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Comparison of functional properties of woven and knitted denim fabrics

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ABSTRACT – REZUMAT

Comparison of functional properties of woven and knitted denim fabrics

The study was aimed to develop a knitted denim fabric and investigate its properties. The said fabric has similar visual appearance to the woven denim fabric, offering additional stretch properties. The twill effect was produced on circular knitting machine using cross terry structures. Woven denim fabric was also produced to compare its properties with knitted denim. The Physical and comfort properties of these fabrics like air permeability, thermal resistance and moisture management, were investigated. Experimental investigation of serviceability i.e Pilling was also carried out. The purpose of study is to compare both woven and knitted denim fabric properties.

Keywords: *woven denim, knitted denim, twill, comfort properties, physical properties, pilling*

Compararea proprietăților funcționale ale țesăturilor denim cu cele ale tricoturilor denim

Studiul a avut ca scop dezvoltarea unui material textil tricotat tip denim și analiza proprietăților acestuia. Tricotul menționat are aspect vizual similar cu materialul textil țesut tip denim, oferind proprietăți suplimentare de întindere. Efectul de legătură diagonal a fost obținut pe mașina de tricotat circulară, folosind structuri cu ochiuri încrucișate. De asemenea, a fost realizată o țesătură denim pentru a compara proprietățile acesteia cu denimul tricotat. Proprietățile fizice și de confort ale acestor materiale, precum permeabilitatea la aer, rezistența termică și proprietățile de control al umidității, au fost analizate. De asemenea, a fost analizată purtabilitatea, prin efectul de piling. Scopul studiului a fost de a compara proprietățile țesăturii denim cu cele ale tricotului denim.

Cuvinte-cheie*: țesătură denim, tricot denim, diagonal, proprietăți de confort, proprietăți fizice, piling*

INTRODUCTION

Textiles can be considered one of the most demanding materials in the world due to their requirements in different fields of applications. They have versatile combination of properties, structures, raw materials and production techniques. With the advent of technology and research there is a desire to have substitute or modified form of each product meeting the new life styles and fashion trends. Denim fabric is one of the most popular casual wear fabrics worldwide.

It was used to produce jeans previously for workers of mining industry, but now it has become a household item, irrespective of gender, profession or age [1]. The convention with jeans is the use of woven denim fabric but knitted denim is also gaining popularity because of its better aesthetic and comfort properties. It is quickly replacing the woven denim especially in ladies and children wear [2].

Conventionally the denim is warp faced twill fabric, produced from spun cotton dyed yarn and white spun cotton used as a weft yarn. Denim is a tough warp faced woven fabric in which the warp thread passes over more than two threads. Woven denim fabrics are produced with different constructions like 3/1 twill, 2/1 twill, 2/2 broken twill and 3/1 broken twill. Woven denim fabric is used for making jeans trousers, shirts jackets, skirts and bags. The woven denim structure gives better stability and durability to the fabric but lacks in proving the stretch ability as the yarn are well interlocked in the interlacement pattern. The other drawback of this fabric is the lengthy development process. The production process of denim fabric in weaving differs from the other conventional fabrics. The warp of denim is first dyed by rope dyeing and then converted to denim fabric. The production process of woven denim is therefore lengthy and also sizing and dyeing processes have raised a lot of environmental concerns [3]. The performance and comfort factors of garments during usage are very important. Generally, the comfortable stretching of fabrics according to body is good desirable properties. In recent years, due to the demand for more comfortable clothing usage of elastin, increased. Knitting is another fabric formation technique, in which elasticity is achieved even without elastin yarn. In knitting fabric is formed by Interloping of yarn. So there is need to have this structure and appearance through knitted structure that is well known to its comfort and stretch ability and better cost as there is no need of yarn preparation. Knitted fabric is generally categorized into warp and weft knitting according to the direction of loop formation. The denim effect can be achieved by three different ways. The first technique is float plated structure, in which the effect is produced from plating yarn. The second technique is by interlock structure, that is double knit structure and fabric is knitted on both sides to give the denim like effect. The third one is most popular and effective technique called cross terry structure. In this structure all the three basic types of stitches of weft knitting are used i.e. knit, tuck and miss. Cross terry is a type of single knit structure in which twill like pattern is achieved by joining the face yarn with ground yarn. It provides freedom to change the float length of twill faced side producing 2/1 and 3/1 terry structure [4].

This cross terry structure also provides freedom to change the float length of twill faced side to produce 2/1 and 3/1 terry structure pattern. In 2/1 terry structure, dyed yarn is knotted by tuck stitch followed by 2 needle float. In 3/1 terry structure, the float is extended to 3 needle followed by knotting with ground loop. The ground and face surfaces can be produced by application of different yarn tensions. Single knit weft knitting machines is generally used to produce this denim like knitted fabric. Recently different developments have also been made to produce denim structure. The different cross terry structure is developed with different float length of twill yarn.

Woven structure gives some characteristics to fabric that is superior in term of durability, strength, dimensional stability but in terms of comfort, shape retention and short production route, knitted fabrics have taken the lead. Since the denim has great demand in the market at present and knitted fabrics are popular for their shape fitting properties, softer handle, comfortable nature and high extension at low tension. Denim effect using knit structures is a new value added product in market. As far as the comparison of woven and knitted denim is concerned, there is no literature available so far particularly for thermo physiological comfort. In this study the performance property i.e. pilling and comfort properties such as air permeability, thermal properties and moisture management properties of woven and knitted denim were compared. Also the physical properties i.e. thickness was compared for both types of fabrics. All the results were evaluated with mean and standard deviation. The objective of this study is to compare both fabric techniques denim structures and generate an idea which structure has better potential in term of properties. Also the effect of yarn count within same manufacturing technique is studied.

EXPERIMENTAL WORK

Materials and method

The 100% cotton yarn with linear densities of 10/1 Ne_c (59 Tex), 11/1 Ne_c (53.6 Tex), 12/1 Ne_c (49.2 Tex), 14/1 Ne_c (42 Tex), 16/1 Ne_c (36.9 Tex), 18/1 Ne_c (32.8 Tex) were selected on the basics of market well known constructions of woven denims. The 100% cotton yarn with linear densities of 20/1 Ne_c (29.5 Tex) and 30/1 Ne_c (19.6 Tex) were used for the construction of weft knitted denim to produce comparable areal density fabric as woven denim.

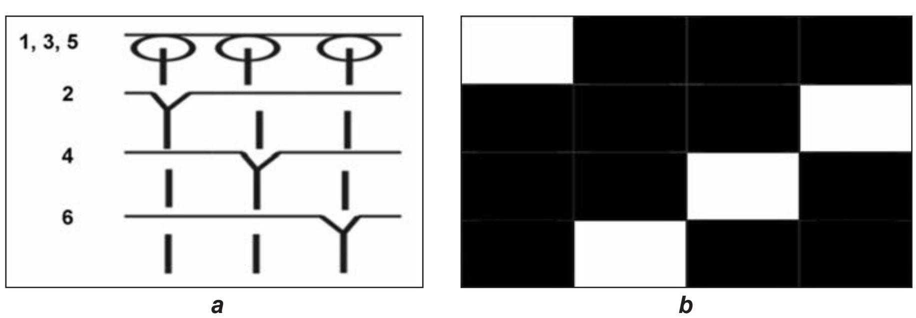

Fig. 1. Fabric structures developed: *a* – needle repeat of 2/1 terry; *b* – weave repeat of 3/1 twill

Fabric productions

The denim effect in weft knitted single knit fabric was produced on single cylinder machine made by Fukuhara, Japan having gauge of 20 needles per inch and machine diameter was 30 inches. The cross terry structure of 2×1 was used to produce the twill line effect in knitted fabric. Total 3 sample were produce by varying the loop length and position of yarn that is given in table 1. The knitted denim effect was obtained using cross-terry structure with 3 tracks repeat as shown in figure 1, *a*.

Moreover, the woven denim was produced on Sulzer Ruti, Model P-7200 1994 (projectile weft insertion mechanism). The woven denim fabric was constructed using 3/1 Right hand twill (RHT). Total 3 samples were produce by varying the warp and weft densities. The construction of woven denim samples is given in table 1. Repeat was shown in figure 1, *b*.

Fabric processing

The fabrics taken off the machines are not in relaxed state and may shrink in subsequent processing causing problem for the garment manufacturing or subsequent laundering. Therefore, it is necessary to wash the produced fabrics, allowing them to achieve normal relaxed state. Before testing, the samples were washed and tumble dried at 60°C. This process was repeated three times. After that the sample were conditioned for 24 hour in standard atmospheric conditions, 25±2°C and 65±5% relative humidity.

Testing

The produced knitted denim fabric was characterized for different performance properties. The physical parameters of all the developed samples were noted in the relaxed state. Parameters like stitch length, stitch density and areal density of knitted fabric were measured. Moreover, the warp and weft densities and areal density were measured of samples.

Air permeability of both type of fabrics was measured using SDL-Atlas air permeability 021A tester according to standard i.e. ASTM D737. The area of test specimen was 20 cm^2 and was tested under pressure of 100 Pa. Thermal resistance test was performed

Table 1

FABRIC CONSTRUCTION OF WOVEN AND KNITTED DENIM						
Sample ID	**Woven**		**Sample ID**	**Knitted**		
	Fabric construction	**Areal density (g/m^2)**		**Structure**	**Stitch length (cm)**	**Areal density (g/m^2)**
W1	14×18/92×58, 3/1RHT	247	K1	2×1 Terry K-30s Ne T-20s Ne	K-0.15 cm T-0.30 cm	273
W2	10×16/76×57, 3/1RHT	291	K2	2×1 Terry K-20s Ne T-20s Ne	K-0.15 cm T-0.30 cm	330
W3	11×12/73×58, 3/1RHT	316	K3	2×1 Terry K-20s Ne T-20s Ne	K-0.15 cm T-0.28 cm	340

Where, K = knit loop, T = tuck loop,
Where, blue/indigo dyed yarn used at tuck loop and white yarn used as knit loop

under steady state conditions using sweating Guarded Hot plate test method according to standards ISO 11092:1993. Liquid moisture management properties were measured as per standard AATCC test method 195-2012. Pilling resistance of both woven and knitted fabrics and other surface changes were investigated using Martindale tester according to standard ASTM D4970/D4970M-10e1.

The measurements of thermal properties and moisture management were repeated 5 times and for air permeability was repeated 10 times. The average and SD of data were calculated for all tests. All the measurements were made under standard atmospheric conditions.

RESULTS AND DISCUSSION

The samples of woven and knitted structures were characterized according to the standard procedure.

Areal density

The term GSM of fabric means the weight of the fabric in grams per square meter (weight per unit area). It is also known as areal density. When yarn fineness increases its areal density decreases. This phenomenon is found common to all structures. The yarn linear density (yarn count) has direct relationship with fabric areal density. The areal density of knitted fabric for same structure of fabric decreases as the yarn count become finer and increases as the yarn count become coarser. As yarn count becomes finer, no of fibers/correction decreases so weight decreases.

Fabric thickness

The denim fabric thickness was determined by thickness tester and is given in figure 2. It shows a simple comparison of thickness of all the samples. As yarn count becomes finer, thickness decreases due to decrease of no of fibers/cross section. The knitted fabric is twice thick as compared to the woven structure. Knitted fabric is much thicker and softer than woven fabric as it has a complicated 3-dimensional structure. Knitted fabrics have loops and air space is present in the loop structure. In interloping structure, the old loop yarn has to pass over and under the new loop. By using tuck stitches in knitting, the fabric thickness increases as more yarn accumulate at the same point at clearing position. Also between sample K2 and K3, by changing stich length of tuck loop thickness increases.

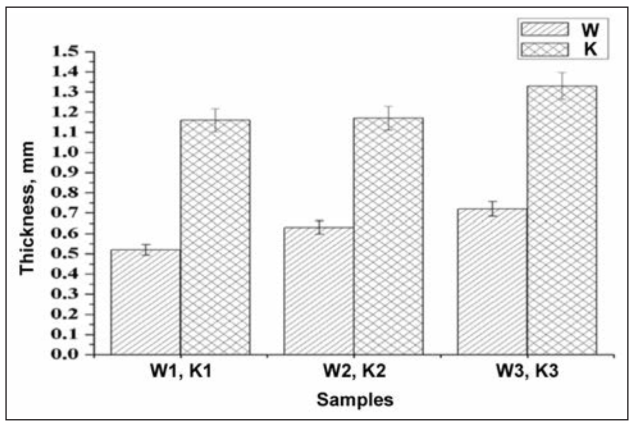

Fig. 2. Fabric thickness of woven and knitted denim

Air permeability

The air permeability of woven and knitted denim sample was performed and the test results are shown in figure 3. The air permeability of a fabric is a very sensitive indicator. Generally, the air permeability of a fabric can influence its comfort behaviours in several ways. The higher air permeability rate the quickest heat-loss obtained from a textile material. As the yarn count becomes coarser, fabric thickness increases so air permeability decreased. The results of the present study support the findings of previous studies [5–6]. The interloping structured of knitted denim allows more air to pass through the fabric. The results satisfy the facts that knitted structure have more porosity than woven structure, which cause higher air permeability value for knitted structure. Knitted fabrics have loops and air space is present in

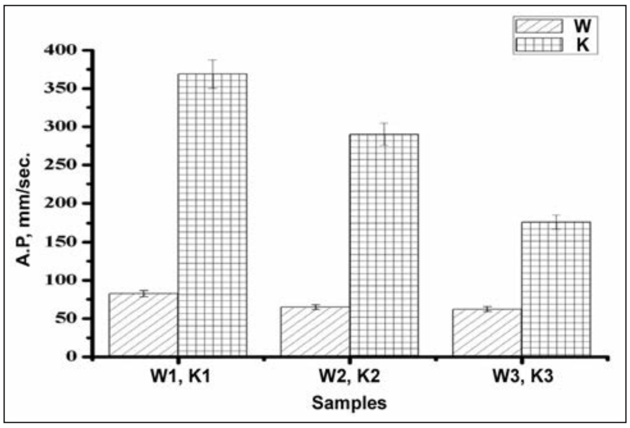

Fig. 3. Air Permeability value of knitted and woven denim

the loop structure. The permeability of fabric directly depends on the structure of the fabric (pore size and pore size distribution). The fabric having higher number of pores and pore size is more permeable [7].

Thermal resistance

The resistance results of all samples are shown in figure 4. As count become coarser more thermal resistance value achieved. It may be due to increase of hairiness thus increasing content of air pores between loops of yarns, which leads to clogging of air. Higher level of hairiness results in more physical entrapment of air pores which leads to increased thermal insulation [8].

The thermal resistance of knitted denim is higher as compared with woven denim. This is because of interloping structure of knitted fabric which provides the gaps. The air traps in these gaps gives the results of better insulation properties. Air is known to be less heat conductive as compared to any textile fiber. Thermal Resistance of fabric mainly depends on the resistance offered by entrapped air within the fabric and inherent thermal resistance of fiber content [9] as all fiber has same content i.e. cotton, the change in the thermal resistance cannot be attributed to the material. Fabric physical properties also effect thermal properties. A higher areal density of material also contributes to the increased thermal resistance. A thicker fabric also adds to the thermal resistance of the material.

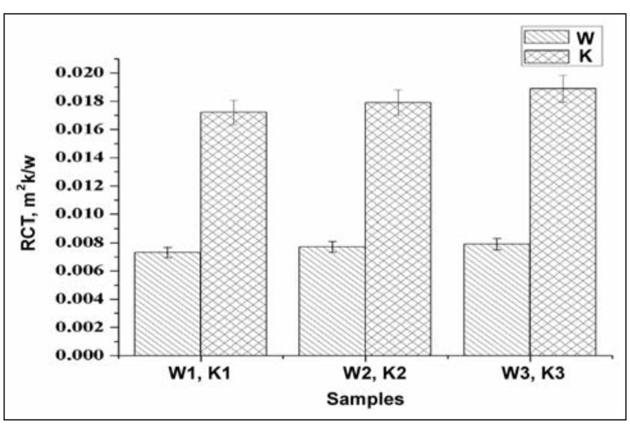

Fig. 4. Thermal resistance of woven and knitted denim

Liquid moisture management test

The Overall Moisture Management Capability (OMMC) of the knitted denim fabrics was determined using moisture management tester. A drop of test solution was dropped on the fabric surface and changes in the fabric liquid moisture content are measured in terms of electrical resistance. The moisture content changes quantify the dynamic liquid moisture transport in multiple dimensions [10]. This liquid moisture management test was performed using standard test of AATCC-195-2012. The results are shown in figure 5. As count become coarser moisture management properties (OMMC) decreased due to indirect effect of physical properties i.e. areal density and thickness.

The moisture transport properties of knitted structure are fairly good as compared to the woven denim. These results are attributed to the cross terry structure in which more yarn surface is exposed in the fabric as compared to woven in which the yarn is interlocked in the structure. It is obvious from the results that the knitted denim has higher value of OMMC as compared to the woven, and can rapidly remove the sweat from the body by transmitting it outside of the fabric.

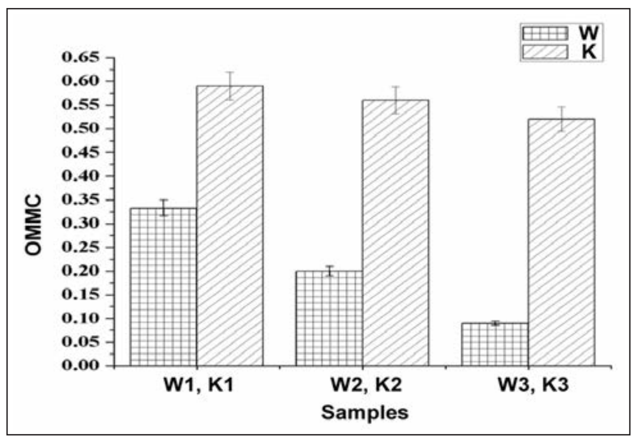

Fig. 5. OMMC results of woven and knitted denim

Pilling test

In pilling resistant test, the woven fabric shows better resistant to pilling as compared to knitted denim. The yarn that is used for making woven denim has higher twist (TPI) as compared to the knitted denim yarn. The results are shown in table 2.

Table 2

PILLING COMPARISON OF WOVEN AND KNITTED DENIM

Sr #	Pilling for woven	Pilling for knitted
1	3 (moderate)	2 (severe pilling)
2	2 (severe)	2-3 (moderate pilling)
3	3.5 (slight)	1-2 (v. severe pilling)

CONCLUSION

Knitted denim fabric and woven denim were produced to investigate the effect of certain parameters on their comfort properties (moisture management, air permeability and thermal properties. It was concluded that the knitted denim fabric exhibited better moisture management, air permeability and thermal resistance value. Although pilling resistance of woven denim is better than knitted denim. It was concluded that effect of yarn linear density also influence fabric properties. On the basic of results it can be concluded that knitted denim fabric performed better than woven structure on the basis of comfort and value. Moreover, the knitted denim provides economical products with higher potential growth for the said industry. The knitted structure can also provide variety of designs with overall better comfort values as compared with woven fabric structures.

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A comparison between Chinese finger trap and Roman sandals suture in peritoneal dialysis catheters for chronic kidney disease applied in veterinary medicine

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ABSTRACT – REZUMAT

A comparison between Chinese finger trap and Roman sandals suture in peritoneal dialysis catheters for chronic kidney disease applied in veterinary medicine

Catheters designed for chronic peritoneal dialysis have Dacron cuffs meant to protect the patient against bacterial infection and catheter migration that may lead to a high peritonitis rate in case of extensive use. Peritoneal catheter is fixed by suturing the skin with a non-absorbable monofilament thread ranging from 4/0 to 2/0. The two types of sutures most commonly used are Roman sandal and Chinese fingertrap. In this study we selected 44 dogs, both males and females with CKD (Chronic Kidney Disease) undergoing peritoneal dialysis. We have created two groups: first group (A) of 22 patients were treated using a peritoneal catheter for chronic treatment, with Roman sandal suture and the second group of 22 patients (B) were treated using a peritoneal catheter for chronic treatment, with Chinese fingertrap suture. All patients from group A kept the catheters until the end of the treatment (22 out of 22, 100%). Eight out of 14 patients (36.36%) from group B needed secondary suture. Four out of the eight patients (18.18%) form the group B needed secondary suturing because of the suture weakening. Three out of the eight patients (13.63%) form the group B needed secondary suturing of the catheter because of the skin rupture at the initial placement spot of the suture. One of the eight patients (4.54%) form the group B needed secondary suturing of the catheter because of the catheter replacement, due to the weakening of the suture and its lack of resistance to the aggression manifested by the patients.

Keywords: *peritoneal, dialysis, catheter, suture, polypropylene, veterinary*

O compariție între sutura Chinese fingre trap și Roman sandal utilizate la cateterele de dializă peritoneală în terapia bolii renale cronice aplicate în medicina veterinară

Cateterele pentru dializă peritoneală cronică au manșete de Dacron menite să protejeze pacientul împotriva infecțiilor bacteriene și migrării cateterului, care pot duce la o rată ridicată a peritonitei în cazul utilizării prelungite. Cateterul peritoneal este fixat prin sutura pielii cu un fir monofilament neabsorbabil, variind de la 4/0 la 2/0. Cele două tipuri de suturi utilizate cel mai frecvent sunt Roman sandal și Chinese fingertrap. În acest studiu, am selectat 44 de câini, atât masculi, cât și femele, cu BRC (bolală renală cronică) supuși dializei peritoneale. Am creat două grupuri: primul grup (A) din 22 de pacienți a fost tratat utilizând un cateter peritoneal pentru terapia cronică, cu sutură Roman sandal, iar al doilea grup de 22 de pacienți (B) a fost tratați utilizând un cateter peritoneal pentru tratamentul cronic, cu sutura Chinese fingertrap. Toți pacienții din grupul A au păstrat cateterul până la sfârșitul tratamentului (22 din 22, 100%). Opt din 14 pacienți (36,36%) din grupul B au nevoie de o sutură secundară. Patru dintre cei opt pacienți (18,18%) din grupul B au nevoie de sutură secundară din cauza slăbirii suturii. Trei dintre cei opt pacienți (13,63%) din grupul B au avut nevoie de sutură secundară a cateterului din cauza rupturii pielii la locul inițial de plasare a suturii. Unul dintre cei opt pacienți (4,54%) din grupul B a necesitat sutură secundară a cateterului din cauza înlocuirii cateterului, a slăbirii suturii și a lipsei de rezistență la agresiunea manifestată de către pacient.

Cuvinte-cheie: *peritoneală, dializă, cateter, sutură, polipropilenă, veterinară*

INTRODUCTION

Dialysis represents the separation process of a colloidal dispersion substance from molecular dispersion particles, based on the property of certain membranes to retain only colloidal particles [1–2].

Peritoneal dialysis is indicated in various cases of intoxication and metabolic abnormalities. It can also be employed to remove dialyzable toxins, such as ethylene glycol, ethanol, barbiturates, propoxyphene and hydantoin, as well as in cases of electrolyte imbalances, such as hyperkalemia [1, 3].

Dialysis is also indicated in patients showing acute nonanuric uremia, when blood urea nitrogen (BUN) reaches levels over 100 mg/dl or when creatinine is higher than 10 mg/dl [4].

Peritoneal dialysis is contraindicated in patients with peritoneal adhesions, fibrosis or abdominal malignant tumors [4].

The ideal catheter for dialysis allows for an adequate administration and evacuation of the dialysate, it determines minimum subcutaneous losses, it minimizes infection both in the peritoneal cavity and in the subcutaneous tissue [1].

Catheters for acute dialysis are placed percutaneously, under local anaesthesia, with the help of a stiletto and they require immediate heparinization. These catheters are usually straight with orifices at the distal end. Acute catheters generally do not have Dacron cuffs in order to protect the patient against bacterial infection and catheter migration, that may lead to a high peritonitis rate in case of extensive use [5–8].

Catheters for chronic peritoneal dialysis have specific models, both intraperitoneal and extraperitoneal, in order to reduce secondary effects and to minimize blockage. These catheters are made of silicon, rubber or polyurethane [2, 6].

Catheters designed for chronic peritoneal dialysis have Dacron cuffs meant to protect the patient against bacterial infection and catheter migration that may lead to a high peritonitis rate in case of extensive use [1, 9–10].

After the placement, the peritoneal catheter is fixed in place by suturing the skin with a non-absorbable monofilament thread ranging from 4/0 to 2/0. The two types of sutures most commonly used are the Roman sandal and the Chinese fingertrap [1, 11].

The most monofilament thread used in peritoneal dialysis catheter placement is polypropylene (PP). Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications. It is produced via chain-growth polymerization from the monomer propylene. Polypropylene belongs to the group of polyolefins and is partially crystalline and non-polar. Its properties are similar to polyethylene, but it is slightly harder and more heat resistant. It is a white, mechanically rugged material and has a high chemical resistance. Polypropylene is the second-most widely produced commodity plastic (after polyethylene) and it is often used in packaging and labelling.

Once surgically placed, in human medicine, peritoneal dialysis catheters should be used after at least 10 to 14 days. This period of time allows for wound healing, scar formation around the Dacron cuffs and minimization of dialysate leakage around the penetration site of the catheter. For obvious reasons, in veterinary medicine, peritoneal dialysis requires the immediate use of the peritoneal catheters, since most of the cases are major emergencies and they cannot be postponed for such duration of time [1].

In this study, we have tested peritoneal catheters surgically placed with two types of sutures: Roman sandal and the Chinese fingertrap.

MATERIALS AND METHODS

In this study we have selected 44 dogs, both males and females with CKD (Chronic Kidney Disease) undergoing peritoneal dialysis. The study started in January 2014 and finished in June 2019. All patients were tested for other associated pathologies and none of the selected patients presented other morbidities of infections of the peritoneal cavity or at the skin, around the catheter placement area.

The patients' age has two to 16 years old and the longest period that they were submitted to peritoneal dialysis has 18 months. The shortest period of treatment was 14 months.

The diseases that were treated were: CKD after acute intoxication with ethylene glycol, babesiosis, or CKD age induced.

We have created two groups of patients: first group (A) of 22 patients were treated using a normal peritoneal catheter for chronic treatment, with two Dacron cuffs and Roman sandal suture and the second group of 22 patients (B) were treated using a normal peritoneal catheter for chronic treatment, with two Dacron cuffs and Chinese fingertrap suture.

In both groups, the peritoneal catheters were placed under general anaesthesia and the catheters were placed using a surgical technique and they required immediate heparinization. The surgical placement of the catheter allowed the visualization of the abdominal cavity and it is useful in omentectomy. Surgical omentectomy was also recommended due to the high risk of catheter blockage by the omentum. Peritoneal dialysis catheters were trimmed (cut), resizing them at the desired level for entering the peritoneal cavity, in order to reach the bottom of the

Fig. 1. Roman sandal suture for the temporary peritoneal catheter in dogs with CKD (orig.)

Fig. 2. Chinese fingertrap suture for the permanent peritoneal catheter in dogs with CKD (orig.)

Douglas pouch. The catheters were pre-measured and, after being cut, they were inserted into the cavity. The abdominal muscles were sutured using an absorbable monofilament thread and the last suture, or a separate suture point, was anchored in the distal Dacron cuff of the peritoneal catheter. Subsequently, the anterior end of the catheter was passed through a subcutaneous lateral tunnel and it was exteriorized through the skin at 3–5 cm from the main incision line, so that the second Dacron cuff was located at subcutaneous level.

The catheters were fixed in place by suturing the skin with a non-absorbable monofilament thread ranging from 4/0 to 2/0, depending on the patient size.

We used Roman sandal technique in patients from the group A and Chinese fingertrap suture as in patients from the group B in order to place and maintain sutures.

After the placement of the catheters, all patients form group A and group B received special catheter bandaging and dressing of the wound. They also had a special corset to prevent the patient to reach the catheter and to be able to pull it from the peritoneal cavity. All the owners received the same training in catheter handling and patient and wound dressing.

After the initialization of the treatment in the Clinic, all patients were sent home with certain instructions for the owners and submitted to therapy made by the owners, after careful training.

All the patients were treated with the same peritoneal dialysis fluids, form the same medical company. The exchanges and the dwelling time were comparable between the patients.

RESULTS AND DISCUSSIONS

After analysing all the data form the patient undergoing peritoneal dialysis, we have reached important data. All cases were followed until fully recovered or end of treatment (death). All patients that died were still under peritoneal dialysis.

All patients from the first group, having placed normal peritoneal catheter for chronic treatment, with two Dacron cuffs and Roman sandal suture kept the catheters until the end of the treatment (22 out of 22, 100%). Eight out of 14 patients (36.36%) from the second group, having placed normal peritoneal catheter for chronic treatment, with two Dacron cuffs and Chinese fingertrap suture, needed secondary suture. Four out of the eight patients (18.18%) form the group B needed secondary suturing of the catheter because of the suture weakening. Three out of the eight patients (13.63%) form the group B needed secondary suturing of the catheter because of the skin rupture at the initial placement spot of the suture. One of the eight patients (4.54%) form the group B needed secondary suturing of the catheter because of the catheter replacement, due to the weakening of the suture and its lack of resistance to the aggression manifested by the patients.

The only disadvantage of the technique for placing the permanent dialysis catheters, comparing to the one using the percutaneous placement with local anaesthesia is a longer working duration for the procedure, higher costs, and a longer incision for the catheter placement.

Table 1

RESULTS OBTAINED AFTER ANALYSING ALL THE DATA FROM THE PATIENTS IN THE TWO GROUPS

Results	Group A		Group B	
	Number	Frequency (%)	Number	Frequency (%)
Suture weakening	0	0	4	18.18
Skin rupture	0	0	3	13.63
Catheter replacement	0	0	1	4.54
TOTAL	0	0	8	36.36

CONCLUSIONS

Using a permanent dialysis catheter needs longer work duration for the procedure, with higher costs, and a longer incision for the catheter placement, but with less risk.

In our study, all patients from the first group, having placed normal peritoneal catheter for chronic treatment, with two Dacron cuffs and Roman sandal suture kept the catheters until the end of the treatment (22 out of 22, 100%), which means that Roman sandal suture is a safer and stronger suture, this finding being similar with the research of Thornhill J.A. [9].

Four out of the eight patients (18.18%) form the group B needed secondary suturing of the catheter because of the suture weakening, which means that Chinese fingertrap suture is a less safe and stronger suture.

Three out of the eight patients (13.63%) form the group B needed secondary suturing of the catheter because of the skin rupture at the initial placement spot of the suture, which means that extra care is needed when suturing the skin at the initial point.

One of the eight patients (4.54%) form the group B needed secondary suturing of the catheter because of the catheter replacement, due to the weakening of the suture and its lack of resistance to the aggression manifested by the patients, which also means that Chinese fingertrap suture is a less safe and stronger suture, data being similar with the research of Kushwaha and Singh [10].

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Field research and methodologies for textile industry innovation in the context of European economy

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ABSTRACT – REZUMAT

Field research and methodologies for textile industry innovation in the context of European economy

This paper presents several aspects concerning the field and desk research based on the methodologies in the context of the European economy. Also, this work presents brief aspects about innovation, fundamental, applied research and needs of training in the textile sector for managers, students, assistant managers and experts from Romania. A survey-based on questionnaires and statistical analysis was performed, in order to achieve the landscape of training needs in the area of the Bucharest region.

Keywords: *textile, field research, methodology, economy, innovation*

Inovarea în domeniul cercetării şi metodologiilor pentru industria textilă în contextul economiei europene

În această lucrare sunt prezentate câteva aspecte privind domeniul şi instrumentele necesare cercetării pe baza metodologiilor impuse în contextul economiei europene. De asemenea, în cadrul acestei lucrări sunt prezentate pe scurt aspectele privind inovarea, cercetarea fundamentală, aplicativă şi nevoile de pregătire în domeniul textil pentru directori, asistenți manager, studenţi şi experţi din România. Pentru a obţine o viziune de ansamblu asupra nevoilor de cursuri în regiunea Bucureşti a fost realizat un studiu pe baza chestionarelor şi a analizei statistice.

Cuvinte-cheie: *textile, domeniul de cercetare, metodologie, economie, inovare*

INTRODUCTION

The innovation represents a new idea, method, device or a change made to an existing product, idea, or field. Many times the term innovation is confused with the invention term that represents a device, technology, or process generated after study and experimental part [1]. Several authors present innovation metaphorically as “creator and destroyer of industries and corporations”, describing a model of survival for companies, namely to keep a balance between supporting new and established innovations [2]. Also, innovation is described as a specific tool of entrepreneurs, how they exploit change as an opportunity for a different business or service. Besides, the entrepreneurs should search for the source of innovation, the change, and the opportunities for successful innovation. In this paper, innovation is defined as an “act that endows resources with a new capacity to create wealth. Innovation, indeed, creates a resource useful for something and thus endows it with economic value” [3].

Some researchers presented in antithesis the debut of the innovation product vs. process innovation, and they state that the “product innovation starts high and decreases rapidly and the process innovation increases over time” [4] (figure 1).

The innovation is defined as being “not simply developing new technologies into new products or services, but in many cases finding new models for doing business in the face of change”. For example, in 2006, “Threadless, an online T-shirt company founded in 2000, had profits of $6 million on revenues of $18 million, from T-shirts that had been designed, marketed, and bought by members of the public”. This business model user-centered is considered the most profitable in the clothing retail business [5].

The basic types of research are descriptive, analytical, applied, fundamental, qualitative and quantitative.

In 2011, Kumar, R., claimed that basic research consists “in developing and testing theories and hypothe-

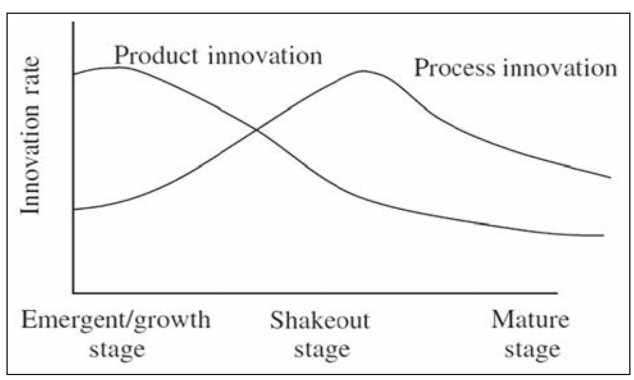


Fig. 1. The relative importance of product as opposed to process innovation throughout the industry life cycle. *Source*: Adapted from Abernathy and Utterback, 1978 [4]

ses that are intellectually challenging to the researcher but cloud or not to have a practical application at present or in the future". The hypotheses tested are based on very abstract and specialized concepts. Fundamental research also refers to the development, examination, verification, and refinement of research methods, procedures, techniques and tools for the research methodology [6]. The goal of fundamental research is to develop universal knowledge and to discover statistically significant correlations and effects [7]. The applied research is defined as the method of finding a solution for an immediate problem facing a society or an industrial/business organization [8]. Applied research develops information for clarifying or verifying an immediate social problem. "Fundamental and applied research differ in purposes, context and methods" (table 1). The applied research goal is to understand, to address problems and to discover practically significant effects or correlations [8].

Table 1

DIFFERENT CONTEXTS – FUNDAMENTAL VS. APPLIED RESEARCH	
Fundamental	**Applied**
Academic settings	Government, foundation, research institutes, business/industrial setting
Self-initiated	Client initiated
Funded by grants	Funded by contracts
Single researcher	Research team
Single discipline	Multidisciplinary
Lab or class	Field
Flexible	Inflexible
Lower cost sensitivity	Higher cost sensitivity
Less time pressure	More time pressure

BACKGROUND AND CONTEXT ANALYSIS OF RESEARCH & INNOVATION IN THE TEXTILE AND CLOTHING MANUFACTURING SECTOR IN EUROPE

The leading producers of textiles and fashion goods in the EU are Italy, Germany, France, Spain, Portugal, UK, Belgium, Poland, Romania, and Austria. They produce clothes, carpets, home textiles, cellulosic fibers and technical textiles used in various sectors [9–10]. In Europe, textile and fashion companies are predominantly SMEs. They directly employ 1.69 million people, 70% of whom are women. Romania is the 2nd largest employer in textile industry (figure 2).

The statistics regarding the total employment figures for the textile and clothing manufacturing industry in the European Union (EU28) from 2009 to 2018, split the employment by segment (man-made fibers, clothing, and textile). Of the three segments, the clothing manufacturing industry employed the most

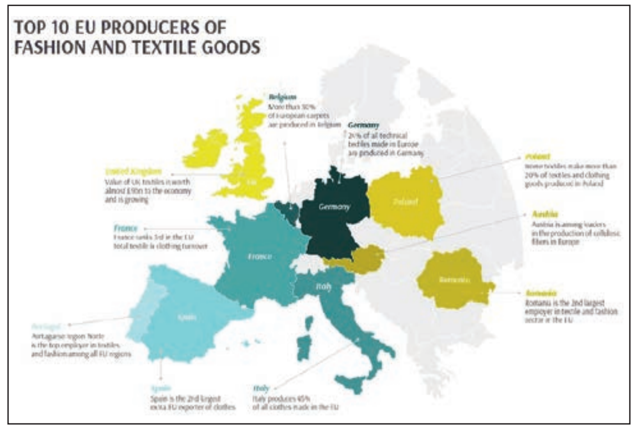


Fig. 2. European producers – top 10 [9]

significant number of people. In 2017, the clothing-manufacturing industry employed around 1.01 million people and in 2018, around 0.987 (figure 3). By analyzing the employment in the textile industry between 2009 and 2018 can be observed a decreasing tendency.

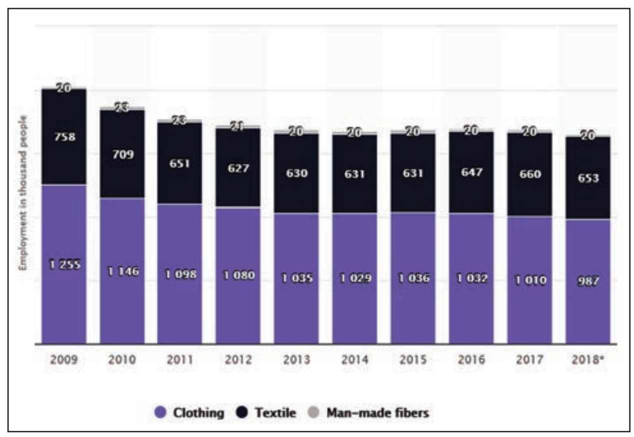


Fig. 3. Total employment in textile and clothing manufacturing industry in Europe 2009–2018 [10]

In figure 4 the statistic presents the main five global import markets for clothing coming from outside the European Union-28, ranked by their value from 2015 to 2018. China ranked as the leading clothing supplier, with imports to the EU valuing at approximately 29.9 billion euros in 2018. Among the various EU countries, the United Kingdom (UK) had the third-highest value of clothing imports in 2016, following Germany and France. This aspect is due to the prominence of leading clothing retailers, such as Primark and Next, which have a strong store presence in the country. As of September 2017 there were, for example, 182 Primark stores in the UK. The United Kingdom also has an active export market for clothing, albeit not as strong as its import values, with exports nearly doubling over 16 years, to 8.1 billion U.S. dollars in 2016.

This statistic shows the revenue of the manufacture of other textiles in Romania [12–14] by segment from 2010 to 2015, with a forecast to 2022. The global view shows that the revenue of the manufacture of other textiles in Romania will be approximately 1,113 million U.S. dollars by 2022 (figure 5).

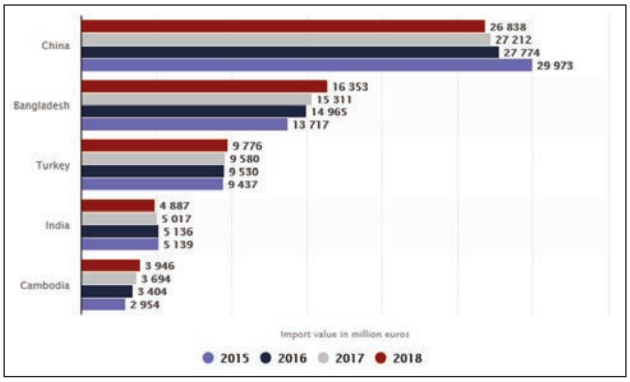


Fig. 4. The main five global import markets for clothing coming from outside the European Union-28, ranked by their value from 2015 to 2018 [11]

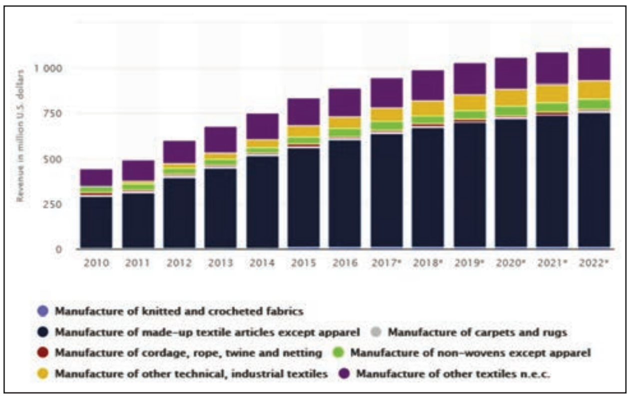


Fig. 5. Revenue of manufacture of other textiles in Romania by segment from 2010 to 2015, with a forecast to 2022 [12]

FIELD RESEARCH METHODOLOGY FOR BUCHAREST REGION

Our field research is based on survey questionnaires and was designed according to standard research methodology. The field research was applied to the following two groups of respondents:

- Group 1: Managers and professionals from T&C industries;
- Group 2: Relevant experts (experts from HEIs, VET professionals, intermediary organizations belonging to textiles and clothing sector).

The outputs of field research consist in info about:

- Perceived training needs related to research &innovation of managers and professionals of textile and clothing manufacturing industries;
- Perceived problems, challenges, new functionalities, gaps and mismatches existing in the sector;
- Inputs from HEI experts, VET professionals, intermediary organizations about the requested needs of the sector in terms of innovation.

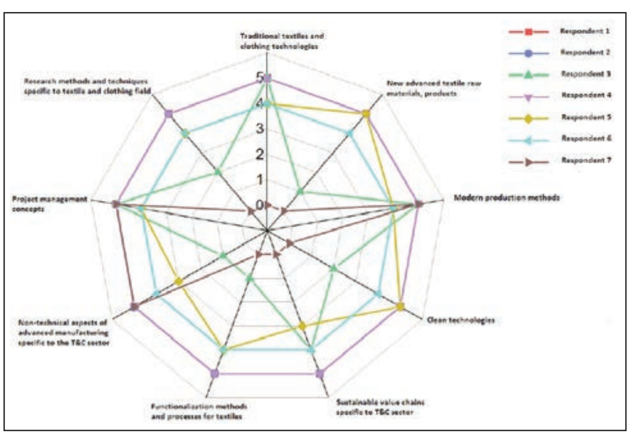
Perceived training needs related to research & innovation

Concerning the question about the staff needs further training related to research and innovation, 86% of respondents gave a definite answer while a respondent gave a negative answer. Concerning the perceived training needs, in the region Bucharest-Ilfov the answers distributions (figure 6, *a*) shows that it is a strong need for modern production methods and project management concepts, while for non-technical aspects of advanced manufacturing specific to the T&C [15–16] sector and traditional textiles and clothing technologies are considerable needs for training. Besides, it is a weak interest in training for functionalization methods and processes for textiles and sustainable value chains specific to T&C sector. All respondents have selected as considerable aspects such as creativity for the development of textile materials and products, digital skills, market trend analysis and risk management in R&D (figure 6, *b*).

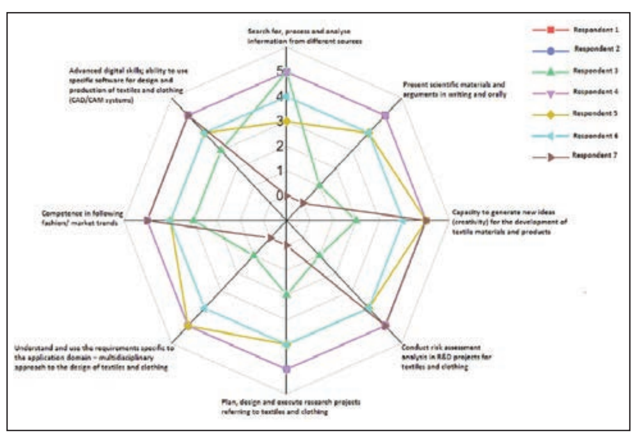
Perceived problems, challenges, new functionalities, gaps and mismatches existing in the sector

The perceived problems, challenges, and gaps were analyzed by using answers from experts and managers/professionals of textile industries involved in the survey.

The experts also specify that the companies do not frequently require R&D services and the request for project research does not come from companies to

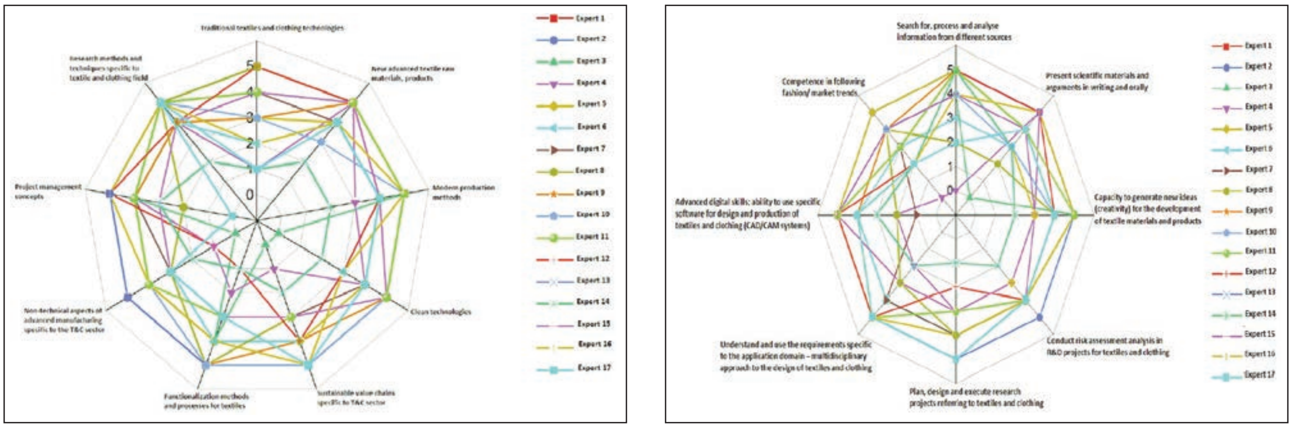


a



b

Fig. 6. Distribution of the answers about staff needs: *a* – answers impact for training needs; *b* – answers impact for skills and competencies needs



a *b*

Fig. 7. Distribution of the answers concerning training needs, skills, and competencies: *a* – answers for training needs from experts; *b* – answers for skills and competencies need from experts

institutes/universities because the companies are not very interested in research and innovation. Moreover, the researchers propose the research themes to companies. Also, experts claim that companies have insufficient experience in R&D.

Concerning the main problems/challenges about research and innovation in the T&C sector, 94% of experts consider that the main problems are the insufficient funds and the difficulties in accessing the fund for research and innovation, while 82% of experts consider as the primary problem lack of personnel specialized in R&D activities. Regarding the technology required for developing innovative products, about 76% of experts consider this aspect a real problem because new technologies are costly.

In the context of insufficiently applied research projects, 76% of experts consider that the main gaps consist in different visions regarding the research and innovation, while 70% of experts consider that the institutes or universities and companies have different research agendas and the companies do not trust concerning universities or institutes. Additional gaps observed by experts are:

- Lack of professionalism of the new T&C industries after 1995;
- The cultural and creative industries that emerged after 2005, are not recognized by the universities and the proper research.

Concerning the main problems, 86% of managers consider that the funds are insufficient and the access is difficult, while 57% consider that the absence of three key factors, such as technology, specialized personnel in R&D and the market for innovative products, represents a problem. Besides, 43% of managers consider that the problem consists of lack of IPR knowledge.

Regarding the main gaps about research and innovation, 71% of the managers consider that central gap consists in the fact that HEIs/research institutes and companies have different research agendas, while 57% consider that companies perceive research and innovation differently and 43% of the managers consider that are insufficient research projects.

Inputs from HEI experts, VET professionals, intermediary organizations about the requested needs of the sector in terms of innovation

By analyzing the mean values for the scores provided by experts for training needs (figure 7), it should be noted that the experts consider that the essential training programs are related to research methods and techniques specific to textile and clothing field, new advanced textile raw materials and products and modern production methods. With a score below four, the experts appreciate that clean technologies and project management are essential.

By analyzing the mean values for the scores provided by experts for skills and competencies needs (figure 7, *a* and *b*), it is evident that the experts consider as relevant competencies the capacity to analyze and understand the information, creativity, digital skills, and risk analysis. Regarding the innovation in the T&C sector, 14 experts consider that innovation in the T&C sector should refer to both technological and non-technological innovation.

In addition, we received from experts supplementary suggestions concerning:

- **Training needs:**

The first suggestion was to learn how to elaborate validation method accredited by RENAR.

The second suggestion was to introduce new courses about textile ecology and circular economy based on textile recycling.

The third suggestion was to introduce basic concepts about human-centered production, social design, industrial design and T&C Business.

- **Skills and competencies:**

The suggestion is to develop or improve skills such as the ability to analyze, synthesize contradictory information and visionary thinking.

CONCLUSIONS

In conclusion, the experts have indicated certain aspects of improvement, such as:

- The selected training needs should be the starting point for adaptation or creating new courses.

- The results of this survey must be addressed to the companies, research institutes, universities, and all policymakers.

Also, some experts consider that should be more issues addressed by deliverable, such as:

- The distribution of age groups in research;
- The percentage of public funding about private financing;
- The need to work in a research team with members having a high level of scientific expertise.

This study is useful for educational institutions (universities, institutes of technology, academies), enterprises (suppliers, R&D centres, innovation lab, pools), public bodies (chambers of commerce, local governments, professional associations) and users (students, manufacturing companies, creative companies, teachers, researchers, designers, project managers) at European, national and regional levels.

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Development of an inexpensive functional textile product by applying accounting cost benefit analysis

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ABSTRACT – REZUMAT

Development of an inexpensive functional textile product by applying accounting cost benefit analysis

This research is to utilize accounting cost benefit analysis for manufacturing of economically cost-effective cut resistant gloves knitted from core spun yarns made up of nylon and polyester with E-glass as core. E-glass has a significant impact on the cut resistance and abrasion resistance of the gloves. The gloves are knitted by using core spun yarns, and tested for their physical, cut & abrasion resistant properties. Economic characteristics of final product are critically observed and analysed through cost benefit analysis. Results elaborate that Polyester/E-glass hand gloves have special mechanical properties like Abrasion resistance and Blade cut resistance. Instead, Nylon/E-glass hand gloves have good air permeability. Cost benefit analysis reveal that the outcomes are comparable to functional requirements within low cost.

Keywords: *cost benefit analysis, gloves cut resistance, abrasion resistance, core spun yarn*

Dezvoltarea unui produs textil funcțional convenabil prin aplicarea analizei cost-beneficiu

Acest studiu are ca scop utilizarea analizei cost-beneficiu pentru fabricarea mănușilor rezistente la tăiere, convenabile din punct de vedere economic, tricotate din fire filate din nailon și din poliester cu miez din E-glass. E-glass are un impact semnificativ asupra rezistenței la tăiere și a rezistenței la frecare a mănușilor. Mănușile sunt tricotate folosind fire filate cu miez și sunt testate pentru proprietățile lor fizice, precum rezistența la tăiere și rezistența la frecare. Caracteristicile economice ale produsului final sunt observate și analizate în mod critic, prin analiza cost-beneficiu. Rezultatele arată faptul că mănușile din poliester cu miez E-glass prezintă proprietăți mecanice, precum rezistența la frecare și rezistența la tăiere. În schimb, mănușile din nailon cu miez E-glass prezintă permeabilitate la aer ridicată. Analiza cost-beneficiu relevă faptul că rezultatele sunt comparabile cu cerințele funcționale, păstrând costurile reduse.

Cuvinte-cheie: *analiza cost-beneficiu, rezistența la tăiere a mănușilor, rezistența la frecare, fir filat cu miez*

INTRODUCTION

Individuals employed in high mechanical risk areas are bare to hurts and leads to major harm to human life, machinery and material. Principally, hands and arms face most of the hazards, which stimulated development of protected gloves and sleeves. Protective gloves manufactured from HDPE and Nylon blended yarns are the superlative but expensive [1].

The cost benefit analysis estimates the overall values of a proposed project and then evaluates its effectiveness that how a much a project is beneficial in terms of cost and generate maximum revenue [2]. It may be calculated as:

$$NPV = (1 + r)^t \quad (1)$$

NPV is the net present value.

There is no unravelling problem in steel core yarns which offer better cut and abrasion resistance, but steel is a metal which conducts heat and electricity and limits there use in controlled conductive conditions [3].

Leather and wire mesh steel gloves are being manufactured from many years providing protection but are not comfortable to wear. Invention of high-performance fibers and polymers made room for manufacturing of engineered fabrics for protection competing with conventional materials [4].

The need of time is to build a product with protection, comfort and low cots all in one. Fiber structures, yarn structures and mechanical properties of fiber are the most dominant aspects to shape goods for protection against clean & sharp edge cuts [5].

Cut resistance is the ability of material to withstand impairment when challenged with a moving sharp-edge object. The total energy obligatory to proliferate a cut majorly subject to the coefficient of friction among the cutting edge and the material [6].

Protection against cut can be enhanced by increasing material weight of constituent materials, using high performance materials or by means of composite yarns in various blends of stainless steel, fiberglass and synthetic yarns. Weight is directly proportional to flexibility, affecting hand fatigue. Finishes and coatings can be applied on the outer surface of gloves to enhance grip on slipping surfaces [7–8].

High performance polyethylene filament, HPPE staple fibers, fiberglass, stainless steel, polyester, polyamide and cotton are being used to produce composite yarns for cut resistant textile products. The ultimate objective is to meet the cut resistance values as per European standard EN388 (1994) [9].

E-glass in blend with Polyester or Nylon composite yarns doesn't have many applications in this area. Such combinations have not been studied before and now this research gap will be filled through this study by combining high performance properties of glass fiber along with some normal filaments like polyester and nylon for cost benefits and flexural properties in final product [10].

Composite yarns or core spun yarns are comprised of two elements; the core, which is most of the time a synthetic monofilament yarn surrounded by the second constituent, a staple fiber sheath [11].

The core component gets zero to low twist level and promises to provide high strength of the yarn while the out sheath of staple fibers provide physical properties to yarn surface [12].

Friction spinning system can produce a wide range of composite yarns with core-sheath concept, through selective blend options of diverse materials in the core and sheath with linear density of Ne 1s to 18s, having transfer speeds up to 300 m/min [13].

H.W. Krausa, H.A. Soliman and H. Stalder also provide a detail study to explain the yarn manufacturing process in friction spinning [14]. Nathaniel H. Kolmes developed composite yarns from single glass fiber strand with linear density of yarn denier ranging from about 1800 to about 5000. This yarn provided the flexibility to knit along with good cut and abrasion resistance properties [15–16].

Another study from Jeffery W. Simons, Hyung-Seop Shin, Donald A. Shockey, and David C. Erlich elaborates the cut resistance of some yarns manufactured form high performance fibers like Spectra, Kevlar and Zylon [17]. This was done under shear-tension loading mechanism by penetrating a blade like knife in transverse direction of yarns at a constant rate while each yarn was firmly held from both ends in jaws [10]. It was found that the strain to initiate a cut and total energy required to cut are highly affected by the blade sharpness, yarn tension between both jaws and finally the slicing angle. It was observed that Zylon has superior cut resistance in contrast to Kevlar and Spectra at all combinations of above three parameters.

Ramesh Kumar used a blend of polyester and viscose fibers with 70:30 blend ratio as a sheath element and 36 drawn polyester filaments of 150 denier as core components of a composite yarn. It was concluded that the composite yarn is more even along with high modulus in comparison to simply friction spun yarn [18].

There is a study to diverse types of para-aramid fibers classified on their origin; Virgin Kevlar fibers, 2nd grade Kevlar fibers and recycled Kevlar fibers. It is observed that cut resistance is same for all three because of the similar transverse characteristics of fibers and fibrils generated on the surface of yarns during regeneration process which play key role in cut resistance property of knitted fabric. The abrasion resistance test exhibits that virgin Kevlar fibers lose 10%, 2nd grade fibers lose 12% and recycled Kevlar lose 40% weight in 1st 1k cycles of abrasion resistance. But recycled fibers provide cost benefit [19].

MATERIALS & METHODS

E-glass, nylon and polyester are used to produce composite yarns with different blend ratios.

E-glass is the most inexpensive glass fiber and is used when high electrical resistance and strength are the key requirements. Glass fiber has a more specific resistance compared to steel.

Silica, SiO_2, is the major constituent of glass, but variable volumes of dissimilar metal oxides are also involved in configurations for diverse usages. Silica forms an amorphous network upon solidification, thus capturing metal atoms. Glass fiber softens at temperature around 800°C [7, 20].

The chemical forces inside the amorphous inorganic glass play key role in its high modulus of 70–80 GPa (table 1). This high value of modulus is the primary reason for the use of glass filament in the manufacturing high performance composite yarns.

Table 1

MECHANICAL PROPERTIES OF THE USED GLASS CORE

Parameter	Value
Filament Denier	100
No. of filaments per yarn	212
Twist (TPI)	1.05
Tensile strength (GPa)	5.96
Tensile modulus (GPa)	76
Density (g/cm^3)	2.58
Elongation at break (%)	4.85

Glass is brittle in nature due to which it can't be used as a yarn in textile, predominantly it is not possible to knit gloves where yarn undergoes numerous turns and twists during knitting process. When it is used in core in composite yarns, glass provides brilliant performance results. And now it is being used in manufacturing of knit gloves and fabrics for cut resistant and flame-retardant applications.

Nylon is one of the most broadly used synthetic fiber with reasonable tensile strength and very good abrasion resistance. The latter one makes it a good material for safety gloves. The properties of nylon staple fibers used for this study are presented in table 2.

Polyester is most widely used synthetic fiber with unique properties of low cost, moderate tensile

Table 2

PROPERTIES OF USED NYLON STAPLE FIBERS	
Parameter	**Value**
Tenacity (g/den)	8.6
Fineness (den)	2.6
Staple length (mm)	50
Moisture regain (%)	4
Elongation (%)	15
Density (g/cm^3)	1.14

strength, good abrasion resistance in textured form and has broad chemical resistance. It is also available in various forms, types and classifications. But polyester has low melting and glass transition temperature and it is prone to burning risk. But in form of various bends with other fibers it is good for controlling the cost of a composite yarn. Cost benefit is the major objective of study and polyester will play important role in it. The properties of polyester staple fibers used for this study are presented in table 3.

Table 3

PROPERTIES OF USED POLYESTER STAPLE FIBER	
Parameter	**Value**
Tenacity (g/den)	6.8
Fineness (den)	1.2
Staple length (mm)	50
Moisture regain (%)	0.4
Elongation (%)	22
Density (g/cm^3)	1.37

Equipment

Spinning preparatory process blow room, card and draw frame are utilized for sheath materials. This sheath was then combined with core material the glass fiber at friction spinning machine to produce composite yarns.

Lakshmi Fine Opener consisting of manual feed mechanism with a spiked beater of 320 mm, diameter revolving at 750 rpm with production rate of 220 kg/h was utilized at blow room. Carding process consisted of Lakshmi LC363 card machine with chute feed system directly connected with blow room line.

Reiter RSB-D40 was utilized as drawing frame with auto-leveler and capable to process stable fibers in the range 22–62 mm.

Dref-3000 friction spinning machine having six spindles have been utilized for composite yarn manufacturing through friction spinning. This machine is capable to produce core spun yarns at delivery speed of 300 m/min. Yarn is directly wound onto the cone package of 1.5 kg.

Shima Seiki SFG-I flat knitting machine was used to produce knitted gloves. It is the latest automatic seamless gloves manufacturing machine with original sinker system, durable needle bed and lubrication system. 180 rpm speed is utilized for fingers while 105 rpm at palm knitting stage.

Fingers of the glove are knitted in a tubular style, with different lengths as per fitting to human hands. The connection point between the fingers is critical because there are the chances of hole between the fingers. To overcome this issue and link fingers with palm and on another cross linking of loops is done at the edges of fingers. Thumb finger is knitted at the end of all fingers and palm knitting as no needles are free to make it before. The joining of palm and thumb finger is done by split transfer in knitted tubular row.

Then the palm of glove is shaped from both edges to narrow down to fit a human hand or wrist It is done by sequential tapering of the tubular knitted fabric by transporting some loops inside the fabric through the two needle beds. The rows between the two tapering activities, the steps involved in transfer toward the inside of the fabric and the number of transferred stitches effect the narrowing process of glove at knitting machine. These are the critical factors to control.

Testing of gloves has been done at following equipment:

- Abrasion Resistance testing under ASTM D4966-98 done at Martindale abrasion tester.
- USTER Tensorapid for testing of tensile strengths of yarns.
- Coup test utilized for testing of cut resistance as per EN 388-2003.
- Air Permeability test performed as per EN 9237.

Methods

Two sheaths of polyester and nylon were prepared for the manufacturing of core spun yarn to be used in manufacturing of knit gloves. The physical and mechanical properties of these yarns and gloves were analyzed to compare the impact of varying sheath material.

To prepare the sheath material for the composite yarn, Polyester fibers were fed to the Lakshmi Fine Opener after manual opening of fibers revolving at 750 rpm under 55% relative humidity and 29°C temperature.

Opened fibers form a batt at the chute feed mechanism just before the carding machine and evenly fed to the taker-in zone of Lakshmi LC363 carding machine. Critical carding machine settings involve taker-in speeds revolving at 700, 1100 and 1500 rpm respectively, distance between feed plate and taker-in which was 0.05 inch, speeds of cylinder and top set operating at 500 rpm and 4.5 inch/min respectively, the gauge between top-set and cylinder set to 0.009 inch at front and 0.013 inch at back. Carding was done at 57% relative humidity and 28°C temperature at production rate of 22.5 kg/h at 90m/min delivery speed with 93% efficiency.

The 62 grains/yd carded was fed at Toyoda Breaker Draw Frame to produce 60 grains/yd drawn sliver at 280 m/min delivery speed at 80%. This drawn sliver was then fed to another finisher draw frame Reiter RSB-D40 operating at 320 m/min with 85% efficiency. Similar process is used for both Nylon and Polyester Sheaths.

Six slivers were fed to the opening zone of the friction spinning machine to form the sheath around the core of glass fiber. The opening zone was incorporated with a carding drum have a tooth wire structure. One core sliver was passed through the drafting zone to form the bottom cover over core filament. Both core and sheath slivers form the sheath portion of composite yarn.

E-glass filaments were fed from below to form the core of composite yarn. E-glass filaments of 100 denier were used to make the count of 75 tex at 62% RH and 27°C. Yarns are then coded for better understanding in subsequent testing. Polyester with glass core named as PG and Nylon with glass core named as NG Assigned Coding is given in table 4.

Table 4

CODING		
Sample identity	Linear density (tex)	Core denier
PG	74	100
NG	74	100

Delivery and spinning speeds were optimized to achieve the final composite yarn count while the opening zone speed was kept constant for all specimens. Only sheath material proportions were changed to adjust the final yarn linear density.

Each composite yarn was used to manufacture six pairs of glove samples on gloves knitting machine. Each glove was made by feeding two ends of a composite yarn at the same time. Yarn feeding rate and courses per inch (CPI) were kept constant for each sample made from each composite yarn to ensure all the parameters at gloves stage do not change.

For each composite yarn fed to the knitting machine, feed rate and CPI were kept same irrespective of change of sheath material. Production details of making gloves from Polyester/Coolmax, Nylon/Coolmax as sheath and Glass as core are described in table 5.

TESTING

Yarn samples

Breaking force, elongation at break, breaking time and tenacity are assessed for yarn samples at standard atmosphere conditions of 22°C temperature and 65% relative humidity.

Glove samples

Gram per sq. Meter mass (GSM) of gloves was measured by cutting two square inch fabric from each glove and then weighed to calculate GSM by given formula:

$$GSM = \text{Weight in grams} \times 775 \qquad (2)$$

Table 5

PRODUCTION DETAILS OF MAKING GLOVES				
Sample identity	Glove specs length × width (mm)	End points	WPI/CPI	GSM
PG	240 × 100	2	7 / 7	295
	240 × 100	2	7 / 7	297
	240 × 100	2	7 / 7	296
	240 × 100	2	7 / 7	295
	240 × 100	2	7 / 7	298
	240 × 100	2	7 / 7	295
NG	240 x 100	2	7 / 7	290
	240 × 100	2	7 / 7	292
	240 × 100	2	7 / 7	292
	240 × 100	2	7 / 7	292
	240 × 100	2	7 / 7	291
	240 × 100	2	7 / 7	292

Cut resistance and air permeability tests were performed as per standards.

RESULTS

Yarns

A significant change has been observed in mechanical properties of composite yarns with change in sheath material. These mechanical properties along with yarn coefficient of variation are listed in table 6.

Table 6

YARN MECHANICAL PROPERTIES					
Yarn sample code	Breaking force (cN)	CV (%)	Tenacity (cN/tex)	CV (%)	Elongation at break (%)
PG	821.6	4.61	11.29	4.75	2.61
NG	725.7	11.28	9.78	12.01	2.35

Table shows the comparative analysis of elongation at break of both the composite yarns (GCP & GCN) obtained by changing the sheath type.

Analysis shows significant change in breaking force while changing sheath type from Nylon to Polyester due to the greater tensile strength of Polyester than Nylon.

Effect of changing sheath type on tenacity is not significant for composite yarns because yarn tenacity is mostly dependent on core material type and size.

Gloves

Abrasion resistance tested at Martindale abrasion tester in accordance with ASTM D4966-98 shown below results (table 7).

Cut resistance measured by coup test in accordance with EN 9237 shows below results (table 8).

For both the gloves made from both the composite yarns, good air permeability was achieved. GCN

Table 7

TESTED ABRASION RESISTANCE						
Sample code	**Abrasion resistance cycles**					**Level achieved**
	1st	2nd	3rd	4th	Avg.	
PG	2.2k	2.2k	2.3k	2.2k	2.2k	3
NG	2.6k	2.7k	2.7k	2.6k	2.6k	3

Table 8

TESTED CUT RESISTANCE						
Sample code	**Cut index values**					**Performance level**
	1st	2nd	3rd	4th	Avg.	
PG	9.23	9.86	9.76	9.98	9.7	3
NG	9.39	7.92	8.41	9.78	8.87	3

gloves, made by using Nylon in sheath with Coolmax, show better air permeability performance as compared to GCP made by using Polyester in sheath with Coolmax.

Table 9

TESTED AIR PERMEABILITY				
Sample Code	**Face (mm/s)**		**Back (mm/s)**	
	1	2	1	2
PG	259	269	269	247
NG	356	383	367	358

Accounting cost benefit analysis

New developed gloves are very beneficial regarding cost in mid-range applications in contrast to aramid and steel core gloves. Values for aramids and steel core gloves are taken as per market average sale price for comparison with the cost of new product.

Table 10

COST BENEFIT ANALYSIS INDICATORS		
Glove type	**Development cost**	**Cost benefit (%)**
Steel core	70$	0
Aramids	58$	18
PG/NG	34$	51

CONCLUSION

It is concluded that the newly developed cut resistance gloves are inexpensive and user friendly with achievement of Level 3 in cut resistance. In view of cost benefit analysis, it is obvious that almost 50% cost is saved in this product in contrast to steel core and aramid based cut resistant gloves of same levels. No doubt, this product may not perform up to the mark where the requirement is cut level 5 but up to the level 3, this will compete with its costly counterparts. Cost benefit analysis has also helped to conclude and compare the outcomes with more clarity. It is also recommended to use some other cellulose-based fiber blends with glass core to improve comfort properties along with functional performance level.

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Simulation and characterization of circular hexagonal braiding fabric structure

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ABSTRACT – REZUMAT

Simulation and characterization of circular hexagonal braiding fabric structure

Hexagonal braiding technology is a kind of state-of-the-art braiding method, which uses hexagonal horngears to drive yarn carriers and make yarns intertwined into fabrics. In terms of hexagonal braiding principles, the braiding parameters like initial arrangement of yarn carriers, yarn number and horngears sequence were defined, and then the movement paths of yarn carriers in hexagonal braiding process and stitch length were obtained, which could be converted into coordinates on the xoy plane and the coordinates along z-axis. In that case, a group of spatial coordinates were got to create the yarn trajectories and fabric structures in Matlab. And then, B-spline curve was utilized to fit the yarn trajectories. Considering the compactness of hexagonal fabric, the coordinates conversion algorithm and conversion matrix were utilized to optimize the fabric structure, so a more compact fabric structure was established. The braiding angle variation and volume fraction of fabric showed that after coordinates conversion the braiding angles became more stable than original fabric model, and the fiber volume fraction of fabric was improved too. So the fabric structure model was available to describe hexagonal fabric structure, which can offer the reference for the further study on properties of hexagonal braiding technology and application of hexagonal braided fabric.

Keywords: *Matlab simulation, coordinates conversion, algorithm, braiding angle, volume fraction.*

Simularea și caracterizarea structurii împletiturii tubulare hexagonale

Tehnologia de împletire hexagonală este o metodă de împletire de ultimă generație, care folosește angrenaje cu discuri dințate hexagonale pentru a antrena conducătorii de fir și a realiza încrucișarea firelor în împletitură. În ceea ce privește principiile împletirii hexagonale, s-au definit parametrii de împletire, precum dispunerea inițială a conducatorilor de fir, numărul de fire și succesiunea discurilor, apoi s-au obținut traiectoriile de mișcare ale conducătorilor de fir în procesul de împletire hexagonală și lungimea segmentului de legare a firului în cadrul împletiturii, care ar putea fi transformate în coordonate pe planul xoy și coordonate de-a lungul axei z. În acest caz, un grup de coordonate spațiale a fost obținut pentru a crea traiectoriile firelor și structurile împletiturii în Matlab. Ulterior, curba B-spline a fost utilizată pentru a fixa traiectoriile firelor. Referitor la compactitatea împletiturii hexagonale, algoritmul de conversie a coordonatelor și matricea de conversie au fost utilizate pentru a optimiza structura împletiturii, astfel încât s-a stabilit o structură mai compactă a împletiturii. Variația unghiului de împletire și fracția volumică a împletiturii au arătat că, după conversia coordonatelor, unghiurile de împletire au devenit mai stabile decât la modelul original al împletiturii, iar fracția volumică a împletiturii a fost optimizată. Astfel, modelul de structură a împletiturii a fost utilizat pentru a descrie structura hexagonală a împletiturii care poate sta la baza studiului suplimentar asupra proprietăților tehnologiei de împletire hexagonale și a domeniilor sale de aplicare.

Cuvinte-cheie: *simulare Matlab, conversia coordonatelor, algoritm, unghiul de împletire, fracția volumică*

INTRODUCTION

Braided fabrics are widely used in different industrial areas, because of its high specific strength, specific modulus and damage tolerance [1–3]. Traditionally, there are two methods to fabricate braided fabrics, one is track-column braiding, and the other one is rotary braiding [4–6]. Researchers study on fabric fabrication process and fabric structures in order to analyse the mechanical properties of braided fabrics. Frank Ko put forward the hexagonal braiding theory in 2008, which used hexagonal horngears as drive mechanism to move yarn carriers and fabricate fabrics. And then, University of British Columbia and RWTH Aachen University built the hexagonal braiding loom, and gave the basic definition of hexagonal braiding. Theoretically, hexagonal braiding technology can be utilized in many complex shapes fabrics braiding, and it has great potential in net-shaped preform fabrication [7–8]. However, the fabric structures and the characterization of hexagonal fabrics have not been studied further yet. In order to study the characterization of hexagonal fabrics, it needs to establish the model of hexagonal fabrics. Based on Matlab, the fabric structure is easy to be simulated in the software. In some references, the simulation process is complicated, because varied programming tools were combined together, which decreased the flexibility of structural model establishment [9–11]. In this paper, a conversion algorithm was proposed to simulate the hexagonal braiding structure according to the characterization of circular hexagonal fabric.

METHOD AND DISCUSSION

The hexagonal braider and braiding principles

The yarn carriers are aligned in gaps among hexagonal horngears, as shown in figure 1, *a*. When motors drive horngears, yarn carriers will move in the gaps and make the yarns intertwine in space to fabricate fabric. The hexagonal braider in University of British Columbia (UBC) was shown in figure 1, *b*. Generally, researchers tried to establish the yarn model through spatial coordinates on yarn trajectory, and the spatial coordinates were determined by every position of yarn carriers' movement and the take-up speed [12–13]. So it needs to confirm horngear rotation sequence, initial positions of yarn carriers and take-up speed for hexagonal fabric structure establishment. And then, these parameters could be converted into spatial coordinates (x_i, y_i, z_i) on yarn trajectories. The arrangement of horngears and yarn carriers was shown in figure 1, *c*, there were 30 yarns arranged circularly on the bedplate. The braiding principle is that the horngears 1-1, 1-3 and 1-5 rotated clockwise, and then horngears 1-2, 1-4 and 1-6 rotated counter-clockwise, these two groups of horngears cannot rotate at the same time, but rotated one by one. The angles of every rotation are 60 degrees. So the paths of yarn carriers can be traced (figure 1, *d*), all 30 yarns would move as two groups equally in two close paths, red path and blue path.

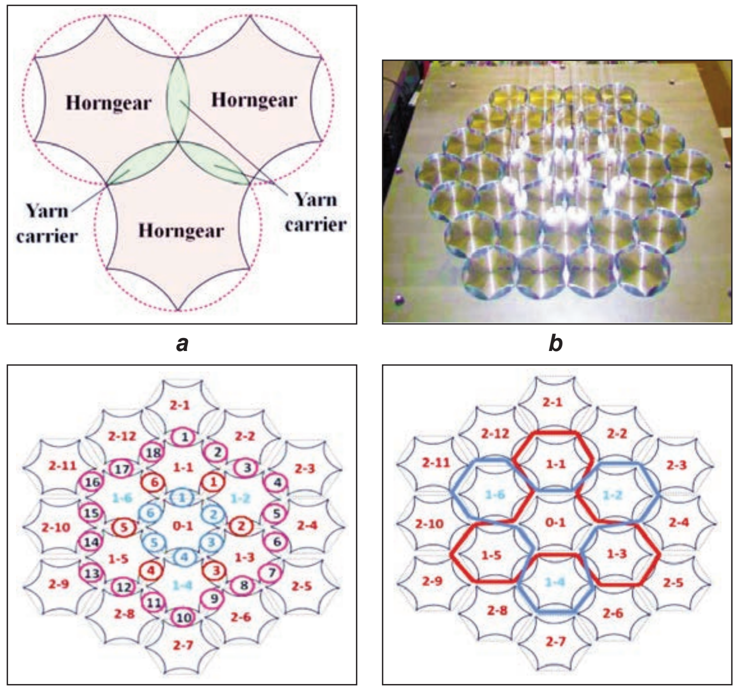


Fig. 1. Hexagonal braiding method: *a* – relationship of horngears and yarn carriers; *b* – hexagonal braider; *c* – braiding bedplate and yarn carriers' positions; *d* – paths of yarn carriers

The coordinate system of braiding bedplate and yarn trajectory fitting

Following the sequence of horngears rotation, yarn carriers move between horngears, which can drive yarns intertwined into fabric. Therefore, during braiding process yarn carrier position of every step can be converted to correspondent coordinates to depict the yarn's trajectory. The coordinates of every position on the braiding bedplate can be defined as in figure 2, *a*. The yarns moved along with yarn carriers, which included the planar movement on plane *xoy* and the vertical movement along *z* axis, and also, the take-up speed was related to the stitch length and braiding angle of fabric. If the yarns in fabric were defined as $yarn_i$, the coordinates of $yarn_i$ on plane *xoy* could be defined as (x_i, y_i), while the coordinate of *z* axis was defined as *b*. So the spatial coordinates of $yarn_i$ at step *N* is (x_i, y_i, b), and the matrix size of $yarn_i$ in one braiding cycle was $3 \times N_{max}$. All the coordinates along yarns were connected with short lines to create original yarns trajectories. The original yarn trajectories were only based on the movement steps of yarn carriers and not smooth. So the B-spline was utilized to fitting yarn trajectories to make them smoother through extract data points in coordinates matrix (figure 2, *b*).

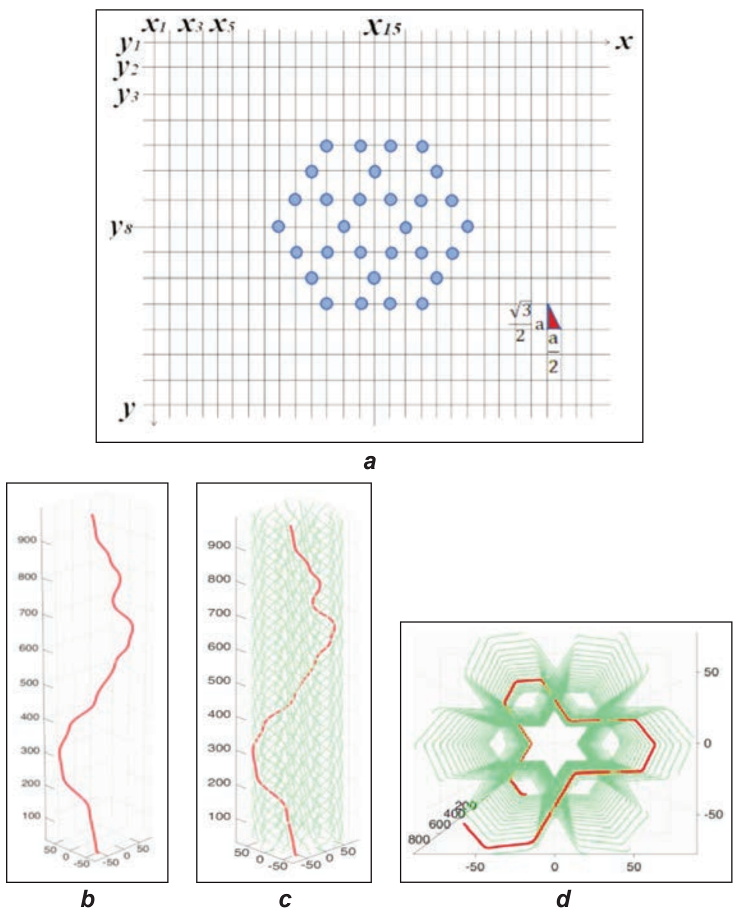


Fig. 2. Bedplate geometry and fabric model: *a* – coordinates of bedplate; *b* – single yarn; *c* – side view of fabric; *d* – top view of fabric

The fabric model establishment and coordinates conversion

If the shape of the yarns' cross-sections was round and had the same diameters along the yarn, the part of original model was shown as in figure 2, *c*. In this model, the distance between yarns was large, which only could stand for the intertwining pattern of yarns. Considering the jamming of fabric would lead to the yarns' displacement in radial direction of cross-section, the conversion function for yarns in radial direction should be:

$$\begin{cases} x' = \rho_{i1}\cdot x\cdot \cos(g) - \rho_{i1}\cdot y\cdot \sin(g) \\ y' = \rho_{i2}\cdot x\cdot \sin(g) + \rho_{i2}\cdot y\cdot \cos(g) \\ z' = \rho_{i3}\cdot z \end{cases} \tag{1}$$

Where $[x', y', z']^T$ and $[x, y, z]^T$ were the yarns' coordinates after and before conversion, g was the conver- sion angle and ρ_{i1}, ρ_{i2}, ρ_{i3} were conversion coefficients.

In braided fabric, the stitch length was related to yarn jamming condition and braiding parameter. If the i data point on yarn was A_i, F_1 and F_2 were the tension of point A_i on the yarn, A_{i+1} and A_{i-1} were two points adjacent to A_i. The direction of F_c was the same as bisector of $\angle A_{i+1}A_iA_{i-1}$, and the direction of displacement X_{FA} (figure 3, *a*). The plane β including lines A_iA_{i+1} and A_iA_{i-1}, and the plane α including A_iA_i' was vertical to β, so the intersecting line of plane α and plane β was the conversion direction of original data point A_i, and $coff\_z_i$ was conversion coefficient. The data point A_i' was the result of point A_{i-1} revolved around A_i by angle φ. After conversion, A_{i-1} became A'_{i-1}. Line $A_{i-1}A_i$ was not coincident to z axis, so it was converted into l_{xoz} (figure 3, *b*), the relationship was shown as:

$$\gamma = <\overrightarrow{l_{xoy}}, \vec{x}> = \arccos \frac{\overrightarrow{l_{xoy}}\cdot \vec{x}}{|\overrightarrow{l_{xoy}}|\cdot|\vec{x}|} = \arccos\left(\frac{(\overrightarrow{x'_{A_{i-1}} - x_{A_i},\, y'_{A_{i-1}} - y_{A_i}})\cdot \vec{x}}{|(\overrightarrow{x'_{A_{i-1}} - x_{A_i},\, y'_{A_{i-1}} - y_{A_i}})|\cdot|\vec{x}|}\right) \tag{2}$$

$$\begin{cases} x''_{A_{i-1}} = x'_{A_{i-1}}\cdot \cos(\gamma) - y'_{A_{i-1}}\cdot \sin(\gamma) \\ y''_{A_{i-1}} = x'_{A_{i-1}}\cdot \sin(\gamma) - y'_{A_{i-1}}\cdot \cos(\gamma) \\ z''_{A_{i-1}} = z'_{A_{i-1}} \end{cases} \tag{3}$$

$$\beta = <\overrightarrow{l_{xoz}}, \vec{z}> = \arccos \frac{\overrightarrow{l_{xoz}}\cdot \vec{z}}{|\overrightarrow{l_{xoz}}|\cdot|\vec{z}|} = \arccos\left(\frac{(\overrightarrow{x''_{A_{i-1}} - x_{A_i},\, z''_{A_{i-1}} - z_{A_i}})\cdot \vec{x}}{|(\overrightarrow{x''_{A_{i-1}} - x_{A_i},\, z''_{A_{i-1}} - z_{A_i}})|\cdot|\vec{x}|}\right) \tag{4}$$

$$\begin{cases} x'''_{A_{i-1}} = x''_{A_{i-1}}\cdot \cos(\beta) + z''_{A_{i-1}}\cdot \sin(\beta) \\ y'''_{A_{i-1}} = y''_{A_{i-1}} \\ z'''_{A_{i-1}} = -x''_{A_{i-1}}\cdot \sin(\beta) + z''_{A_{i-1}}\cdot \cos(\beta) \end{cases} \tag{5}$$

Where γ was the intersecting angle of line $A_{i-1}A_i$'s projection on plane xoy and x axis. After conversion, new data points Q_{A1} and Q_{A2} were got as:

$$Q_{A1}A_1 = A'''_{i-1}A_i \cdot coff\_z_i \tag{6}$$

$$\begin{cases} X_{QA2} = Y_{QA1} \\ X_{QA2} = Y_{QA1}\cdot \cos(\varphi) - Z_{QA1}\cdot \sin(\varphi) \\ X_{QA2} = Y_{QA1}\cdot \sin(\varphi) + Y_{QA1}\cdot \cos(\varphi) \end{cases} \tag{7}$$

Finally, the optimized model was established as shown in figure 3, *c* and figure 3, *d*.

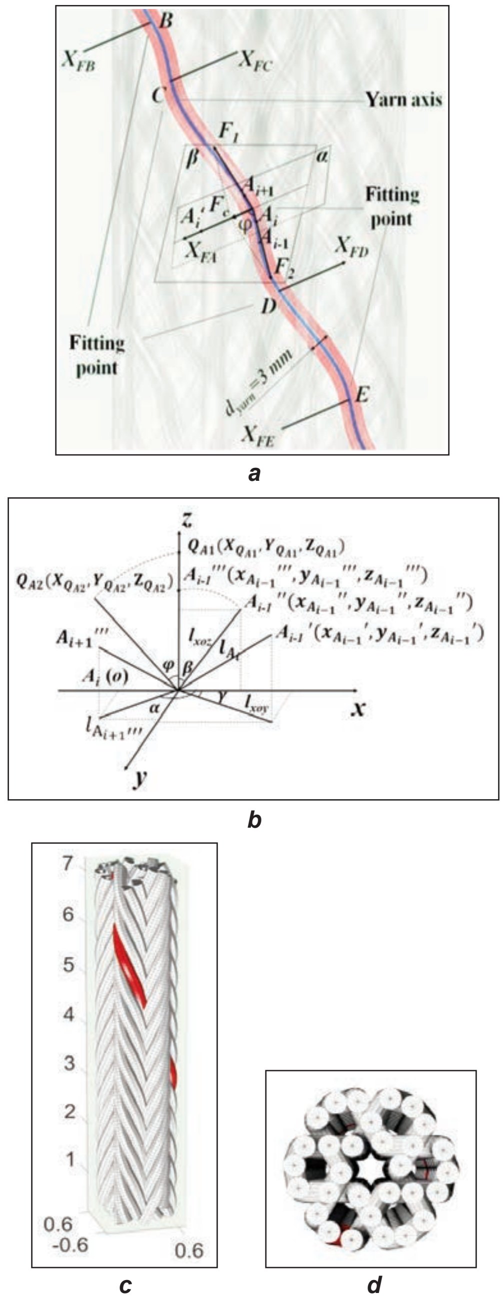
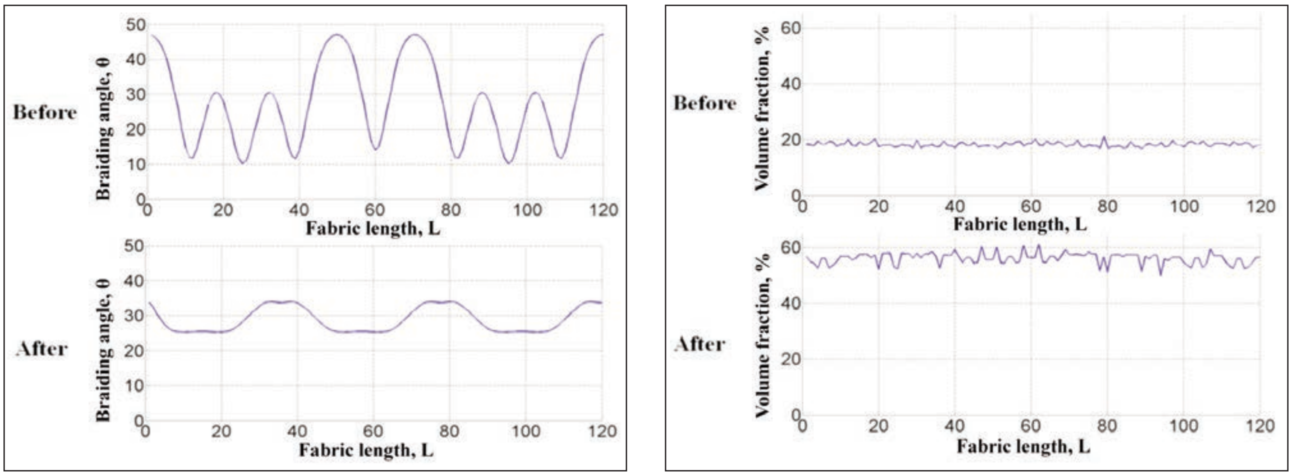


Fig. 3. Fabric model optimization: *a* – fabric surface; *b* – coordinate system; *c* – side view; *d* – top view

The braiding angle and volume fraction

After conversion, the variation of fabric's braiding angle θ could be measured in order to validate the conversion algorithm, and the measurement definition was shown as:



a *b*

Fig. 4. Braiding angle and fiber volume fraction: *a* – braiding angle variation before and after conversion; *b* – V_f before and after conversion

$$\theta = \angle \overrightarrow{A_{i-1}A_i}, \vec{z} \tag{8}$$

$$\vec{z} = (0, 0, 1) \tag{9}$$

The braiding angle varied periodically and had three wave crests in figure 4, *a*. After coordinates conversion, the range of angle fluctuation reduced from about 35 degree to about 10 degree.

Fiber volume fraction was a parameter to show the characterization of fabric, theoretically, we can use ratio of areas of yarns cross-section and fabric cross-section to calculate it as:

$$V_f = \aleph \frac{A_y}{A_f} \tag{10}$$

Where V_f was fiber volume fraction of fabric, A_y and A_f were areas of yarn cross-section and fabric cross-section, $\aleph$ was fiber packing ration and the value was 0.785. And the fiber volume fraction was improved from about 18% to about 56% as shown in figure 4, *b*, which meant the fabric structure was more compact.

CONCLUSION

In this paper, the process of hexagonal braiding was articulated and a circular hexagonal fabric model was established in Matlab. Based on coordinate conversion algorithm, the original model was optimized. It seemed that the intuitive image, braiding angle and volume fraction of the model were improved significantly after coordinate conversion, which validated the availability of conversion algorithm and could give reference to the foreseeable study on other properties of hexagonal braided fabrics.

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Tactile design of manipulator fingers based on fingertip/textile friction-induced vibration stimulations

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ABSTRACT – REZUMAT

Tactile design of manipulator fingers based on fingertip/textile friction-induced vibration stimulations

Textile-like soft and flexible products are widely used in our daily life. Understanding the relationship between the tactile sensations of textiles and the tactile stimuli is essential for developing humanoid robot's finger haptic system, especially for certain kind of robot systems such as service robots and exploratory robots. This paper built a frequency space that can qualitatively represent a roughness sensation of textiles by a developing independently random match algorithm in combination with neurophysiological features of cutaneous mechanoreceptors. The experimental results show that the sum of amplitude in frequency range between 18 and 118 Hz can effectively describe the roughness sensory of textile with accuracies of 98.5%. In other words, by applying the sum of amplitude in frequency range between 18 and 118 Hz could successfully match roughness sensation of textiles, and it will help engineer of humanoid robot design manipulator finger haptic system in textile field.

Keywords: *vibration, frequency space, roughness sensation, textile*

Proiectarea tactilă a degetelor pentru manipulare bazată pe stimularea vibrațiilor induse de vârful degetului/frecarea materialului textil

Produsele ușoare și flexibile precum materialele textile sunt utilizate pe scară largă în viața noastră de zi cu zi. Înțelegerea relației dintre senzațiile tactile ale materialelor textile și stimulii tactili este esențială pentru dezvoltarea sistemului haptic al degetelor robotului umanoid, în special pentru anumite tipuri de sisteme robotice, precum roboții pentru manipulare și roboții de explorare. Această lucrare a dezvoltat un spațiu de frecvență, care poate reda calitativ senzația de rugozitate a materialelor textile, prin elaborarea unui algoritm independent aleatoriu ce combină caracteristicile neurofiziologice ale mecanoreceptorilor cutanați. Rezultatele experimentale arată că suma amplitudinii în intervalul de frecvență cuprins între 18 și 118 Hz poate descrie în mod eficient rugozitatea senzorială a materialelor textile cu o precizie de 98,5%. Cu alte cuvinte, aplicând suma amplitudinii în intervalul de frecvență cuprins între 18 și 118 Hz, s-ar putea obține cu succes senzația de rugozitate a materialelor textile și va ajuta la dezvoltarea sistemului haptic al degetelor robotului umanoid pentru domeniul textil.

Cuvinte-cheie*: vibrație, domeniu de frecvență, senzație de rugozitate, material textil*

INTRODUCTION

Tactile sensing is an important ability for a humanoid robot which interacts in a complex environment. It can be achieved by deriving a spatial vibration signal from the fingertip sliding across material's surface and then generating a proper stimulating signal to the manipulator fingers [1–2]. In this context, to sense and evaluate materials characteristics, understanding the relationship between tactile sensations and vibration stimuli is critical. Especially, for textile products that are widely used in our daily life, the tactile system of robots should have the ability to identify and discriminate textile materials with acceptable accuracy.

On the other hand, neurophysiologists and psychologists have acknowledged the importance of vibrotactile signals in understanding human tactile perception. It has been observed that four cutaneous mechanoreceptors can give us the ability to estimate tactile qualities in fingertip. They are SAI units (Merkel cells), SAII units (Ruffini corpuscles), RA units (Meissner corpuscles) and PC units (Pacinian corpuscles), respectively. Among them, SAI units are sensitive to low-frequency vibration, frequency range from 2 to 16 Hz. These units transmit the information about pressure and structure of objects to the brain. The RA units are most sensitive to tangential force and can be easily excited by the frequency range between 2 and 60 Hz. The PC units, however, are very sensitive to mechanical transient vibrations in high frequencies, in the range of 40 to 500 Hz. The SAII units are sensitive to the lateral stretching and the sensitive frequency range is from 100 to 500 Hz [3–4].

Some study results have indicated that the intensity and energy density of vibration signals have great influence on the sensations of roughness/smoothness [5]. And the vibration spectrum distribution have an effect on the sensation of softness [6]. Moreover, some researchers set frequency domain according to receptor characteristics to analysis tactile sensation but they hypothesis that the frequency bands are independent [3–4, 7]. However, although a tactile sensation is related to the vibration signals, an investigation of vibration frequency domain between the provided tactile stimuli and the achieved perception is still mysterious. Especially, for textile materials composing of fibers and yarns, the friction-induced vibration signals of textile and fingertip are more complex and include vibration components from high frequency to low frequency. Different vibration domain contains different material characteristics. Among them, the high frequency components depend on the surface hairiness and microscopic textures, and the low frequency signals are due to the main surface pattern textures of textiles. So to understand how vibration frequency domains affect textile tactile perception is considered a key to improve the communication efficiency in the design of manipulator fingers in the textile field.

This paper uses random matching algorithm to seek a vibration frequency space which can qualitatively represent roughness sensation. Here the frequency domain of fingertip/textile vibration signal is arbitrarily divided into ten frequency sub-bands, and the amplitude of each divided frequency domain is calculated. Noteworthy, each frequency sub-band is a matrix space. Meanwhile, the sum of amplitude in each frequency domain is used to match roughness sensation of textiles. The well-matched vibration frequency space will efficiently represent the tactile sensation of textile and throw light on a tactile design of manipulator fingers.

EXPERIMENTAL WORK

Materials and method

To seek the ranges of frequency to predict roughness sensation, four random fabrics which are obvious surface textures were chosen as experimental materials in our experiments. The specification parameters were shown in the table 1, and their stereoscopic microscope images were presented in figure 1.

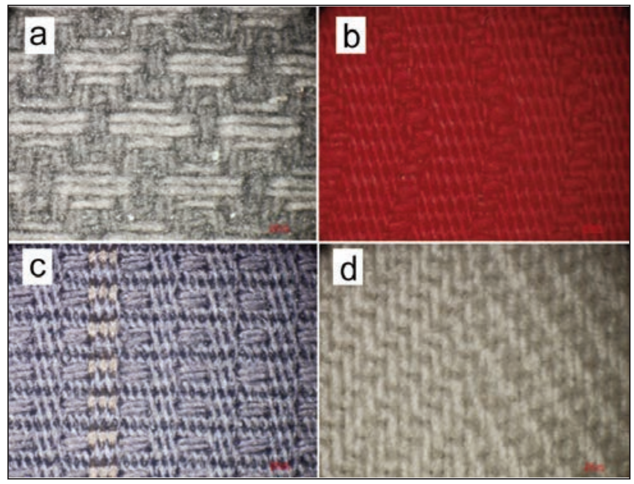


Fig. 1. Four random fabrics

Evaluation conditions

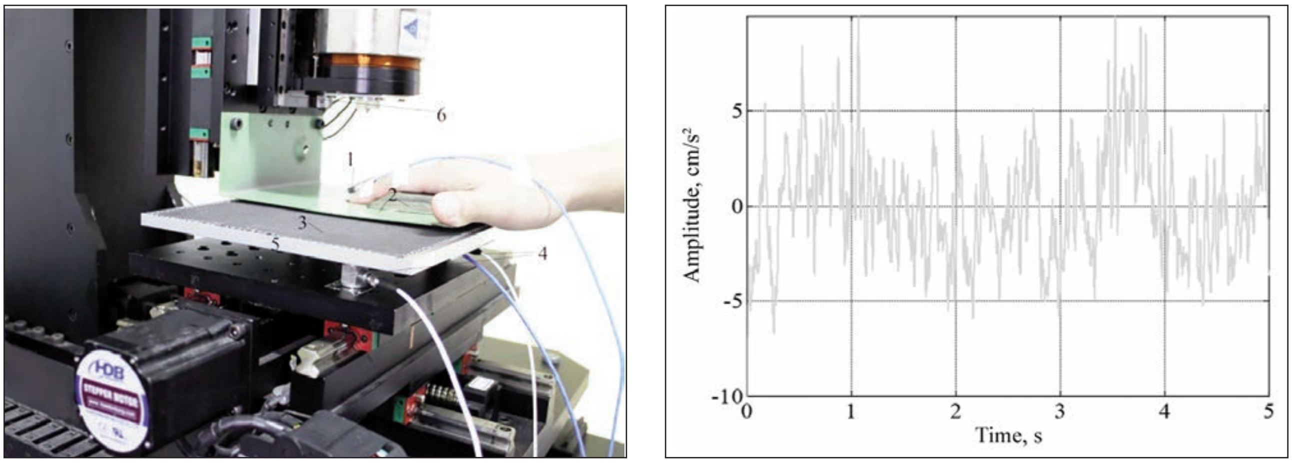
Four fabrics were preconditioned for 24 h before evaluation and tests were performed in standard atmosphere (20±2°C and 65±5% relative humidity). The sensory evaluation method refers to AATCC Guidelines for the Subjective: Evaluation of Fabric Hand [8]. To obtain reliable results, strict controlled procedures have been implemented and the evaluation has been performed in blind condition for replicating thrice. Subjects were eighteen men and twelve women, aged from 18 to 24, and most of them were textile background.

Friction-induced vibration signal acquisition

To control the applied normal load and the relative sliding velocity, the finger is fixed and the experimental samples are moved from left to right at a constant speed. A low mass (0.8 g) accelerometer (Model 356A01) with high sensitivity (1 mV/mm/s^2) is applied on the finger nail to measure global vibrations (figure 2, *a*). Notice, the mass of accelerometer has not effect on the signal [9]. At the same time, the force transducers (500 mV/lb, Model 208C01) are placed below the sample holding platform for monitoring the global contact force. During sliding process, the normal applied load is about 0.8 N and the scanning speeds are 10 mm/s for textile. This is because the scanning speeds are commonly in the range 10 mm/s to 50 mm/s, higher for hard objects and lower for textile [10–12].

Table 1

SPECIFICATION PARAMETERS				
No.	**Warp x Weft density (yarns/10 cm)**	**Count (Ne)**	**Composition**	**Weight (g/m^2)**
1	95 × 64	16 × 16	Cotton 100%	244
2	65 × 100	40 × 32	Cotton 100%	208
3	175 × 108	40 + 150D × 40	Cotton 95.5% / Terylene 4.5%	175
4	78 × 59	12 × 8	Cotton 100%	341



a *b*

Fig. 2. Signal acquisition: *a* – Schematic diagram: *1* – Accelerometer, *2* – finger supports, *3* – textile sample, *4* – force transducers, *5* – base plate, *6* – 3D motion control platforms; *b* – vibration signal of sample A

Frequency space of friction-induced vibration signals

Using the random matching algorithm, the frequency bands of fingertip/textile vibration signal were divided arbitrarily into ten sub-bands with different width. Considering the frequency response characteristics of the mechanical receptors [3, 13], narrow bandwidths are set for the lower frequency bands, whereas wide bandwidths are used for higher frequency bands.

Here, $f_0 = 0$, $f_{10} = 500$, and f_i values are natural numbers between 0 and 500.

$$f_1 = f_0 + \{1,2,\ldots,10\};$$
$$f_2 = f_1 + \{1,2,\ldots,20\};$$
$$f_3 = f_2 + \{1,2,\ldots,20\};$$
$$f_4 = f_3 + \{5,10,\ldots,50\};$$
$$f_5 = f_4 + \{5,10,\ldots,50\};$$
$$f_6 = f_5 + \{5,10,\ldots,50\};$$
$$f_7 = f_6 + \{10,20,\ldots,100\};$$
$$f_8 = f_7 + \{10,20,\ldots,100\};$$
$$f_9 = f_8 + \{10,20,\ldots,100\};$$

Meanwhile, the sum of the amplitude spectra within each of above sub-bands was calculated. The sum of the amplitudes in the j_{th} sub-band for material i was determined as follows:

$$a_{ij} = \int_{f_{j-1}}^{f_j} a_i(f)\,\mathrm{d}f \qquad (1)$$

where f and $a_i(f)$ are the frequency and amplitude, respectively.

And then, a search procedure is made for all of sub-band widths (f_0–f_{10}) to find an optimized match between the vibration frequency space and roughness perception.

RESULTS AND DISCUSSION

Roughness sensation scores

To avoid the personal reference difference of each assessor's score, the tactile evaluation data was normalized firstly, the Grubbs tests are performed to reject the abnormal value, which were probably affected by accidental factors in subjective experiment such as fatigue etc. The magnitude estimation method was used to quantify tactile roughness of four fabrics, and the scores are shown in figure 3.

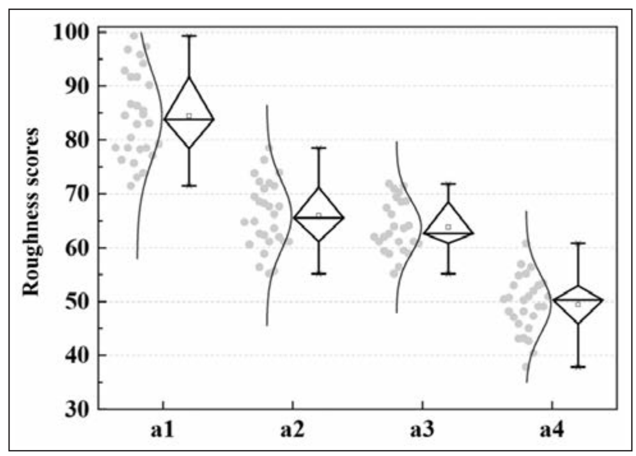


Fig. 3. Tactile roughness of four random fabrics

Frequency sub-bands

The random matching algorithm is used to calculate the frequency space, all of frequency domains are shown in table 2. It is noteworthy that each sub-band is a matrix. The size of matrix is the number of each frequency sub-bands. Next, the sum of acceleration amplitude in each of frequency sub-bands is calculated according to Equation (1). At the same time, the amplitude of each the frequency sub-band is imported in to a three-dimensional space (500 Hz × 500 Hz × Amplitudes). In this way, the contour of Amplitude-Frequency shows the amplitude distribution in each frequency space, as shown in figure 4.

In figure 4, the brighter color illustrates the bigger amplitude. Interestingly, the main amplitude is mainly distributed within 0–100 Hz. But it is still not clear which frequency sub-band can influence the roughness sensation. Some researchers have concluded

Table 2

FREQUENCY DOMAIN				
$f_0 - f_1$	$f_1 - f_2$	$f_2 - f_3$	$f_3 - f_4$	$f_4 - f_5$
(0–10)	$\begin{pmatrix} 1 & \cdots & 21 \\ \vdots & \ddots & \vdots \\ 10 & \cdots & 30 \end{pmatrix}$	$\begin{pmatrix} 2 & \dots & 22 \\ \vdots & \ddots & \vdots \\ 30 & \cdots & 50 \end{pmatrix}$	$\begin{pmatrix} 3 & \dots & 53 \\ \vdots & \ddots & \vdots \\ 50 & \dots & 100 \end{pmatrix}$	$\begin{pmatrix} 8 & \dots & 58 \\ \vdots & \ddots & \vdots \\ 100 & \dots & 150 \end{pmatrix}$
	$f_5 - f_6$	$f_6 - f_7$	$f_7 - f_8$	$f_8 - f_9$
	$\begin{pmatrix} 13 & \cdots & 63 \\ \vdots & \ddots & \vdots \\ 150 & \cdots & 200 \end{pmatrix}$	$\begin{pmatrix} 18 & \cdots & 118 \\ \vdots & \ddots & \vdots \\ 200 & \cdots & 300 \end{pmatrix}$	$\begin{pmatrix} 28 & \cdots & 128 \\ \vdots & \ddots & \vdots \\ 300 & \cdots & 400 \end{pmatrix}$	$\begin{pmatrix} 38 & \cdots & 138 \\ \vdots & \ddots & \vdots \\ 400 & \cdots & 500 \end{pmatrix}$

that the intensity of vibration signals has a great influence on roughness sensation [14]. The random research results for the maximum sum of amplitude in all frequency sub-bands are shown in figure 5. It shows that the maximum sum of amplitude appears in the range from 18 to 118 Hz. Therefore, it can hypothesize that the sum of amplitude in this frequency sub-band could represent roughness sensation. Moreover, the frequency range conforms with the neurophysiology results and the width of sub-band included is narrow previous studies [3–4, 14].

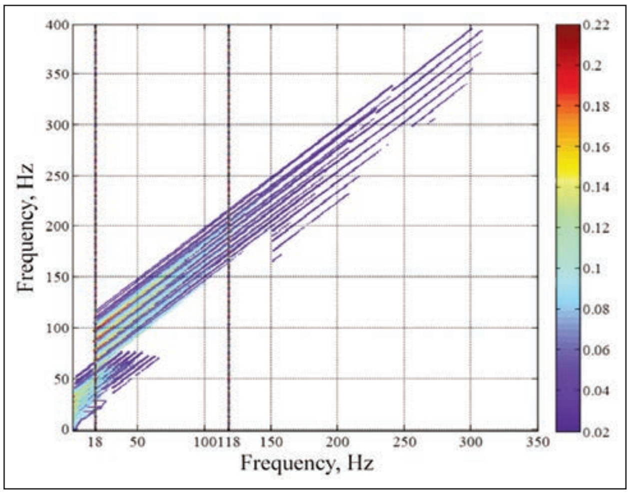


Fig. 4. Contour of Amplitude-Frequency spectrum

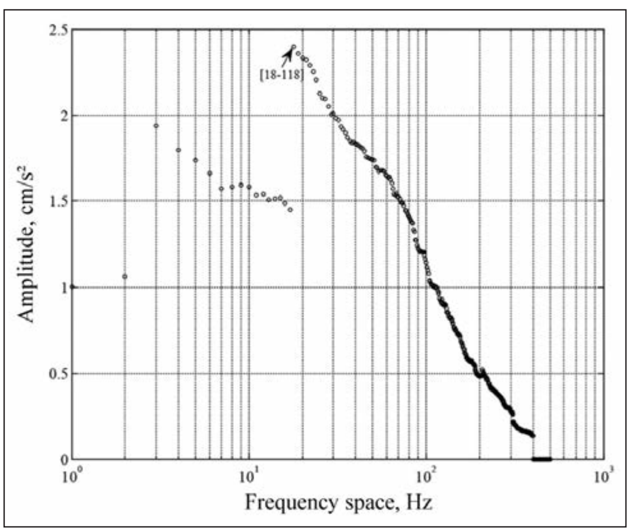


Fig. 5. Acceleration amplitude of different frequency space

Vibrotactile frequency Space Matched with Roughness sensation scores

To investigate how accurately the vibration signals of textiles could estimate the roughness sensation, the normalization value of amplitude which searched frequency sub-band (18–118 Hz) is compared with sensory evaluation. Figure 6 shows the comparison of the vibration and estimated value. Inspiringly, the tendency of vibration signals accord with the sensory evaluation but the value is smaller than sensory evaluation. This could be due to signal attenuation in acquisition process. At the same time, we calculate the lin's concordance correlation coefficients [15] of vibration value and sensation evaluation value, the correlation coefficients is 0.985 illustrating that searched frequency sub-band is effective for representing roughness sensation.

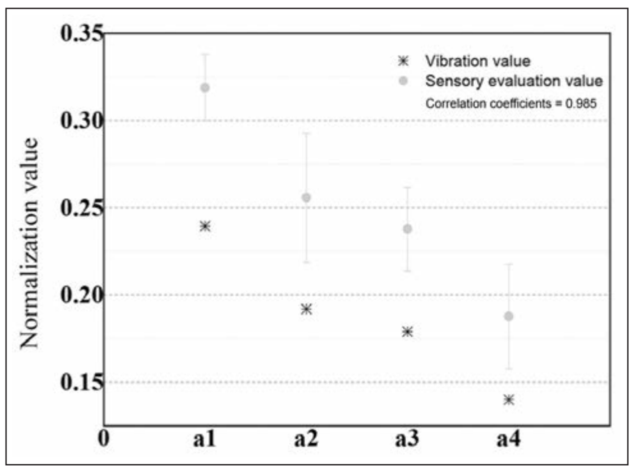


Fig. 6. Vibration and estimated value of four random fabrics

CONCLUSION

This study matched successfully the fingertip/textile vibration signals and the roughness sensation with a random matching method. The experimental results demonstrate that the sum of amplitude in frequency space between 18 and 118 Hz can describe the roughness sensory of textile with accuracies of approximately 98.5%, although the intensity of amplitude is lower than sensory evaluation. Such a frequency space can be helpful for the analysis and design of humanoid robot's fingers considering that human textural precepts are multidimensional. And it is also meaningful the manipulator fingers to identify and discriminate textile materials.

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Water footprint calculation and assessment of viscose textile

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ABSTRACT – REZUMAT

Water footprint calculation and assessment of viscose textile

Water footprint is used as an indicator to quantify the impacts on water resource and water environment. Based on water footprint standards established by the International Standardization Organization (ISO), this paper proposed a new quantitative indicator for water alkalization, and calculated the water footprints involved in viscose textile production. In addition, water footprint accounting results were comprehensively evaluated by LCA polygon method which was developed to interpret LCA results. Results showed that: (1) water scarcity footprint of viscose textile production was 60.511 m^3 H_2O eq/ton, of which 85.71% was from the viscose fiber production; (2) water eutrophication footprint of viscose textile production was 12.439 kg PO_4^{3-} eq/ton, the major contribution (84.37%) was given by COD and BOD_5; (3) water acidification footprint and water alkaline footprint of viscose textile production were 81.453 kg SO_2 eq/ton and 55.675 kg OH^- eq/ton, mainly due to H_2SO_4 and NaOH input during the spinning process, respectively; (4) water ecotoxicity footprint of viscose textile production was 3828.169 km^3 H_2O eq/ton, mainly derived from Zn^{2+} in spinning wastewater; (5) LCA polygon analyses showed that environmental load in the spinning was the largest, followed by the pulping and then the dyeing.

Keywords: *viscose textile, water footprint, LCA polygon, calculation and assessment*

Calculul și evaluarea amprentei de apă a materialelor textile din viscoză

Amprenta de apă este utilizată ca indicator pentru a cuantifica impactul asupra resurselor de apă și a mediului. Pe baza standardelor de amprentă de apă stabilite de Organizația Internațională de Standardizare (ISO), această lucrare a propus un nou indicator cantitativ pentru alcalinizarea apei și a calculat amprentele de apă implicate în producția materialelor textile din viscoză. În plus, rezultatele calculului amprentei de apă au fost evaluate prin metoda poligonului LCA, care a fost dezvoltată pentru a interpreta rezultatele LCA. Rezultatele au arătat că: (1) amprenta de apă a producției de materiale textile din viscoză a fost de 60,511 m^3 H_2O ech./tonă, din care 85,71% proveneau din producția de fibre de viscoză; (2) amprenta de eutrofizare a apei din producția de materiale textile din viscoză a fost de 12,439 kg PO_4^{3-} ech./tonă, contribuția majoră (84,37%) a fost dată de COD și BOD_5; (3) amprenta de acidifiere a apei și amprenta alcalină a apei din producția de materiale textile din viscoză au fost de 81,453 kg SO_2 ech./tonă și 55,675 kg OH^- ech./tonă, în principal datorită aportului de H_2SO_4 și respectiv NaOH în timpul procesului de filare; (4) amprenta de ecotoxicitate a apei din producția de materiale textile din viscoză a fost de 3828,169 km^3 H_2O ech./tonă, provenită în principal din Zn^{2+} din apele uzate; (5) analizele prin metoda poligonului LCA au arătat că filarea a înregistrat un impact semnificativ asupra mediului, urmată de procesare și apoi de vopsire.

Cuvinte-cheie: *materiale textile din viscoză, amprentă de apă, metoda poligonului LCA, calcul și evaluare*

INTRODUCTION

Water issues are common and about 32% of the water in China faces serious water pollution problems [1–2]. The textile industry is recognized as a precious stone for domestic economic in China [3] and viscose textile are favored by consumers because of their high clothing comfort, skin friendly nature and breathing capability [4]. China is the world's largest consumer of viscose staple fiber, and the apparent consumption of domestic viscose staple fiber increased from 1.49 million tons in 2011 to 3.49 million tons in 2017. Viscose fiber is made from raw materials such as cotton linters, wood or bagasse, which is alkali-impregnated to form alkali cellulose, reacted with carbon disulfide to form sodium cellulose sulfonate, and made into a spinning solution in a dilute alkali solution. The regenerated fiber is formed in the plasticizing bath, refined by drawing and cutting, and finally dried and packaged into a finished product. Then, it is spun and woven into a grey fabric, which is then dyed and finished into textile product. As can be seen from the above, viscose textile production process chain is long and complicated, and massive amount of water is consumed. According to statistics, the production of 1 ton of cotton pulp consumes 72 tons of freshwater, the production of 1 ton of viscose staple fiber consumes 65 tons of freshwater, and production of 1 ton of dyed textiles consumes

100–120 tons of freshwater. Furthermore, the wastewater discharged into the environment is also in large quantities, which contains a large amount of alkali, organic matter, acidic pollutants and toxic pollutants, leading to multiple water environmental impacts. Water footprint based on the theory of virtual water was proposed by Hoekstra in 2002. Water Footprint Net (WFN) defined it as a volume measure of water consumption and water pollution both directly and indirectly by producers or consumers, including green water footprint, blue water footprint, and grey water footprint [5–7]. The water footprint developed by WFN focused the assessment of water sustainability and failed to reflect the environmental impact of water consumption and water pollution. Wang et al. introduced the water footprint methodology of the textile industry and applied it to the water footprint calculation of a dyeing factory [8]. In 2014, the ISO 14046 defined water footprint as a metric to quantify the potential environmental impacts, including water availability, scarcity, eutrophication, acidification, and ecotoxicity [9–10]. Water scarcity footprint is an indicator for measuring the impact of water use on local water resources, which has been applied to evaluate the water use in poultry, cables, cacao, dairy products and textiles [10–16]. Water degradation footprint is an indicator for quantifying the environmental impact of wastewater pollutants, which can be divided into water eutrophication footprint, water acidification footprint, and water ecotoxicity footprint according to the environmental impact category. These quantitative results are characterized by PO_4^{3-} (or P) equivalent, SO_2 equivalent and effluent equivalent, respectively [17–18]. Huang et al. and Bai et al. calculated water eutrophication footprint of crops and poultry, respectively [10,19]; Linhares et al. expressed the results of water eutrophication footprint and water ecotoxicity footprint in terms of P equivalent and 1,4-DB equivalent, respectively [20]. These multidimensional indicators based on LCA (Life Cycle Assessment) theory can quantify the impacts of pollutants on the water environment from different angles, but makes it impossible to overview the water environmental load of different textile products or different process segments. To this end, "LCA polygon" methodology was developed to interpret LCA results. Daniel et al. considered LCA polygon as a tool for comparing the results of inventory analysis and Georgakellos et al. applied it to wastewater management and comparison of three soft-drink containers [21–23]. Lovarelli et al. based on the concept of similar LCA polygons, defined the polygon area based on the actual value of the quantitative index as the Water Pollution Water Indicator (PWI), and the larger the value of PWI, the more serious the degree of water pollution [24]. Therefore, it is possible to use a single indicator value as a general estimate of the combined output of each type of environmental impact, which facilitates a clear and objective comparison between different products or processes and helps to gain manageability.

The aim of this study was to quantify the impact of viscose textiles from cotton linters to dyed fabrics on water resources and water environment based on water footprint theory. According to the quantitative results, the LCA polygon method was used to comprehensively evaluate the water resources environmental load of production stages.

MATERIALS AND METHODS

System boundary

In this study, viscose textile went through three stages from raw material to fabric: viscose fiber manufacturing, weaving, fabric dyeing and finishing. Among them, viscose fiber manufacturing and fabric dyeing and finishing consumed a large amount of water resources, and the wastewater discharge caused multiple water environmental impacts (figure 1) [25–27].

Water footprint

Water scarcity footprint

Water scarcity footprint is used to assess the potential environmental impact associated with water scarcity in a region caused by production. The water stress index (WSI) was used as water scarcity characteristic

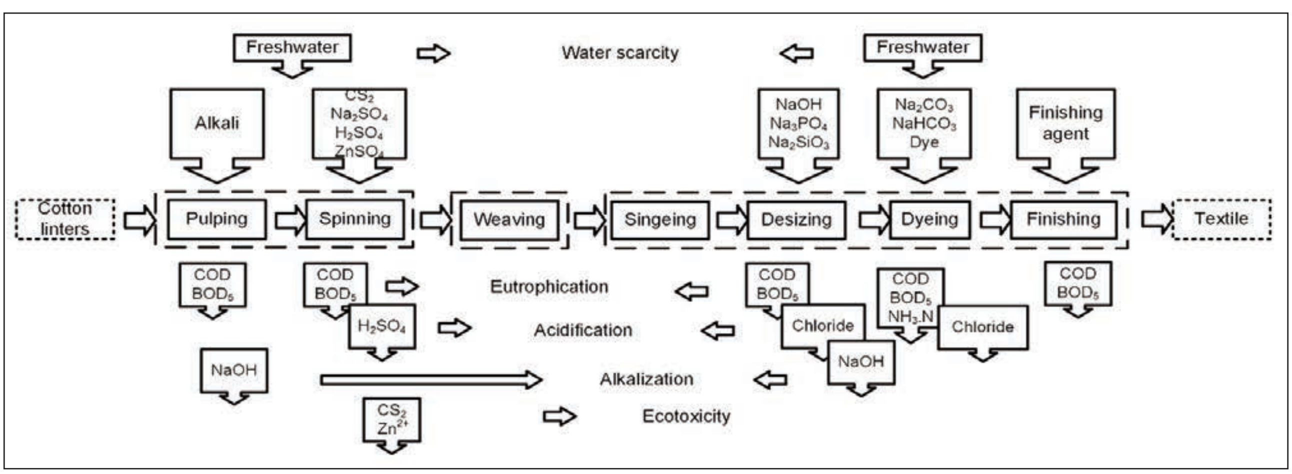


Fig. 1. System boundary of viscose textile production

factor in this study, which was based on with-drawal-to-availability ratio [28]. The calculation equation used for water scarcity footprint is as follows:

$$WF_{sc} = \sum_{j}^{n} \frac{WSI_j}{WSI_{av}} \times Q_j \quad (1)$$

where WF_{sc} (m^3 H_2O eq) is water scarcity footprint; Q_j (m^3) is freshwater consumption of per unit product in position j; WSI_{av} is average water stress index of the global; WSI_j is water stress index corresponding to Q_j.

Water degradation footprint

Water degradation footprint is used to measure the effects of pollutants on the water environment, which has included water eutrophication footprint, water acidification footprint, and water ecotoxicity footprint. Water eutrophication footprint is used to measure the potential water eutrophication impacts resulting from discharge of nitrogen and phosphorus pollutants. Water acidification footprint can be determined by pollutant emissions and the potentials that pollutants release hydrogen ion (H^+) (as compared to sulfur dioxide (SO_2)). Water ecotoxicity footprint is used to evaluate the toxic effect on species in the aquatic ecosystem, which is based on maximum tolerable concentration [17, 29]. The calculation methods of water eutrophication footprint, water acidification footprint, and water ecotoxicity footprint are as follows:

$$WF_E = \sum_{i}^{n} CF_{E,i} \times M_i \quad (2)$$

$$WF_{AC} = \sum_{i}^{n} CF_{AC,i} \times M_i \quad (3)$$

$$WF_{AET} = \sum_{i}^{n} CF_{AET,i} \times M_i \quad (4)$$

where WF_E (kg), WF_{AC} (kg) and WF_{AET} (kg) are water eutrophication footprint, water acidification footprint and water ecotoxicity footprint, respectively; $CF_{E,i}$ (kg/kg) is characteristic factor of eutrophication pollutant i; $CF_{AC,i}$ (kg/kg) is characteristic factor of acidification pollutant i; $CF_{AET,i}$ (m^3/mg) is characteristic factor of ecotoxic pollutant i; M_i (kg) is the emission of pollutant i.

Existing water degradation footprint indicators lack quantitation methods for alkaline impact. This paper proposed water alkaline footprint to quantify the effects of water alkalinity caused by textiles production. Water alkaline potential can be considered as the propensity that pollutants accept H^+ (as compared to Hydroxide ion (OH^-)). Water alkaline footprint is the alkaline potential of 1 kg of pollutant multiplying by the pollutant emissions. The calculation equation used for water alkaline footprint is as follows:

$$WF_{AL} = \sum_{i}^{n} CF_{AL,i} \times M_i \quad (5)$$

where WF_{AL} (kg) is water alkaline footprint; $CF_{AL,i}$ (kg/kg) is characteristic factor of alkaline pollutant i; M_i (kg) is the emission of pollutant i.

LCA polygon

In the hypothetical system of n impact categories, regular n-sided polygons are formed, different axes represent environmental impact categories with different personality characteristics (proportions and units). The axes intersection is zero and different impact categories have different actual values, forming a new n-sided polygon called LCA polygon. In the radial system of the shaft, the order of the various water footprints affects the area of the polygon, so all possible multilateral areas should be calculated and averaged to make the results more objective. The number of triangles with R_i and R_{i+1} as sides is $n(n-1)/2$, and the average area of the LCA polygon is calculated as Equation (6) [21]. Consequently, the area of the LCA polygon can be used to represent the combined value of water footprints, and the larger the area value, the more serious the environmental load.

$$E_{av}^{pol} = nE_{av}^{tr} = \frac{1}{2} \sin\left(\frac{360°}{n}\right) \left\{ n \left[\frac{2\sum_{i,j=1,i<j}^{n} R_i R_j}{n(n-1)} \right] \right\} \quad (6)$$

Data

Data of freshwater use, wastewater and pollutants discharge were collected based on the monitoring data of wastewater discharge ports of viscose fiber production enterprises and dyeing enterprises, which were derived from the website www.ipe.org.cn. The functional units were 1 ton of viscose fiber and 1 ton of fabric, respectively (table 1 and table 2). The environmental impact characteristic factors involved in this paper are shown in table 3 [17, 30]. The WSI of China was 0.478 [10] and the average WSI of the global was 0.602 [31].

Table 1

FRESHWATER USE, WASTEWATER AND POLLUTANTS DISCHARGE OF VISCOSE FIBER MANUFACTURING

Production stage		Freshwater (m^3/t)	Wastewater (m^3/t)	COD (mg/L)	BOD_5 (mg/L)	H_2SO_4 (mg/L)	NaOH (mg/L)	CS_2 (mg/L)	Zn^{2+} (mg/L)
Pulping	Presoaking	40	36.76	8027	350	-	2400	-	-
	Washing	25	23.95	585	200	-	200	-	-
Spinning	Stock solution	4	3.48	2300	550	-	450	126.50	55
	Two-bath	4	3.81	1037	200	12000	-	25.40	338
	Acid station	16	14.42	415	100	790	-	25.84	28.73
	Scouring	28	25.42	868	150	2480	-	17.47	298

Table 2

FRESHWATER USE, WASTEWATER AND POLLUTANTS DISCHARGE OF FABRIC DYEING AND FINISHING								
Production stage	**Freshwater (m^3/t)**	**Wastewater (m^3/t)**	**COD (mg/L)**	**BOD_5 (mg/L)**	**NH_3-N (mg/L)**	**Chloride (mg/L)**	**NaOH (mg/L)**	**Na_2CO_3 (mg/L)**
Desizing	4.50	4.48	5000	1000	15	100	2500	100
Dyeing	13.50	13.45	800	200	2.50	250	1800	66
Finishing	1.50	1.50	250	300	-	-	-	-

Table 3

ENVIRONMENTAL IMPACT CHARACTERISTIC FACTORS			
Environmental impact	**Pollutant**	**Characteristic factor**	**Unit**
Eutrophication	COD	0.022	kg/kg
	BOD_5	0.11	
	NH_3-N	3.64	
Acidification	H_2SO_4	0.65	kg/kg
	Chloride	0.88	
Alkalization	NaOH	0.425	kg/kg
	Na_2CO_3	0.321	
Ecotoxicity	Zn^{2+}	0.38	m^3/mg
	CS_2	0.18	

RESULTS AND DISCUSSIONS

The water footprints of viscose textile

Figure 2 shows the water scarcity footprint of viscose textile production. From figure 2, we can see that water scarcity footprint of viscose textile production was 60.511 m^3 H_2O eq/ton, and was divided into two parts: viscose fiber manufacturing and fabric dyeing and finishing, the water scarcity footprint of the former was generally larger than the latter. Water scarcity footprint of viscose fiber production was 51.866 m^3 H_2O eq/ton. Among viscose fiber production, the pulping process had the largest water scarcity footprint (28.815 m^3 H_2O eq/ton) that was mainly from freshwater input in presoaking and washing processes and accounted for 55.6% of viscose fiber manufacturing stage. Water scarcity footprint of fabric dyeing and finishing was 8.645 m^3 H_2O eq/ton. Among fabric dyeing and finishing, the dyeing process had the largest water scarcity footprint (5.985 m^3 H_2O eq/ton), because the water use in the dyeing process included not only the dye liquor, but also the rinsing water after the dyeing.

Figure 3, *a* shows the water degradation footprint results of viscose fiber production. From figure 3, *a*, we can see that there were obvious differences between the pulping and the spinning. Water eutrophication footprint and water alkaline footprint of the pulping were 8.742 kg PO_4^{3-} eq/ton and 39.531 kg OH^- eq/ton, and were about 5.0 and 59.4 times as much as the spinning, respectively. The main raw material for the pulping process was cotton linters, which were immersed in lye, resulting in a large amount of organic and lye residues in the wastewater. Consequently, high concentrations of COD, BOD_5 and NaOH caused large water eutrophication footprint and water alkaline footprint, respectively. The pulping process did not cause water acidification footprint and water ecotoxicity footprint, while the water acidification footprint and water ecotoxicity footprints of the spinning process were 78.1 kg SO_2 eq/ton and 3828.206 km^3 H_2O eq/ton, respectively. Water ecotoxicity footprint of the spinning process was caused by CS_2 and Zn^{2+}, which were from CS_2 input in the stock solution and $ZnSO_4$ input in the acid station, respectively. Water ecotoxicity footprint that Zn^{2+} contributed was 3598.078 km^3 H_2O eq/ton and accounted for about 94.0% of the total water ecotoxicity footprint. Water acidification footprint of the spinning process was mainly from H_2SO_4 input in acid station. This shows that the environmental impacts caused by wastewater discharge from different

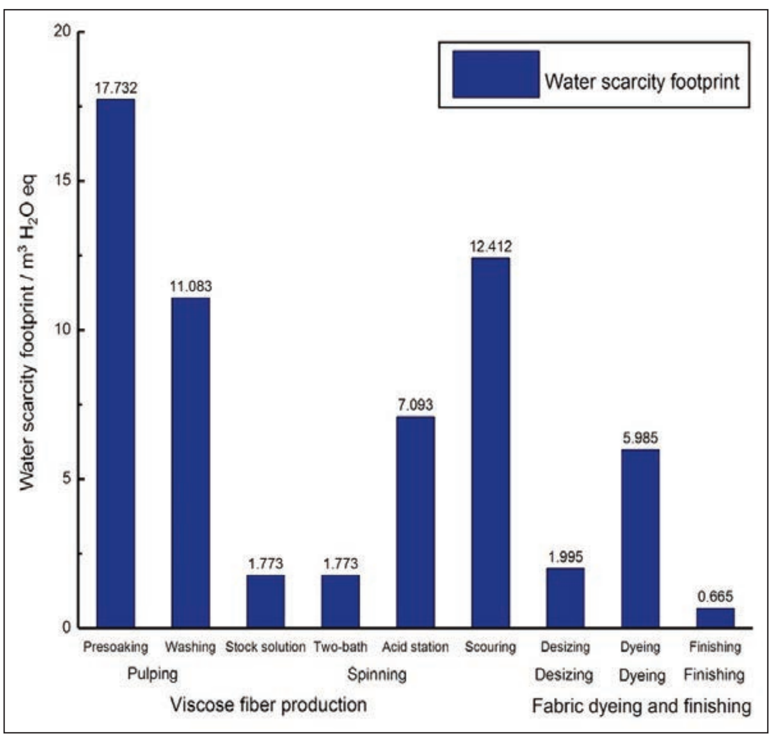


Fig. 2. Water scarcity footprint of viscose textile production

processes were different, which was mainly due to the different inputs of chemicals in different production processes. The concentration of H_2SO_4 in the two-bath wastewater was about 4.8 times that in the scouring wastewater, but the volume of the scouring wastewater was about 6.7 times that of the two-bath wastewater, consequently the water acidification footprint of the scouring was the largest, the value was 40.977 kg SO_2 eq/ton and contributed about 52.5% of water acidification footprint of the spinning process. Therefore, when assessing whether the wastewater quality meets emission standards, not only the concentration of pollutants should be detected, but also the corresponding amount of wastewater discharged.

Figure 3, *b* shows the water degradation footprint results of viscose fiber fabric dyeing and finishing stage. From figure 3, *b*, we can see that water eutrophication footprint, water acidification footprint and water alkaline footprint were 1.944 kg PO_4^{3-} eq/ton, 3.353 kg SO_2 eq/ton and 15.478 kg OH^- eq/ton, respectively. Water eutrophication footprint was mainly caused by COD, BOD_5 and NH_3-N, where COD and BOD_5 contributed about 78.5%. Water acidification footprint came from chloride in the desizing and dyeing wastewater. Water alkaline footprint was caused by NaOH and Na_2CO_3, of which NaOH contributed about 97.6%.

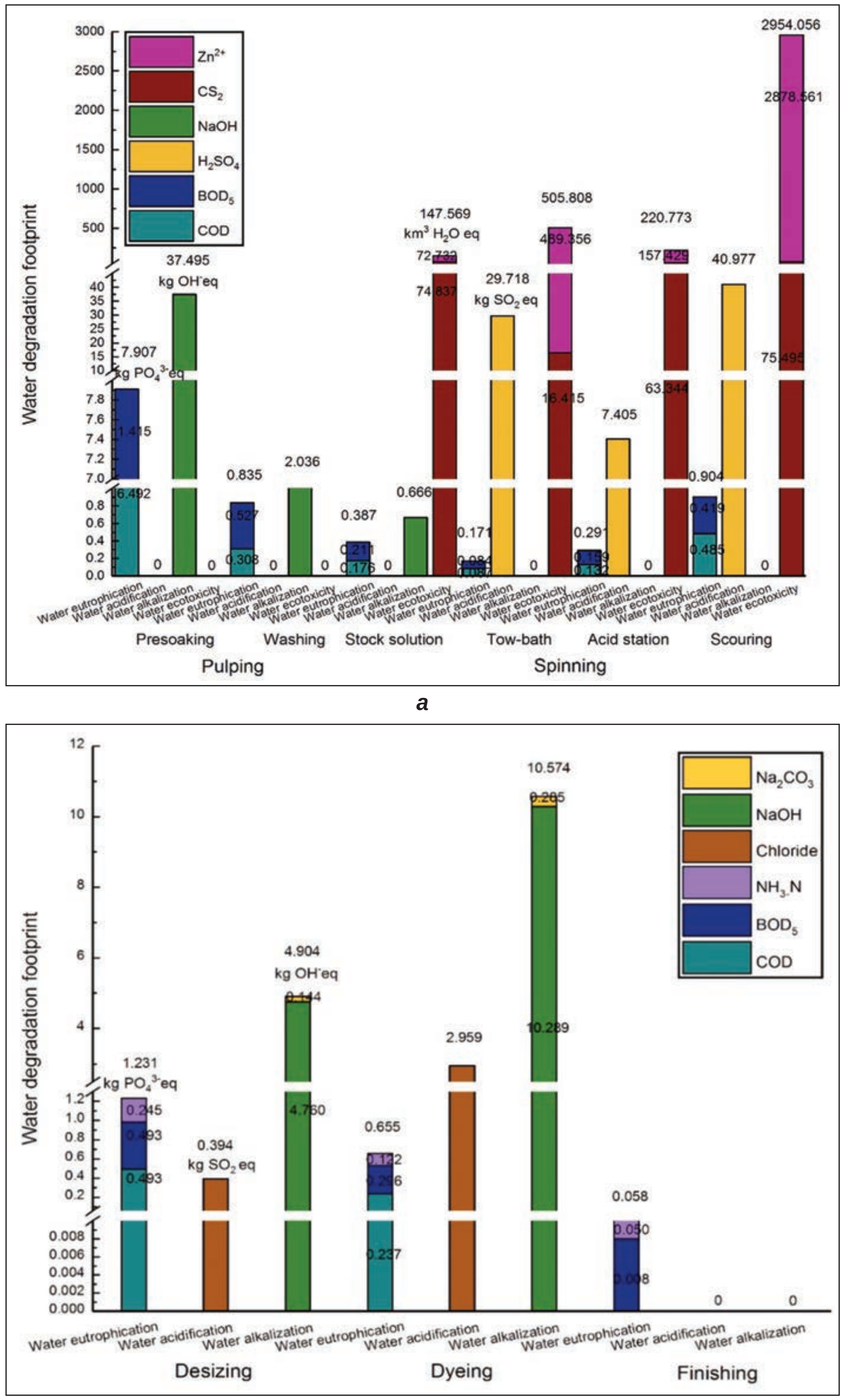
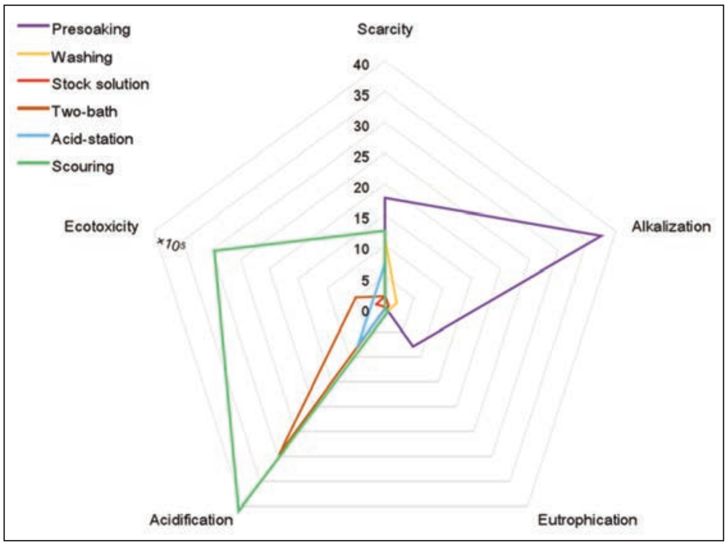


Fig. 3. Water degradation footprint of viscose textile: a – water degradation footprint of viscose fiber manufacturing stage; b – water degradation footprint of viscose fiber fabric dyeing and finishing stage

Comprehensive evaluation of the water footprints of viscose textile

In this paper, LCA polygon method was applied to comprehensively evaluate the water footprints of viscose textile production. Firstly, the water footprint LCA polygons of viscose fiber production and fabric dyeing and finishing were drawn (figure 4) according to the water footprint accounting results of viscose textile production (figure 2 and figure 3).

Then, the areas of LCA polygon were calculated according to Equation (6). From figure 5, we can see that the water resources environmental load of the viscose fiber production was far greater than that of the fabric dyeing and finishing. The water resources environmental load of the scouring in the viscose fiber production was the largest, followed by the two-bath, the acid station and the stock solution, and



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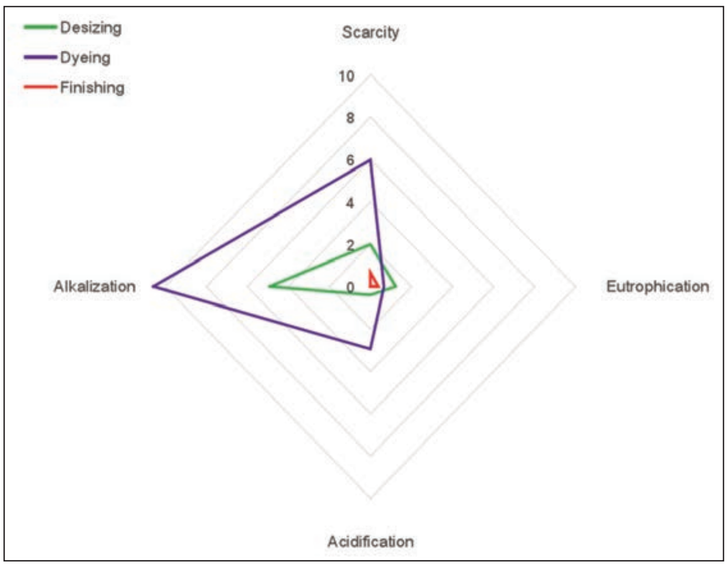

b

Fig. 4. Water footprint LCA polygon of viscose textile: *a* – water footprint LCA polygon of viscose fiber manufacturing stage; *b* – water footprint LCA polygon of viscose fiber fabric dyeing and finishing stage

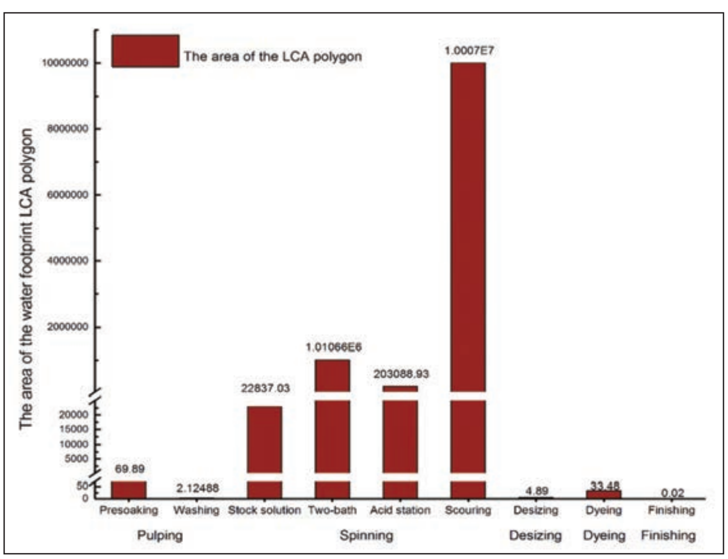

Fig. 5. The area of the water footprint LCA polygon of each production process

then the presoaking and the washing. The areas of corresponding water footprint LCA polygon were 10006962.44, 1010657.30, 203088.93, 22837.03, 69.89 and 2.12, respectively. Combined with figure 2 and figure 3, we found that water scarcity footprint, water eutrophication footprint and water alkaline footprint of the presoaking were larger than other five processes, but its LCA polygon area ranked fifth. This was because the presoaking did not cause water ecotoxicity footprint, but the four processes in front of it did. The fabric dyeing process caused four types of environmental impacts: water scarcity footprint, water eutrophication footprint, water acidification footprint and water alkaline footprint, but its comprehensive environmental impact score was less than the presoaking process involving only three types of environmental impacts, because its four indicator actual values were relatively small.

In summary, water resource environmental load of the viscose fiber production was larger than that of the fabric dyeing and finishing. Because the viscose fiber production involved the water ecotoxicity footprint and the actual value was very large, while the fabric dyeing and finishing did not involve. In this case, whether water ecotoxicity footprint could be considered as the dominant factor that causing the serious environmental load of the viscose fiber production.

CONCLUSIONS

Previous studies on the treatment of industrial production wastewater were mostly limited to the measurement and treatment of conventional pollutants such as COD and BOD_5 [32–34]. For the first time, this paper comprehensively analysed the environmental impact of wastewater pollutants according to the characteristics of input and output of viscose fiber textile production process. Based on the ISO 14046 method, the environmental impacts of pollutant were classified and quantified, the water alkaline footprint was proposed and the accounting model was constructed to make up for the lack of water alkaline quantification methods in the ISO method.

This study performed water footprint and LCA polygon analyses of viscose textile production and explored the key factors that contribute to environmental load on water resource. The water footprint analyses showed that water resources environmental load caused by viscose textile production was mainly derived from water scarcity, water eutrophication, water acidification, water ecotoxicity and water alkaline. In wastewater treatment, it is often only concerned with high concentrations of conventional contaminants. But in this study, it can be seen from the water environmental load LCA polygon and its area value that the water ecotoxicity footprint that Zn^{2+} and CS_2 caused contributed more to the comprehensive assessment results of water resources environmental load, although their contents were lower than other pollutants. In addition, in general research, CS_2 is generally considered to be a gas and only causes air pollution. However, a small portion of CS_2 in this study was dissolved in acid station and discharged with the wastewater, resulting in water ecotoxicity. Therefore, in order to reduce the water ecotoxicity footprint of the viscose fiber production, the relevant production department can appropriately adjust the solution formulation of the acid station, reduce the input of CS_2 and $ZnSO_4$ or find their alternative chemicals.

In this study, water scarcity footprint of the pulping with the value of 28.815 m^3 H_2O eq/ton were the largest in the viscose textile production, this means that massive amount of water was consumed in the pulping process. The viscose fiber production department can improve the presoaking process, reduce the input of fresh water and alkali, or increase the recovery rate of black liquor. Moreover, this paper calculated the average water scarcity footprint in China, the water scarcity footprint would be even large if the pulping process occurred in water-deficient area. Furthermore, the calculation results of the water degradation footprint did not take into account the differences in the water environment of each region, such as the natural background concentration. The same pollutants are discharged into clean water bodies and heavily polluted water bodies, and the load on the two water bodies will be definitely different. The LCA polygon analyses showed comprehensive evaluation of water resources environmental load in viscose textile production. Significantly, the units of water scarcity footprint and water ecotoxicity footprint are m^3 H_2O equivalent, while the units of water eutrophication footprint, water acidification footprint, and water alkaline footprint are kg reference pollutant equivalent. It may be controversial to put the indicators with different unit categories on the same plane for comprehensive evaluation, but the final results did roughly reflect the overall environmental load. In future research, attempts should be made to convert the water footprint results to the same equivalent, so that the comprehensive environmental impact expressed by the LCA polygon area will be more accurate.

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Investigation of the technical and physical properties of metal composite 1×1 rib knitted fabrics

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ABSTRACT – REZUMAT

Investigation of the technical and physical properties of metal composite 1x1 rib knitted fabrics

In this study, it was aimed to determine electromagnetic shielding effectiveness, antibacterial activity, surface resistivity and bending rigidity properties of 1×1 rib knitted fabrics. For this purpose, copper (Cu), stainless steel (SS) and silver (Ag) wires were commingled with two nylon filaments to produce metal composite yarns. 1×1 rib fabrics were produced by these composite yarns. Electromagnetic shielding effectiveness (EMSE), antibacterial activity, surface resistivity and bending rigidity of the composite knits were measured. Electromagnetic shielding measurements of samples were conducted between 1.0–5.0 GHz frequency. Antibacterial activity test was applied according to AATCC 100 standard against K. pneumoniae and S. aureus bacteria. Results showed that knitted fabrics generally have lower SE values than 10 dB at wale direction. The double layer samples provide higher EMSE than single layer samples for all metal types. Maximum EMSE value was obtained as 57.12 dB. The use of metal wire significantly reduced surface resistivity of knitted fabrics. Copper composite knitted fabrics showed 99 % antibacterial activity against both bacterial species. When compared to the control sample, the use of metal wire significantly increased the rigidity of the samples.

Keywords: *composite yarns, composite fabric, knitted fabric, physical properties, technical properties*

Analiza proprietăților tehnice și fizice ale compozite metalice din tricot patent 1x1

În acest studiu, s-a urmărit determinarea eficacității ecranării electromagnetice, a activității antibacteriene, a rezistivității la suprafață și a proprietăților de rigiditate la încovoiere a tricotului patent 1×1. În acest scop, fire de cupru (Cu), oțel inoxidabil (SS) și argint (Ag) au fost combinate cu două filamente de nailon pentru a produce fire compozite metalice. Tricoturile patent 1×1 au fost produse utilizând aceste fire compozite. Ulterior, au fost determinate eficacitatea ecranării electromagnetice (EMSE), activitatea antibacteriană, rezistivitatea la suprafață și rigiditatea la încovoiere a tricoturilor compozite. Măsurătorile de ecranare electromagnetică ale probelor au fost efectuate la o frecvență de 1,0–5,0 GHz. Testul de activitate antibacteriană a fost aplicat conform standardului AATCC 100 față de bacteriile K. pneumoniae și S. aureus. Rezultatele au arătat că tricoturile prezintă, în general, valori ale ecranării elecromagnetice mai mici de 10 dB în direcția șirului de ochiuri. Probele cu dublu strat asigură valori EMSE mai mari decât probele cu un singur strat pentru toate tipurile de metale. Valoarea maximă EMSE obținută a fost de 57,12 dB. Utilizarea firului metalic a redus semnificativ rezistivitatea la suprafață a tricoturilor. Materialele tricotate din compozit de cupru au prezentat 99% activitate antibacteriană pentru ambele specii bacteriene. În comparație cu proba martor, utilizarea firului metalic a crescut semnificativ rigiditatea probelor.

Cuvinte-cheie*: fire compozite, material compozit, material tricotat, proprietăți fizice, proprietăți tehnice*

INTRODUCTION

Electromagnetic (EM) shielding is becoming an increasingly important feature in industrial applications, secret and shielded rooms, wall covering, healthcare products, protective clothing, military tents and worker clothes. Fabrics containing conductive metal wires are one of the widely used materials for EM shielding. These materials have shown rapid developments with increasing interest in recent years. In many studies in the literature, it has been investigated the importance of knitting structure, density, weight, thickness, tightness, machine gauges, yarn and conductive material types on the electromagnetic shielding effectiveness (EMSE) of the knitted fabrics [1–11].

Perumalraj and Dasaradan (2009), Ortlek et al. (2011), Çeken et al. (2011) and Abdulla et al. (2017) have been widely investigated the effect of knitting geometry to EMSE. Different types of knitted structures producing with the same yarns affected EMSE values because of length and position of float, tuck and loop in the knit fabric structure [6, 9]. For the production of knitted fabric containing metal wires, researchers preferred different methods such as flat [3], circular [4] and warp knitting machines [8]. In these machines, the effects of different machine gauge and tightness factor on EMSE were analyzed [10]. Ring core [1, 7, 9], siro core [2], plied [3, 5], hollow spindle [4, 8, 11], Dref [12] and commingled [13–16] composite yarns containing metal wires or metal wires as direct [3] were used during knitting process in the literature. Previous research findings have reported that EMSE decreases with the increase of frequency. Also fabrics having denser conductive materials give higher shielding results depending on the measurement direction [4, 9]. Moreover, these knitted fabrics including metal wires were laminated or used as a component of the composite structure. Generally, lamination, composites and multilayer fabrics show a higher EMSE values than knitted fabrics. Furthermore, an increase in angle and number of layers provide positive impact on the EMSE [7–8, 11–12]. Yu et al. (2015) found that the structures at 90° intervals showed a better EMSE values compared to those at 0° and 45° intervals [8].

The aim of this research is to determine the physical and technical properties of knitted fabrics containing metal composite yarn. In this context, composite yarns were produced with the commingling principle instead of other mentioned conventional techniques. Stainless steel, copper, silver wires and two polyamide 6.6 filaments was combined in intermingling machine. Obtained yarns were knitted in flat knitting machine. Antibacterial activity, surface resistivity and electromagnetic shielding effectiveness of sample were tested as technical properties. Bending rigidity was also measured as physical property. Results were analyzed statistically.

MATERIAL AND METHOD

Production of composite yarn and knitted fabric samples

In the study, 3-component metal composite yarns were produced by commingling technique. Metal wire was centered between two polyamide yarns to prevent the breaking of metal wires by the effect of compressed air (figure 1).

Copper (Cu), stainless steel (SS) and silver (Ag) wires were commingled with polyamide yarns at 5 bar pressure and 150 m/min production speed. Properties of filaments and composite yarns are given in table 1.

Table 1

TECHNICAL PROPERTIES OF FILAMENTS AND COMPOSITE YARNS	
Filaments	**Technical Properties**
Polyamide 6.6 (PA)	78 denier/68 filaments
Silver Monofilament (Ag) (Isolated)	107 denier (47 μ diameter)
Copper Monofilament (Cu)	157 denier (50 μ diameter)
Stainless Steel Monofilament (SS)	144 denier (50 μ diameter)
Composite Yarns	
PA + SS + PA (PSSP)	222 denier/137 filaments
PA + Ag + PA (PAgP)	261 denier/137 filaments
PA + Cu + PA (PCuP)	306 denier/137 filaments

Microscope images of composite yarns were taken at 20× magnification ratio by digital camera microscope (figure 2).

Stainless steel, copper and silver composite yarns were knitted to 1×1 Rib fabrics with same parameters by Shima Seiki SFF152 flat knitting machine. In order to increase the EMSE by considering the results of

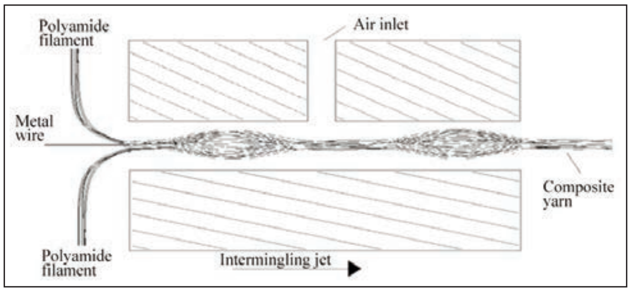


Fig. 1. The 3-component commingling process

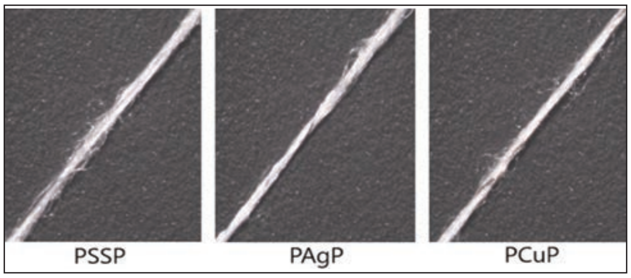


Fig. 2. Microscope images of different types of composite yarns (20×)

Table 2

PROPERTIES OF COMPOSITE FABRICS				
Sample codes*	**Yarn type**	**Course/cm**	**Wale/cm**	**Weight (g/m^2)**
Control	PA	12	14	249.00
CuS	PCuP	12	11	377.50
SS	PSSP	11	12	278.30
AgS	PAgP	12	11	326.00

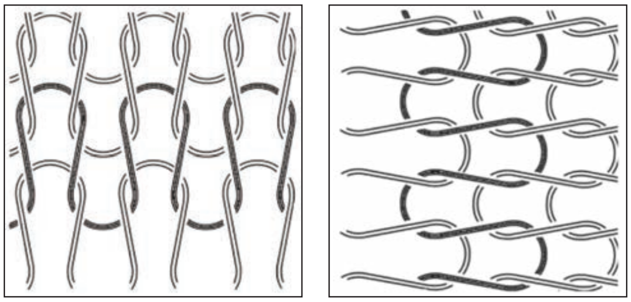
* The last letter of sample code was used as D for double layer samples (ex. CuD)

the previous studies [17–18], double layer samples were produced by sewing. The properties of composite fabrics are given in table 2.

Measurement of electromagnetic properties

The reflection (S11/S22) and transmission (S21/S12) coefficients of knitted fabrics were measured according to free space test method by using Agilent PNA-L model network analyzer with the range of 1.0–5.0 GHz. The measurement system was calibrated with the keysight (Agilent) 85056A mechanical calibration kit. In the free space method, measurements can be performed in the usage area of the product. This method is almost non-limiting in terms of sample sizes and types and allowing for a wide frequency range [19–20]. In measuring process, single and double layer samples were placed between two horn antennas at course (figure 3, *a*) and wale (figure 3, *b*) directions by rotating clockwise 90°. In addition to EMSE, absorbed and reflected power ratios were also examined.

The measured S parameters (S11/S22 and S12/S21) were used for EMSE characterization. EMSE is defined as logarithmic form of the ratio between the field or power intensity with (E_T) and without (E_0)



a *b*

Fig. 3. Placements of sample at: *a* – wale direction; *b* – course direction

shielding material. SE values can be calculated as dB by the following Equation 1 [21–22]:

$$SE = 20\log\left|\frac{E_0}{E_T}\right| = 20\log\left|\frac{H_0}{H_T}\right| = 10\log\left|\frac{P_0}{P_T}\right| \quad (1)$$

The transmitted power (*T*), reflected power (*R*) and absorbed power (*A*) were calculated by using Equations 2, 3 and 4 [23].

$$T = \left|\frac{\text{Transmitted electric field}}{\text{Incident electric field}}\right|^2 = \left|\frac{E_T}{E_i}\right|^2 = |S_{12}|^2 = |S_{21}|^2 \quad (2)$$

$$R = \left|\frac{\text{Reflected electric field}}{\text{Incident electric field}}\right|^2 = \left|\frac{E_R}{E_i}\right|^2 = |S_{11}|^2 = |S_{22}|^2 \quad (3)$$

$$A = 1 - (T + R) \quad (4)$$

Especially, the reflectivity of the electromagnetic shield causes secondary interference [24]. Moreover, absorbability of material helps to reduce the visibility on radar [25]. Therefore, it is more meaningful to examine these components separately when defining electromagnetic characterization of materials. Obtained data were analyzed statistically in four different frequency ranges as 1–2, 2–3, 3–4 and 4–5 GHz. These frequencies are in the class D, E, F, G of U.S. military microwave bands [26].

Measurement of surface resistivity

Conductivity of the knitted fabric was measured by using ELME MULTIMEG megohmmeter at 55.0% relative humidity (RH) and 20.0°C. Surface resistivity test was carried out according to “TS EN 1149-1: Electrostatic properties – Part 1: surface resistivity” standard. The measurements were repeated 10 times for each sample in wale and course directions. The classification of samples was carried out according to their resistivity (ohm/sq) as given in table 3 [27].

Table 3

SURFACE RESISTIVITY CLASSIFICATION OF MATERIALS

Classification	Surface resistivity (ohm/sq)
Conductive	$<10^5$
Dissipative	10^5 to 10^{12}
Insulating	$>10^{12}$

Antibacterial activity test

Antibacterial activity tests were performed according to AATCC 100 standard. AATCC 100 is a quantitative method for the determination of antibacterial activity of textile materials. *K. pneumoniae* and *S. aureus* which causes various infections in humans were chosen as test bacteria to investigate the antibacterial properties of knitted fabric samples.

Bending rigidity test

The bending rigidity test provides information about softness of fabric. Thus, bending rigidity of the knitted fabrics was tested to determine the effect of the metal wire on the softness of fabrics. The test was conducted according to ASTM D 4032 standard. Tests were repeated 5 times for each sample by using a digital pneumatic stiffness tester. Obtained data were analyzed statistically.

RESULTS AND DISCUSSION

General evaluation for 1–5 GHz frequency range

The weft knitting structure and the contact points of loops were examined together for describing the EMSE behaviors at different directions in detail. In weft knitting, the loops are formed in the course direction. So, the conductive wire shows continuity along the course direction of fabric, whereas, the conductivity in the wale direction only occurs with the contact of metal wires at the connection points of the loops. Thus, the conductivity is interrupted in the wale direction. In previous studies it was noted that the orientation of the conductive yarns has an important effect on the EMSE and weft knitted fabrics have EMSE ability in their course direction [28–30]. In our study, all knitted samples showed lower EMSE than 10 dB for wale direction in accordance with previous studies. Maximum EMSE values were determined as 57.12 (CuD), 54.27 (AgD) and 48.73 (SD) in the course direction of double layer samples. EMSE, absorbed and reflected power ratio of single and double layer knitted fabrics at course direction are given in figure 4.

In first step, the entire data set was subjected to statistical analysis for general evaluation. Normality of data was examined with Kolmogorov-Smirnov test. Data was not distributed normally with p values less than 0.05. Kruskal-Wallis and Mann-Whitney U, which are distribution free and rank-based nonparametric tests, were applied to determine the difference between groups and with-in-group respectively [31–32]. Results are given in table 4.

According to result, the difference in the number of layer did not cause a significant change in the absorbed and reflected power ratio ($p > 0.05$). But, double layer samples provided significantly higher EMSE then single layer samples in the 1–5 GHz frequency range ($p < 0.05$). Similar to our results, Chen et al. determined that the EMSE increases as fabric thickness increases and the tendency of EMSE keeps the similar shielding effectiveness at various frequencies. Also they noted that the protective activity of a

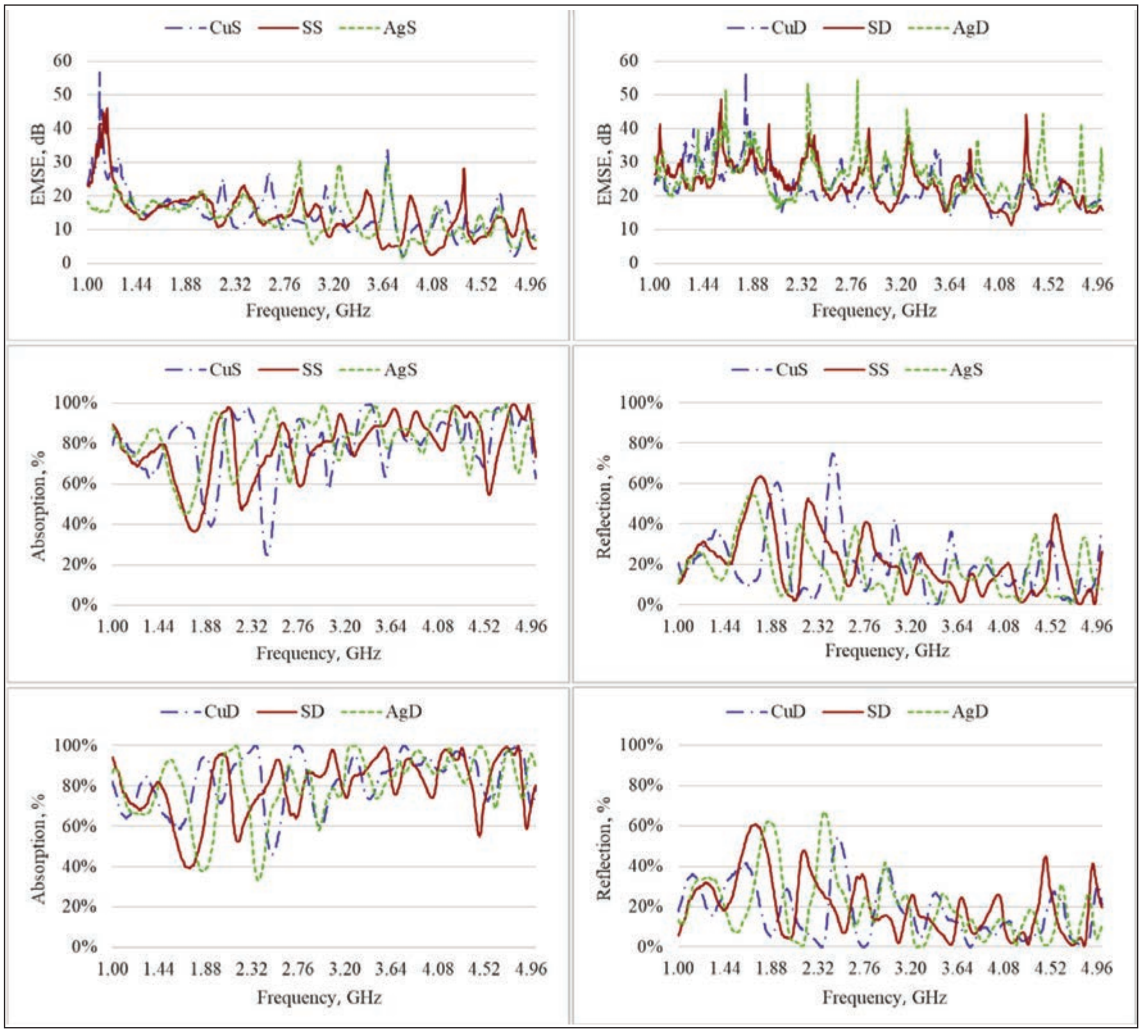


Fig. 4. EMSE, absorbed and reflected power ratio of single and double layer knitted fabrics

Table 4

KRUSKAL-WALLIS AND *MANN-WHITNEY U TESTS STATISTICS OF METAL TYPES

Material type		Single layer			Double layer		
		EMSE	Absorbed power ratio	Reflected power ratio	EMSE	Absorbed power ratio	Reflected power ratio
Mean ranks	SS	**1388.51**	1248.05	**1587.77**	1326.31	**1289.58**	**1562.85**
	Cu	**1405.53**	**1442.02**	**1550.81**	1225.65	1478.41	1424.74
	Ag	1306.96	**1410.93**	962.42	1549.04	**1333.02**	1113.41
Asymp. Sig.		0.017	0.000	0.000	0.000	0.000	0.000

* Groups with no statistically significant difference were marked in bold.

single layer is unsatisfactory for general applications, but multilayer fabrics can provide adequate shielding effectiveness [17].

It can be said that the absorbed and reflected power ratio of different metal types were significantly different. In addition, the results indicated that the metal types had a determinant on the ratio of absorbed/reflected power. Mean ranks showed that the samples containing SS and Cu showed higher EMSE and reflected power ratio than Ag samples for single layer. The change in the number of layers had a different effect on different metal types. The increase in the number of layers was significantly increased the performance of the silver composite sample and these samples showed higher EMSE than SS and Cu samples respectively. The probable cause of the situation was that different types of metals have different absorption/reflection properties.

In figure 4, EMSE showed a decreasing trend with increasing frequency. Hence, spearman's correlation analysis was performed to determine the level and significance of this trend (table 5).

Studies in the literature reported that the reflection loss decreases with increasing frequency oppositely

Table 5

SPEARMAN'S CORRELATION RESULTS			
Correlation coefficients		**Frequency**	
		Single layer	**Double layer**
EMSE	Correlation coefficient	–0.652*	–0.512*
	Sig. (2-tailed)	0.000	0.000
	N	2733	2733
Absorbed power ratio	Correlation coefficient	0.451*	0.445*
	Sig. (2-tailed)	0.000	0.000
	N	2733	2733
Reflected power ratio	Correlation coefficient	–0.241*	–0.254*
	Sig. (2-tailed)	0.000	0.000
	N	2733	2733

* Correlation is significant at the 0.01 level (2-tailed).

the absorption loss [31–32]. Wavelength of incident waves decreases by increasing frequency. So, electromagnetic waves having shorter wavelength can penetrate the gaps of fabrics [33–34]. The significant Spearman correlation coefficient value of –0.652 confirms what was apparent from the graph; there appears to be a strong negative correlation between the EMSE and frequency for single layer samples. There was a moderate level negative correlation (–0.512) for double layer samples. It can be said that the double layer samples provided more stable shielding than single layer against the shorter wavelength. The obtained results were consistent with the literature. In table 5, the closer correlation coefficients indicated that the change in the number of layer did not make a significant difference on the absorbed/reflected power ratio against the frequency. On the other hand, there is a significant correlation between the absorbed power ratio and frequency at moderate level.

Evaluation of EMSE with segmentation of frequency range

Different metal types can show different performance for various frequency ranges. Changing performance in different segments can be overlooked when all data is used. Therefore, in this section, EMSE and absorbed/reflected power ratio of samples were analyzed for 1–2, 2–3, 3–4 and 4–5 GHz frequency ranges separately for making a comprehensive EMSE characterization. Statistical tests results are given in table 6.

According to table 6, in the range of 1–3 GHz, stainless steel had a better EMSE than copper and silver, the performance of copper came into prominence between 3–5 GHz for single layer samples. There was no statistically significant difference among the EMSE values of the double layer samples in the 1–2 GHz range. It was determined that the increase in the number of layers increased the performance of silver composite sample than others. AgD samples showed the best performance especially in the 3–5 GHz range. Reflected power ratio of SS sample is higher than CuS and AgS samples between 1–3 GHz frequency ranges. CuS samples came into prominence with reflected power ratio between 3–5 GHz similarly the EMSE results. AgS sample showed a better absorbed power ratio between 1–3 and 4–5 GHz

Table 6

KRUSKAL-WALLIS AND *MANN-WHITNEY U TESTS STATISTICS FOR METAL TYPES									
Metal type		**Single layer**				**Double layer**			
		1–2 GHz	2–3 GHz	3–4 GHz	4–5 GHz	1–2 GHz	2–3 GHz	3–4 GHz	4–5 GHz
		EMSE							
Mean Ranks	SS	371.90	379.35	339.57	312.42	326.73	399.58	291.18	**278.49**
	Cu	380.14	**301.60**	372.89	**377.02**	359.58	**243.14**	319.59	**311.07**
	Ag	**279.96**	346.55	310.54	333.56	345.69	384.78	**412.23**	**433.44**
Asymp. Sig.		0.000	0.000	0.168	0.002	0.206	0.000	0.000	0.000
		Absorbed power ratio							
Mean Ranks	SS	**285.92**	**278.63**	**334.15**	[a]342.38	**322.94**	328.48	321.00	333.09
	Cu	368.52	365.13	**430.05**	**[a]309.19**	368.98	**379.45**	385.89	353.78
	Ag	377.57	383.74	**258.80**	371.43	340.08	319.57	**316.11**	336.14
Asymp. Sig.		0.000	0.000	0.002	0.003	0.043	0.002	0.000	0.481
		Reflected power ratio							
Mean Ranks	SS	**483.75**	**406.57**	**339.32**	[a]338.97	**467.66**	356.60	365.50	349.42
	Cu	**428.74**	319.30	**454.56**	**[a]372.70**	**430.28**	**305.32**	368.45	327.36
	Ag	**119.51**	301.64	**229.12**	311.33	**134.06**	365.58	**289.05**	346.22
Asymp. Sig.		0.000	0,000	0.002	0.004	0.000	0.002	0.000	0.434

* The group, which is statistically different from the others, was marked in bold.
[a] The difference is not significant.

Table 7

KRUSKAL-WALLIS TEST STATISTICS OF NUMBER OF LAYERS FOR EMSE					
Frequency ranges (GHz)		1–2	2–3	3–4	4–5
Mean ranks	Single layer	422.52	397.09	394.93	372.03
	Double layer	952.48	971.91	968.07	990.97
Asymp. Sig.		0.000	0.000	0.000	0.000

Table 8

TESTS STATISTICS OF SPEARMAN'S CORRELATIONS								
Correlation Coefficients	**Single Layer**				**Double Layer**			
	1–2 GHz	2–3 GHz	3–4 GHz	4–5 GHz	1–2 GHz	2–3 GHz	3–4 GHz	4–5 GHz
	EMSE							
Correlation Coff.	–0.306	–0.157	–0.316	–0.103	0.431	0.109	–0.119	0.043
Sig. (2-tailed)	0.000	0.000	0.000	0.007	0.000	0.004	0.002	0.257
	Absorbed power ratio							
Correlation Coff.	–0.316	–0.021	0.235	0.009	-0.190	–0.157	0.218	–0.079
Sig. (2-tailed)	0.000	0.577	0.000	0.810	0.000	0.000	0.000	0.040
	Reflected power ratio							
Correlation Coff.	0.253	0.018	–0.257	–0.014	0.089	0.156	–0.371	0.079
Sig. (2-tailed)	0.000	0.639	0.000	0.721	0.020	0.000	0.000	0.039

ranges. Absorbed power ratio of CuD samples is generally higher than the other samples in the 1–4 GHz ranges. There was no statistically significant difference among the metal types in terms of the absorbed and reflected power ratio values between 4–5 GHz range. Kruskal-Wallis tests results of EMSE for number of layers are given in table 7.

According to table 7, double layer samples showed higher EMSE at statistically significant level than single layer for all segments. Spearman's correlation analysis was conducted to determine correlations between EMSE, absorbed/reflected power ratio and frequency. Test results are given in table 8.

In table 8, EMSE values showed a decreasing tendency with increasing frequency between 1–5 GHz frequencies. In addition, this correlation was at moderate level with –0,652 correlation coefficient. When frequency was examined in segments, it can be said that there is a weaker significant correlation in the same direction for single layer samples. On the other hand, the increase in the number of layer changed the inclination of this trend as positive in the range of 1–3 GHz. It showed that the double layer samples provide better EMSE against increasing frequency. There were generally weak correlations between absorbed/reflected power ratios and frequency.

It can be mentioned the three different shielding mechanisms in double layer structure. In the first mechanism, the waves passing through the first layer are absorbed by the second layer. In the second mechanism, some of the waves reflected from the second layer are absorbed by the first layer. In the third mechanism, repetitive reflections occur between the first and second layers and these waves are mostly absorbed and transformed into heat. Furthermore when waves that reflected from the first layer and second layer are in opposite directions to each other, destructive interference can be occur and create a wave that is weaker than either of them [35–36]. In the research this effect was considered in total absorption. Multilayer structure, which consists of the composite material having higher absorption ability in upper layer and the reflective material for the second layer, can be more effective for reducing the secondary interference considering these mechanisms, the possible design recommendations to reduce the secondary interference for different frequency ranges are given in table 9.

Table 9

STRUCTURE RECOMMENDATIONS TO REDUCE THE SECONDARY INTERFERENCE		
Frequency	**First layer**	**Second layer**
1-2 GHz	Ag or Cu Composites	SS Composite
2-3 GHz	Ag or Cu Composites	SS or Ag Composites
3-4 GHz	Cu Composite	SS or Cu Composites
4-5 GHz	Ag or SS Composites	SS, Cu or Ag Composites

Surface resistivity test results

Surface resistivity of composite and control sample measured at 55 % RH and 20°C conditions. Means of test results are given in table 10.

According to classification in table 10, test results show that 100% polyamide knitted fabric was nonconductive as expected. In addition, the isolation of silver affected the results and the silver composite materials exhibited insulating behavior. On the other hand, copper and stainless steel composite fabrics could be classified as conductive with their very low surface resistivity.

Table 10

SURFACE RESISTIVITY TEST RESULTS		
Sample type	**Surface resistivity (ohm/sq)**	
	Wale direction	**Course direction**
Control sample (100% PA)	> 2×10^{12}	> 2×10^{12}
Copper composite	< 10^3	< 10^3
Stainless steel composite	< 10^3	< 10^3
Silver composite	3.87×10^9	> 2×10^{12}

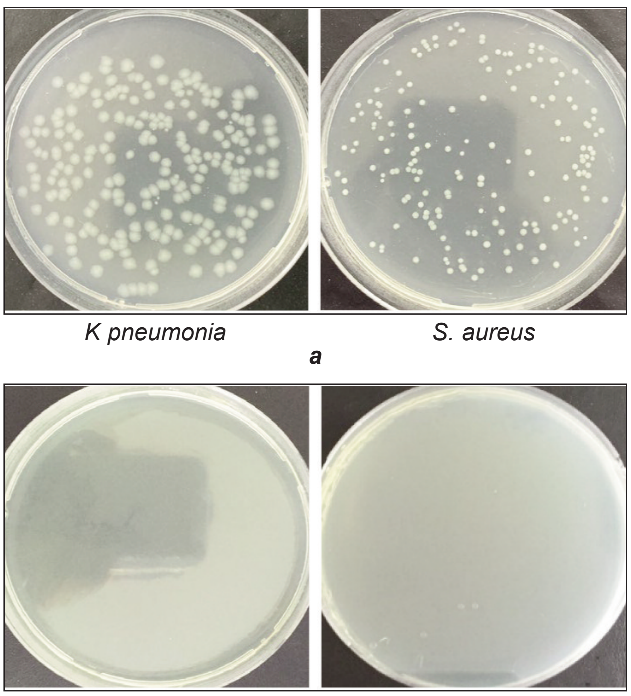
Table 11

BENDING RIGIDITY TEST RESULTS		
Sample type	**Means of stiffness (kgf)**	**CV (%)**
Control sample (100% PA)	0.120	1.897
Copper composite	0.305	3.361
Stainless steel composite	0.304	4.563
Silver composite	0.261	9.171

Antibacterial activity test results

Previous studies in the literature mentioned that the elemental silver and stainless steel (AISI 316L) have no antimicrobial properties [37–39]. Thus, antibacterial activity test was only applied to copper composite samples. Test results showed that the copper composite samples showed very high antibacterial activity against *K. pneumoniae* and *S. aureus* bacteria. After 24 hours of incubation time, there was no colony in petri dishes for both bacteria. Petri dishes photos of copper composite sample for 0 (*a*) and 24 (*b*) hours are given in figure 5.

In our copper composite knitted sample, this rate was about 50 % and it provided 99% antibacterial (bactericidal) activity against *K. pneumoniae* and *S. aureus* bacteria (figure 5).



K pneumonia *S. aureus*

a

K pneumonia *S. aureus*

b

Fig. 5. Petri dishes photos after 0 and 24 hours contact times

Bending rigidity test results

Bending rigidity test was conducted to determine the softness of the composite samples. Results are given in table 11.

Test results were evaluated statistically. Kolmogrov Simirnov and levene tests were applied to determine normality of the data and homogeneity of variance respectively. Analysis showed that the distribution was normal (sig = 0.160) but the variance was not homogeneous (sig. = 0.006). ANOVA and Tamhane multiple comparison test were applied to data. According to ANOVA, difference between the groups was statistically significant (sig. = 0.000). Tamhane multiple comparisons test was applied. According to result, the use of metal wire in structure significantly increased the rigidity of the samples as noted in previous studies [40]. However, the metal type has no significant effect on the stiffness of knitted fabrics.

CONCLUSION

In the study, the metal wires were successfully intermingled with two PA yarns and knitted into 1×1 rib fabrics with a flat knitting machine. Technical (EMSE, surface resistivity and antibacterial activity) and physical (bending rigidity) properties of metal composite knitted fabrics were investigated. Results of study summarized below.

- All knitted fabrics had lower EMSE value than 10 dB for wale direction. Double layer samples provided significantly higher EMSE then single layer samples. In addition, the difference in the number of layer did not cause a significant change in the absorbed and reflected power ratio. Metal types were significantly determinant on the absorbed and reflected power ratios. The samples containing SS showed higher reflected power ratio than Cu and Ag samples respectively. It was observed that different metal types react differently by the change in the number of layers. The increase in the number of layers was significantly increased the performance of the silver composite sample and double layer Ag samples showed higher EMSE than SS and Cu samples respectively.
- There was a negative correlation at moderate level for both single and double layer samples. It can be said that the double layer samples provided more stable shielding than single layer against the shorter wavelength.
- Segmented data analysis showed that the metals had different performance in different frequency ranges. In the range of 1–3 GHz, stainless steel had a better EMSE than copper and silver, the

performance of copper came into prominence between 3 and 5 GHz for single layer samples. It was determined that the increase in the number of layers significantly increases the performance of samples containing silver. AgD samples showed the best performance especially in the 3–5 GHz range.

- Reflected power ratio of SS sample higher than CuS and AgS samples between 1 and 3 GHz frequency ranges. CuS samples came into prominence with reflected power ratio between 3 and 5 GHz similarly the EMSE results. AgS sample showed a better absorbed power ratio between 1 and 3 GHz and 4 and 5 GHz ranges. There was no significant difference among the metal types in terms of the absorbed and reflected power ratio values between 4 and 5 GHz ranges.
- The surface resistivity of the control fabric was higher than 10^{12} ohm/sq. In this case, the control sample classified as isolative. The use of Cu and SS wire extremely reduced the resistivity and structure became conductive with the value less than 10^3 ohm /sq.
- Antibacterial activity tests showed that the copper composite knitted fabrics provided 99 % antibacterial (bactericidal) activity against *K. pneumoniae* and *S. aureus* bacteria.
- The use of metal wire in structure significantly increased the rigidity of the samples more than twice.

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Innovative concept for personalized pattern design of safety equipment

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ABSTRACT – REZUMAT

Innovative concept for personalized pattern design of safety equipment

The competitive pressure of globalization is causing textile and garment manufacturers to lower production costs, increase their efficiency and to create leaner value-adding processes. To be able to cope with these changes, measures must be implemented, including the improvement of the internal organization, and the establishment of co-operations with external organizations to create a continuous supply-demand network.

The current paper presents the innovative concept for personalized pattern design of safety equipment applied within SC MATEI CONF GRUP SRL, highlighting the importance of personalization and its competitive advantages, from the idea to the prototype or product and testing it.

The research implementation used 3D body scanning for analysis and determination of anthropometric measurements and conformation, 3D CAD technology for automatic rapid design of patterns in Made to Measure system, modelling and simulation of product in the virtual environment on customized mannequin highlighting the body-product correspondence.

Keywords: *innovation, safety equipment, 3D body scanning, virtual simulation*

Concept inovativ de proiectare personalizată a echipamentelor de protecție

Presiunea competitivă a globalizării determină producătorii de produse textile și de îmbrăcăminte să reducă costurile de producție, să crească eficiența și să creeze valoare adăugată. Pentru a putea face față acestor provocări, este imperios necesar să se implementeze măsuri precum optimizarea organizării interne și cooperarea cu organizații externe pentru crearea unei rețele continue de cerere și ofertă.

Lucrarea prezintă conceptul inovativ de proiectare personalizată a echipamentelor de protecție aplicat în cadrul companiei SC MATEI CONF GRUP SRL, cu evidențierea avantajelor competitive, de la idee la realizarea prototipului sau produsului și testarea acestuia.

Implementarea activităților de cercetare a presupus utilizarea scanării 3D a corpului pentru analiza și determinarea dimensiunilor antropometrice și conformației, cât și a tehnologiei CAD 3D pentru proiectarea automată rapidă a tiparelor realizate în sistem Made to Measure, modelarea și simularea produsului în mediul virtual pe manechin personalizat, evidențiind corespondența corp-produs.

Cuvinte-cheie: *inovare, echipament de protecție, scanare 3D a corpului, simulare virtuală*

INTRODUCTION

The competitive pressure of globalization is causing textile and garment manufacturers to lower production costs, increase their efficiency and to create leaner value-adding processes. To be able to cope with these changes, measures must be implemented, including the improvement of the internal organization, and the establishment of co-operations with external organizations to create a continuous supply–demand network. As a result, production logistics as well as information and communication technologies have gained importance, in order to keep job functions requiring higher qualifications within Europe [1–3].

Clothing products and safety equipment are ideal for personalization and customization according to consumer requirements, which do not fit into standard sizes (body size and atypical conformations or special requirements) and are an important niche for the garments sector [4–7].

The current paper presents the innovative concept for personalized pattern design of safety equipment applied within SC MATEI CONF GRUP SRL, highlighting the importance of personalization and its competitive advantages, from the idea to the prototype or product and testing it.

The beneficiary Company, SC MATEI CONF GRUP SRL has experience of 12 years in the industry of individual protective equipment. This vast experience allows the development of protection solutions dedicated to each client. The main object of activity of the company is the production and marketing of safety equipment of category I – simple design; category II – neither of simple design nor of complex design; category III – complex design, both for the national and international market. The company MATEI CONF

GRUP has the mission declared to offer solutions of protection of the highest degree of performance, through the professionalism and the dedication shown towards partners [8].
The introduction of the innovative concept for personalized pattern design of safety equipment within SC MATEI CONF GRUP SRL represents a complex process, which includes a multitude of activities, which have as final objective the obtaining of optimal correspondence between the shape of the studied body/subject and the safety equipment.
To address the objectives of the work the following steps were performed:
1. Introducing a new IT application in the design of personalized equipment, by 3D scanning the subject with dimensions outside the size standards.
2. After scanning, the system can automatically extract from the scanned body (virtual) over 100 dimensions.
3. Check the accuracy of the 3D scanner and the software for extracting anthropometric dimensions. For the subject studied a measurement protocol was generated, which facilitates the determination of the size of the garments and whether or not they fit in the size standards.
4. Analysis of the individual particularities of the body, necessary in designing personalized patterns.
5. Analysis and selection of the model of the safety equipment, found in the portfolio of the beneficiary company SC MATEI CONF GRUP SRL.
6. Verification of the method of designing the patterns using the software of automatic design by making the patterns, based on the individual body dimensions. The results of this verification are the patterns designed with Gemini Pattern Editor, the Made-to-measure module, for the selected safety equipment.
7. Verification of the pattern matching, according to the individual dimensions of the body, by modelling 2D/3D patterns and simulating the safety equipment on the body or the virtual mannequin, parameterized to the dimensions of the selected body.
8. The dimensional correspondence of the body-product and the draping mode have been verified realistically, by wearing the safety equipment and viewing the match.

ANTHROPOMETRIC DIMENSIONS ANALYSIS

The studied subject was scanned using the body scanner 3D VITUS XXL and the measurement protocol and virtual body or parameterized virtual mannequin (figure 1) were generated, which were the basis for designing the personalized patterns in Made-to-Measure system. The selected subject has the following main body dimensions extracted from the measurement protocol:

- **Body height (Ic) 172 cm;**
- **Bust circumference (Pb) 129 cm;**
- **Waist circumference (Pt) 122 cm;**
- **Hip circumference (Ps) 120 cm.**

According to this data, it was noticed that the bust circumference is placed in the superior limit of stan-

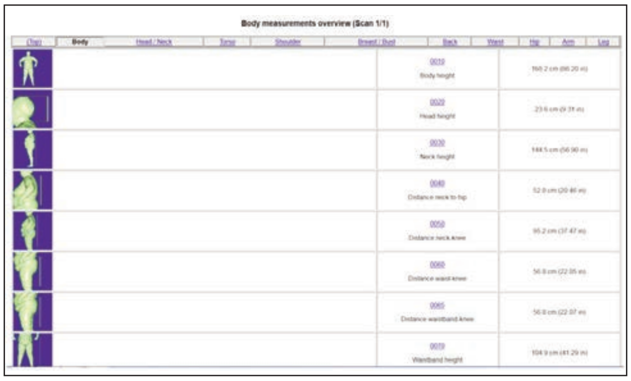

Fig. 1. Measurement protocol resulted from the 3D body scanning

dardized values according to the standard SR 13545 – Clothing. Women's Body Measurement and Garment Sizes [9]. In this standard, the maximum height of the body is 190.9 cm. Also, the maximum standard circumference of the bust has a value of 128 cm.

PERSONALIZED DESIGN OF SAFETY EQUIPMENT

Safety equipment protects the health and even the lives of millions of workers and professionals who are exposed to dangerous situations every day. This equipment must offer a delicate balance between the required level of protection, reduced weight and comfort during wear for several hours without impact on work performance.
In the study, the model of the safety equipment was analysed and selected, which was then customized by the innovative technological design and production solutions. The company SC MATEI CONF GRUP SRL selected the **Overalls suit with chest and waist pants**, which is in its portfolio and has been developed according to the corresponding technical description.
The costume is made in a combination of colours: light blue with navy blue and blue with red and consists of the blouse, chest trousers and waist support pants (figure 2). The overalls suit with chest pants and waist pants are worn by the operative personnel in the repair, maintenance and inspection activities of water pipes.
The blouse consists of breasts, back, drawstring, sleeves, collar, pockets and slit. The top of the blouse is blue (drinking water) or red (waste water). Above the horizontal seams of application of the pockets, the microfilm reflective tape is applied, throughout the width of the breasts (2 rows).
The chest trousers consist of the front, back, chest and straps. The trousers are provided in the frontal side with two knees made of corduroy navy blue material, resistant to wear. Inside them there are inserted foam shields for protection that closes with Velcro tape. At the end, the pants are provided with two straps of microfilm horizontal reflectors. The sides are provided with rib knit for adjusting the waist pants and giving the movement lightness. The structure of

the knit is rib 1×1, which ensures the return to the useless form after a movement.
The trouser with waist support is made from the outside of waterproof blue material and is composed of the following benchmarks: front, back, waist and lining for inside pants.

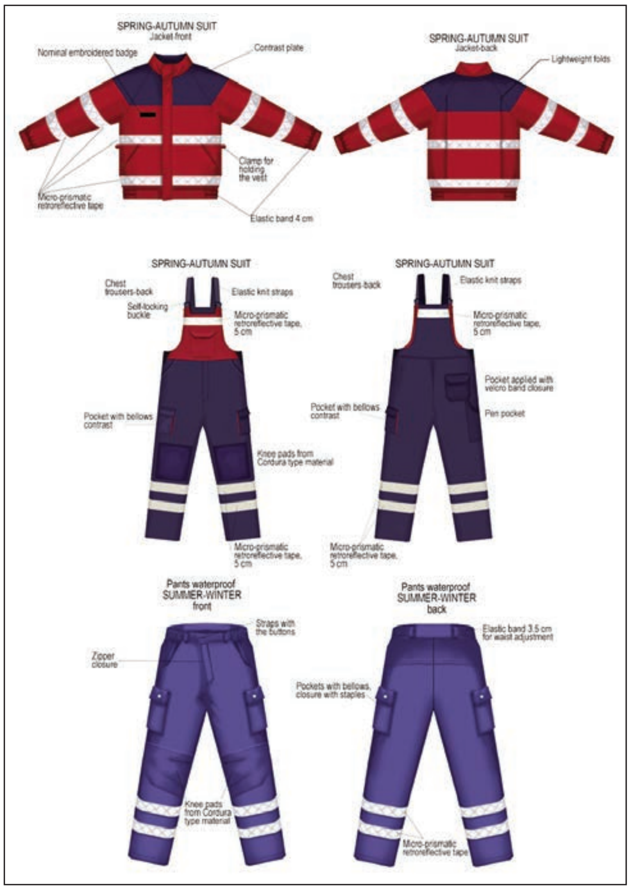

Fig. 2. Overalls suit with chest and waist pants

The costume was made from fabric 35% PES, 64% TENCEL and 1% AS, the blue color with the mass of 205 g/m^2.
Physical-mechanical and physical-chemical characteristics of the fabric were determined in the accredited laboratories of INCDTP (table 1). The elaborated test reports were used in textile material characterization in the 3D simulation.
The underwear coupled with the Overalls suit with chest and waist pants is made from TENCEL™ Lyocell that naturally manage the transportation of moisture, contributing to breathable fabrics that provide a less favourable environment for bacterial growth, offering better hygienic qualities.
The design of the basic and model patterns for the selected safety equipment was based on the geometric method of pattern construction, using Gemini Pattern Editor's special CAD design software, the Made-to-Measure module. In this module, basic patterns are created for each type of clothing item, which are then modified by specific algorithms, depending on the model of the safety equipment selected and the dimensions of the body taken from the measurement protocol (figure 3).
Verification of personalized patterns matching, designed according to individual body dimensions, was accomplished by modelling 2D/3D patterns and simulating safety equipment on the parameterized mannequin, by using Optitex PDS software for visualization, modelling and fitting the virtual body of the prototype. The virtual try-on system involves transferring and fitting safety equipment to human body with various shapes and postures, with grade preservation. To achieve this goal, safety equipment must be treated as elastic models and their deformation is controlled by the laws of dynamics [10].

Table 1

PHYSIC-MECHANICAL AND PHYSIC-CHIMICAL CHARACTERISTICS OF FABRIC (SELECTION)

Characteristic		**UM**	**Values obtained in the accredited laboratories of INCDTP**	**Reference document**
Mass		g/m^2	205±5	SR EN 12127:2003
Weave		-	Diagonal 3/1	SR 6431:2012
Warp density		threads/10 cm	345±5	SR EN 1049-2/2000
Weft density		threads/10 cm	265±5	SR EN 1049-2/2000
Tensile strength warp		N	950	SR EN ISO 13934-2013
Tensile strength weft		N	900	SR EN ISO 13934-2013
Tear strength warp		N	50	SR EN ISO 13937-1: 2001/AC:2006
Tear strength weft		N	40	SR EN ISO 13937-1: 2001/AC:2006
Colour fastness to	perspiration acid alkaline	level	4 4	SR EN ISO 1 05-E 04:2013
	rubbing dry wet		3 3	SR EN ISO 105-X12:2003
	light		4	SR EN ISO 105-802:2015

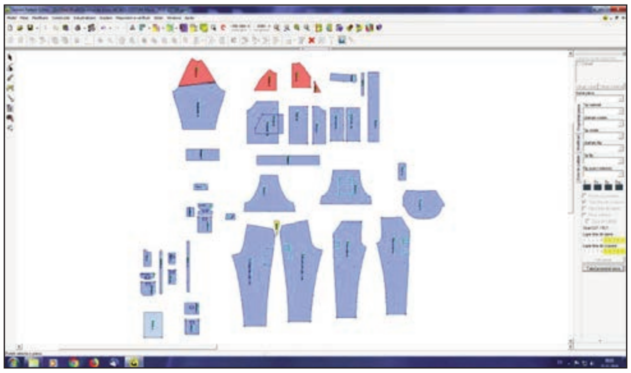

Fig. 3. The design of customized patterns of Overalls suit in Gemini Pattern Editor

Transforming patterns designed with the Gemini Pattern Editor into Optitex PDS from 2D to 3D, to obtain the virtual prototype of customized safety equipment was done in the following stages:

- parameterizing a virtual mannequin according to the anthropometric dimensions resulting from body measurement;
- shaping the surface of the patterns to obtain the 3D shape of the product with the addition of sewing lines and guide points (figure 4);
- introduction of information about the materials from which the work equipment is made (fibrous composition, drape, shrinkage, mass etc.);
- virtual try-on of the product on the virtual mannequin (figure 5);
- checking and modifying the pattern to ensure body-product correspondence.

In order to check the body-to-product correspondence, the software has a function that shows the degree of ease/adjustment of the product on the body, called the Tension Map (figure 6), in which the red colour shows that the product presses the body, the blue colour shows high ease and green colour

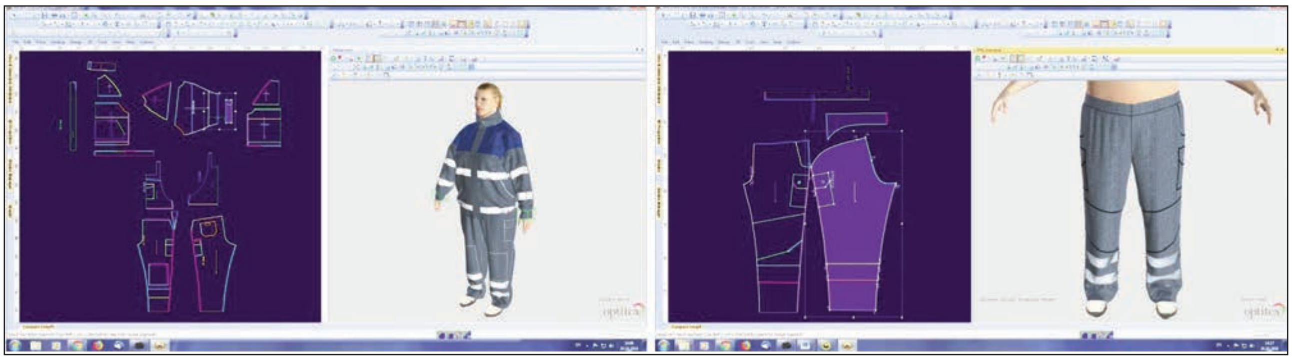

Fig. 4. The 2D patterns of the customized Overalls sit with seam lines

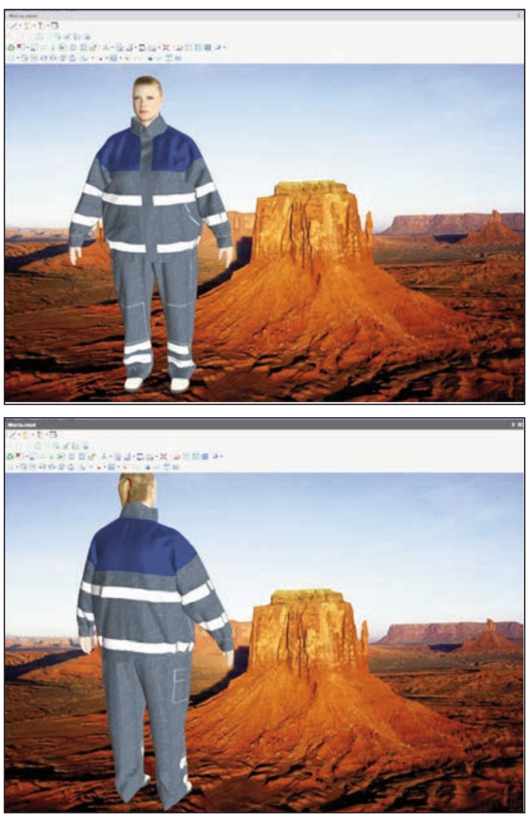

Fig. 5. Virtual try-on and verification of the customized safety equipment

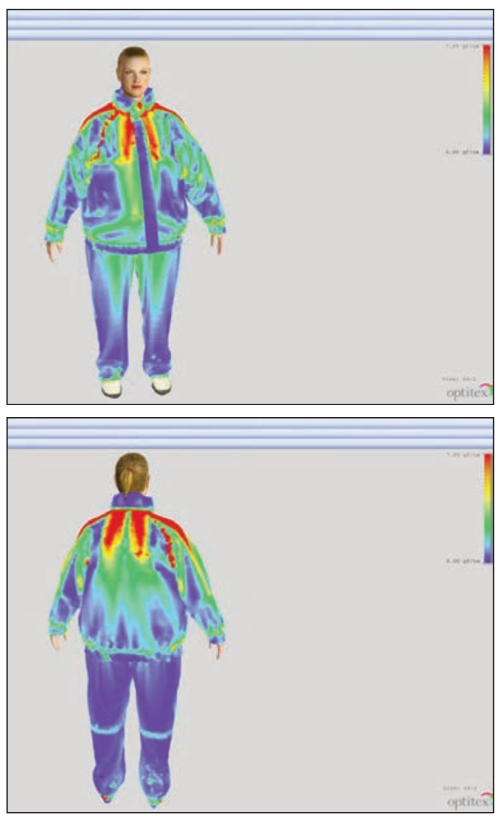

Fig. 6. Tension map for the overalls suit pattern verification

shows that the product corresponds to the dimensions. Thus, it can be seen that the jacket product corresponds dimensionally.

Also, the chest and waist trousers fit on the waist line and are slightly wide on the hips line and at the end. The degree of ease indicated by the simulation software is justified by the patterns chosen for the jacket and the trousers that have a semi-rigid figure on the body. With this information, the designer could return to 2D patterns by making the necessary corrections.

The real prototype of personalized safety equipment selected by the beneficiary company SC MATEI CONF GRUP SRL was tested on the actual body of the subject. Following the test, it was found that the outfit corresponds dimensionally, without forming unsightly creases or folds and without creating discomfort in wearing.

CONCLUSIONS

By action of customization it is understood individuality, customization and awareness, that each wearer has different conformation and carries out specific activities. Customized safety equipment involves the dimensional and conformational aspects of the body, respectively the product size as well as the quality-linked functionality criterion, aspects regarding its wearability and protection tested in accredited laboratories, the effects over the individual comfort.

The research implementation used 3D body scanning for analysis and determination of anthropometric measurements and conformation, 3D CAD technology for automatic rapid design of patterns in made to measure system, modelling and simulation of product in the virtual environment on customized mannequin highlighting the body-product correspondence. These recent technological advances lead to a restructuring of the clothing industry, increasing the capacity to efficiently and readily satisfy the requests of each customer or even to produce clothing items with increasingly more efficient services for the client.

ACKNOWLEDGEMENTS

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Comparison of silk fabric dynamic drapability and correlation analysis of impact factors

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ABSTRACT – REZUMAT

Comparison of silk fabric dynamic drapability and correlation analysis of impact factors

Drapability is the unique performance that allows the fabric to be bent in multiple directions. Silk fabric has well hand feeling and draping property, it is suitable for studying the dynamic drape performance of fabric. In this paper, we select 15 different samples of silk fabrics to measure its structural characteristics, mechanical properties and drape characteristics for studying the impact factors of dynamic draping property about silk fabric. A correlation analysis is made with the measured fabric parameters to get the factors sequence which mainly affects the dynamic draping property of fabric. Experimental result shows that the draping property of silk fabric is affected by many performance parameters, however, the latitudinal tensile is the biggest impact factor among all these parameters.

Keywords: *dynamic drape; correlation analysis; silk; impact factor; fabric performance parameters*

Analiza drapajului dinamic al țesăturilor din mătase naturală și a corelației factorilor de impact

Drapajul reprezintă proprietatea care permite îndoirea țesăturii în mai multe direcții. Țesătura din mătase naturală prezintă tușeu și drapaj corespunzătoare pentru studierea drapajului dinamic. În această lucrare, au fost selectate 15 probe diferite de țesături din mătase naturală, pentru a determina caracteristicile structurale, proprietățile mecanice și caracteristicile de drapaj ale acestora, în scopul studierii factorilor de impact ai drapajului dinamic. Analiza de corelație a fost efectuată utilizând parametrii țesăturii pentru a determina factorii care influențează, în principal, drapajul dinamic. Rezultatele experimentale au arătat că drapajul țesăturii din mătase naturală este influențat de o multitudine de parametri de performanță, însă, rezistența la tracțiunea este cel mai important factor de impact.

Cuvinte-cheie*: drapaj dinamic, analiză de corelație, mătase naturală, factor de impact, parametrii de performanță ai țesăturii*

INTRODUCTION

Fabric draping performance refers to the degree and forms of fabric draping under its own weight, which refers to the degree and the form of fabric draping that are resulted by the gravity of the fabric. It is an important index to evaluate the fabric hand feeling, appearance, quality and the 3D forms. According to the fabric of the state, the draping state of fabric can be divided into static draping and dynamic draping. The static draping describes the natural state of the fabric affected only by gravity, the dynamic draping describes the motion state of the fabric caused by the external forces. Due to the dynamic draping of the fabric is greatly affected by many factors of the fabric, such as performance parameters, the material quality, the structure, the weaving method, and etc. Even the methods which measuring the parameters also will lead to the different draping results. Excellent measuring methods and evaluation indexes have great meanings for the textile industry. In recent years, many scholars focus on how to evaluate draping performance of the fabric and have done some related researches. Some scholars [1] propose the improvement methods of the simulation models by the original parameters, some scholars [2] propose methods to improve the measurement method to get more accurate parameters. However, few scholars study the impact factors of the fabric draping performance. Guo Hongxia [3] do some research to compare the drapability of the bamboo knitted fabric and discuss the correlation of its influencing factors. It is only qualitatively analysed the draping property of the bamboo knitted fabric, but lacked quantitative analysis.

Silk fabric has a well hand feel and draping performance with good moisture and health care function, it is the common fabrics on the market. In order to describe the fabric under the motion state of draping and the 3D simulation for the movement of the fabric, we take the silk fabric as an example and select 15 kinds of silk fabrics to evaluate and analyse all the parameters which probably influence the dynamic draping of silk fabric. These parameters include the fabric structural parameters, mechanical performance parameters, physical performance parameters and other parameters. In this paper, we want to obtain the most important impact factors which influence the dynamic draping performance of the silk fabric.

PARAMETERS MEASUREMENT OF SILK FABRIC

Fabric structural characteristics parameters

In order to compare the differences of the silk fabric drape [3], we selected 15 kinds of silk fabrics which are made of 100% mulberry silk. They include Jianhong crepe, Fancy crepe georgette, Silk spinning, Silk taffeta, Habotai, Silk twill, Double palace, Plain crepe, Crepe de chine, Pearl satin, Shun weft satin, Heavy crepe, Sangbo satin, Spun silk, Hangluo. We number the fabric from 1 to 15 and get its basic structural parameters as shown in table 1

From the sample fabric structure above, we can classify the materials into three categories, including plain, twill and satin [4]. No. 5 fabric Hangluo is the unit of plain with gauze organization.

From the perspective of the twisting properties of fabric sample, No. 1, No. 3, No. 6, No.13 and No.14 are crepe weave fabric, warp wire not twisting or weak twisting, weft wire used two left two right strong twisting, the overall presentation crepe effect of fabric. No. 2, No. 8 and No. 15 belongs to the spinning fabric which warp and weft are not twisting.

Fabric mechanical property parameters

In order to get the mechanical performance of all kinds of silk fabrics, each kind of fabric are cut from 20 cm * 20 cm sample 3 pieces along the directions of the warp and weft. We make the experiment to test the mechanical properties of the 15 silk fabric samples respectively under low stress environment with automatic fabric style evaluation system KESFB-AUTO-A (Kawabata Evaluation System for Fabric system).

KES-FB-AUTO-A instrument consists of KES-FB1 tensile and shearing tester, KES - FB2 pure bending tester, KES - FB3 compression tester, KES - FB4 friction and surface tester and other related data processing equipment [5]. The instrument used to measure the fabric tensile, shearing, bending, compression, friction, mechanical performance, physics properties index for a total of 16 under low stress environment. The test is done under the standard atmospheric condition.

Tensile performance measurement

The tensile performance parameters include work ratio WT (stretch to 500 gf/cm), linearity LT (below the tensile curve area), recovery rate RT (the degree of tensile deformation energy recovery), elongation EMT (extend to the load of 500 gf/cm). The tensile performance of the fabric reflects that the fabric deformation degree under stress. The draping and tensile of fabric under the gravity have obvious correlation. The tensile performance parameters are measured and listed in table 2.

Bending and shearing performance testing

The bending performance of the fabric describes the deformation of the warp direction or weft direction when the external force is acted on the fabric along the normal plane. It reflects the fabric softness, the shape and draping degree of the fabric. The bending performance parameters include the bending rigidity B and bending hysteresis 2HB.

Table 1

FABRIC BASIC STRUCTURAL CHARACTERISTICS PARAMETERS

Sample no.	Sample name	Organization mode	Yarn linear density (tex)		Density [root·(10 cm)$^{-1}$]		Areal density (g·m^{-2})
			Warp	Weft	Warp	Weft	
1	Fancy crepe georgette	plain	7.58	4.46	880	400	86.217
2	Silk spinning	twill	3.81	17.80	410	600	95.883
3	Jianhong crepe	plain	6.00	10.63	640	456	87.367
4	Sangbo satin	satin	11.49	15.30	500	280	99.850
5	Hangluo	mixture	3.69	6.55	480	400	69.400
6	Double palace	plain	6.00	21.27	280	300	90.792
7	Shun weft satin	satin	3.69	4.65	1020	380	52.750
8	Habotai	plain	6.11	7.08	670	460	72.067
9	Silk taffeta	plain	7.93	3.65	720	408	71.217
10	Plain crepe	satin	2.96	3.95	530	410	67.650
11	Silk twill	twill	5.80	7.25	560	410	60.300
12	Pearl satin	satin	3.95	6.73	1402	438	70.333
13	crepe de chine	plain	4.18	9.23	660	376	63.100
14	Heavy crepe	plain	5.34	26.67	1550	470	202.800
15	Spun silk	plain	12.23	13.58	520	268	98.425

Table 2

FABRIC TENSILE PERFORMANCE PARAMETERS								
Sample no.	LT		WT $(gf \cdot m^{-2})$		RT (%)		EMT (%)	
	warp	weft	warp	weft	warp	weft	warp	weft
1	0.447	0.393	8.717	13.183	64.627	56.507	7.800	13.420
2	0.574	0.653	5.017	5.250	72.103	81.270	3.497	3.213
3	0.468	0.456	13.033	16.583	60.873	44.613	11.143	14.633
4	0.546	0.829	7.200	2.100	68.293	96.857	5.270	1.027
5	0.608	0.666	6.233	4.950	66.323	64.997	4.107	2.980
6	0.403	0.842	5.700	1.850	77.780	100.927	5.660	0.880
7	0.600	0.323	2.733	14.183	94.550	48.057	1.823	17.570
8	0.554	0.867	9.833	3.733	70.683	89.733	7.110	1.723
9	0.819	0.799	2.417	4.000	86.980	85.423	1.180	2.003
10	0.576	0.642	4.583	7.300	78.947	61.040	3.180	4.553
11	0.691	0.576	2.250	4.233	96.313	82.730	1.303	2.943
12	0.662	0.631	4.050	7.867	77.370	61.857	2.450	5.010
13	0.523	0.480	14.400	13.017	65.053	47.370	11.013	10.853
14	0.535	0.738	5.367	7.350	72.360	82.760	4.017	3.987
15	0.444	0.663	5.367	12.467	79.510	42.910	4.837	7.527

Table 3

FABRIC SHEAR AND FLEXURAL PROPERTIES PARAMETER										
Sample no.	G (gf/cm•degree)		2HG (gf/cm)		2HG5 (gf/cm)		B $(gf \cdot cm \cdot m^{-2})$		2HB $(gf \cdot cm \cdot m^{-2})$	
	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
1	0.227	0.200	0.117	0.037	0.150	0.043	0.021	0.012	0.227	0.200
2	0.303	0.237	0.260	0.053	0.427	0.130	0.014	0.038	0.303	0.237
3	0.230	0.220	0.187	0.170	0.237	0.210	0.017	0.011	0.230	0.220
4	0.257	0.283	0.120	0.053	0.503	0.393	0.045	0.160	0.257	0.283
5	0.227	0.223	0.210	0.080	0.293	0.103	0.037	0.021	0.227	0.223
6	0.230	0.250	0.160	0.053	0.267	0.160	0.017	0.202	0.230	0.250
7	0.223	0.217	0.097	0.060	0.093	0.060	0.046	0.007	0.223	0.217
8	0.230	0.260	0.037	0.017	0.303	0.260	0.019	0.063	0.230	0.260
9	1.063	1.033	1.053	0.743	4.343	4.297	0.043	0.017	1.063	1.033
10	0.227	0.210	0.110	0.037	0.180	0.070	0.032	0.010	0.227	0.210
11	0.237	0.237	0.160	0.160	0.360	0.327	0.030	0.021	0.237	0.237
12	0.243	0.253	0.237	0.070	0.460	0.230	0.050	0.019	0.243	0.253
13	0.220	0.190	0.170	0.053	0.243	0.050	0.012	0.010	0.220	0.190
14	0.303	0.243	0.170	0.050	0.453	0.213	0.101	0.304	0.303	0.243
15	0.233	0.220	0.093	0.037	0.227	0.100	0.035	0.016	0.233	0.220

The shearing performance of the fabric describes the deformation along the diagonal direction. It reflects the important properties of the fabric draping form related with the fabric surface modeling. Shearing performance parameters include the shearing stiffness G, Shear lag value of 2HG, shear lag value 2HG5. The bending and shearing performance parameters are tested and listed in table 3.

Compression, friction and surface performance testing

Fabric performance is a physical index used to reflect the fabric softness, the bearing capacity and comfortable, which has a close relationship among inherent quality, compression performance in thickness direction, fluffy fullness, the smoothness of the fabric surface, and etc. These parameters related with the

Table 4

THE COMPRESSION FRICTION AND SURFACE PERFORMANCE PARAMETERS											
Sample no.	MIU		MMD		SMD (u)		LC	WC (gf·cm·m^{-2})	RC (%)	T0 (mm)	Tm (mm)
	warp	weft	warp	weft	warp	weft					
1	0.116	0.178	0.007	0.010	1.435	4.377	0.601	0.092	64.102	0.361	0.300
2	0.156	0.165	0.007	0.005	1.589	1.168	1.162	0.286	11429.860	0.304	0.205
3	0.146	0.166	0.011	0.013	3.770	4.085	0.436	0.117	56.823	0.402	0.295
4	0.125	0.163	0.006	0.008	5.818	1.749	0.500	0.065	58.058	0.297	0.236
5	0.124	0.189	0.015	0.011	3.267	2.871	0.507	0.101	57.999	0.308	0.227
6	0.131	0.184	0.016	0.008	7.439	2.002	0.516	0.065	53.302	0.246	0.194
7	0.106	0.154	0.004	0.008	1.366	3.082	0.468	0.203	68.428	0.373	0.200
8	0.113	0.127	0.008	0.009	1.267	1.672	0.431	0.061	54.062	0.224	0.167
9	0.121	0.137	0.022	0.009	0.944	1.940	0.578	0.046	62.473	0.166	0.134
10	0.124	0.198	0.003	0.005	0.571	1.792	0.562	0.065	58.321	0.217	0.171
11	0.164	0.166	0.006	0.005	0.712	0.735	0.669	0.047	63.707	0.154	0.126
12	0.106	0.158	0.003	0.006	2.256	1.859	0.543	0.077	60.836	0.258	0.202
13	0.116	0.170	0.010	0.008	3.304	2.689	0.514	0.086	62.812	0.308	0.241
14	0.158	0.133	0.009	0.005	7.051	1.936	0.322	0.136	52.701	0.615	0.445
15	0.129	0.195	0.008	0.010	6.088	3.256	0.519	0.065	56.891	0.278	0.227

three performances have influence on the fabric draping form. They include the compression ratio WC, compression recovery rate RC, linear compression degree LC, the thickness of the fabric T0, stable thickness Tm. The compression performance parameters of different fabrics are tested and listed in table 4.
The friction and surface performance of the fabric reflects the friction between the fabric and the other objects. It has major influence on the hand feel of the fabric. Friction and surface performance have relation with the smoothness of the fabric surface. The smoothness has a certain influence on the friction of the fabric itself. The friction and surface performance parameters include dynamic friction coefficient MIU, the friction coefficient of mean deviation MMD, surface roughness of SMD. All these parameters are tested and listed in table 4.

Draping performance testing

In this paper, YG811-F is used to test the drapability parameters; it is a knitting fabric draping testing instrument. The evaluation indexes of fabric mainly include drape coefficient and active rate. Among these, drape coefficient is used to measure the drape form of static fabric; the other is used to describe the dynamic drape properties of fabrics.
The drape coefficient can be computed with the following formula:

$$F = \frac{A_F - A_d}{A_D - A_d} \times 100\ (\%) \tag{1}$$

Where, A_F is the projected area of the sample, A_D – the area of the sample, and A_d – the area of the tester disc. It can be derived that the bigger the drape coefficient is, the harder the fabric is and the worse drapability of the fabric is.

The active rate can be computed with the following formula:

$$A = \frac{X_s - X_D}{1 - X_s} \tag{2}$$

Where, X_s is the static drape index, X_D – the dynamic drape index.
Fabric drapability includes two indicators about the trailer degree and trailer form. Trailer degree refers to the fabric degree of free boundary prolapse only with gravity. According to the national standard GB/T233292009 textile fabric drape measurement, measurement device is shown in figure 1. It is usually using draping coefficient F to indicate the degree of fabric draping. Draping form mainly refers to the three dimensional surface shape. Due to the anisotropy of the fabric, the three dimensional shape of the fabric has the effect of asymmetry. The actual process, generally represented by the corrugated profile curve drape expanded view [6–7]. Specifically, the fabric shape is usually described with draping wave, maximum amplitude, minimum amplitude, the average amplitude.

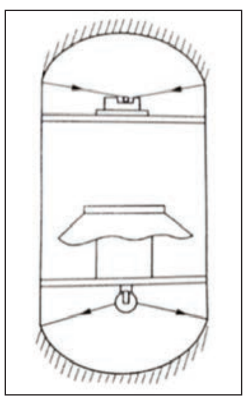


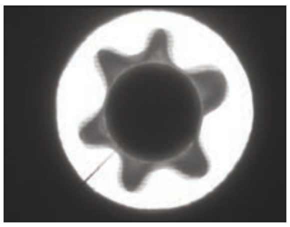
Fig. 1. YG811 fabrics drape tester

The sample is cut to be a diameter of 24 cm circular specimen. Testing is done under standard atmospheric conditions (as shown in figure 2), that is in static and with the speed 40 r/min respectively. The performance parameters include static draping coefficient $F0$, dynamical

Table 5

FABRIC DRAPING PERFORMANCE PARAMETERS						
Sample no.	Static wave number, N0	Static drape coefficient, F0	Dynamic wave number, N1	40r/min Dynamic Wave number, F1 (%)	Stiffness, Y (%)	Aesthetic coefficient, Ac (%)
1	6	58.25	6	62.52	63.58	21.93
2	4	47.51	5	51.51	55.93	13.71
3	6	28.46	6	32.10	35.66	10.43
4	3	50.31	3	54.03	58.42	7.91
5	4	38.24	5	42.54	46.62	11.79
6	3	50.69	4	55.27	59.40	10.74
7	5	36.57	5	40.79	45.55	10.54
8	6	42.66	6	48.12	52.88	14.19
9	2	64.01	2	64.94	68.67	5.75
10	5	29.28	5	32.98	35.95	9.59
11	5	43.36	6	48.12	52.82	13.21
12	5	37.07	5	41.96	45.89	12.29
13	6	26.17	6	32.28	35.96	10.64
14	3	53.51	3	56.34	60.31	8.70
15	5	32.07	5	36.80	40.80	10.03

a



b

Fig. 2. Sample 3: *a* – static drape figure; *b* – 40 r/min dynamic drape figure

draping coefficient *F*1, static wave number *N* (unit is *a*). The draping performance parameters are tested and listed in table 5.

EXPERIMENTAL DATA PROCESSING

Correlation analysis

In this paper, the correlation analysis is done with the testing data listed in table 1 to table 5. Correlation analysis is often used to analyse the correlation factors of the variables to measure the degree of correlation among the different variables. The idea of the correlation analysis is to get correlation coefficient matrix by calculating the co-variance matrix of sequence. The correlation coefficients describe the strength and direction of the linear relationship between the two random variables, then through the correlation coefficient to determine the correlation between parameters.

At present, the fabric draping coefficient is used to describe the degree of fabric draping, that is the draping coefficient smaller, the better the draping. In our experiment, we need to get real silk fabric index on the direction of mechanics and structure, and the interrelation between the real silk fabric draping. By measuring basic parameters and mechanical performance parameters, then we use more dynamic drape indexes. There are 40 kinds of parameters to represent a silk fabric and make a sequence of these parameters. We make the correlation analysis with the sequence.

Firstly, every kind of fabric samples of the test indexes are formed to be a sequence, each column $\mathbf{X}_i = (x_1, x_2, \ldots, x_{15})^T$ is composed with each kind of performance parameters of 15 kinds of samples, for the convenience of calculation, we classify the first column X_1 for fabric dynamic drape coefficient *F*1.

With the sequence **X**, the tested data of different samples are inconsistent, so first step of data processing is to standardize the indicators. The original tested data are dimensionless index evaluation values, these data must have the same order, so that the indicators should be compared and processed. Commonly data standardization method is used to complete the procedure such as min-max standardization and Z-score standardization. In the paper Z-score standardization is used. Each column sequence is transformed with the following equation:

$$y_i = \frac{x_i - \mu}{\sigma} \quad (3)$$

The y_i equals to dimensionless values which resulted form the original data x_i standardization. μ is the average of each kind of data, σ – the standard deviation of all the data. After the original data sequence **X** is processed, the corresponding normalized sequence $\mathbf{Y} = (Y_1, Y_2, Y_3, \ldots, Y_n)$ is obtained. After this processing sequence of each column of the index parameter of the mean to 0, variance is 1. Then through the calculation of co-variance matrix of a

Table 6

THE CORRELATION COEFFICIENT COMPARISON WITH F1										
Contrast index with F1	Y	F0	RT latitude	N0	N1	WT latitude	G longitude	G latitude	2HG5 longitude	2HG5 latitude
|r|	0.996	0.996	0.683	0.605	0.566	0.518	0.516	0.513	0.503	0.493
Contrast index with F1	2HB longitude	2HG longitude	B latitude	2HB latitude	MIU latitude	2HG latitude	EMT latitude	LT latitude	MMD longitude	WT longitude
|r|	0.459	0.453	0.434	0.434	0.420	0.402	0.397	0.394	0.388	0.361
contrast index with F1	D	EMT longitude	T longitude	B longitude	T latitude	LT longitude	SMD latitude	LC	Ac	RC
|r|	0.332	0.321	0.294	0.255	0.223	0.210	0.204	0.159	0.158	0.124
Contrast index with F1	MIU longitude	S longitude	RT longitude	MMD latitude	Tm	S latitude	SMD longitude	WC	T0	
|r|	0.121	0.112	0.109	0.099	0.073	0.063	0.062	0.028	0.015	

standardized sequence **Y**, getting the correlation coefficient matrix R:

$$R = \begin{pmatrix} \mathrm{Cov}(Y_1,Y_1) & \mathrm{Cov}(Y_1,Y_2) & \cdots & \mathrm{Cov}(Y_1,Y_{40}) \\ \mathrm{Cov}(Y_2,Y_1) & \mathrm{Cov}(Y_2,Y_2) & \cdots & \mathrm{Cov}(Y_2,Y_{40}) \\ \vdots & \vdots & \ddots & \vdots \\ \mathrm{Cov}(Y_{40},Y_1) & \mathrm{Cov}(Y_{40},Y_2) & \cdots & \mathrm{Cov}(Y_{30},Y_{40}) \end{pmatrix} = \begin{pmatrix} r_{1,1} & r_{1,2} & \cdots & r_{1,40} \\ r_{2,1} & r_{2,2} & \cdots & r_{2,40} \\ \vdots & \vdots & \ddots & \vdots \\ r_{40,1} & r_{40,2} & \cdots & r_{40,40} \end{pmatrix} \quad (4)$$

In the formula, **Y** $=(Y_1,Y_2,Y_3,\ldots,Y_n)$ is the standardized sequence **X**, in accordance with the preceding specified in the first column X_1 for the fabric of the dynamic drape coefficient $F1$, then Y_1 is the standardized dynamical draping coefficient. $r_{i,j} = \mathrm{Cov}(Y_i, Y_j)$ is the co-variance of the column i and the column j, that is also called the correlation coefficient, which reflects the strength of the correlation between the two columns attributes.

The following step is to select the first row of the correlation coefficient matrix R, each of the correlation coefficient r indicate the strength of the correlation between the dynamic draping coefficient of fabric $F1$ index and other indicators, in $r_{1,1} = 1$. According to the correlation coefficient of the absolute value size, the absolute value of related coefficient $r_{i,j}$ is got and has the following relationship comparison shown in table 6.

Result analysis

The table above gives the correlation coefficient between the experimental dynamical draping coefficient and other parameters. The data are indexes which are used to measure linear correlation between the variables, the range of r is between [–1,1]. When $r = 0$, X, Y are not related; when $|r| = 1$, X, Y is completely related. We can conclude that X and Y have a linear functional relationship. The change of X leads the change of Y partially. At the same time, the absolute value of r is greater; the change of Y is greater. When $|r| > 0.8$, X and Y are highly correlated. When $|r| < 0.3$, X and Y are lowly correlated.

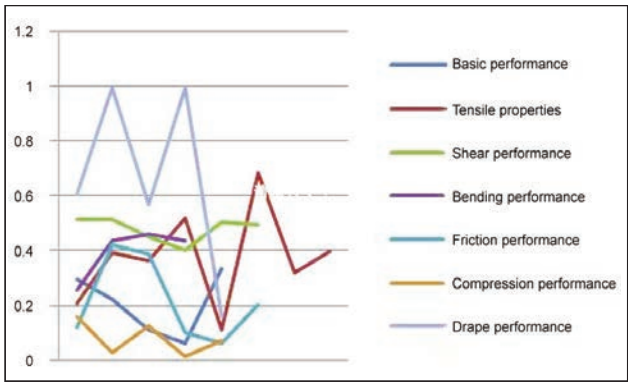


Fig. 3. Correlation between the various indicators and dynamic drape of fabric

From the above table 6 and figure 3, we can conclude: the silk fabric dynamic draping performance and representative fabric compression performance indexes (LC, RC, WC, T0, Tm), the friction and surface performance indexes (MIU, MMD, SMD) and fabric density index (S) related to small, and the representative of the fabric static drape indexes (F0), the weft tensile performance indexes (RT weft, WT weft, LT weft, EMT weft) and the bending and shearing performance indexes (G, 2 HG5, 2HG, B, 2 HB) have strong correlation.

Among them, the warp fabric tensile performance indexes (RT warp, WT warp, LT warp, EMT warp) have a lower correlation with the fabric dynamical draping performance, however the weft tensile performance indexes (RT warp and WT warp, LT warp, EMT warp) have a higher correlation with the fabric dynamical draping performance. The result shows that warp direction and weft direction of the silk fabric have more influence on the drapability.

Comparing fabric No. 11 sample and fabric sample No. 14, which is the same spun silk of two kinds of fabric drape, the drape coefficient of spun silk twill No. 14 is larger, the drape of spun silk twill is obviously better than plain weave silk. The same twill drape no. 13 is better than the same kind of Silk

CONCLUSION

Fabric draping performance is one of the important factors which influence the fabric appearance and hand feel. Silk fabric has better draping performance, so the researcher always gives priority to material. By measuring the parameters of real silk fabrics, we can make a comprehensive evaluation of the influence of various parameters on the fabric drape. This provides a basis for our further research on fabric dynamic simulation.

We can get the following conclusion from experiment in this paper:

- The weft tensile property index of real silk fabric has a great influence on the degree of dynamical draping, and the next ones are the shearing performance indexes and the bending performance indexes. Friction performance indexes, compression performance indexes of weft tensile performance indexes of real silk fabrics and fabric density have little effect on dynamical draping.
- The most of the absolute value of correlation coefficient between 0.3 to 0.5, the parameters that affect the real silk fabric dynamical drape should be multifarious.
- The most relevant index with dynamic drapability is static drapability of silk fabric. This is similar to our understanding of fabric.
- Twill silk spinning class silk fabric dynamical draping is superior to plain spun silk fabrics, satin silk fabric dynamical draping is better than plain silk fabrics. This is consistent with our daily experience. The results prove the validity of our experiment.
- The next job is to treat analysis in the paper which influence the parameters of the fabric draping, and establish mathematical model to provide theoretical basis for the fabric draping model and dynamical simulation.

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Stress studies for clothing companies applying the social relationship of companies

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ABSTRACT – REZUMAT

Stress studies for clothing companies applying the social relationship of companies

Mental health is a major component of human health in the workplace. The phenomenon of stress felt by workers in Europe is in the order of 22%. A study conducted by the Higher Institute of Work and Health (ISST) (2007–2009), showed that the stress in Tunisia was in the order of 17%. In France the stress is 12.6% and in the United States of America (USA) is in the order of 12%. In this context, the aim of this study is to use the Karazek method and the stratified sampling method to evaluate the psychosocial (PSR) and psycho-organizational risks of Tunisian staff in northern Tunisia within a grou. of 4 companies applying the method (CSR) social relationship of companies to the clothing sector and their prevalence in the sections studied. The overall average total percentage of stress at work (JOB strain) that we found is 15.4% which were distributed in 7 sections of which those with significant percentages are: the ironing which is in the order 4.8% of the Stressed population and represents 31.16% of the overall stress of the same section, the preparation accounts 3.6% of the population and 23.37% of the global stress. In order to the well-being at work, to fight against the occupational diseases, the demotivation, brain drain, the bad process of the recruitments, the sources of nonperformance, the errors of forgetfulness, the defects and the organizational attempts to reduce the percentage of stress and to bring appropriate solutions.

Keywords: *mental health, Karazek, PSR, psycho-organizational, CSR, motivation.*

Studiu privind stresul din companiile producătoare de îmbrăcăminte care aplică metoda relațiilor sociale

Sănătatea mintală este o componentă majoră a sănătății umane la locul de muncă. Fenomenul de stres resimțit de lucrătorii din Europa este de 22%. Un studiu realizat de Institutul Superior de Muncă și Sănătate (ISST) (2007–2009) a arătat că stresul din Tunisia a fost de 17%. În Franța, stresul este de 12,6%, iar în Statele Unite ale Americii (SUA) este de 12%. În acest context, obiectivul acestui studiu este să utilizeze metoda Karazek și metoda de eșantionare stratificată pentru a evalua riscurile psihosociale (PSR) și psiho-organizaționale ale personalului din nordul Tunisiei, în cadrul unui grup din 4 companii din sectorul de îmbrăcăminte, care aplică metoda relațiilor sociale (CSR) și prevalența acestora în secțiunile studiate. Procentul mediu total de stres la locul de muncă (tulpina JOB) descoperit este de 15,4%, care a fost distribuit în 7 secțiuni, dintre care cele cu procente semnificative sunt: activitatea de călcare, cu un procent de 4,8% din populația stresată și reprezintă 31,16% din stresul total al aceleiași secțiuni și activitatea de pregătire care reprezintă 3,6% din populație și 23,37% din stresul global. Pentru a aduce o stare de bine la locul de muncă, trebuie să se combată bolile profesionale, demotivarea, neproductivitatea, procesul necorespunzător al recrutărilor, sursele neperformanței, erorile umane, defectele, iar organizațiile trebuie să încerce să reducă procentul de stres și să aplice soluții adecvate.

Cuvinte-cheie*: sănătate mintală, Karazek, PSR, psiho-organizațional, CSR, motivație*

INTRODUCTION

Mental health issues are one of the leading causes of the global burden of disease, which is a challenge in effectively gather the combination of mental and physical health needs that are part of a broader problem of people with concomitant illnesses [1]. For this reason, psychosocial factors at work are recognized as risk factors for health. In this context, the Karazek questionnaire is a tool for evaluating psychosocial factors at work [2]; that allow the collective assessment of the well-being at work of groups and individuals. In addition, these elements can determine work-related stress. On the other hand, new socio-cultural and medical knowledge has raised awareness of the role of the workplace as one of the social determinants of health [3]. In addition, psychosocial risks arise from the interaction between work content, organization, technological, environmental, workers, resources and need competencies [4]. For this its prevalence example in France, 2/3 of employees will not work carefully [5]. In Tunisia in the clothing (clothing) sector, stress was estimated at 23% [6]. This thinking led “very early” to gain both employee well-being and improved production by rethinking the relationship between work and health [7]. In the study of stressors, their frequency and intensity are the most important characteristics to consider [2]; Which can influence the health of workers chronically and expose them to psychosocial risks and work-related stress that can multiply and affect the human body and its organs [8–9]. In this context, the European Agency for Safety and Health at Work (EU-OSHA) defines work-related stress as the feeling of uneasiness and discomfort felt by workers who have to cope with demands and pressures that do not match their knowledge and ability [10]. In addition, statistics show that the prevalence of psychosocial risks and work-related stress are available to varying degrees across countries and regions. For example, 40 million people in the European Union (EU) have been affected by work-related stress. According to the report of the European Risk Observatory published in 2009, in Europe, work-related stress accounts for between 50% and 60% of all lost working days [11]. The present study is a cross-sectional exploratory study that investigates the relationship between stress and work in terms of signs and psychological traits, personality traits, learning styles, and job satisfaction in the clothing industry. The study is conducted on a pilot sample of adult employees in the Tunisian work environment who started to apply CSR (Corporate Social Responsibility) [12].

METHODS OF WORK AND MATERIALS USED

In this study, we used a participatory approach for our work in three stages [13]. Collect data in respect of confidentiality:
1) Indicators related to the operation of the company such as absenteeism less than 3%, a work schedule of 8 h/day, the percentage of defects less than 1%, labor disputes, the rate of supervision around 10%, versatility, average age, average experience of company staff etc. Indicators related to the health and safety of employees, example of diseases such as MSDs "Musculoskeletal Disorder" [14–15] which is of the order of 2% for some workers declared (have MSDs) in this group of companies, exposure time etc.
2) Build the list of indicators. What needs to be done and understood by all the company's staff and establish a social dialogue with the staff of the company.
3) Put the indicators into perspective to objectify the psychosocial risks which will then be evaluated according to the level of stress, the search for causes and the risk sections and then implement a prevention action plan.
The first tool we used, the Karazek questionnaire, consists of several important determinants of the individual work environment: decision latitude, psychological demands at work, physical hardness, isometric physical load, occupational safety [16–17] and social support at work [6]. This test was of French version (Karazek R., 1998) in an anonymous way, integrating socio-demographic and professional factors, with a practical approach of the method of evaluation by using several factors age, sex, seniority married or unmarried, average number of children by age and degree of versatility; and to calculate the weightings of the scores with this model, the following scale was used: 1 to 4, depending on the degree of satisfaction [17] (table 1).
The second tool used: The stratified sampling method: it consists in subdividing a heterogeneous population into a stratum (subgroup). This method

Table 1

SCALE ACCORDING TO KARAZEK

Appreciation	Totally not satisfied	Not satisfied	Satisfied	Very satisfied
Degree of satisfaction	1	2	3	4

consists in finding in the sample the same proportions for each of the strata according to the characteristics chosen for the study in the target population. [18–20] This study used a 95% confidence percentage and a precision rate of 0.05.
The formulas of Karazek [14–16]:
Decisional latitude

$$\mathbf{DL} = 4 \times [Q4 + (5 - Q6) + Q8] + 2 \times [Q1 + (5 - Q2) + Q3 + Q5 + Q7 + Q9] \quad \textit{(the threshold 70)} \quad (1)$$

The psychological demand

$$\mathbf{PD} = Q10 + Q11 + Q12 + (5 - Q13) + Q14 + Q15 + Q16 + Q17 + Q18 \quad \textit{(the threshold 21)} \quad (2)$$

Social support

$$\mathbf{SS} = Q23 + Q24 + Q25 + Q26 + (5 - Q27) + (5 - Q28) + Q29 + Q30 + Q31 + Q3 \quad \textit{(the threshold < 24)} \quad (3)$$

The gratitude

$$\mathbf{Gr} = (5 - Q27) + (5 - Q28) + Q29 + Q30 + Q31 + Q32 \quad \textit{(the threshold < 15)} \quad (4)$$

If the psychological demand score is greater than 21 and the decision latitude score is less than 70, the individual is in the "stressed" area and is therefore considered to be "under stress". And if this score added to the social support score is greater than 24, we have the case of "ISO STRAIN" (figure 1).
Computer tools were also used; like XLSTAT-Premium, and Excel version: 2013. Regarding the CSR method; its goal is to attract and retain employees, but also to make them proud of their membership in the company, to increase financial and social performance in the following way: Develop a policy:

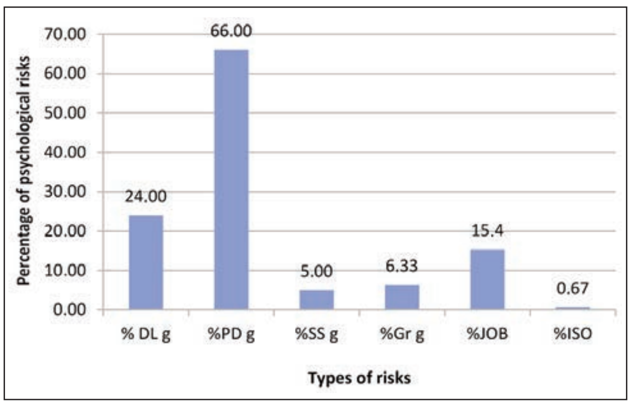

Fig. 1. Global Distribution Chart of Stress Parameters

choose a line of work that allows to involve employees and that is meaningful within the company. Deploy a tactic Continuous improvement and measure results according to examples of measurable indicators: absenteeism rate, turnover, social and labor barometer [12] etc.

RESULTS

The decision latitude (DL) had an average value of 74.78, a difference (± 6.82), a median of 74 years was high and 300 employees, which affects 24% of the workforce studied. Psychological demand (PD) with an average value of 22.56 with a difference (± 2.77), a high median value of 23 to 21, which is the threshold value: it represents a percentage of 66% of the studied population. The population that deserves the most social support is: 5%, with a fairly high average of 28.84 compared with a threshold 24 of a median of 30 and a difference of (± 2.56). However, 95% were satisfied. With respect to recognition, 6.33% was not achieved, compared to 93.67% with an average median of 18.2 and a median of 18 and a threshold of > 15. We have 24% of the population studied. has a decision latitude and 66% have a strong psychological demand. We also have 5.00% who need more social support than others. In addition, 6.33% of the workforce has recognition problem. 15.4% of the workforce has a tense stress “JOB strein” and 0.67% has a job “ISO strein”. All of this brings us back to talking about the percentages of psychosocial factors by sex (figure 2).

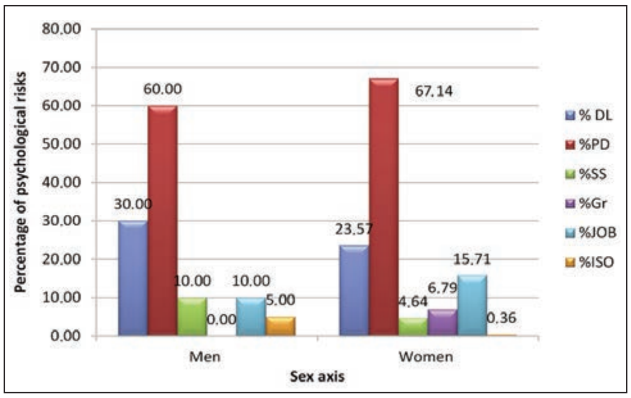

Fig. 2. Percentages of psychosocial factors by gender

According to this graph, which summarizes the study’s situation for men and women: It can be emphasized that the overall decision latitude (DL) is higher for men (30%) than for women (21.43%). while psychological demand is the opposite; among women (67.14%) among men (60%). We also have 10% men and 4.64% women asking for an improvement in their social supports. With regard to recognition, a percentage of 6.79% of women and no demand in men were obtained. As we obtained a percentage of 10%, which constitutes a tense work situation “JOB S TREIN”. For women, the percentage is around 15.71%. For ISO STREIN, the percentage obtained among men who are 5% higher than the percentage of women: 0.36%. These results obtained make it possible to determine the levels of classification of the psychological risk or even table 2.

Table 2

PERCENTAGE OF RISK FACTORS PER CLASSIFICATION LEVEL				
Percentages (%)	Relaxed	Active/dynamic		
	24,67	44,67		
	19,67	15.4 ⇨	JOB	
			0.67 ⇨	ISO
	Passive	Tense Work		

When the combination of DL/PD risk factors was obtained, the following percentages were obtained: 44.67% of the population is dynamic based on their positive psychological risk factors. For the passive population its percentage is 19.67% and the relaxed population has a percentage of 24.67%. There is some stress due to high decision latitude and low psychological demand. We have 15.4% of the sample size of the four companies with a “high” stress risk that requires taking preventive and curative measures to minimize it. We also have 0.67% of the study population having an “ISO effect” among the following factors: DL + PD + SS of some people working with this population and communication that needs to be improved. To do this, we will focus our study and analysis on job classification levels to avoid the risk of preaching mental disorders [20] and then think of finding solutions, corrections and improvements to reduce the other two levels: Relaxed and passive to be active (table 3).

According to this study, there is a proportional relationship between experience, age and versatility, especially among women. More than women’s early learning (age), the lower the psychological risk to the future will be when she is over 30 (see table 3). Example: women who have experience (0–10 years) have a 9.3% stress percentage and their ages under 20 have a stress percentage 7.86% more those with a degree of versatility 5 operations have a stress percentage 9% and these percentages decrease in time and learning functions.

Note: Women over the age of 30 have been found to have tense stress “job strain” as their learning was done in an age > 20 years.

Prevalence:

The prevalence of stress-related job stress factors in relation to the work sections is summarized in figure 3. This graph shows that the ironing, preparation and sewing sections have the highest percentages that are prioritized to solve them and that can influence the production and quality of work because these sections have the largest population in the companies.

Table 3

SUMMARY OF RISK FACTORS AS A FUNCTION OF THE PARAMETERS OF STRESS			
No.	**Risk factors**	**Settings**	**Prevalence and percentages men and women** M: Men/W: Women
1	Job strein	Experience 0–10 years 10–20 years >20 years	It is around **5%** for men and **9.3%** for women. It decreases with time, around 4.6% for women and remains constant at 5% for men. More than we are experienced, the percentage of the risk decreases to 1.43% for both sexes M/W
2	Job strein	Ages < 20 years 20–30 years 30–40 years >40 years	It varies between 3% for women and 5% for men. It increases to **7.86%** women and remains stable in men * It decreases in both sexes M/W to 2.83% F and 0% M Continues to decrease towards the 2% for the women and remains null in the men.
3	Job strein	Degree of versatility * <5 operations * 5–15 operations * >15 operations	* In both sexes it is around 5% M / W. It increases in women to **9%** and remains stable in men by 5%. * The risk decreases remarkably towards 1.4% W and 0% M
4	Job strein	Number of persons married with children and their ages * <6years * >6 years * without children	* For men is around 5% while among women is: **8.5**%. * remains stable at the men in 5% it decreases towards 5.83% for the women. * Null in men and low in women 1%

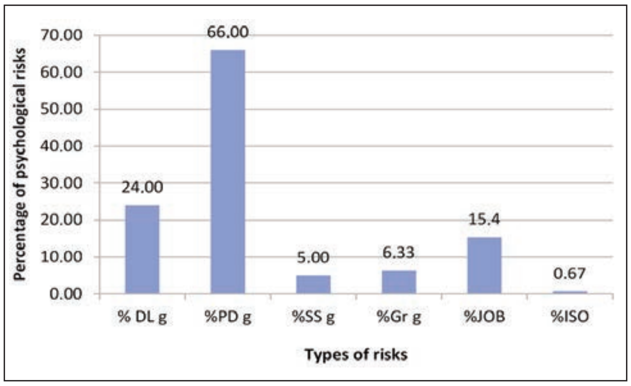

Fig. 3. Psychology risk prevalence

They represent more than 80% of the total numbers of sections affected by stress. For example; women who work in the ironing section who have experience between (0–10 years), ages between 17 and 30, married with children under 6 years are the ones who are the most stressed and they represent 64.9% of the effective with stress tense "JOB strein".

DISCUSSION ON THE RESULTS

Comparison of the results with other studies in the clothing sector in Tunisia: Stress studies in Tunisia are fairly recent and require more effort, equipment, human and financial efforts, the table below, column 2 of this study, presents new figures. In this context, it can be remarkable to reduce stress at work through the management system of these companies that apply the best possible while integrating scientific and organizational techniques for the best of each. This group of companies has a stress rate of 15.4%; while for other studies tends between 17% and 23%

Table 4

COMPARISON ON RISKS FACTORS			
Study (n)	**This study**	**Abidi et al.** [22]	**Magroun I. et al.** [6]
Sector	Sewing	Sewing	Multisectorial
Population	300	322	954
Country	Tunisia	Tunisia	Tunisia
Strength work (%)	15.4	23	17
PD (%)	66	-	41
PDW (%)	67.14	-	45
PDM (%)	55	-	40
DL(%)	24	-	49
DLW (%)	21.43	-	47
DLM (%)	30	-	50
SS (%)	5	-	-
SSW (%)	3.57	-	-
SSM (%)	10	-	-
Gr (%)	6.33	-	-

W: Women / M: Men

[22, 6]. In addition, only 5% of respondents are not satisfied with their social support for different parameters (communication, support of colleagues and other factors with in-depth research in psychology with other methods and tools ...) when the 95% are satisfied 80% of the population gave the karazek questionnaires a score of 4/4 (Q19, Q20, Q21) 41% overall is due to the type of work, tasks and operations according to the sections requiring more than efforts to decrease is 24%, which is lower than that developed by I. Magroun and all that was of the order of 49%.

CONCLUSION AND PERSPECTIVES

To conclude, once factors have played an important role in calculating risk factors, it is important to become familiar with research on work sections, to highlight causes and to think about solutions value. Companies in the worker/agent category are still doing more than is required for them. In addition, the company must develop cooperation with the world to achieve the objectives of the CSR project. We have the percentage of stress 15.4%, women of age between 17 and 30 years old who are the most stressed because of these parameters "Aged, experience, versatility, age of their children 6 years", as well as others who deserve further study. In addition, they (women) represent 10% of the overall population and 64.9% of the workforce "JOB STREIN", while women who are older (40 years to 50 years) and started their careers early are less stressed than working conditions are favorable (wages, needs, willingness to learn ...). Based on these results, this group of companies is still thinking of developing their managerial and organizational strategy towards sustainable development projects by keeping SMART objectives on several levels: health, ergonomic safety CSR, motivation [23], quality according to priorities and the urgency of the problems while applying other tools such as 7 M [21, 24] etc. Finally, we must try to reduce the annual tension stress of 2% to obtain a maximum percentage of 5% of our objectives.

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A dedicated wearable device integrated in textiles

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ABSTRACT – REZUMAT

A dedicated wearable device integrated in textiles

The wearable devices have a big role in increasing the quality of life that should take into account also the persons with disabilities. Our research focuses on a certain category of persons with disabilities, namely those with visual impairments. Thus, once again the technological progress must be capitalized in favour of the less fortunate. We propose an original device easy to use and integrate into any textile product. The device contains a microcontroller, sensors and actuators. The sensors collect information from the outside world and provide a "picture" of it by means of tactile and acoustic actuators. The research opens the possibility of designing of fabrics using nanotechnology to have sensors and actuators directly into the fabric.

Keywords: *model, quality of life, simulation, ultrasonic sensor, visually impaired*

Posibilități de integrare a unui dispozitiv portabil în produse textile

Rolul dispozitivelor portabile este mai ales de creștere a calității vieții, ținând cont și de persoanele cu dizabilități. În cadrul cercetării se analizează o anumită categorie de persoane defavorizate și anume cei cu deficiențe de vedere. Astfel, încă o dată progresul tehnologic trebuie să fie valorizat în favoarea celor mai puțin favorizați. Se propune un dispozitiv original ușor de utilizat și de integrat în orice produs textil. Dispozitivul conține un microcontroler, senzori și elemente de acționare. Toate acestea culeg informații din lumea exterioară și oferă o "imagine" a acesteia, prin elemente de acționare tactile și acustice. Cercetarea poate fi un punct de plecare în proiectarea unor materiale textile folosind nanotehnologii, pentru crearea de senzori și elemente de acționare direct în materialul textil.

Cuvinte-cheie: *model, calitatea vieții, simulare, senzor ultrasonic, deficiențe de vedere*

INTRODUCTION

The continuous development of the IT sector in general has influenced the quality of life. The innovative products in the textile industry propose solutions with incidence on certain areas like medicine [1] in putting forward new ways to design and produce virtual prototypes of garments adapted for people with scoliosis [2], other impairments [3] and fashion like the design of a three dimensional virtual apparel online application web page [4] or the use of 3D surface geometry for modelling and simulation purposes [5].

Due to the great development of the smartphones in recent years it has become a habit for us all to have a powerful computer in our pocket. This led to the ease of wear sensors even in clothing. Time ago any measurement of the athletic performance or health problems was possible only in specialized cabinet. Today it is usual to wear devices that give us a measure of our health. All worn devices with sensors fit in the category of wearables and their main purpose is to improve the quality of life [6].

Wearables are something usual in areas such as medicine with wearable sensors that gather a large amount of data for the clinical environment in order to have a better knowledge and communication with the patient [7–8], and also wearable accelerometers in order to assess levels of impairment and the individual's functional limitation after stroke [9]; and such as fashion with wearable devices treated as digital jewelry in order to reflect the tastes and moods, and allow to express the personalities, cultural beliefs, and values of each person [10], or the interplay of electronic textiles and wearable technology in the fashionable technology treated as the intersection between design, fashion, science and technology [11]. This has created the concept of smart clothes that cover many areas that work together to improve the quality of life, well-being and health [12].

Figure 1 highlights the state of the art both from the conceptual and the applicability point of view regarding the wearable technologies, while exploring the evolution of the concepts and approaches, identifying the place that fits our research.

As can be seen, our research is placed between medicine and fashion applied for the visually impaired individuals. The undertaken research implies a multidisciplinary approach, requiring focused market researchers, electronic engineers and textile designers.

Next, we present the pros and cons of the wearable technology from the point of view of present applications and use (figure 2).

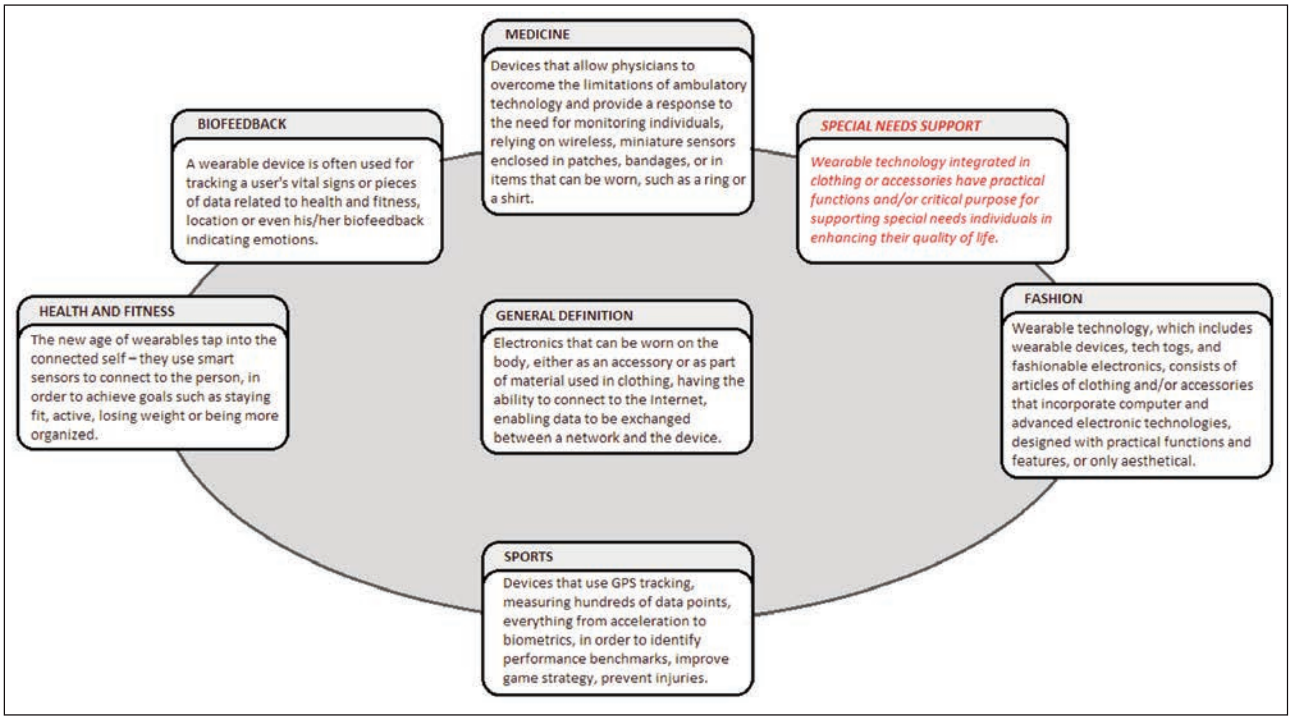

Fig. 1. Definitions of wearable technology

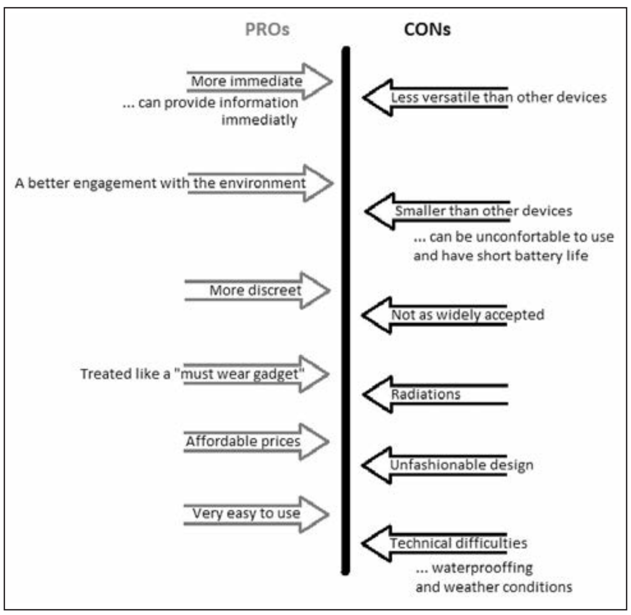

Fig. 2. Analysis of wearable technology

The goal of the general wearable technology pros and cons evaluation is to determine the characteristics of our device. Customizing our device led us to taking advantage of some pros and cutting out some of the cons. Thus, our device, from the point of view of specific application for people with special needs, is characterized by:

– More immediate having high speed sensors and actuators
– A better engagement with the environment: compensate an individual's natural sensors offering an "image" of the real world.
– More discreet: both in use and design, not making it weird to wear
– Potentially more fashionable: integrated, even hidden for certain tasks, in a cap or cloth
– Affordable prices: making a balance between price and usefulness
– User friendly: ready to use for the visually impaired persons
– Moreover, the weather conditions influence and the waterproofing are the same as the textile product's ones.

EXPERIMENTAL WORK

The research included both a part of creating a prototype, which is based on the results of the market research, and a part of modeling and simulation of the proposed prototype operation in different types of environment.

In figure 3 there is presented the electronic principle diagram of the proposed device.

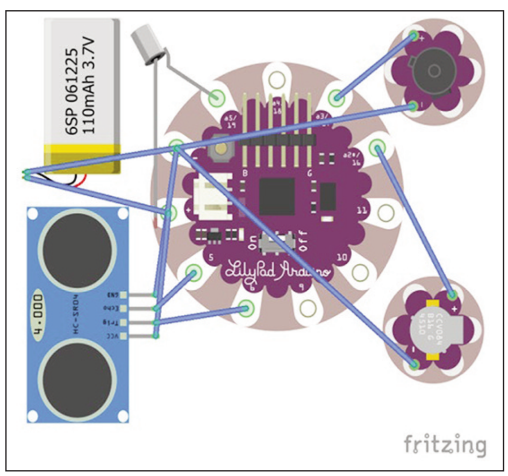

Fig. 3. Prototype design

As can be seen, we considered for this device two sensors: one tilt sensor and one ultrasound sensor, two actuators: one vibrating motor and one buzzer all controlled by a microcontroller integrated in a wearable platform powered by a LiPo battery.
This device can be placed on any type of cloth, as can be seen in figure 4.

a

b

Fig. 4. Device placement: *a* – on a cap; *b* – on a shirt

In order to validate our idea and to find out the "voice" of the client, we turned to the Associations of Visually Impaired from Romania. From the answers received there were considered relevant 78%. From these, 36% considered the device very useful and 43% of them appreciate the price as affordable and 29% of them appreciate the dimensions as acceptable. The results were encouraging. All the other categories, even those who could not evaluate (they requested further details), found it useful to design and then test the device. Regarding the category that considers that there are necessary major changes compared to the presented design, they proposed improving the functionality via a miniature camera and a system of sensors mounted on the white cane.

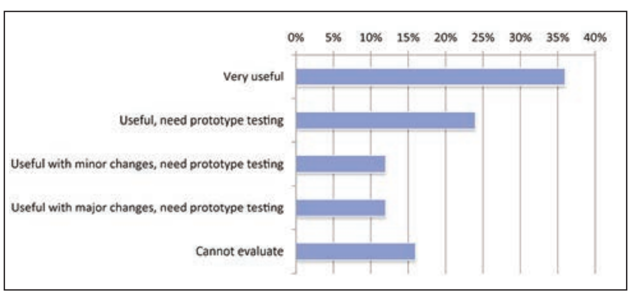

Fig. 5. "Voice" of the client

For our research we considered the case of the device applied on a cap, in order to have as input also the head movement angle to scan the environment by means of the ultrasound sensor.
The simplified diagram used to write the mathematical model is presented in figure 6.

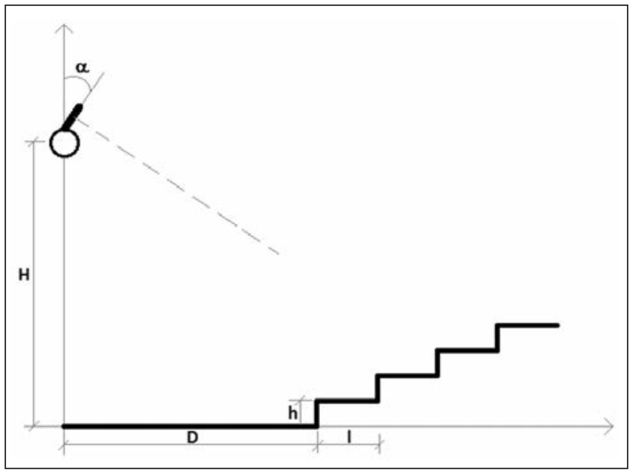

Fig. 6. Model outline

We considered for the ultrasonic sensor only the wave perpendicular to the sensor, even if it has a detection angle of 30°, as can be seen in figure 7; errors are negligible for the case study.

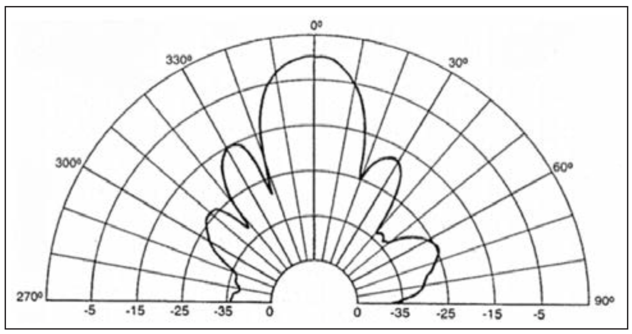

Fig. 7. Typical beam pattern ultrasonic sensor [13]

As obstacles we considered a series of steps, having the following mathematical model:

$$step(x) = \sum_{k=0}^{n} \theta(x - D - k \cdot l) \quad (1)$$

where:

- θ is Heaviside function;
- *D* – the distance to the first step;
- *l* – the width of a step;
- *n* – the number of steps.

The equation for the sensor output is:

$$y = H - x \tan(\alpha) \quad (2)$$

Where:

- *H* is the height of the person;
- α – the tilt angle of the head.

By solving the resulting equations we get:

$$x = \frac{H - k \cdot h}{\tan(\alpha)} \in [100 - (k-1) \cdot l,\ 100 - k \cdot l], \quad k = 0 \ldots n \quad (3)$$

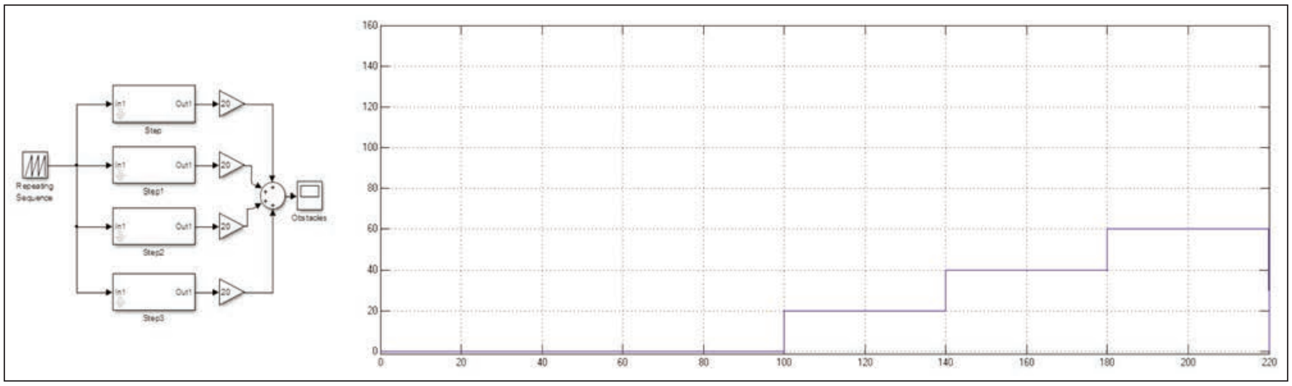

Fig. 8. Simulation of step obstacles

In our mathematical model we considered as inputs:

- Person's height *H* = 160 cm
- Head tilt angle α = 0...60º
- Obstacles have a straight line of 100 cm and 3 steps of *l* = 40 cm width and *h* = 20 cm height each (figure 8).

Table 1

SIMULATION PARAMETERS			
Sl no.	**Distance (m)**	**Simulated Time of flight (millisecond)**	**Theoretical Time of flight (millisecond)**
1	0.3047	1.79	1.7923
2	0.5	2.94	2.941
3	1.0	5.882	5.882
4	1.5	8.82	8.823
5	2.0	11.76	11.764

In simulation we took into account the operation mode of the ultrasonic sensor, which determines the distance to the obstacle based on response time, or time of flight (table 1 [14]).

RESULTS AND CONCLUSIONS

The model output data highlights the correlation between the detected obstacles profile on sweeping the angle α (head tilt) in the interval (0…60º) (figure 9).

As can be seen, it can identify a low height obstacle, which means obstacles very close to the ground, at a distance from 90 cm up to a distance of 300 cm. As the obstacle is higher, so the sensing distance is reduced to a minimum of 3 cm, due to the limitations of the sensor. If the usual obstacles are at very small distance and also of low height, the device can be mounted on the white cane.

Our research fits into the current trend of the concept of smart cloths that is closely related to wearable technology. It highlights the importance of wearable devices that can be used to help support personal control over the quality of life, health and well-being mostly for visually impaired individuals.

We propose a device considered useful by the Associations of Visually Impaired from Romania. This device is simple to use and provides tactile and audible feedback that allows the visually impaired to make an "image" of the surroundings. The results of performed simulations prove that this feedback is an

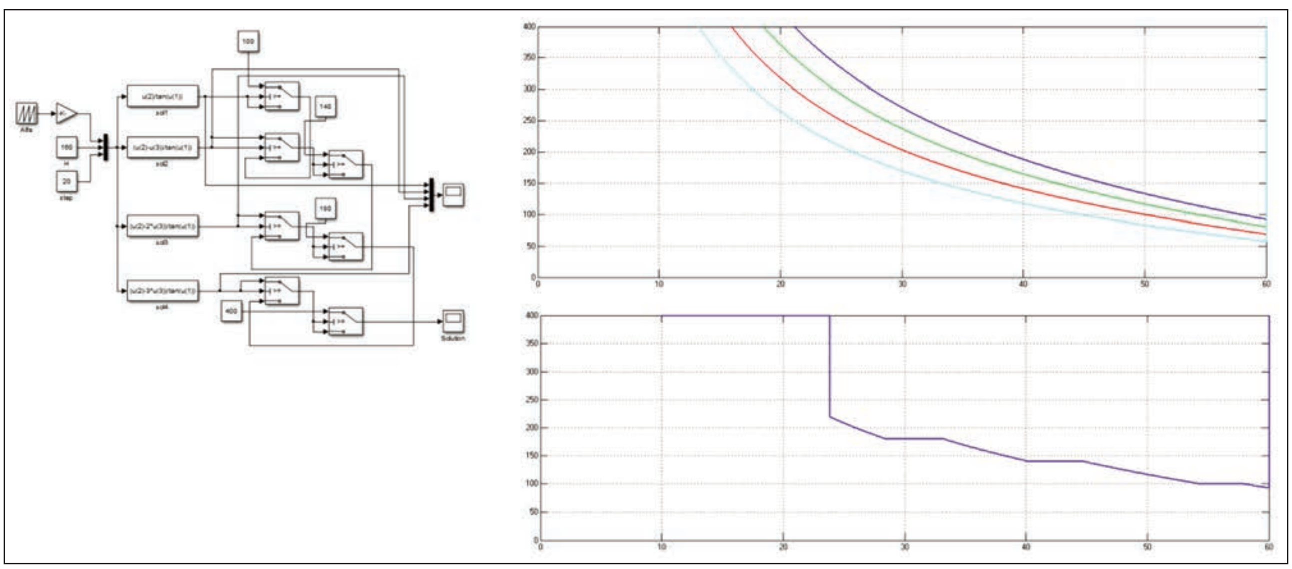

Fig. 9. Simulation results

outline of the obstacle, which is detected from 90 cm to 300 cm from the individual's position. The response time for the distance of 200 cm is about 12 ms. The fact that the used ultrasonic sensor has a tight angle (30°) for this case is an advantage because the obstacle detected is controllable from the positioning in space point of view. A sensor with a 360° angle would mean a large amount of information to be processed by the individual. Thus, our device can be used alone or in combination with other accessories for visually impaired people. Future developments may be in the following directions: miniature camera with wide angle, comparable to the view angle of humans of about 120°, to identify the contour and position of the obstacles and also the use of sensors embedded into the fabric by means of nanotechnologies, in which case even if the sensors have tight angle, by their appropriate positioning on the cloth, the obstacles can be identified similar to the case of miniature camera use.

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Perspectives regarding the organizational culture within the Romanian textile industry

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ABSTRACT – REZUMAT

Perspectives regarding the organizational culture within the Romanian textile industry

The present paper proposes to determine the types of organizational cultures that exist within the Romanian textile industry, starting off from Handy's typology according to which there are four types of cultures, respectively the Task Types, the Power Types, the Role Types and the Person Type. In this sense, we have conducted an empirical study made up of two questionnaires, the first regarding the organizational culture within the Romanian textile industry – from the point of view of employees without leadership positions, and the second regarding the organizational culture within the Romanian textile industry – from the managerial point of view. Interviews were conducted on employees and managers from local companies, by using direct questions, with multiple choice answers, with the purpose of ensuring transparency and objectivity when processing and analyzing the data. The database of this study contains 110 completed and validated questionnaires, divided into the two respondent categories: employees in leadership positions – 65 questionnaires, operating personnel – 45 questionnaires. By utilizing the Cronbach Alpha test, a correlation matrix, the KMO and Bartlett test, a functional analysis, we have validated the viability, the relevance of the items, the existence of a correlation between them, the construction of synthetic variables, thus demonstrating the presence of 4 types of organizational cultures within the Romanian textile industry.

Keywords: *organizational culture, types of organizational culture, Power Type, Task Type, Role Type, Person Type, correlation matrix, Cronbach Alpha test, KMO and Bartlett test*

Perspective privind cultura organizațională în industria textilă românească

Lucrarea de față își propune să determine tipurile de culturi organizaționale care există în industria textilă românească, pornind de la tipologia lui Handy, conform căreia există patru tipuri de culturi, respectiv Tipuri de sarcini, Tipuri de putere, Tipuri de rol și Tip de persoană. În acest sens, s-a realizat un studiu empiric alcătuit din două chestionare, primul privind cultura organizațională din industria textilă românească – din punctul de vedere al angajaților fără funcții de conducere și al doilea cu privire la cultura organizațională în cadrul industriei românești de textile – din punct de vedere managerial. Interviurile au fost adresate angajaților și managerilor companiilor locale, prin utilizarea întrebărilor directe, cu răspunsuri cu alegere multiplă, cu scopul de a asigura transparența și obiectivitatea la prelucrarea și analizarea datelor. Baza de date a acestui studiu conține 110 chestionare completate și validate, împărțite în cele două categorii de respondenți: angajați în funcții de conducere – 65 de chestionare, personal de execuție – 45 de chestionare. Folosind testul Cronbach Alpha, o matrice de corelație, testul KMO și Bartlett și o analiză funcțională, au fost validate viabilitatea, relevanța datelor, existența unei corelații între ele, construcția de variabile sintetice, demonstrând astfel prezența a 4 tipuri de culturi organizaționale în industria textilă românească.

Cuvinte-cheie: *cultură organizațională, tipuri de cultură organizațională, Tip de putere, Tip sarcină, Tip rol, Tip persoană, matrice de corelație, test Cronbach Alpha, test KMO și Bartlett*

INTRODUCTION

The need to know the types of organizational cultures primordially reside in the impact that they have at an organizational level. Seeing that they rely on human resources, its typology can sometimes envelop the typology of its members, as they often adhere to the ideas promoted by the organization.

In trying to construct an agreeable work environment and to form employees that are responsible and content with the work done, the organization delineates certain norms regarding behaviours, habits and rituals specific to different types of organizational cultures. As mentioned by Hofstede [1] (2012) an organization's excellence is given by its members, by the way they think, act and learn together.

Another opinion that is worthy of remembrance is that of Schein [2], according to whom internal integration of the members of the organization is determined by modes of communication, degree of inclusion, power distribution, organizational climate, reward system, ideology and religion, elements taken into consideration when determining types of organizational cultures.

Although the specialized literature tackles the innumerable benefits that culture has on an organization, stress is not always placed on the notion of analysing the specific type of culture for each organization. Although at first glance one might conclude that organizations have a single type of organizational culture, our opinion differs. We consider thus that we can encounter elements or values from several types of organizational cultures within the same organization. Moreover, even where there isn't a question of a specific type of strong organizational culture, one can identify certain constitutive elements belonging to other culture types [3]. The textile industry is one which, from this perspective, is a combination of organizational culture types since in this sector, we consider that the elements inherent to the culture types are determined both by the national specificities and the types of culture specific to the external organizations that have acquired control upon becoming the majority shareholders [4]. Since individual behaviour is the result of experience and development, researchers have proven the existence of some discrepancies with respect to professional level, results, information presentation, ethics and actions undertaken.

In our opinion, regardless of the different opinions that attempt to make explicit the existence of a type of organizational culture this concept has in mind certain constitutive elements: rules of behaviour, the norms that develop within the work group, the dominating values adopted by the organization, the philosophy that guides policy regarding business partners, the rules established for the efficient functioning of the organization, the spirit and climate that characterize the organization internally and in relation to the surrounding environment [5].

The importance of analysing the types of organizational cultures is given also by the practical bonds that it presents, in potentiating the organization's performance. Peters and Waterman provide a strong argument through studies conducted within successful companies, showing that [6] top performers create a wide culture, a coherent framework in which people seek to adapt accordingly [7].

If we refer to the types of organizational cultures within companies in the Romanian textile industry that have undergone a major restructuring due to the privatization process, it is natural for us to analyse to what extent the type of organizational culture of a foreign company that has become a majority shareholder of a national companies have left their mark on the national organizational culture [8].

Starting from this data but also from the conceptual foundation of the issues analysed, we have set out to determine the types of organizational cultures that exist within the Romanian textile industry.

We cannot analyse the existing organizational cultures within the Romanian textile industry without researching the types as they are defined by various specialists. Analysing the specialized literature, we can affirm that a vast number of studies have been comprised with the purpose of understanding what an organizational culture is, of quantifying its impact or of understanding where the diverse taxonomy comes from. In addition, we can state that there is no definitive mode of evaluating an organizational culture, in this respect, a series of dimensions have been identified that can be utilized from case to case. Here we note: individual initiative, integration, managerial aid offered to employees, identity, reward system, attitude concerning risk, conflict tolerance and modes of communication or control.

These dimensions are presented individually or in various combinations, in order to establish various classifications of the different types of cultures that may be encountered within organizations. Outline the main types of cultures that have been developed over time, depending on several factors such as: contribution to performance, the configuration and role of the leadership, risk levels, communication methods, level of participation etc. Starting from these theoretical classifications we have developed the present study [9–11].

RESEARCH METHODOLOGY

In order to study the types of organizational cultures that are manifest within Romanian textile industry, we have conducted a research based on 2 types of questionnaires: one regarding the organizational culture within the Romanian textile industry from the perspective of operating personnel, and the second regarding the organizational culture within the Romanian textile industry from the perspective of management.

As mentioned above, the main research instrument used is the questionnaire, and the associated research method is the indirect administration through an electronic communication format and channel, as well as the direct distribution in the company headquarters. The results have been synthesized within an electronic format, forming the database needed to process and analyze the acquired information [12].

The study is based on the data from 110 completed and validated questionnaires, divided along the 2 categories of respondents (employees with leadership roles – 65 questionnaires, operating personnel – 45 questionnaires).

The questionnaire that was applied has captured aspects of the textile industry at the national level. We have chosen this approach since at the national level there are no ample studies in this direction of research [13]. The premises that we've started off from when making our choice are as follows:

(1) *The Questionnaire* offers the authors of the research the possibility of also setting up questions with nonstandard answers. We considered this research instrument to be opportune, considering the specificity of the domain. Seeing that it makes use of the opinions, values and psychological demeanor of human resources in the evaluation of the taxonomy of organizational cultures, the questionnaire offered us the prefect premise in this endeavor.

(2) The data collection method was the on-site administration of questionnaires within the textile companies, as well as the indirect method, by electronic communication.
(3) The applied questionnaire was a mixed one, including both open ended and closed ended questions, as well as control questions. In addition, it includes dichotomous questions (with YES or NO answers), *open ended questions* that allow for answers of an unspecified length, *multiple-choice questions*, also called *semi-open ended* (a limited number of given answers), *scaling responses*, also called *questions with ranked answers within a hierarchy* (the Likert scale – through which individual *preferences* can be tested gradually).
(4) The results were recorded, stored and structured, resulting in a *database* required for the analysis.

In determining the existing types of organizational culture within the Romanian textile industry, we start off from Handy's typology, which analyzes four types of cultures, respectively Task Type cultures, Power Type cultures, Role Type cultures and Person Type cultures – We continued the research utilizing the Cronbach Alpha test (for the viability of the selected variables and items), a correlation matrix, the KMO and Bartlett test (to determine the existence of a significant correlation between them) as well as a functional analysis in order to establish the weight value of each variable and to identify the retained percentage from the initial information;

Afterwards we used the graphic representation of the four types of cultures as well as a comparison between them for respondents that are operating personnel as well as for managers, by grouping the answers.

DETERMINING THE TYPES OF ORGANIZATIONAL CULTURES THAT EXIST WITHIN THE ROMANIAN TEXTILE INDUSTRY

In order to identify the types of organizational structures we have proposed to analyze the responses of 110 respondents, respectively 65 manages, 45 operating personnel. We have developed an empirical study based on questionnaires, at the level of the Romanian textile industry, both at the level of operating personnel as well as with leadership positions. We have built the 4 variables: *Task Type culture – "we work together", Power Type culture – we take it upon ourselves to do things first", Role Type culture – "let's do things right"* and *Person Type culture – "let's complete our tasks very well"*, using items such as – the questions from the questionnaires.

Starting from the source documents mentioned we have constructed and processed the database covering the following stages

a) *Identifying the questions related to the proposed objective*

Twenty-seven questions were selected from questionnaire no. 1 *Section B* for operating personnel, and from questionnaires no. 2 *Section C*, 26 questions for manages, questions that capture the 4 types of organizational cultures (*Task Type* – 9 items, *Power Type* – 5 items, *Role Type* – 7 items and *Person Type* – 6 items in the case of the first questionnaire, respectively 5 items in the case of the second).

b) *The precision of the data and the internal consistency of the synthetic variables (Task, Power, Role and Person) that were built with the help of a set of items (the questionnaire questions were encoded in order to be processed)*

In this sense, for each type of organizational culture we had in mind the 2 categories of respondents, following these steps:

1) *Validating the reliability of the items used in the construction of the variables (quality of data) – Cronbach Alpha Test*
2) *Certifying the existence of a relationship between items – Correlation Matrix and KMO and Bartlett Test*
3) *Factorial analysis in order to elaborate and validate a factor/variable that ties together the chosen items – Principle component Analysis and determining the equation that expresses the link between the synthetic variable and the items*

Research methodology for the Task Type organizational structure in the case of managers

1) Cronbach Alpha Test – this coefficient can have a value between 0 and 1 [14], however in order to significantly influence the synthetic variable, the minimum value has to be 0.7 [15].

The instrument for measuring the *Task* dimension was made up of 9 items. We have tested the viability, obtaining an initial value for this coefficient of 0.842, which demonstrates that the items which refer to the measurement of the *Task Type* organizational culture have a high degree of viability. Seeing that eliminating the first item would lead to a slight, insignificant increase in the value of the test (a new coefficient of 0.850), we decide to keep them all (table 1).

Table 1

VIABILITY OF ITEMS – CRONBACH ALPHA TEST FOR THE TASK TYPE CULTURE (MANAGERS)

Item name (selected questions)	Cronbach Alpha if the item is eliminated	Cronbach Alpha Final
C1	0.850	No variable eliminated
C5	0.829	
C8	0.824	
C12	0.815	
C18	0.821	
C21	0.823	
C24	0.816	
C33	0.825	
C35	0.827	

Source: authors' projection

Table 2

CORRELATION MATRIX BETWEEN ITEMS FOR THE TASK TYPE CULTURE (MANAGERS)									
Item name	**C1**	**C5**	**C8**	**C12**	**C18**	**C21**	**C24**	**C33**	**C35**
C1	1.000								
C5	0.236	1.000							
C8	0.259	0.423	1.000						
C12	0.368	0.434	0.491	1.000					
C18	0.146	0.369	0.347	0.452	1.000				
C21	0.208	0.420	0.359	0.361	0.488	1.000			
C24	0.256	0.373	0.460	0.494	0.607	0.497	1.000		
C33	0.247	0.309	0.366	0.439	0.428	0.343	0.400	1.000	
C35	0.156	0.275	0.369	0.401	0.409	0.462	0.362	0.507	1.000

Source: authors' projection

Conclusion: The Cronbach Alpha test confirms that all selected items can be used in constructing the synthetic variable of the Task Type organizational culture.

2) Correlation Matrix – maximum values recommended are 0.8 – 0.9 (table 2) [16].

All the values are positive and do not surpass the maximum recommended values, this being proof that the data analysis is not affected by multicollinearity.

KMO and Bartlett Test – the KMO coefficient has to have a value above 0.5 (table 3).

Table 3

KMO AND BARTLETT TEST FOR THE TASK TYPE CULTURE (MANAGERS)		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.870
Bartlett's Test of Sphericity	Approx. Chi-Square	418.715
	Df	36
	Sig.	0.000

Source: authors' projection

The KMO coefficient registered a value of 0.870 (>0.5), while the Bartlett coefficient obtained the following values: c^2 = 418.715; Df = 36; p = .000, within which Sig (p = .000) has a value lower than 0.05.

Based on these tests, we can affirm that between the 9 items there exist significant correlations and the data can be subject to factorial analysis.

3) Analysis of the Principle Components – shows the degree of importance (the relevance of the analysis)

Within this analysis, a factor is highlighted that explains the 45.16% of the total variation of the 9 remaining items.

In table 4 Matrix Component one can observe that all the items have a factorial charge greater than 0.5, all maintained for the validity of the study.

The charge of the synthetic variable Task Type Culture is high, 45.16% of the initial information is retained. The equation that expresses the link between the synthetic variable and the chosen items is the following:

Table 4

COMPONENT MATRIX	
Item name	**Synthetic variable**
	Charge
C1	0.528
C5	0.633
C8	0.679
C12	0.743
C18	0.725
C21	0.695
C24	0.756
C33	0.673
C35	0.659

Source: authors' projection

$$\text{Charge} = 0.105C1 + 0.156C5 + 0.167C8 + 0.183C12 + 0.178C18 + 0.171C21 + 0.186C24 + 0.165C33 + 0.163C35$$

After wards we conducted a Centralization of Results – Cronbach Alpha test – data quality (table 5).

In the case of managers, the initial value of the Cronbach Alpha coefficient was 0.511; by eliminating the item C20, it becomes 0.569; finally, by renouncing the item C17, the value reaches the level of 0.634, close to the minimum of 0.7.

In the case of operating personnel, the initial value of the Cronbach Alpha coefficient was 0.533; by eliminating the items C20 and C17, the value reaches the level of 0.707, surpassing the minimum 0.7.

Valid conclusions for managers and employees are as followed:

- In the case of the Rope Type organizational culture, 2 items were eliminated, only 5 items remaining in the variable construction;
- In the case of the other organizational cultures, the quality of data has been certified, all items having

Table 5

RESULTS OF THE CRONBACH ALPHA COEFFICIENT				
Synthetic variable	**Managers**		**Operating personnel**	
	Cronbach Alpha Coefficient	**Item number**	**Cronbach Alpha Coefficient**	**Item number**
Task Type Culture	0.842	9	0.857	9
Power Type Culture	0.803	5	0.836	5
Role Type Culture*	0.634	5	0.707	5
Person Type Culture	0.753	5	0.827	6

Source: authors' projection

been validated that were considered initially for the construction of the variables.

1) Correlation matrix – Both in the case of managers and operating personnel, the registered values are positive and do not surpass the maximum of 0.8, which demonstrates the existence of a relationship between the items that are considered for the construction of each variable, respectively, each type of organizational culture.

The KMO and Bartlett Test – Both in the case of managers and operating personnel, the KMO coefficient has values that are above 0.5, arguing for the existence of a significant correlation between the chosen items, an aspect that allows for the carrying out of a factorial analysis of the 4 variables.

2) Factorial analysis – The results obtained from the application of the Principal Component Analysis is presented in figure 1.

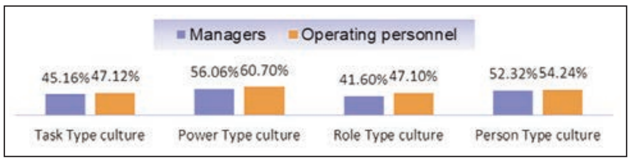


Fig. 1. Factorial Analysis results
(*Source*: authors' projection)

All 4 synthetic variables, respectively Task Type culture, Power Type culture, Role Type culture, Person Type culture, have a high charge, the percentage of initial information that is retained for each variable being significant. Thus, the equations for the 4 variables are as followed:

Equations – Managers

- Task = 0.105C1 + 0.156C5 + 0.167C8 + 0.183C12 + + 0.178C18 + 0.171C21 + 0.186C24 + + 0.165C33 + 0.163C35;
- Power = 0.258C2 + 0.273C6 + 0.273C9 + + 0.268C13 + 0.263C16;
- Role = 0.335C3 + 0.374C10 + 0.231C14 + + 0.231C22 + 0.349C34;
- Person = 0.240C4 + 0.294C7 + 0.313C11 + + 0.296C15 + 0.230C29.

Equations – Operating personnel

- Task = 0.135B1 + 0.175B5 + 0.169B8 + 0.175B12 + + 0.169B18 + 0.128B21 + 0.170B24 + + 0.158B34 + + 0.170B36;
- Power = 0.253B2 + 0.260B6 + 0.272B9 + + 0.240B13 + 0.258B16;
- Role = 0.300B3 + 0.333B10 + 0.302B14 + + 0.227B22 + 0.286B35;
- Person = 0.216B4 + 0.239B7 + 0.245B11 + + 0.229B15 + 0.216B23+0.211B30.

As a result of processing the data from a statistical point of view, using the Cronbach Alpha test, correlation matrix, KMO and Bartlett text and factorial analysis, the viability of the items, the existence of a correlation between them and the construction of the 4 synthetic variables, respectively Task Type culture, Power Type culture, Role Type culture, Person type culture, have been validated based on the items identified, a fact that permitted us to continue the research by means of a graphic centralization of the answers given (figures 2–11).

Based on the data gathered, the four types of organizational cultures have been represented graphically, both for operating personnel as well as managers, by grouping respondents according to the Likert scale used, respectively: (5) Totally agree, (4) Partially agree, (3) Neither agree or disagree, (2) Partially disagree, (1) Totally disagree.

Perspective of the operating personnel

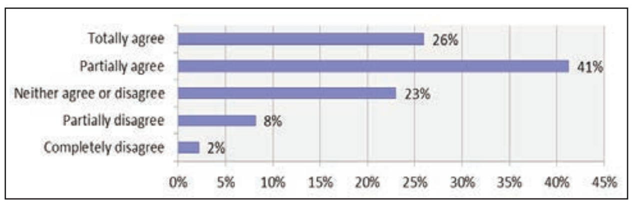


Fig. 2. Task Type organizational culture from the perspective of operational personnel
(*Source*: authors' projection)

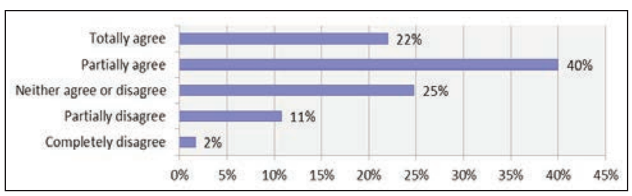


Fig. 3. Power Type organizational culture from the perspective of operational personnel
(*Source*: authors' projection)

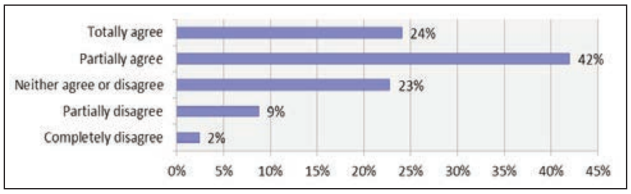


Fig. 4. Role Type organizational culture from the perspective of operational personnel
(*Source*: authors' projection)

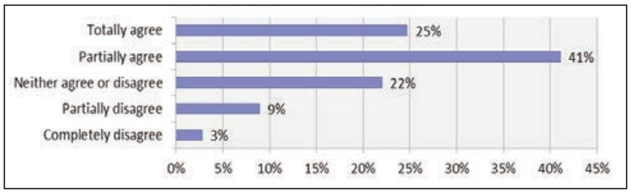
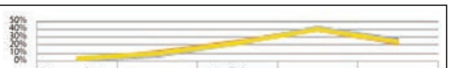


Fig. 5. Person Type organizational culture from the perspective of operational personnel
(*Source*: authors' projection)

In order to increase the degree of observation of the results we graphically present a comparison of the resulting types of organizational cultures.



	Completely disagree	Partially disagree	Neither agree or disagree	Partially agree	Totally agree
Task Type culture	2%	8%	23%	41%	26%
Power Type culture	2%	11%	25%	40%	22%
Role Type culture	2%	9%	23%	42%	24%
Person Type culture	3%	9%	22%	41%	25%

Fig. 6. Comparison between the types of organizational cultures from the perspective of operational personnel
(*Source*: authors' projection)

Management perspective

We may conclude that, irrespective of the types of organizational cultures found within a analyzed companies that they belong to, both operational personnel and employees in leadership positions accept them, being in agreement with their characteristics.

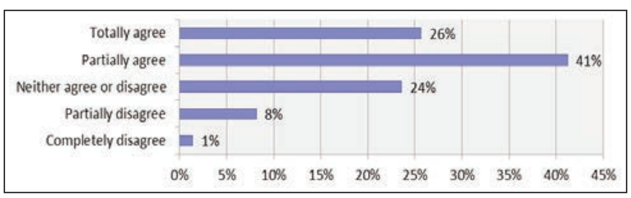


Fig. 7. Task Type organizational culture from the perspective of managers
(*Source*: authors' projection)

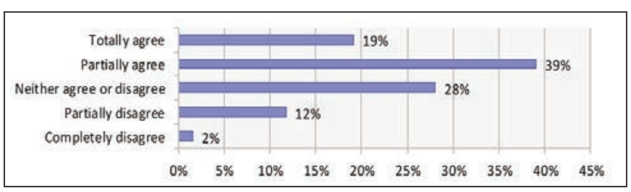


Fig. 8. Power Type organizational culture from the perspective of managers
(*Source*: authors' projection)

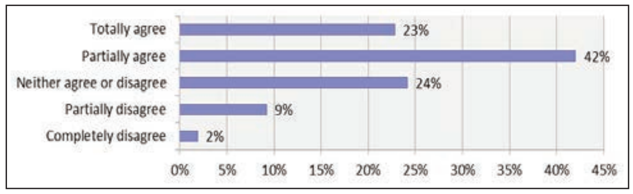


Fig. 9. Role Type organizational culture from the perspective of managers
(*Source*: authors' projection)

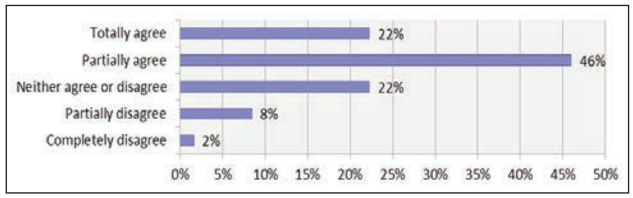
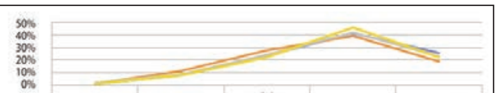


Fig. 10. Person Type organizational culture from the perspective of managers
(*Source*: authors' projection)



	Completely disagree	Partially disagree	Neither agree or disagree	Partially agree	Totally agree
Task Type culture	1%	8%	24%	41%	26%
Power Type culture	2%	12%	28%	39%	19%
Role Type culture	2%	9%	24%	42%	23%
Person Type culture	2%	8%	22%	46%	22%

Fig. 11. Comparison between the types of organizational cultures from the perspective of managers
(*Source*: authors' projection)

CONCLUSIONS

Considering the steps taken during the statistical analysis of the data gathered, respectively:

- testing data quality, the viability of the items, by using the Cronbach Alpha coefficient;
- demonstrating the existence of a relationship between the items that were identified when constructing each variable in turn, by using the correlation matrix and the KMO and Bartlett test;
- identifying a high degree of charge of the 4 constructed variables and a high percentage of initial information retained, applying the Main Component principle and stabilizing the equation that expresses the link between these variables and the considered items.

We may conclude that all the synthetic variables considered respectively, the Task Type, Power Type, Role Type and Person Type organizational cultures have a high charge level, retaining a significant percentage of the initial information, and the items that were considered for each culture type are viable.

Since each type of organizational culture relies on human resources, its typology can sometimes encompass the typologies of its members, these often adher to the ideas promoted by the organization.

Moreover, even where one can speak of a certain type of strong organizational culture, certain constitutive elements belonging to other types of cultures can be identified, reiterating the idea that an organization cannot exist without elements of an organizational culture.

Since individual behavior is the result of experience and development, research has shown the existence of a discrepancy with respect to professional level, obtained results, presentation of information, ethics or actions taken.

In our opinion, irrespective of the different points of view that try to highlight the basis for organizational cultures, this concept has in mind certain constitutive elements: rules of behavior, the norms that are developed within the work group, the dominant values adopted by the organization, the philosophy that guides the policy regarding business partners, the rules that have been established for the efficient functioning of the organization, the spirit and climate that characterizes the organization internally and in relation to the outside world.

Diagnosing the type of organizational culture permits one to observe the human behavior within the organization and the valuing of the relationships that are relevant for its functioning, which can contribute both to adaptation to the outside world, as well as to the need for internal integration by connecting the whole personnel to the strategic objectives of the organization, a cohesion of the working groups being vital for its efficient functioning.

In order to implement the strategies and policies of each company in the textile industry, it is important to know the environment in which they work, to identify the types of culture that are manifested. In this regard, it is important to know the shareholding structure, the culture of the country of origin, the organizational structure, the infrastructure, the people and their values. Employees will reflect on the standards regarding systems of value, knowledge and behavior so as to adapt the elements of the national culture to the specifics of the organizational culture within the organizations they belong to.

All 4 types of organizational cultures presented above promote certain typologies, modes of behavior and values. Some of these cultures condense rapid and repeated changes, others are subjected to innovation with greater difficulty. For example, Handy [12] associates 2 of the 4 types respectively, the Role Type culture and the Person Type culture with stability and reluctance to change, while the other 2 types (the Task Type culture and the Power Type culture) he associates with flexibility and adaptability to change. Thus, the last two types of organizational cultures promote change and implement very rapidly the modifications that they undergo. Organizations will develop a dominant style of organizational culture, however it is important to remember that these include elements that are characteristic to all 4 types of cultures, a fact which expresses the character diversity of groups and individuals.

Closely related to the results of the audit, in order to meet the challenges of globalization, a dynamic environment and the need for innovation [17], the companies should be permanently open to changes [18]. In this respect, it will be important to build up a vision of what the organization should be and how the organizational culture can contribute. The vision represents a powerful tool about the leaders' conception of what is the company, where it should go in few years, what the ways to arrive there are and what the managers value most.

The project for redesigning the organizational culture is a complex one and it is going to use a wide range of tools, going from anthropological and management till the mathematical fields [19]. Changing and realigning the components of a new culture, a stronger one, ask from the leaders a high commitment in order to create a more attractive company for its members. This should lead to a higher functionality and better results that can be revealed by the financial statements of the textile companies [20]. The vision and the new dimensions of the organization culture that will be adopted and applied will significantly contribute to the companies' competitiveness, both at regional, national and international levels.

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Improving the perspectives on quality of life for adolescents with cerebral palsy by medical textile

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ABSTRACT – REZUMAT

Improving the perspectives on quality of life for adolescents with cerebral palsy by medical textile

The quality of life (QoL) can be defined as the individual's perception of his own existence, both from the point of view of the physical integrity of the body's structures and of functionality too, as well as of the activity, respectively the capability of performing tasks, and of the participation, regarded as the involvement in the life situations.
From a medical perspective, the quality of life assessment is an indicator that provides important information, closely related to the improvement of the health status and the effectiveness of the therapeutic-rehabilitative interventions. The textile sector by research-development activities and by its numerous projects and accomplishments in the biomaterials, biotechnologies and medical device, showed a steady focus, in close relation to the medical field, on disabled persons' quality of life and on the facilitation of their social and professional integration.
The aim of rehabilitative interventions is to obtain the best possible physical and mental health, allowing each patient to build social relationships with family and community and, on the other hand, to acquire professional skills for being able to find a suitable job which will improve his wellbeing and quality of life.
This paper presents how adolescents with cerebral palsy and their parents/caregivers perceive the quality of life of the adolescent taking into consideration the activity limitations and the participation restrictions.
The results of the study showed the existence of discrepancies between adolescents' and parents' reports regarding the QoL, with adolescents' reporting a higher QoL than did their parents.
Optimism and positive thinking can be seen as augmentation factors of the therapeutic interventions' effects by increasing the adolescent's involvement in the rehabilitation process, having as direct benefit early and better results.

Keywords: *health, education, participation, social inclusion, wellbeing*

Îmbunătățirea percepțiilor asupra calității vieții adolescenților cu paralizie cerebrală prin textile medicale

Calitatea vieții poate fi definită ca percepția individului asupra propriei existențe, atât din punct de vedere al integrității fizice a structurilor organismului și al funcționalității corpului, cât și al activității, respectiv al capacității de a îndeplini sarcini, și al participării, privită ca implicare în situațiile de viață.
Din perspectivă medicală, evaluarea calității vieții reprezintă un indicator care furnizează informații importante, strâns legate de îmbunătățirea stării de sănătate și de eficacitatea intervențiilor terapeutice de recuperare. Sectorul textil, prin activitățile sale de cercetare-dezvoltare și numeroase proiecte și realizări în domeniul biomaterialelor, biotehnologiilor și dispozitivelor medicale, a arătat un interes permanent, în strânsă legătură cu domeniul medical, pentru a îmbunătăți calitatea vieții persoanelor cu dizabilități și pentru a le facilita incluziunea socială și profesională.
Scopul tratamentului de recuperare este de a obține cea mai bună stare de sănătate fizică și psihică posibilă, care să permită fiecărui pacient, pe de o parte, să construiască relații sociale cu familia și cu comunitatea și, pe de altă parte, să dobândească abilități profesionale pentru a putea găsi un loc de muncă adecvat, care să ducă la o creștere a prosperității și calității vieții.
Acest articol prezintă modul în care adolescenții cu paralizie cerebrală și părinții/aparținătorii acestora percep calitatea vieții adolescentului luând în considerare limitările activității și restricțiile de participare.Rezultatele studiului au arătat că adolescenții, spre deosebire de părinții/aparținătorii lor, sunt mai optimiști în ceea ce privește percepția calității vieții lor. În acelaşi timp, există diferenţe semnificative ale valorilor indicatorilor de percepţie cu privire la calitatea vieţii, atunci când luăm în considerarea tipologia afecţiunilor cerebrale investigate. Optimismul și gândirea pozitivă pot fi priviți ca factori de amplificare a efectelor intervențiilor terapeutice prin creşterea implicării adolescentului în procesul de recuperare, având ca beneficiu direct apariția precoce a unor rezultate mai bune.

Cuvinte-cheie: *sănătate, educație, participare, incluziune socială, bunăstare*

INTRODUCTION

International Classification of Functioning, Disability and Health – Children & Youth Version (ICF-CY) defines "mental functions of attention, memory and perception… activities involving play, learning, family life and education" as "components of health and health-related components of well-being (o.n.HRQoL)" [1]. Thus, health refers not only to Body Functions and Structures (physiological functions of body systems and, respectively anatomical components of the body), but to Activities (execution of tasks) and Participation (involvement in life situations), too.

World Health Organization (WHO) defines health as "… state of complete physical, mental, and social well-being not merely the absence of disease..." and QoL as "an individual's perception of their position in life in the context of the culture and value systems in which they live … in relation to their goals, expectations … concerns" [2].

A new and very humane vision of WHO – according to the level and expectations of a developed and civilized society – considers that the problematic situational ensemble represented by the handicap of a disabled person is primarily a result of the society/community's (for now) inability to have compensate the individual for invalidity so that, their activity and participation, socio-economic, are (almost) unchanged. In this respect, some authors recommend to use the term "disabled child" instead of "child with a disability", considering that society and environment are the ones that disables them [3].

Information technology (IT) field/tech sector/tech industry, represented by the virtual infrastructure and the related communication possibilities, is an opportunity to implement this humanitarian vision of non-discrimination and social inclusion of persons with physical disabilities, and consequently mobility limitations, helping them to overcome barriers constituted by physical distances between individuals, communities and institutions.

In addition to this, the European Union's strategies included the development of digital services, based on, along with the specific infrastructure of communications services, human capital. Thus, the European Disability Strategy (2010–2020) highlighted among the priority areas for joint action between the EU and EU countries – accessibility, participation, education and training, employment – in order to empower people with disabilities so that they can fully enjoy their rights and participate in society and the economy on an equal basis with others [4]. Two EU's priorities in the field of education are reducing early school leaving to less than 10% across EU member states [5] and reaching the target that 40% of young Europeans have a higher education qualification [6].

The textile sector by research-development activities and by its numerous projects and accomplishments in the bio-materials, biotechnologies and medical device, showed a steady focus, in close relation to the medical field, on disabled persons' quality of life and on the facilitation of their social and professional integration [7–8]. The textile materials used for healthcare and hygiene products are those commonly used on hospital wards for the care and hygiene of the patient and includes bedding, clothing, mattress covers, incontinence products, cloths and wipes.

Cerebral palsy (CP) is a group of non-progressive abnormalities of movement and posture, which results from an aggression on the brain during its developmental period, causing activity limitation, frequently accompanied by sensory, cognitive, behavioral disorders and, sometimes epilepsy.

Recent studies indicate a prevalence of CP from 1.5 to more than 4 per 1000 children [9], with an increase in the last decades [10]. According to World Health Statistic, the high quality of prenatal care, skilled birth care and postnatal care of the mother and newborns, decreased the worldwide rate of death in the first month of life by over 40% in the last 17 years [11]. But, on the other hand, the improved rate of survival of preterm and low-birth-weight infants – both being consider risk factors for CP [9, 12] – raise concerns about the increased frequency of occurrence of neurodevelopmental sequelae, especially on CP.

Cerebral palsy was mentioned for the first time in 1843 by an English orthopedic surgeon named William Little in a series of lectures entitled "Human body deformities" and, as a result, CP was known for many years like "Little's Disease". In the early stages of the disease or at an earlier age it may not be obvious the neurodevelopmental delay due to the immaturity of the nervous system. Motor deficits in CP include weakness, fatigue, incoordination, spasticity, clonus, rigidity, and spasms. Spasticity is an increased muscle tone who can lead to muscle stiffness, functional impairment, and atrophy, followed by muscle fibrosis, contractures, and subsequent musculoskeletal deformities. McGillivray (2016) mentions that, in over 86% of the over 17 million patients diagnosed with CP worldwide, the predominant motor type of CP was spasticity [13]. It was reported a 30% higher incidence of CP in males than in females [14]. According to the topographic distribution of motor involvement: CP can be classified as monoplegia, diplegia, hemiplegia, triplegia, quadriplegia, and double hemiplegia [15]. Among the associated complications may be encountered: cognitive impairment, eating disorders, bladder and bowel dysfunctions sleep disturbances, visual and orthopedic abnormalities. It is well known that "not all children with CP are cognitively impaired, the commonest type (spastic diplegic CP) is characterized by normal cognition" [16].

Quality of life, defined as "the extent to which persons enjoy a good life by achieving a balance in their relations with themselves and with others through creating and sustaining adequate conditions and own potentials over the life course" [17], provides important information about the way in which the adolescent and his parent/caregiver perceive the activity limitations and the participation restrictions due to the impairments in body functions and structures.

A literature review from 1980 to 2007 performed by Viehweger to identify existing HRQoL scales in CP patients shown that is necessary to develop new scales and to improve the available ones, because the properties of existing scales "do not allow for its full and satisfying use" [18].

Livingstone et al. described well-being as having two components: an objective ("functional status" and "health status") and a subjective one ("QoL and HRQoL") [19].

Arnaud (2008) and Gilson (2014) point out that "grater severity of impairment was not always associated with poorer quality of life" [20–21], QoL being related rather to the way in which the individual feels that is accepted by the environment in which he carries out his activity (family, school, society). Studies indicated that "disabled children experience most of life as do non-disabled children", thus is needed to support social and educational policies that... ensure their right as citizens, rather than as disabled children, to participate fully in society" [3].

Pain is considered an important factor that depreciated the QoL due to its physical and psychological effects. Another element with negative impact on quality of life was parents' stress [22], generated by perception of children's illness (physical, socio-emotional and cognitive problems, financial strain etc.), they reporting lower results in all assessed domains. Mpundu-Kaambwa (2018) also highlighted the negative impact of children's chronic disease on QoL reported by parents/caregivers [23].

Berrin has shown in 2007 that, next to pain, fatigue also have a negative impact on one of the QoL domains: school functioning [24]. Teachers should consider these aspects and adapt curricular components to adolescents' potential so that adolescents with special needs can benefit from a quality education that will facilitate their integration into the labor market. In 2006 Varni – the PedsQL developer – demonstrated that fatigue is inversely correlated with school functioning [25].

In addition to above mentioned comorbidities, sleep disturbances are frequently encountered in CP. They affect both the psycho-emotional status of the child and the compliance with the therapeutic-rehabilitative interventions, leading to a "decreased overall HRQoL" [26].

According to Majnemer, psychosocial well-being it doesn't appear to be correlated with motor and other activity limitation, these influencing only physical well-being [27].

Examining physical activity in adults with CP, Waltersson discovered that adults who used to perform physical activity as adolescents had a double probability to do it as adults, too [28]. QoL had been positively influenced by physical activity performance but, aging and reducing frequency of participation had a negative effect on all QoL domains [29].

A cross-sectional cohort study which examined the HRQoL in children and adolescents with CP reported the higher rate of HRQoL in children, followed by adolescents and, in the end, parents. An explanation could be the way in which children feels the limitations and restrictions, which have different significance as the child becomes adolescent, while the parents/caregivers tend to compare their children with healthy children [30].

In 2018 Ozkan compared children's QoL and mothers' burden in different types of CP and established that the lowest children's QoL score was reached in quadriplegia, followed by hemiplegia and diplegia, and demonstrated the existence of a significant negative correlation between mothers' burden and child's QoL [31]. There have been found "positive correlations"… between parent physical health and the physical function of their children with CP… and between parent mental health and the emotional function… psychosocial function… and total health-related quality of life of their children" [32].

Our goal was to assess QoL of adolescents with CP – without major cognition impairment – and to find out if there is any discrepancy between adolescents' self-report and parents' proxy-report and any correlation between the assessed dimensions (activities of daily living, school activities, movement and balance, pain and hurt, fatigue, eating, speech and communication).

MATERIAL AND METHODS

In the study, 162 patients diagnosed with CP and their parents/caregivers were assessed during hospitalization at the National Teaching Centre for Neuropsychomotor Rehabilitation in Children "Dr. Nicolae Robanescu" (NTCNRC), during 2018 using Pediatric Quality of Life Inventory PedsQL™3.0 Cerebral Palsy Module (PedsQL CP), to determine health-related quality of life (HRQoL) dimensions specific to CP.

The study has been approved by the Ethics Committee of NTCNRC under no. 9586/15.12.2017.

Written informed consent from parents/caregivers and adolescent assent were obtained prior to their participation to the study.

The selection of cases for setting up the patients' study group had as criteria for inclusion/exclusion the patients' age and their level of cooperation.

The group has the following characteristics:

- age ranging from 11 to 18 years;
- asymmetric distribution: 35% girls, 65% boys;
- all of them, even those with development disability, had an acceptable level of cooperation during the assessments and were users of medical textiles.

The criterion for inclusion/exclusion the adolescents' parents/caregivers in the study was only their level of cooperation.

PedsQL CP is a health-related quality-of-life instrument developed by Varniet et al. [25], which emphasizes the adolescent's perception. It has 2 components: adolescent self-report and parent proxy-report (to assess parents 'perceptions of their child's HRQoL), which consist of 35 items divided into seven subscales:

- Daily Activities (9 items),
- School Activities (4 items),
- Movement and Balance (5 items),
- Pain and Hurt (4 items),
- Fatigue (4 items),
- Eating Activities (5 items), and
- Speech and Communication (4 items)

to find out how much of a problem each item has been for adolescent during the past one month.

For adolescents who did not have the capacity for self-administration, but did have the capacity for self-report, the PedsQL CP was interviewer-administered. Otherwise, the instrument was self-administered for both parents/caregivers and adolescents, excepting the ones who needed help in reading the items, which could choose between self-administration and interviewer-administration.

Knowing that "children and family members influence one another in transaction through development"

[33], parents and adolescents were questioned separately so as not to influence each other's opinion and perception.
For both adolescents and parents/caregivers, responses are given on a 5-point Likert scale with: 0 *(nevera problem),* 1 (*almost never a problem*), 2 (*sometimes a problem*), 3 (*often a problem*), and 4 (*almost always a problem*). Each scale is then linearly transformed and reverse-scored to a 0–100 scale (0=100, 1=75, 2=50, 3=25, 4=0), so that higher scores indicate lower problems and a better HRQoL.
The statistical processing of primary data was performed with the Statistical Package for the Social Sciences IBM SPSS Statistics for Windows, Version24.

RESULTS

During the study, 162 adolescents with CP and their parents completed PedsQL CP. Almost two-thirds of the sample of adolescents was male. The CP types encountered in study group were hemiplegia (39%), diplegia (31%), quadriplegia (22%), triplegia (4%) and the mixed form (4%) as shown in figure 1.

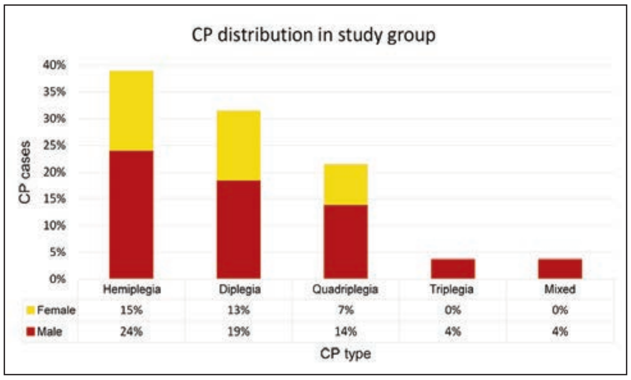

Fig. 1. Participants' characteristics

Both parents and adolescents reported how much of a problem each item from all 7 domains (ADL, school activity, movement and balance, pain and hurt, fatigue, eating activities, speech and communication) has been for adolescent during the past one month. The descriptive analysis for PedsQL CP is presented below in table 1 (adolescents' self-report parents' proxy-report).
There is a statistically significant difference between the answers of parents and children on the PEDsQL questionnaire for all the groups of variables, with the exception of School, where the responses were found to be not statistically different. Motor and cognitive impairments haven't been perceived by adolescents as a limitation regarding the school activities. An explanation of the discrepancies between adolescents' and parents' report regarding school activities, with parents reporting a lower QoL, could be the bullying phenomenon that disabled children are often subjected to, as mentioned in the literature, too [34].
In ADL domain adolescents have an average value of 585.5 (table 1), while parents have an average value of 486.57. Table 2 states that this difference is statistically significant. These mean that adolescents and parents have different perception on adolescents' activities of daily living.
As we can see from the tables 3–5, none of the variables are significantly different for males and females. Quality of life statistics, although slightly different for the two groups (e.g.: ADL value for males is over 40 points higher than females), are not different enough to infer any kind of general, population valid effect.
Of all types of CP, the adolescents with quadriplegia have the lowest QoL in all assessed domain, except for the fatigue. The ANOVA test shows that our groups are significantly different in their perceptions

Table 1

SCALE DESCRIPTIVE ANALYSIS FOR PEDSQL 4.0 GENERIC CORE SCALES PARENT PROXY-REPORT AND CHILD SELF-REPORT

Items		Group statistics			
		N	**Mean**	**Std. Deviation**	**Std. Error Mean**
ADL	Parents	162	486.5741	258.80667	20.33377
	Children	162	587.5000	256.41233	20.14566
School	Parents	162	225.4630	127.55075	10.02133
	Children	162	252.7778	131.69936	10.34728
Balance	Parents	162	297.2222	126.46655	9.93615
	Children	162	402.7778	111.69919	8.77592
Pain	Parents	162	318.9815	100.88142	7.92599
	Children	162	375.0000	42.62359	3.34883
Fatigue	Parents	162	273.6111	127.08662	9.98487
	Children	162	316.6667	88.85923	6.98144
Eating	Parents	162	367.5926	103.46815	8.12923
	Children	162	418.9815	93.82344	7.37147
Total	Parents	162	0.6589	0.18364	0.01443
	Children	162	0.7790	0.14491	0.01139

Table 2

SCALE DESCRIPTIVE ANALYSIS FOR PEDSQL 4.0 GENERIC CORE SCALES PARENT PROXY-REPORT AND CHILD SELF-REPORT										
Items		**Independent Samples Test**								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ADL	Equal variances assumed	0.347	0.556	–3.526	322	0.000	–100.92593	28.62359	–157.23879	–44.61307
	Equal variances not assumed			–3.526	321.972	0.000	–100.92593	28.62359	–157.23880	–44.61305
School	Equal variances assumed	1.640	0.201	–1.896	322	0.059	–27.31481	14.40463	–55.65388	1.02425
	Equal variances not assumed			–1.896	321.671	0.059	–27.31481	14.40463	–55.65399	1.02436
Balance	Equal variances assumed	3.351	0.068	–7.962	322	0.000	–105.55556	13.25684	–131.63651	–79.47460
	Equal variances not assumed			–7.962	317.160	0.000	–105.55556	13.25684	–131.63802	–79.47310
Pain	Equal variances assumed	123.685	0.000	–6.510	322	0.000	–56.01852	8.60442	–72.94649	–39.09054
	Equal variances not assumed			–6.510	216.707	0.000	–56.01852	8.60442	–72.97758	–39.05946
Fatigue	Equal variances assumed	32.885	0.000	–3.534	322	0.000	–43.05556	12.18352	–67.02490	–19.08621
	Equal variances not assumed			–3.534	288.054	0.000	–43.05556	12.18352	–67.03556	–19.07555
Eating	Equal variances assumed	1.246	0.265	–4.683	322	0.000	–51.38889	10.97373	–72.97816	–29.79962
	Equal variances not assumed			–4.683	318.965	0.000	–51.38889	10.97373	–72.97893	–29.79885
Total	Equal variances assumed	9.919	0.002	–6.535	322	0.000	–0.12011	0.01838	–0.15626	–0.08395
	Equal variances not assumed			–6.535	305.483	0.000	–0.12011	0.01838	–0.15627	–0.08394

Table 3

SCALE DESCRIPTIVE ANALYSIS FOR PEDSQL 4.0 GENERIC CORE SCALES PATIENT GENDER					
Group Statistics					
Items	**Gender**	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
ADL	female	60	560.0000	251.02333	32.40697
	male	102	603.6765	259.38801	25.68324
School	female	60	253.7500	133.94479	17.29220
	male	102	252.2059	131.02334	12.97324
Balance	female	60	417.5000	94.02713	12.13885
	male	102	394.1176	120.49693	11.93097
Pain	female	60	381.2500	43.57562	5.62559
	male	102	371.3235	41.83257	4.14204
Fatigue	female	60	315.0000	74.10483	9.56689
	male	102	317.6471	96.83022	9.58762
Eating	female	60	422.5000	84.71037	10.93606
	male	102	416.9118	99.13998	9.81632
Total	female	60	0.7804	0.13861	0.01789
	male	102	0.7782	0.14916	0.01477

Table 4

SCALE DESCRIPTIVE ANALYSIS FOR PEDSQL 4.0 GENERIC CORE SCALES PATIENT GENDER										
Items		**Independent Samples Test**								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
1	2	3	4	5	6	7	8	9	10	11
ADL	Equal variances assumed	1.013	0.316	–1.047	160	0.297	–43.67647	41.70520	–126.04014	38.68720
	Equal variances not assumed			–1.056	127.100	0.293	–43.67647	41.35022	–125.50047	38.14753
School	Equal variances assumed	0.000	0.999	0.072	160	0.943	1.54412	21.49371	–40.90384	43.99208
	Equal variances not assumed			.071	121.604	0.943	1.54412	21.61771	–41.25169	44.33992
Balance	Equal variances assumed	6.268	0.013	1.289	160	0.199	23.38235	18.13596	–12.43437	59.19908
	Equal variances not assumed			1.374	147.593	0.172	23.38235	17.02057	–10.25315	57.01785
Pain	Equal variances assumed	0.908	0.342	1.436	160	0.153	9.92647	6.91200	–3.72404	23.57698
	Equal variances not assumed			1.421	119.751	0.158	9.92647	6.98597	–3.90555	23.75849

Table 4 (*continuation*)

1	2	3	4	5	6	7	8	9	10	11
Fatigue	Equal variances assumed	2.332	0.129	–0.183	160	0.855	–2.64706	14.50080	–31.28472	25.99060
	Equal variances not assumed			–0.195	149.144	0.845	–2.64706	13.54429	–29.41055	24.11643
Eating	Equal variances assumed	1.135	0.288	0.365	160	0.716	5.58824	15.30613	–24.63986	35.81633
	Equal variances not assumed			0.380	139.481	0.704	5.58824	14.69550	–23.46649	34.64296
Total	Equal variances assumed	1.414	0.236	0.093	160	0.926	0.00221	0.02365	–0.04450	0.04891
	Equal variances not assumed			0.095	131.198	0.924	0.00221	0.02320	–0.04369	0.04811

Table 5

DSCALE DESCRIPTIVE ANALYSIS FOR PEDSQL 4.0 GENERIC CORE SCALES CEREBRAL PALSY TYPE

Items		**Descriptives**							
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
1	2	3	4	5	6	7	8	9	10
ADL	diplegia	45	616.6667	252.93729	37.70566	540.6759	692.6574	175.00	900.00
	hemiplegia	69	675.0000	229.36934	27.61282	619.8995	730.1005	100.00	900.00
	quadriplegia	36	395.8333	255.61550	42.60258	309.3455	482.3212	75.00	825.00
	triplegia	6	550.0000	0.00000	0.00000	550.0000	550.0000	550.00	550.00
	mixed	6	550.0000	0.00000	0.00000	550.0000	550.0000	550.00	550.00
	total	162	587.5000	256.41233	20.14566	547.7162	627.2838	75.00	900.00
School	diplegia	45	293.3333	125.38577	18.69141	255.6633	331.0034	50.00	400.00
	hemiplegia	69	266.3043	116.61794	14.03915	238.2897	294.3190	100.00	400.00
	quadriplegia	36	156.2500	141.97271	23.66212	108.2133	204.2867	0.00	400.00
	triplegia	6	325.0000	27.38613	11.18034	296.2600	353.7400	300.00	350.00
	mixed	6	300.0000	0.00000	0.00000	300.0000	300.0000	300.00	300.00
	total	162	252.7778	131.69936	10.34728	232.3439	273.2117	0.00	400.00
Balance	diplegia	45	411.6667	90.39057	13.47463	384.5103	438.8230	225.00	500.00
	hemiplegia	69	433.6957	98.40886	11.84703	410.0553	457.3360	175.00	500.00
	quadriplegia	36	308.3333	123.05632	20.50939	266.6971	349.9696	100.00	450.00
	triplegia	6	450.0000	0.00000	0.00000	450.0000	450.0000	450.00	450.00
	mixed	6	500.0000	0.00000	0.00000	500.0000	500.0000	500.00	500.00
	total	162	402.7778	111.69919	8.77592	385.4470	420.1085	100.00	500.00
Pain	diplegia	45	385.0000	33.02891	4.92366	375.0770	394.9230	275.00	400.00
	hemiplegia	69	370.6522	44.34087	5.33801	360.0003	381.3040	250.00	400.00
	quadriplegia	36	362.5000	51.23475	8.53913	345.1647	379.8353	250.00	400.00
	triplegia	6	400.0000	0.00000	0.00000	400.0000	400.0000	400.00	400.00
	mixed	6	400.0000	0.00000	0.00000	400.0000	400.0000	400.00	400.00
	total	162	375.0000	42.62359	3.34883	368.3867	381.6133	250.00	400.00

Table 5 (*continuation*)

1	2	3	4	5	6	7	8	9	10
Fatigue	diplegia	45	358.3333	63.06562	9.40127	339.3863	377.2803	225.00	400.00
	hemiplegia	69	293.4783	104.81533	12.61828	268.2989	318.6577	50.00	400.00
	quadriplegia	36	314.5833	78.46177	13.07696	288.0357	341.1310	175.00	400.00
	triplegia	6	300.0000	54.77226	22.36068	242.5200	357.4800	250.00	350.00
	mixed	6	300.0000	0.00000	0.00000	300.0000	300.0000	300.00	300.00
	total	162	316.6667	88.85923	6.98144	302.8797	330.4537	50.00	400.00
Eating	diplegia	45	435.0000	90.35913	13.46994	407.8531	462.1469	200.00	500.00
	hemiplegia	69	429.3478	74.87201	9.01353	411.3616	447.3340	200.00	500.00
	quadriplegia	36	366.6667	119.07381	19.84563	326.3779	406.9554	75.00	500.00
	triplegia	6	412.5000	68.46532	27.95085	340.6501	484.3499	350.00	475.00
	mixed	6	500.0000	0.00000	0.00000	500.0000	500.0000	500.00	500.00
	total	162	418.9815	93.82344	7.37147	404.4243	433.5387	75.00	500.00
Total	diplegia	45	0.8286	0.12683	0.01891	0.7905	0.8667	0.57	0.96
	hemiplegia	69	0.8056	0.12047	0.01450	0.7766	0.8345	0.56	0.99
	quadriplegia	36	0.6548	0.16536	0.02756	0.5988	0.7107	0.44	0.96
	triplegia	6	0.8107	0.01174	0.00479	0.7984	0.8230	0.80	0.82
	mixed	6	0.8143	0.00000	0.00000	0.8143	0.8143	0.81	0.81
	total	162	0.7790	0.14491	0.01139	0.7565	0.8015	0.44	0.99

of the PedsQL 4.0 Generic Core Scales, differences that we can analyze from the table 6 results. Thus, for Pain scores, mixed and triplegia results are significantly higher (the mean score is 400) then quadriplegia patients (mean score is 362).

The reliability and internal consistency analysis followed that the items corresponding to each construct have a Cronbach's Alpha value over 0.7 and a composite reliability over 0.7. The Cattel Scree plot and the Total Variance Table resulted from the exploratory

Table 6

SCALE DESCRIPTIVE ANALYSIS FOR PEDSQL 4.0 GENERIC CORE SCALES CEREBRAL PALSY TYPE						
Items		**ANOVA**				
		Sum of Squares	df	Mean Square	F	Sig.
ADL	Between Groups	1905937.500	4	476484.375	8.619	0.000
	Within Groups	8679375.000	157	55282.643		
	Total	10585312.500	161			
School	Between Groups	466748.641	4	116687.160	7.877	0.000
	Within Groups	2325751.359	157	14813.703		
	Total	2792500.000	161			
Balance	Between Groups	460717.391	4	115179.348	11.681	0.000
	Within Groups	1548032.609	157	9860.080		
	Total	2008750.000	161			
Pain	Between Groups	18929.348	4	4732.337	2.716	0.032
	Within Groups	273570.652	157	1742.488		
	Total	292500.000	161			
Fatigue	Between Groups	118716.033	4	29679.008	4.043	0.004
	Within Groups	1152533.967	157	7340.981		
	Total	1271250.000	161			
Eating	Between Groups	157123.792	4	39280.948	4.894	0.001
	Within Groups	1260133.152	157	8026.326		
	Total	1417256.944	161			
Total	Between Groups	0.729	4	0.182	10.781	0.000
	Within Groups	2.652	157	0.017		
	Total	3.381	161			

factor analysis done with SPSS Statistics using an oblique Promax rotation shows that all seven latent variables or constructs have eigenvalues greater than one, and the largest covariance explained by one factor is 28.845%, thus common method bias not being a concern [34]. Only 14 of the all 35 variables measured have a significant effect on the result. One item of the speech and communication domain – how difficult is for other people to understand the patient when he speaks (Var 35) – has the greatest influence on QoL. It is followed by ability to button his/her own shirt (Var 02), ability to use scissors (Var 11) and the ability to cut his/her food (Var 31). For school activities there was no statistically significant difference, so parents and children have similar perceptions regarding this domain (table 7).

Table 7

RELIABILITY ANALYSIS		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.714	0.850	7

CONCLUSIONS

The research emphasized the existence of discrepancies between adolescents' and parents' reports regarding the QoL of adolescents' with CP, with adolescents' reporting a higher QoL than did their parents, as it is also reported in the literature [35]. One explanation for these differences may be that parents relate to the performance of healthy children and the restrictions and limitations – mainly the motor ones – their children are encountered, are perceived to have a negative impact on the ability of children to integrate into family, school and social life. The psychological and social burden of the parents increases the child's psychological discomfort, which can lead to a lower compliance with rehabilitation treatment.

Both parents and children should be advised and encouraged, so that the latter learn new skills that will make possible the appearance of a degree of comfort reflected in physical and financial independence and social inclusion too.

Future work should explore factors that led to these different perceptions of QoL.

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AUTHORS CONTRIBUTION

All the authors have contributed equally to the realization of this work and have approved of its publication.

RECOGNITION

The main author thanks to all the co-authors for the excellent collaboration and support. The present study is being linked to the whole of the PhD work: "Researches on integrated modes for the development of digital and preparatory abilities for writing, in children with cerebral palsy".

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Preliminary investigations of a textile fabric used as support for a sarcophagus from Astra Sibiu Museum

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ABSTRACT – REZUMAT

Preliminary investigations of a textile fabric used as support for a sarcophagus from Astra Sibiu Museum

Historical textiles are fragile and more prone to damage. Regarding this inconvenience, heritage sample analyzes are quite difficult to achieve primarily due to fiber degradation, secondly due to the complex composition (the samples can also contain metallic threads or some other components) and last, but not least, because of the microbiological degradation. The samples evaluated in this paper were used as support for a wooden sarcophagus containing an Egyptian mummy which is estimated to be over 2000 years old.

The purpose of this work was to carry out a preliminary characterization of the samples, using minimally invasive techniques. Thus, two types of methods were used: SEM evaluation and microbiological assessment. SEM analysis revealed that the constituent fibers for all the samples are natural fibers of animal origin: wool and alpaca fibers. SEM also provided information about the surface of the fibers and more than that, by using this equipment it was possible to visualize the degree of degradation most likely caused by the attack of insects and different types of fungi and bacteria. Bioburden isolation from the archaeological samples highlighted that the highest bioburden load was registered by sample B, followed by sample C and sample A. After the screening it was concluded that all samples present both filamentous fungi specific structures and bacteria specific structures. The future studies will be directed towards obtaining more information by micro- or non-destructive methods.

Keywords: *SEM, microbiological assessment, wool, alpaca, Egyptian mummy*

Investigații preliminare asupra unui material textil utilizat drept suport pentru un sarcofag de la Muzeul Astra Sibiu

Materialele textile istorice sunt fragile și, astfel, sunt predispuse la deteriorare. Având în vedere această inconveniență, analizele efectuate asupra probelor de patrimoniu sunt dificil de realizat, în primul rând din cauza degradării fibrelor, în al doilea rând din cauza compoziţiei complexe (probele pot conţine, de asemenea, fire metalice sau alte componente) și nu în ultimul rând din cauza degradării microbiologice. Probele investigate în cadrul acestui articol provin dintr-un material textil ce a fost utilizat drept suport pentru un sarcofag din lemn conţinând o mumie egipteană a cărei vechime este estimată la peste 2000 de ani.

Scopul acestui studiu a fost realizarea unei caracterizări preliminare a probelor, utilizând tehnici de analiză minim invazive. Astfel, două metode au fost selectate: investigarea cu ajutorul Microscopului Electronic de Baleiaj (SEM) și analize microbiologice. Cu ajutorul analizei SEM a fost dezvăluit faptul că toate probele au fost realizate din fibre naturale de origine animală: lână de oaie și de alpaca. Cu ajutorul SEM au fost obţinute și informaţii privind suprafaţa fibrelor și a fost posibilă vizualizarea gradului de deteriorare cauzată, cel mai probabil, de către insecte și diferite tipuri de fungi și bacterii. Analiza microbiologică a probelor arheologice a evidenţiat faptul că proba B a avut încărcarea microbiană cea mai mare, urmată de către proba C și proba A. În urma screening-ului a putut fi concluzionat faptul că toate probele prezintă atât structuri filamentoase specifice fungilor, cât și structuri specifice bacteriilor. Studiile viitoare vor fi direcţionate către obţinerea mai multor informaţii prin utilizarea metodelor micro- și nedistructive.

Cuvinte-cheie: *SEM, analiză microbiologică, lână, alpaca, mumie egipteană*

INTRODUCTION

In order to establish a correct and personalized protocol for the optimal maintenance conditions of the objects with historical and artistic value from museums, a thorough comprehension of the materials from which these objects are made of and their physical and chemical properties is imperious [1]. The aim of this scientific study is to present the results of a preliminary assessment of a textile fabric which has been used as a support for a wooden sarcophagus containing an Egyptian mummy which is estimated to be over 2000 years old.

MATERIALS AND METHODS

Materials

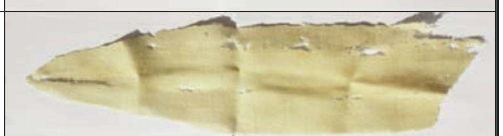
The sarcophagus containing the Egyptian mummy can be found at The Museum of Universal Ethnography Franz Binder, which is a department of the National

Museum Complex ASTRA Sibiu. The three samples that were investigated come from different areas of the textile support for the wooden sarcophagus (figure 1). From the collective memory, the textile support was most likely introduced under the sarcophagus in the 1990s.

Fig. 1. The mummy within the sarcophagus

The samples collected from the textile fabric are presented in table 1 below. In addition to the three textile samples, the dust residue that was present in sample C was also analyzed.

Table 1

THE SAMPLES AND THEIR APPEARANCE	
Sample label	**Sample appearance**
A	
B	
C	

Methods

Scanning Electron Microscopy (SEM)

This method is widely used for the analysis of the morphology of fiber and fabric surfaces [2, 3]. For example, Cybulska M. et al. [4] applied this technique in the analysis of archaeological textile samples from the Roman period and the Middle Ages and they were able to identify the constituent fibers of the evaluated material.

Morphological investigations of the textile samples and the dust in sample C were performed using a FEI Quanta 200 Scanning Electron Microscope. For each textile sample, a very small piece was cut and then it was placed on a specimen stub using double sided conductive carbon tape and analyzed using the following parameters: accelerated voltage: 20.00 kV; detector: GSED. In the case of the dust from sample C, the specimen stub covered with the double sided carbon tape was gently pressed onto the dust and analyzed using the same parameters as for the textile samples. All the SEM micrographs were taken using 1000X magnification.

Microbiological assessment

The three archeological samples were subjected to microbial isolation of main strains present on the fabrics. Approximately 5 grams of each fabric was chopped in smaller pieces (in order to maximize sample surface) and put in a volume of 300 mL sterile physiological saline solution with Tween 80 anionic detergent (Fisher Scientific, UK), a polysorbate surfactant which helps in the process of protein stabilization, allowing a proper dispersion of plated microbial cells (prior to incubation). Samples were agitated on a Promax 2020 shaker (Heidplph) for 5 h at 220 rpm, in order to dislocate the potentially existing microbial cells from the surface of the fabrics. Bioburden isolation was carried out on nine semi-synthetic nutritive media, as following: Czapek-Dox semi-synthetic media (Scharlau, Spain), used for cultivation of fungi, containing nitrogen as a sole source of nitrogen, frequently used for isolation of fungal species such as *Aspergillus*, *Penicillium*, *Paecilomyces*, *Saccharomyces* etc.; Potato-Dextrose-Agar (Scharlau, Spain) usually used for stimulating sporulation and growing of various fungi strains (species of *Aspergillus*, *Saccharomyces*, *Rhodotorula*, *Geotrichum*, *Penicillium*, *Trichophyton* etc.); Malt-Extract-Agar (Scharlau, Spain), a classic culture medium for moulds and yeast (*Aspergillus, Saccharomyces, Penicillium, Candida* etc.), with a high quantity of sugar (maltose, glucose, sucrose) that allows excellent growth and additional necessary growth factors provided by the gelatine peptone; Sabouraud 4% Dextrose Agar (Merck, Germany), a complex medium for cultivation and isolation of yeasts and moulds (*Trichophyton, Microsporum, Geotricum, Penicillium*), with a high concentration in dextrose, which promotes the formation of Conidia and Sporangia spores (combined with low pH value), as well as pigments of yeasts and molds, along with the inhibition of bacterial growth; Bengalrot-Agar with chloramphenicol (Roth, Germany), a selective medium for the enumeration of moulds and yeasts, with additional selectivity against bacterial growth, by the incorporation of the heat-stable antibiotic Chloramphenicol and glucose as incorporated fermentable carbohydrate source, with enzymatic digest of animal and plant tissues providing the essential vitamins, minerals, amino acids, nitrogen and carbon; Nutrient-Agar (Scharlau, Spain), a solid culture medium for general purpose use with less fastidious organisms; Muller Hinton Agar (Oxoid, United Kingdom), a medium usually used for the isolation of pathogenic *Neisseria* species, inclusion of starch ensuring that toxic factors found during growth will be absorbed, thus allowing the development of microorganisms that are present in very small inocula; Simple Gelose (Sanimed, Romania), simple structure media for the isolation and growth of certain strains of bacteria. Except for the Bengalrot, Nutrient-Agar, Muller Hinton and Simple Gelose medias, all other nutritive medias had a concentration of 1g/L chloramphenicol (an antibiotic first isolated from cultures of *Streptomyces venequelae*), for the inhibition of certain bacterial species. After samples agitation, 1000 μL were taken from each shaking solution and plated in duplicates on each nutritive media. Plates were then incubated at 28°C for 7 days and inspected for microbial morphological development.

RESULTS AND DISCUSSION

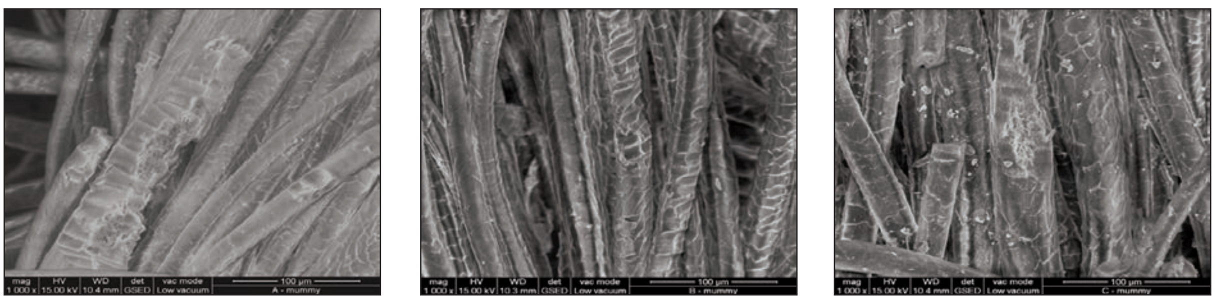
SEM analysis was used to investigate the microscopic appearance of the textile fiber surface, the type of fibers within the material, the diameter of these fibers, traces of insect and microorganisms attacks and the artifact residues (figure 2).

Following the SEM analysis, it can be said that the constituent fibers for all the samples are natural fibers of animal origin. However, the diameters of the constituent fibers vary widely, ranging between 15 and 90 microns. Due to the different appearance of the scales at the surface of the fibers and the very wide range of diameters, it can be preliminarily concluded that the fibers come from two different species of animals. Most likely, the fibers with more prominent and higher scales are wool fibers [5] and those with finer and less delimited scales are alpaca fibers [6].

For all of the textile samples, the extensive degradation caused by insects was highlighted. The most common insects that are known for attacking wool and other protein fibers are the larvae of the Tineidae (clothes moth) and Dermestidae (carpet beetle), although members of other species may attack wool incidentally [7].

Bioburden isolation from the archaeological samples highlighted various degrees of microbial development, based on both the originating archaeological sample, and the nutritive media used (figures 3–5), with certain samples having a higher bioburden degree, in terms of species, compared to others.

The highest bioburden load was registered by sample B (with 11 highlighted plates), followed by sample C (with 6 highlighted plates) and sample A (with 5 highlighted plates). The screening highlighted that all samples present both filamentous fungi specific structures and bacteria specific structures, with the nutritive media used for fungi screening (Czapek Dox, Sabouraud Agar, Bengalrot Agar and Malt Agar) highlighting more fungi-like morphological formations than the three media used for bacterial isolation (Nutrient Agar, Simple Gelose and Muller Hinton). This separation was also strengthened by the presence of chloramphenicol in certain media, when compared to others that can also have a direct influence on the species of isolated strains.



A B C

Fig. 2. SEM micrographs of the textile samples A, B and C, bar: 100 μm

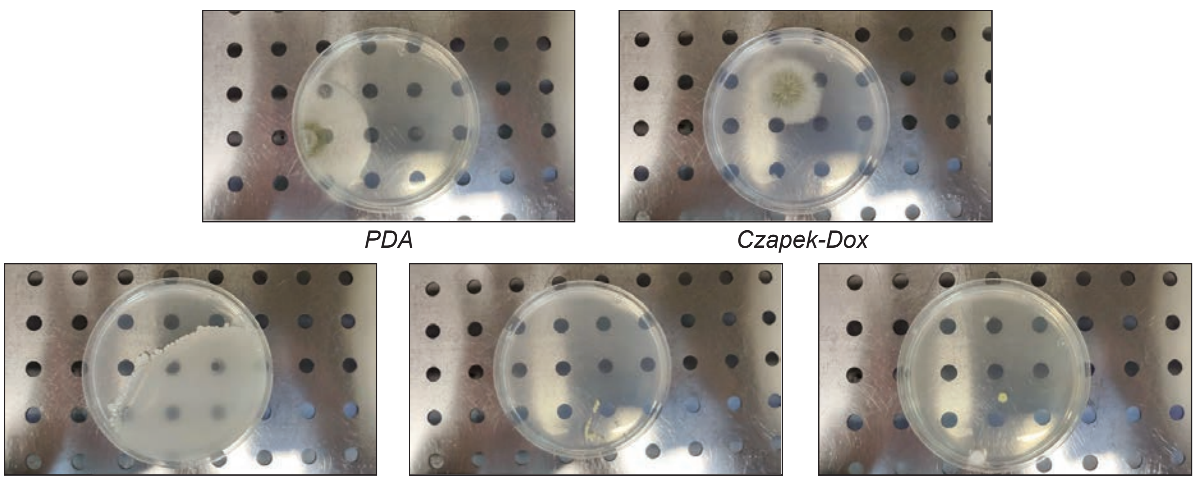


Fig. 3. Bioburden isolation from archaeological sample A

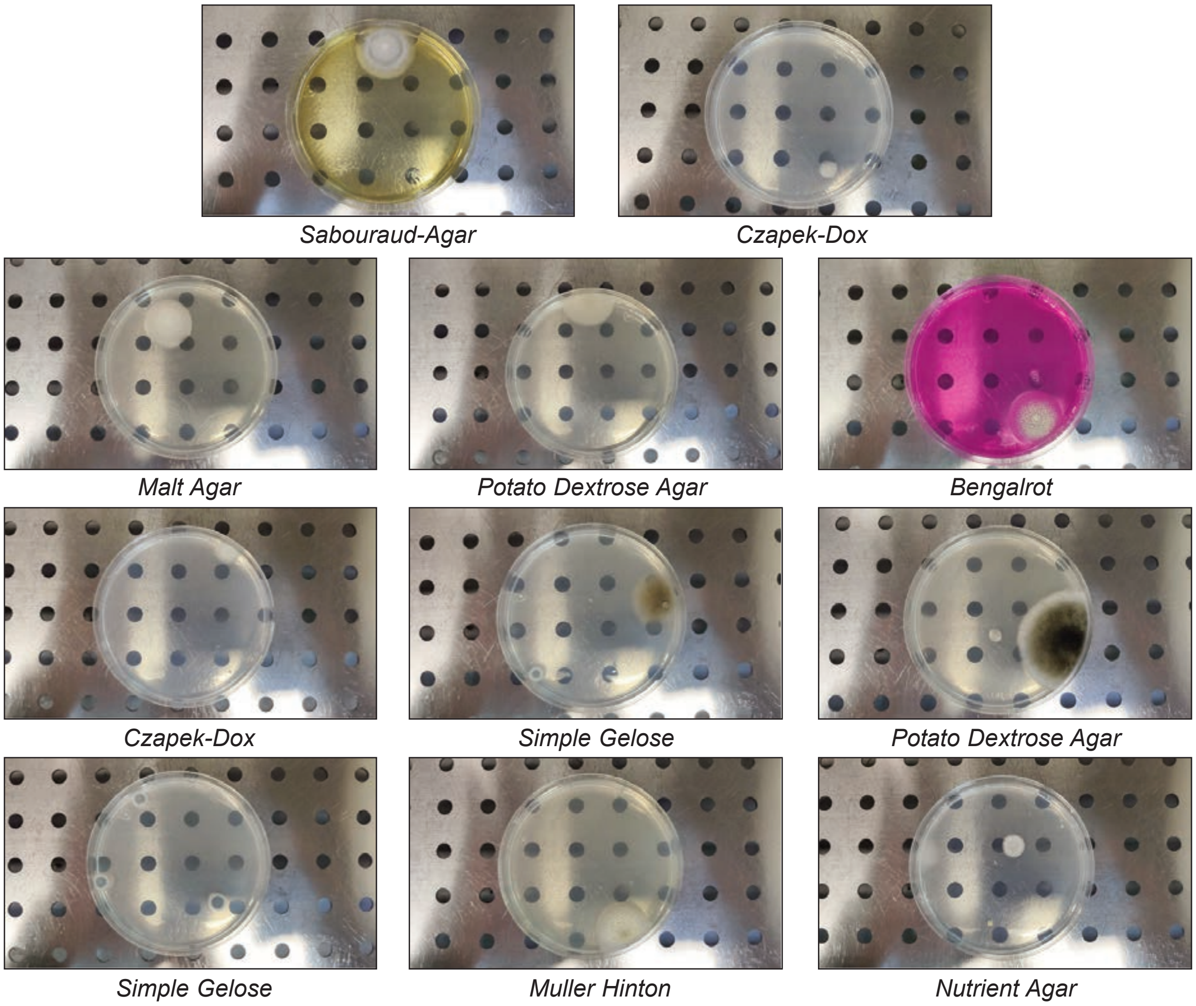


Fig. 4. Bioburden isolation from archaeological sample B

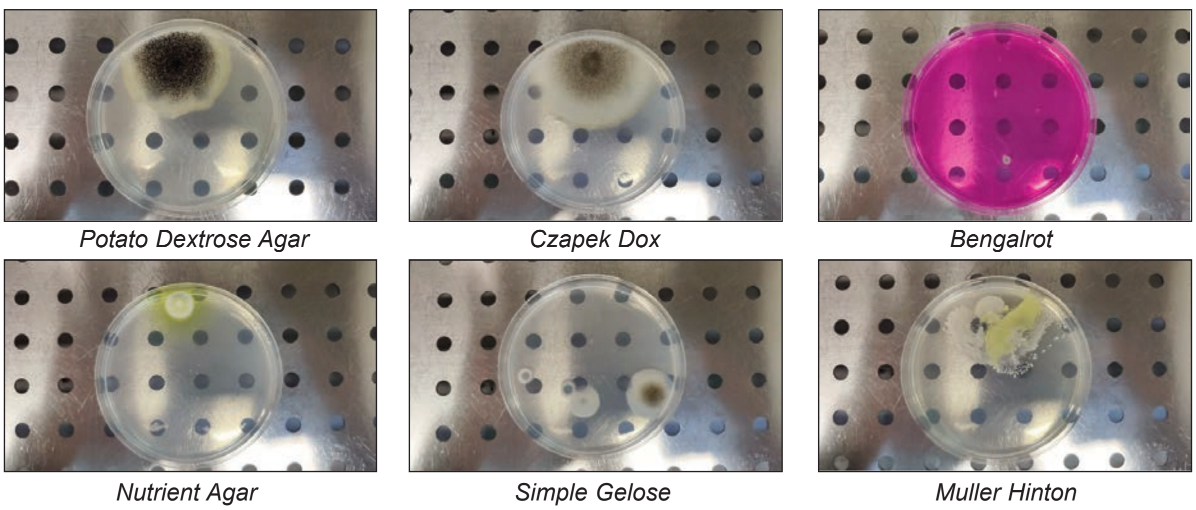


Fig. 5. Bioburden isolation from archaeological sample C

CONCLUSIONS

The results obtained after SEM analysis show that the constituent fibers for all the samples are natural fibers of animal origin. Due to the particularity regarding the diameters, appearance and the surface of the fibers, it can be preliminarily concluded that the fibers come from two different species of animals. Analyzing other existing data in the specialized literature, an estimation of the type of constituent fibers could be made, namely wool and alpaca fibers. In addition to the evaluation of the fiber type, with SEM it was possible to visualize the degree of degradation most likely caused by the attack of insects and different types of fungi and bacteria.

Bioburden isolation from the archaeological samples highlighted that the highest bioburden load was registered by sample B, followed by sample C and sample A.

The conclusion of the screening is that all samples present both filamentous fungi specific structures and bacteria specific structures [8].

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INFORMATION FOR AUTHORS

Industria Textila magazine is an international peer-reviewed journal published by the National Research & Development Institute for Textiles and Leather – Bucharest, in print editions.

Aims and Scope: Industria Textila journal is addressed to university and research specialists, to companies active in the textiles and clothing sector and to the related sectors users of textile products with a technical purpose.

Submission of Manuscripts

All manuscripts with the material proposed for publication, shall be sent to: **industriatextila@incdtp.ro**.

Please include full postal address as well as telephone/fax/e-mail details for the corresponding author, and ensure that all correspondence addresses are included. Also include the scientific title of the authors.

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Manuscripts submitted are check against plagiarism with **Anti-plagiarims System**. Manuscripts of the following types are accepted:

Research Papers – An original research document which reports results of major value to the Textile Community

Book Reviews – A brief critical and unbiased evaluation of the current book, normally invited by the Editor.

Manuscripts shall be submitted in English in single-spaced typing, A4 paper, Arial, margins 2 cm on all sides, under electronic version in Word for Windows format.

The volume of the submitted papers shall not exceed 8 pages (including the bibliography, abstract and key words), typescript pages including tables, figures and photographs.

All articles received are reviewed by minimum two reviewers, renowned scientist and considered expert in the subject the article concerns, which is appointed by the editorial board. After the article has been accepted, with the completions and the modifications required by the reviewers or by the editorial staff, it will be published.

The submission of the above-mentioned papers is by all means the proof that the manuscript has not been published previously and is not currently under consideration for publication elsewhere in the country or abroad.

There may also be published papers that have been presented at national or international scientific events, which have not been published in volume, including the specification related to the respective event.

The articles assessed as inappropriate by the reviewer or by the editorial staff, concerning the subject matter or level, shall not be published.

The manuscript shall be headed by a concise title, which should represent in an exact, definite and complete way the paper content.

The manuscript shall also be headed by complete information about the author(s): titles, name and forename(s), the full name of their affiliation (university, institute, company), department, city and state, as well as the complete mailing address (street, number, postal code, city, country, e-mail, fax, telephone).

Tables and figures (diagrams, schemes, and photographs) shall be clear and color, where possible.

The photographs shall be sent in original format (their soft), or in JPEG or TIF format, having a resolution of at least **300 dpi**.

All tables and figures shall have a title and shall be numbered with Arabic numerals, consecutively throughout the paper and referred by the number in the text.

Generally, symbols and abbreviations shall be used according to ISO 31: Specifications for quantities, units and symbols. SI units must be used, or at least given comprehensive explanations or their equivalent.

Cited references shall be listed at the end of the paper in order of quotation and contain: **for a paper in a periodical** – the initials and surname of the author(s), title of journal and of the article, year and number of issue, number of volume and page numbers; **for a book** – the initial and surname of the author(s), full name of the book, publisher, issue, place and year of publishing, and the pages cited; **for patents** – the initial and surname of the author(s), the title, the country, patent number and year. It is preferable not to use sites as references.

[1] Hong, Y., Bruniaux, P., Zhang, J., Liu, K., Dong, M., Chen, Y., *Application of 3D-to-2D garment design for atypical morphology: a design case for physically disabled people with scoliosis*, In: Industria Textila, 2018, 69, 1, 59–64, http://doi.org/10.35530/IT.069.01.1377

Authors are requested to send an abstract of the paper, preferably no longer than 250 words and a list of 5–6 key words (preferably simple, not compound words, in alphabetical order).