of those sizes. The aim of the system of garment size designation is to provide the necessary information concerning e.g. body rise, chest girth, type of body or some other measure depending on the kind of garment. The garment size designation system (according to HRN)

for men’s upper clothing has been established in terms of body height, chest girth and the whole stature. The basic designation of garment size is based on chest girth and its multiples. For women’s upper clothing the size

designation has been established according to the same principle, while the basic garment size designation is represented by the so-called conventional number and its multiples<sup>16–19</sup>. Furthermore, the specific sizes of body

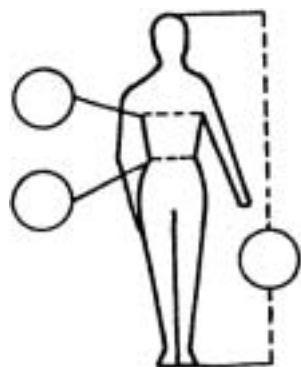


Fig. 2. Garment size designation for a man’s jacket (ISO 3636).

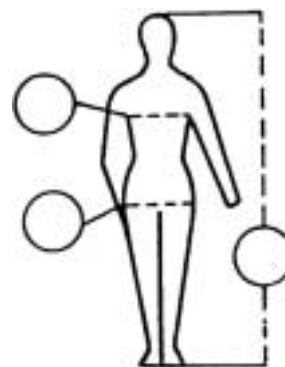


Fig. 3. Garment size designation for a woman’s dress (ISO 3637).

TABLE 1  
GARMENT SIZE SYSTEMS IN SOME EUROPEAN COUNTRIES

Germany	34	36	38	40	42	44	46	48	50
Chest girth	80	84	88	92	96	100	104	110	116
Hip girth	90	94	97	100	103	106	109	114	119
Body rise	168	168	168	168	168	168	168	168	168
Waist girth	64	68	72	76	80	84	88	94.5	101
Italy	38	40	42	44	46	48	50	52	
Chest girth	80	84	88	92	96	100	104	110	
Hip girth	86	90	94	98	102	106	110	116	
Body rise	164	164	164	164	164	164	164	164	
Waist girth	59	62	65	69	73	77	81	85	
The Netherlands		36	38	40	42	44	46	48	50
Chest girth		84	88	92	96	100	104	110	116
Hip girth		93	96	99	102	105	108	114	120
Body rise		168	168	168	168	168	168	168	168
Waist girth		69	72	75	78	81	84	90	96
France	34	36	38	40	42	44	46	48	50
Chest girth	80	84	88	92	96	100	104	110	116
Hip girth	84	88	92	96	100	104	108	112	118
Body rise	160	160	160	160	160	160	160	160	160
Waist girth	58.6	61.8	65.2	68.8	72.6	76.2	79.8	85.1	90.9
Slovenia		36	38	40	42	44	46	48	50
Chest girth		84	88	92	96	100	104	110	116
Hip girth		92	95	98	102	106	110	115	120
Body rise		164	164	164	164	164	164	164	164
Waist girth		69	73	77	81	85	89	95	101
Croatia		36	38	40	42	44	46	48	50
Chest girth		84	88	92	96	100	104	110	116
Hip girth		92	96	100	104	108	112	116	122
Hip girth		164	164	164	164	164	164	164	164
Waist girth		62	66	70	74	78	84	90	96

rise, chest/bust girth and hip girth are often used not only to coordinate but also to designate sizes e.g. in designating systems of Poland and Romania<sup>2</sup>.

Table 1 supplies a general representation of garment size designations for women's upper clothing in a number of European countries and the comparison of the more relevant measures such as bust size, hip size, body rise and waist size<sup>2</sup>. Table 1 illustrates the garment size systems of Germany, Italy, the Netherlands, France, Slovenia and Croatia, which are shown and compared in this paper.

### Results and Discussion

From the analysis displayed on Table 1 we can conclude that each country uses a somewhat specific garment size system. Observing the increase of body sizes from the smallest to the largest one can notice that the values in some of the countries are the same. For example: in some countries the waist girth in the medium size group (38–44) increases for 3 or 4 cm.

The investigation and comparison of garment sizes described in this paper was illustrated by the hind side of women's trousers (same model) (Figure 4). If size 40 is taken as basic in all countries and the hind side of

women's trousers is executed (the model is the same) the resulting cuts will differ from each other (Figure 5) due to variations in body measures.

The essential differences lie in the length of the cut pattern, in waist girth, in hip seams and in hip girth.

Figure 1 can be regarded as a general representation because further investigation showed that various firms for ready-made clothes within the same country do not apply the prescribed size system literally, but there are differences depending on the market and on each particular order. In the example shown in Figure 6 the regulations of the firm Dibari (Germany) and the proposed sizes employed by the firm Articles (the Netherlands) have been applied.

If the grading (increasing or reducing) of a part of the hind side of women's trousers is considered (in the group of countries in which the values of grading correspond), we can conclude that each country and each large firm within a particular country apply a somewhat modified (internal) system/grading table which is not a part of a complete garment size system of that particular country.

Figure 7 shows the grading of the hind side of women's trousers according to the firm Dibari, Germany.

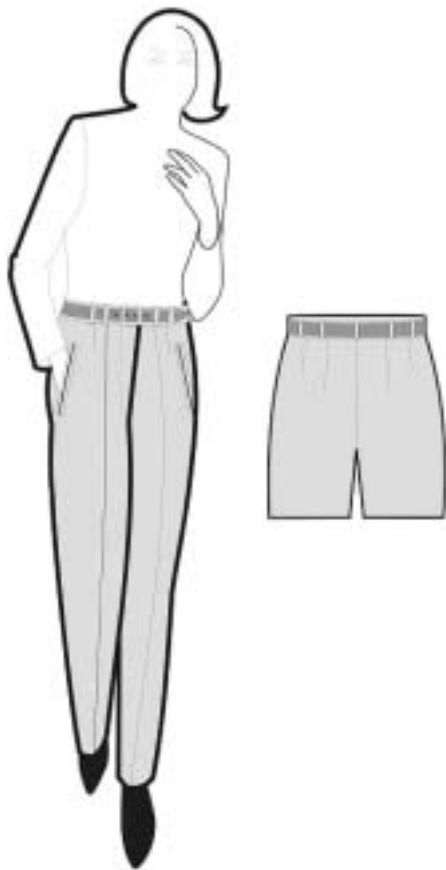


Fig. 4. A pair of women's trousers on which the comparison of garment sizes in several European countries is based.

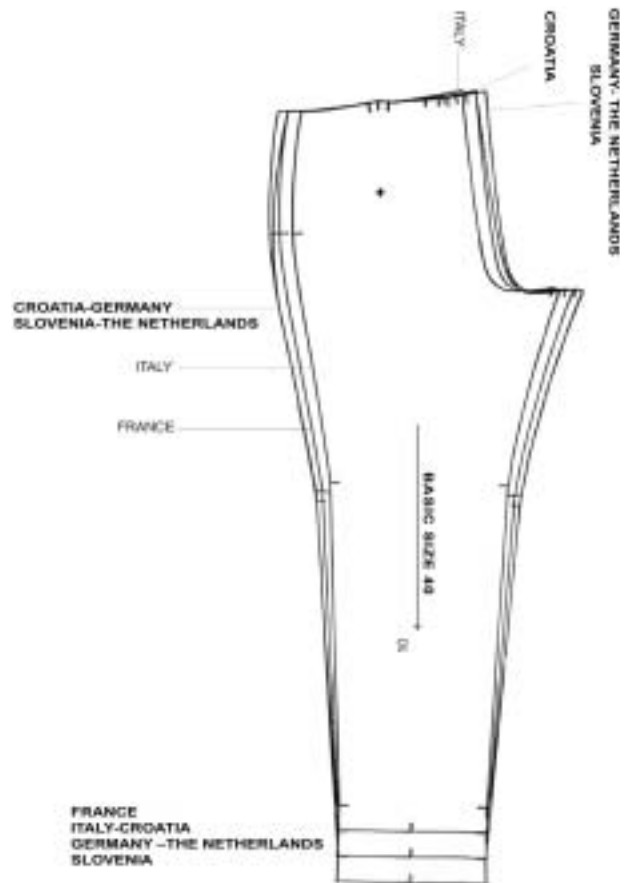
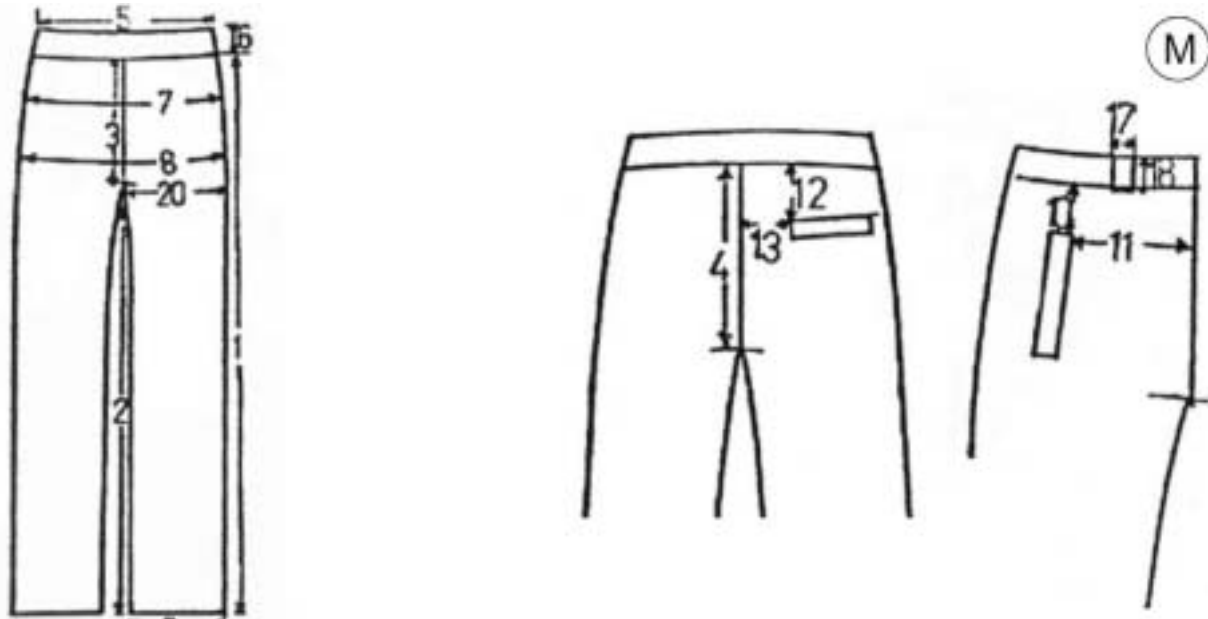


Fig. 5. Construction of the cut of the hind side of women's trousers and the comparison with the model of the basic garment size 40.



	34	36	38	40	42	44	46
1 Side length	108.0	108.0	108.0	108.0	108.0	108.0	108.0
2 Step length	87.4	86.9	86.4	85.9	85.4	84.9	84.4
3 Front cross hem	20.4	21.0	21.6	22.2	22.9	23.5	24.1
4 Back cross hem	33.5	34.4	35.3	36.2	37.2	38.1	39.0
5 Waist length 1/2	36.5	38.0	40.0	42.0	44.5	46.5	48.5
6 Waist width	2.5	2.5	2.5	2.5	2.5	2.5	2.5
7 Pattern length	43.3	44.8	46.8	48.8	51.3	53.3	55.3
8 Hip length 8.5 cm from upper waist edge 1/2	46.7	48.2	50.2	52.2	54.7	56.7	58.7
9 Waist length 18.5 cm from upper waist length 1/2	24.0	24.5	25.0	25.5	26.0	26.5	27.0
10 Hem length							
11 Front waist pocket							
12 Front part pocket							
13 Back waist pocket							
14 Back part pocket	4.0	4.0	4.0	4.0	4.0	4.0	4.0
15 Additional hem 1x4 cm	1.0	1.0	1.0	1.0	1.0	1.0	1.0
16 Number of buttons 24« inner button	13.0	13.0	14.0	14.0	15.0	15.0	15.0
17 Zip length	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18 Hollow width	3.5	3.5	3.5	3.5	3.5	3.5	3.5
19 Hollow length-control	5.0	5.0	5.0	5.0	5.0	5.0	5.0
20 Upper thigh width 1/2	29.9	31.1	32.0	33.2	34.6	35.8	37.0
21 Number of belt hooks	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Fig. 6. Regulations for measures and sketches of the model of women's trousers based on garment sizes of the firm Dibari, Germany.

While Figure 8 shows the grading of the hind part of women's trousers according to the firm Articles in the Netherlands, Figure 9 shows the grading of the hind part of women's trousers according to the firm Emka, Croatia. An internal manner of grading was developed by

individual firms depending on the function and purpose of the clothing item, on fashion trends, on the market etc.

Only if we transformed a basic cut pattern (by means of the transformation table) according to the, let us say, German garment size system, e.g. size 40, and applied a

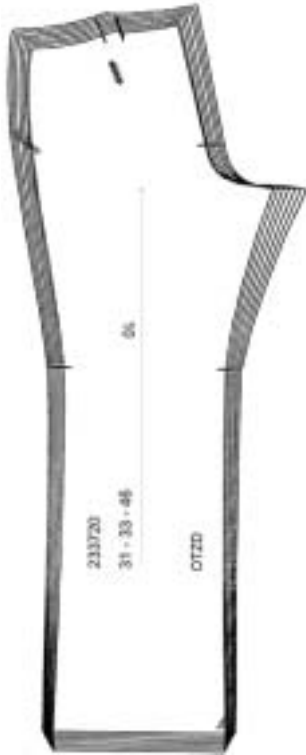


Fig. 7. Grading the hind side of women's trousers according to the firm Dibari, Germany.



Fig. 8. Grading of women's trousers according to the firm Articles, the Netherlands.

unique manner of grading we would be able to clearly observe the differences in grading based on different garment size systems in the countries we are comparing. This is going to be one of the objectives of our forthcoming research work.

### Conclusion

On the grounds of investigations carried out in this paper we can conclude that there do not exist unique international garment size systems. In the last few years new European garment size systems as well as size designation systems have been proposed. These new European garment size systems will definitely be an important contribution to the execution of international systems of those sizes.

In the investigation carried out in this paper it was proven that there are considerable differences between individual systems, which are based on previously established systems dating back to 40 or 50 years ago. The population was fairly different in those days and the body build of the people was considerably different. The Republic of Croatia, Slovenia, Bosnia and Herzegovina etc. ought to start working out new garment size systems, all the more so when bearing in mind their orientation as prospective members of the European Community.



Fig. 9. Grading the back of women's trousers according to the firm Emka, Croatia.

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## ANTROPOMETRIJA I USPOREDBA SUSTAVA ODJEVNIH VELIČINA U NEKIM EUROPSKIM DRŽAVAMA

### SAŽETAK

U ovom radu je ukazano na važnost regionalnih i državnih sustava odjevnih veličina. Visoka kvaliteta, sustavi odjevnih veličina, dizajn odjeće, ekonomičnost danas su središnje točke na kojima se lomi preživjela strategija konkurentnosti bazirane na cijeni proizvoda. Vrijednosti prosječnih tjelesnih dimenzija posljednjih desetljeća su se znatno promijenile. Istražene su različitosti i uspoređeni su sustavi odjevnih veličina u više europskih zemalja. Kao konkretan primjer istraživanja obrađen je zadnji dio ženskih hlača te je izvršena usporedba. Iz svega proizilazi da većina zemalja još uvijek ima svoje službene sustave odjevnih veličina i one se u mnogočemu razlikuju. Pored toga, veće tvrtke u nekim zemljama koriste svoje interne standarde koji ponešto odstupaju. Zaključili smo na temelju istraživanja da oni ovise o funkciji i namjeni odjevnog predmeta, modnim trendovima, dizajnu i ekonomičnosti proizvodnje.