DETERMINATION OF FABRICS PROPERTIES FOR REVERSIBLE GARMENTS

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Abstract. *Transformable fashion is one of the appropriate alternatives to reduce consumption and reinforce consumers to engage in sustainable lifestyle. Transformable fashion can be basically defined as a garment that can be comfortably worn in multiple ways. A reversible garment is a type of transformable fashion which can be worn two ways. Transformable woman's garments belong to the chains of transformations which might include different types of garments. All of them might be made of different fabrics, and they might meet to different quality requirements. Furthermore reversible garment has no true "inside out", and that is why each side must have some lining properties. The main purpose of this research is to obtain recommended value ranges of the fabrics properties for reversible garments in order to meet all of quality requirements. As input data for the research the value ranges of specific parameters of the different types of fabrics' properties were used. But at present we have no detailed knowledge about some of properties. That is why we proposed to evaluate the fabric smoothness by measuring fabric surface roughness characteristics. Thus, the recommended ranges of materials' properties for reversible garments were obtained as an intersection of the uncountable sets determine the value ranges of specific parameters of the materials' properties for different garments types and lining. The obtained values can guarantee high quality products, good looks and long life of the transformable clothing. The procedure which was followed in this work can be used to obtain ranges of materials' properties for transformable garments, the chain of transformation of which include other types of garments, or even to obtain ranges of constructions parameters of transformable (reversible) garment's parts. Besides that the information we have obtained can be used as a basis for expert system of the fabric selection for the garment.*

1 INTRODUCTION

Today, fashion industry is facing a huge challenge towards sustainability because fast fashion is dominating the mass market. Fast fashion and consumers' purchasing format are closely linked to each other.

The life cycle of fashion items are shortened and the items are being replaced within a very short period to fulfil consumers' needs. Consumer needs can be met by determining their functional, expressive, and aesthetic requirements. Transformable fashion is one of the appropriate alternatives to reduce consumption and reinforce consumers to engage in sustainable lifestyle. The traditional wardrobe is similar in basic functionality and no longer sustained social and consumer needs. It results the arising need for transformable fashion.

Transformable garments are very popular nowadays. The ability to change its function makes transformable clothes very useful when life conditions are changing as fast as nowadays. These clothes can be worn for longer periods of time and on various occasions, thus minimizing waste generation in two ways by reducing the consumer's need to purchase additional garments, and by decreasing materials consumption in the fashion industry.

Yeung Yuet Ming in the study of sustainability in transformable fashion[1] says that transformable design is an emerging design method which growing to be a fashion trend, and hence more fashion brands and designers are willing to invent transformable design.

Transformable clothing occupies a considerable part in the range of clothes. It includes children's wear, working wear, sportswear, clothes for pregnant women etc.

There is much different information about the appearance of the transformable clothing in literature, fashion shows, online shops[2], fashion magazines, online fashion reviews[3], patents databases. But we still have little precise information in literature about the process of achieving the quality of transformable clothing. That is why many researchers investigate the principles of transformable garments design. Koo[4] designed functions in transformable garments for sustainability; Zakharkevich and Savchuk[5] dedicated their work to the research of the properties of materials for transformable clothing.

Zakharkevich and Pochuprin[6] have confidence that the study of transformable design and characteristics of the transformable chain can be a base to expert system for rapid change in production of women's outerwear: the required premises were created for the further development of artificial intelligence methods in the processes of managing the designer's training of clothing manufacture and for lowering the risk of making false decisions under the conditions of rapid changes of project situations.

Transformable fashion or convertible fashion can be basically defined as a garment that can be comfortably worn in multiple ways. It can be transformed into another shape and able to transform back to the original shape by altering its components.

A reversible garment is a type of transformable fashion too. A reversible garment is a garment that can be worn two ways. There is no true "inside out" to a reversible garment, since either way, it gives a fashionable appearance.

Transformable woman's garments belong to the chains of transformations which might include different types of garments. All of them usually must be made of different fabrics and, besides that; they must met to different quality requirements. Furthermore reversible garment has no true "inside out", and that is why each side must have some lining properties.

The main purpose of this research is to obtain recommended value ranges of the fabrics properties for reversible garments in order to meet all of quality requirements.

2 EXPERIMENTAL PART

2.1 Input data

As input data for the research the value ranges of specific parameters of the different types of fabrics' properties were used. Compiled list of the fabrics properties of the different fabrics groups includes value ranges of specific parameters with weighting factors more than 0 (according to the recommendation[7]): wrinkle resistance, pilling, the number of cycles of abrasion, dimensional stability (shrinkage), air permeability, elasticity: residual strain, stiffness, water resistance, water permeability, thermal resistance, colour fastness, bursting strength, sewed seam slippage, smoothness, permeability of water vapour, hygroscopicity, etc.

The weighting factors of lining fabrics' properties obtained by scientists of the Khmelnitsky national university[8]. These factors are extremely important especially if fabrics of other groups are proposed as the lining fabrics.

Properties	Weighting factor for the group of fabrics			
	suit fabrics	jacket fabrics	coat fabrics	lining fabrics
Wrinkle resistance, %	0.20	0.16	0.05	-
Pilling, pilli/cm^2	0.15	-	-	-
The number of cycles of abrasion, cycle	0.15	0.06	0.25	-
Dimensional stability (shrinkage), %	0.14	0.15	0.05	-
Air permeability, $dm^3/(cm^2*s)$	0.12	-	0.10	0.19
Elasticity: residual strain, %	0.12	-	0.12	-
Stiffness, $\mu N*cm^2$	0.12	-	0.08	-
Water resistance, mm H_2O	-	0.24	-	-
Water permeability, $g/(m^2*s)$	-	0.22	0.12	-
Thermal resistance, $(m^2*K)/W$	-	0.11	0.20	-
Colour fastness, point	-	0.06	-	0.11
Bursting strength, daN	-	-	0.03	-
Sewed seam slippage (yarn slippage), daN	-	-	-	0.11
Smoothness	-	-	-	0.36
Permeability of water vapour $(g/(m^2*hr)$	-	-	-	0.11
Hygroscopicity, %	-	-	-	0.12
Total	1.00	1.00	1.00	1.00

Table 1: Weighting factors of the fabrics properties.

The list of the fabrics properties of the different groups of fabrics is compiled and presented in table 2. Value of fabrics properties obtained from standards with general specifications for the outerwear of coat-suit assortment [9], lining fabrics[10], woolen fabrics[11], semiwoolen fabrics[12], cotton and mixed fabrics[13], linen fabrics[14], waterproof and jacket fabrics[15], fabrics for waterproofs from chemical and mixed fibres[16], and for the fabrics for dresses[17]. Also recommendations of Buzov[18], and Dell[19] were used.

Properties	Group of fabrics			
	suit fabrics	jacket fabrics	coat fabrics	lining fabrics
Thickness, mm	0.4÷1.3	0.5÷1.4	1.0÷4.0	0.1÷0.5
Surface weigh, g/m^2	100÷400	50÷300	100÷800	40÷180
Wrinkle resistance, %	30 and more	45 and more	40 and more	70 and more
Pilling, pilli/cm^2	0÷4	0÷5	0÷2	0÷6
The number of cycles of abrasion, cycle	4000 and more	3000 and more	4000 and more	850÷1000
Dimensional stability (shrinkage), %	1.5÷5.0	2÷3.5	1.5÷5.0	2.0÷5.0
Air permeability, $dm^3/(cm^2*s)$	40÷375	20÷130	10÷100	100 and more
Elasticity: residual strain, %	0.8÷3.0	–	1.5÷5.0	–
Stiffness, $\mu N*cm^2$	4000÷9000	–	20000÷100000	1000÷1500
Water resistance, mm H_2O	–	200 and more	–	–
Water permeability, $g/(m^2*s)$	–	less than 50	–	–
Thermal resistance, $(m^2*K)/W$	0.02 and more	0.015 and more	0.05 and more	0.03 and more
Colour fastness, point	4.0÷6.0	3.0÷6.0	4.0÷7.0	4.0÷6.0
Bursting strength, daN	35 and more	20 and more	20 and more	16 and more
Sewed seam slippage (yarn slippage), daN	7.0 and more	10 and more	10 and more	0.9÷1.5
Water vapor permeability $(g/(m^2*hr)$	40 and more	50 and more	40 and more	50 and more
Hygroscopicity, %	7-13	7-10	13 and more	6 and more
Coefficient of friction	There is no information	There is no information	There is no information	There is no information

Table 2: Range of fabrics properties.

The number of main groups in table 2 (suit fabrics, raincoat fabrics, coat fabrics, and lining) is determined by types of garments those compose typical chains of transformations. Such chains

were described on the previous stage of this research[20].

2.2 Fabric roughness

According to the value of the weighting factor the main property of lining is smoothness (table 1). In sewing industry such property used to be evaluated by coefficient of friction.

Static friction is friction between two or more solid objects that are not moving relative to each other. For example, static friction can prevent an object from sliding down a sloped surface. In sewing industry it is more useful to define static friction in terms of the maximum angle before which one of the items will begin sliding. This is called the *angle of friction* or *friction angle*. It is defined as $tan\ \theta=\mu_s$ (θ is the angle from horizontal and μ_s is the static coefficient of friction between the objects).

According to results of Flegontov's study[21], the coefficient of friction is usually about 0.3÷1.0: 1 group – the coefficient of friction is less than 0.4; 2 group – 0.4-0.8; 3 group – the coefficient of friction is higher than 0.8. But we have no information about the coefficients of friction for the fabrics with different functions (as it shown in the table 2). The exact value of the coefficient of friction of the fabric can be determined only by experimental way. Besides that its value is depended of experimental conditions. So comparison of the coefficients of friction for different fabrics (main fabric, lining, etc.) is possible just in individual cases.

The roughness and frictional properties of cotton and polyester woven fabrics and relationships between these properties were investigated by group of scientists (Vildan Sular, Eren Oner & Ayse Okur[22]). Statistically significant and high correlations were determined for cotton and polyester fabrics.

So as we can see the roughness could be used for evaluating of the frictional properties of the fabrics. Besides that, the exact value of the roughness is substantive parameter.

In this way empirical measurements of the linings' roughness will determine a range of fabrics which could be used for reversible garments. That is why we proposed to evaluate the fabric smoothness by measuring fabric surface roughness characteristics. Thus, according to a previously published procedure[23], two parameters (Ra, Rmax) were used to reflect fabric roughness: Ra – arithmetical mean deviation of the profile, μm; Rmax – maximum height of the profile, μm. The script and scanned images of tissue samples were used in 3D computer graphics software (Rhinoceros) to evaluate the fabrics' roughness (as it shown on the figure 1). So the size of the tissue samples is 8x8 cm, the sampling length for the evaluation the roughness characteristics is 0.8 mm.

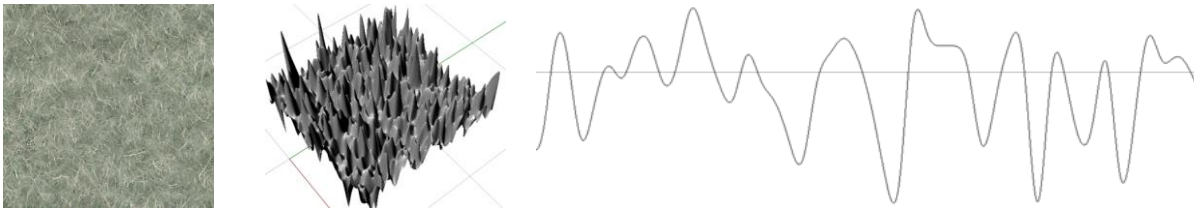

Figure 1: Example of the input data for the measuring fabric surface roughness characteristics (image of the coat fabric sample, 3D surface of the sample, and nominal profile)

Fabric roughness parameters were determinate for lining fabrics, suit fabrics, jacket fabrics, and coat fabrics. The data obtained were analyzed by utilizing the MsExcel statistical package software "Data analysis". Descriptive statistics of fabric surface roughness characteristics present in the table 3. According to the data in the table 3, the ranges of the roughness characteristics for four fabrics groups are obtained. And the minimal numbers of measurements the value of the roughness characteristics for different groups of fabrics were calculated: 58 – for the lining, 122 – for the coat fabrics, 73 – for the suit fabrics, and 50 – for the jacket fabrics. Obviously, that recommended ranges of the roughness characteristics could be applied just to the set of materials,

which were used in the experimental measurements, because as we see in the table 3, the numbers of the experimental measurements are less than calculated numbers.

Statistic parameter	Value of the statistic parameter							
	suit fabrics		jacket fabrics		coat fabrics		lining fabrics	
	Ra	Rmax	Ra	Rmax	Ra	Rmax	Ra	Rmax
Mean	2.66	8.55	2.86	8.56	10.73	33.21	0.86	2.34
Standard Error	0.33	1.16	0.39	1.12	0.76	2.31	0.14	0.39
Median	2.43	8.00	3.27	9.5	9.51	32.85	0.75	2.00
Standard Deviation	1.45	5.05	1.42	4.04	4.28	13.09	0.52	1.46
Sample Variance	2.10	25.47	2.02	16.21	18.35	171.24	0.27	2.12
Kurtosis	-0.15	1.30	-1.71	-1.56	0.46	-0.66	-0.34	0.90
Skewness	0.72	1.15	-0.37	-0.37	0.87	0.39	0.62	1.12
Range	5.08	19.50	3.64	10.60	18.15	48.40	1.74	5.00
Minimum	0.92	2.50	0.92	2.70	3.91	10.20	0.18	0.70
Maximum	6.00	22.00	4.56	13.30	22.06	58.60	1.92	5.70
Count	19	19	13	13	32	32	14	14

Table 3: Descriptive statistics of fabric surface roughness characteristics.

4 RESULTS AND DISCUSSIONS

4.1 Recommended ranges of the fabric properties

The result of previous research of properties of materials for a reversible jacket is the optimum package of materials for the reversible jacket[24]. It based on values of concrete parameters. And the recommended ranges of materials' properties for a reversible jacket were obtained as an intersection of the uncountable sets determines the value ranges of specific parameters of the main fabric and lining.

But reversible clothing includes coat, raincoat and other types of garments (not only jacket). Besides, reversible garments might include different types of garments with both sides. So the used fabrics are different too. And both sides of the garment compose a chain of transformations which include at least two types of garments.

We suppose that the recommended ranges of materials' properties for reversible garments may be obtained as an intersection of the uncountable sets determine the value ranges of specific parameters of the main materials' properties for transformable clothing and lining:

$$S = B \cap A = \{x \mid a < x < b\} \cap \{x \mid c < x < d\} \quad (1)$$

S – set of fabric property for reversible garments;

x – fabric parameter;

B – set of values of the fabric property for the transformable garments;

A – set of values of the fabric property for the lining;

a (c) – minimal value of each fabric property for transformable garments (lining);

b (d) – maximum value of each fabric property for transformable garments (lining).

Minimal and maximum value of each fabric properties for different garments types and lining presented in the table 3.

Thus, the recommended ranges of materials' properties for reversible garments were obtained as an intersection of the uncountable sets determine the value ranges of specific parameters of the materials' properties for different garments types and lining (as it presented in the table 4 and 5).

Property	Classic garment			Transformable garments (not reversible)						
				1 garment type			2 garments types			3 garment types
	tailored jacket	jacket	coat	tailored jacket	jacket	coat	tailored jacket→ jacket	tailored jacket → coat	jacket → coat	
Surface weigh, g/m^2	100÷400	50÷300	100÷800	100÷400	50÷300	100÷800	100÷300	100÷400	100÷300	100÷300
Wrinkle resistance, %	30 and more	45 and more	40 and more	30 and more	45 and more	40 and more	45 and more	40 and more	45 and more	45 and more
Pilling, pilli/cm^2	0÷4	0÷5	0÷2	0÷4	0÷5	0÷2	0÷4	0÷2	0÷2	0÷2
The number of cycles of abrasion, cycle	4000 and more	3000 and more	4000 and more	4000 and more	3000 and more	4000 and more	4000 and more	4000 and more	4000 and more	4000 and more
Dimensional stability (shrinkage), %	1.5÷5.0	2÷3.5	1.5÷5.0	1.5÷5.0	2÷3.5	1.5÷5.0	2÷3.5	1.5÷5.0	2÷3.5	2÷3.5
Air permeability, dm^3/(cm^2*s)	40÷375	20÷130	10÷100	40÷375	20÷130	10÷100	40÷130	40÷100	20÷100	40÷100
Elasticity: residual strain, %	0.8÷3.0	–	1.5÷5.0	0.8÷3.0	–	1.5÷5.0	0.8÷3.0	1.5÷3.0	1.5÷5.0	1.5÷3.0
Stiffness, μN*cm^2	4000÷ 9000	–	20000÷ 100000	4000÷ 9000	–	20000÷ 100000	4000÷ 9000	–	20000÷ 100000	–
Water resistance, mm H_2O	–	200 and more	–	–	200 and more	–	200 and more	200 and more	200 and more	200 and more
Water permeability, g/(m^2*s)	–	less than 50	–	–	less than 50	–	less than 50	less than 50	less than 50	less than 50
Thermal resistance, (m^2*K)/W	0.02 and more	0.015 and more	0.05 and more	0.02 and more	0.015 and more	0.05 and more	0.02 and more	0.05 and more	0.05 and more	0.05 and more
Colour fastness, point	4.0÷6.0	3.0÷6.0	4.0÷7.0	4.0÷6.0	3.0÷6.0	4.0÷7.0	4.0÷6.0	4.0÷6.0	4.0÷6.0	4.0÷6.0
Bursting strength, daN	35 and more	20 and more	20 and more	35 and more	20 and more	20 and more	35 and more	35 and more	20 and more	35 and more
Sewed seam slippage (yarn slippage), daN	7.0 and more	10 and more	10 and more	7.0 and more	10 and more	10 and more	10 and more	10 and more	10 and more	10 and more
Water vapor permeability (g/(m^2*hr)	40 and more	50 and more	40 and more	40 and more	50 and more	40 and more	50 and more	40 and more	50 and more	50 and more
Hygroscopicity, %	7.0÷13.0	7.0÷10.0	13.0 and more	7.0÷13.0	7.0÷10.0	13.0 and more	7.0÷10.0	13.0	–	13.0

Table 4: Recommended ranges of fabrics properties (part 1).

Property	Transformable garments (reversible)						
	1 garment type			2 garment types			3 garment types
	tailored jacket	jacket	coat	tailored jacket → jacket	tailored jacket → coat	jacket → coat	
Roughness (arithmetical mean), μm	0.92-1.92	0.92-1.92	-	0.92-1.92	-	-	-
Roughness (maximum height), μm	2.5-5.7	2.7-5.7	-	2.7-5.7	-	-	-
Surface weigh, g/m^2	100÷180	50÷180	100÷180	100÷180	100÷180	100÷180	100÷180
Wrinkle resistance, %	70 and more						
Pilling, pilli/cm^2	0÷4	0÷5	0÷2	0÷4	0÷2	0÷2	0÷2
Dimensional stability (shrinkage), %	2.0÷5.0	2÷3.5	2.0÷5.0	2÷3.5	2.0÷5.0	2÷3.5	2÷3.5
Air permeability, dm^3/(cm^2*s)	100÷375	100÷130	100	100÷130	100	100	100
Elasticity: residual strain, %	0.8÷3.0	–	1.5÷5.0	0.8÷3.0	1.5÷3.0	1.5÷5.0	1.5÷5.0
Thermal resistance, (m^2*K)/W	0,03 and more	0,03 and more	0,05 and more	0,03 and more	0,05 and more	0,05 and more	0,05 and more
Colour fastness, point	4.0÷6.0						
Bursting strength, daN	35 and more	20 and more	20 and more	35 and more	35 and more	20 and more	35 and more
Water vapor permeability (g/(m^2*hr)	50 and more						
Hygroscopicity, %	7.0 and more	7.0 and more	13.0 and more	7.0 and more	13.0 and more	–	13.0 and more

Table 5: Recommended ranges of fabrics properties (part 2).

As we see from the tables 4 and 5 some values have no intersection. That is why selection of the fabrics for such garments might be completed with the desirability function method for the optimization of fabric selection for the reversible garments with the “most desirable” values of the properties.

4.2 Colours selection

All kinds of garments must have enough aethetic quality level[25]. According to recommendations, which were described by Koblyakova[26], and Slavinskaya[27], compiled indexes list of the aethetic garment quality is represented in the table 6. Obviously, that some of requirements for the reversible garments might be different than for the classic garments.

Complex index	Group index	Index of the subgroup	Index notation
Concordance of the modern style and fashion trends – Q_1	Shape – Q_{11}	Basic shape	Q_{111}
		Derivative shape	Q_{112}
	Lines – Q_{12}	Constructive lines	Q_{121}
		Decorative lines	Q_{122}
	Colour scheme of the garment style – Q_{13}	Concordance the colours to the fashion trends	Q_{131}
		Harmony of the materials colors	Q_{132}
		Concordance colours and usage circumstances	Q_{133}
		Concordance colours and appearance of the consumer	Q_{134}
	Material texture – Q_{14}	Rigidity	Q_{141}
		Plasticity	Q_{142}
	Shape of small and decorative parts – Q_{15}	Geometrical	Q_{151}
		Sinuous	Q_{152}
Grade of the composition perfection of the garment style – Q_2	Architectonic of the shape – Q_{21}	Proportion	Q_{221}
		Scale	Q_{212}
		Rhythm	Q_{213}
		Symmetry or asymmetry	Q_{214}
	Plasticity expression – Q_{22}	Static or dynamic	Q_{221}
		Compliance with the rules of the subordination	Q_{222}
		Compliance with the rules of allocation of composite centre	Q_{223}
	Tectonics of the shape– Q_{23}	Unity of the form and its structural elements	Q_{231}
		Interrelation of form and material	Q_{232}
		Interrelation of design and material	Q_{233}
Salable appearance of the product – Q_3	Garment appearance – Q_{31}	Fitting of the garment	Q_{311}
		Symmetry and processing quality of the garment (garments parts)	Q_{312}
		Quality of the seams	Q_{313}
		Quality of the decorative stitching	Q_{314}
	Internal processing of the garment – Q_{32}	Processing quality of the garment inside	Q_{321}
		Processing quality of the lining	Q_{322}
		Correspondence of the lining’s colour to the main fabric’s colour	Q_{323}
	Expression of the labels – Q_{33}	Originality of the labels	Q_{331}
		Expression	Q_{332}
		Informational content	Q_{333}

Table 6: Indexes of the aethetic garment quality.

As we see in the table 1 group index “Internal processing of the garment” (Q_{32}) correspond with the lining. But reversible garments have no true "inside out" and as a result they have no lining. For example, such quality index as “correspondence of the lining's colour and the main fabric's colour” (Q_{323}) for reversible clothing has quite different meaning than the same index for the typical garment.

Then both sides of the reversible garment must meet consumers aesthetic requirements the same way as appearance of the garment. That is why we selected aesthetic quality indexes for the harmonization of the transformable (including reversible) garments from the list in the table 1. We obtained the weighting factors of the indexes of the harmonisation aethetic garment quality, which represented in the table 7.

Group index	Weighting factor	Subgroup index	Weighting factor	Index	Index notation	Weighting factor
Q_{21}	0.489	Q_{221}	0.318	Ratio the garment size and consumer height	Q_{2211}	0.107
				Proportional allocation of the constructions lines	Q_{2212}	0.105
				Proportion of the size and allocation of the parts of the garment	Q_{2213}	0.106
		Q_{212}	0.171	Concordance garment size and human body size	Q_{2121}	0.112
				Concordance the size of the parts and size of the whole garment	Q_{2122}	0.059
Q_{31}	0.196	Q_{311}	0.196	Fitting of the garment	Q_{3111}	0.196
Q_{13}	0.315	Q_{131}	0.110	Concordance the colours to the fashion trends	Q_{1311}	0.110
		Q_{132}	0.116	Harmony of the materials colours	Q_{1321}	0.116
		Q_{133}	0.053	Concordance colours and usage circumstances	Q_{1331}	0.053
		Q_{134}	0.036	Concordance colours and consumer's appearance	Q_{1341}	0.036
Total	1	Total	1	Total		1

Table 7: Weighting factors of the indexes of the harmonisation aethetic garment quality.

As we see in the table 7 group index "Colour scheme of the garment style" (Q_{13}) corresponds with the material colour and its weighting factor is one of the highest. So we compiled the lists of the recommended colours for the consumers' types in the table 8. As input data for the list we used recommendations, which were described by Henderson[28] and Kuleshova[29].

Consumer type	Recommended colours for the consumers' types (monochrome harmony), %						
	chromatic – Q_{1341}						achromatic – Q_{1342}
	red	green	blue	yellow	violet	natural	
Winter	C = 10…40 M = 30…100 Y = 0…70 K = 0…10	C = 67…91 M = 5…39 Y = 50…74 K = 0…39	C = 30…100 M = 2…88 Y = 0…31 K = 0…17	C = 6…11 M = 6…19 Y = 69…89 K = 0	C = 30…100 M = 25…100 Y = 0 K = 15…55	C = 0…35 M = 0…20 Y = 0…20 K = 0..100	C = 0 M = 0 Y = 0 K = 0…100
Summer	C = 0…36 M = 40…100 Y = 0…70 K = 0…40	C = 35…84 M = 0…18 Y = 19…60 K = 0…3	C = 30…100 M = 2…88 Y = 0…31 K = 0…17	C = 12…20 M = 3…8 Y = 29…62 K = 0	C = 25…100 M = 15…90 Y = 0 K = 0…55	C = 0…30 M = 5…40 Y = 0…55 K = 0…55	C = 0…35 M = 0…20 Y = 0…20 K = 10…75
Autumn	C = 0 M = 40…100 Y = 35…95 K = 0…40	C = 88…59 M = 18…35 Y = 75…100 K = 15…30	C = 50…100 M = 0…47 Y = 15…47 K = 0…27	C = 10…13 M = 19…47 Y = 77…91 K = 0	C = 40…80 M = 80…100 Y = 0 K = 25…55	C = 0 M = 60…100 Y = 80…100 K = 25…65	C = 10…40 M = 5…40 Y = 20…90 K = 5…40
Spring	C = 0 M = 45…100 Y = 25…80 K = 0	C = 27…86 M = 0…24 Y = 61…100 K = 0…12	C = 31…84 M = 1…28 Y = 2…32 K = 0…2	C = 2…8 M = 9…15 Y = 55…88 K = 0	C = 20…80 M = 25…100 Y = 0 K = 0…45	C = 0 M = 7…60 Y = 12…100 K = 0…65	C = 5…35 M = 5…20 Y = 20…55 K = 5…30

Table 8: Recommended colours for consumers' types.

In the tables 8 we used the CMYK colour model: C – Cyan, M – Magenta, Y – Yellow, K – Key. The value of each colour tone for the real materials samples might be obtained by any raster graphics editor (for example, GIMP). Thus the selection of the materials colour could be done even through online-catalog with images of the materials samples.

5 CONCLUSIONS

The information we have obtained can be used as a basis for expert system. Such system is intended for make a decision about selection of fabric for the garment. Input data in system must be the list of fabric properties, garment type (typical, transformable, or reversible), and consumer type. The rules of selection the materials are formed in the tables 4, 5, and 8. In each table the results are at the intersection of few antecedents. Thus these tables form the basis of the simple knowledge-base system.

Besides that the obtained values can guarantee high quality products, good looks and long life of the transformable (including reversible) clothing. The list of recommended ranges of fabrics properties includes multiple characteristics and that is why it could be used as a basis of the desirability function method for the optimization of fabric selection for the reversible garments with the "most desirable" values of the properties.

As a result of the experiment the minimal number of measurements the value of the roughness characteristics for different groups of fabrics was obtained. And recommended ranges of the roughness characteristics could be applied just to the set of materials, which were used in the experimental measurements. The result of the measurements confirms possibility of usage the proposed characteristic to evaluate fabric's smoothness.

The procedure which was followed in this work can be used to obtain ranges of materials' properties for transformable garments, the chain of transformation of which include other types of garments, or even to obtain ranges of constructions parameters of transformable garments' parts.

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