The influence of equipment manufacturing technologies on performance in sports

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Abstract. The study of the equipment used to practice sports as a hobby or performance has become a growing field of applied research. The professional equipment with the sensual comfort properties which it has to fulfill has become more and more a "fashion" accessory; its appearance can have a psychological impact that can influence the outcome of a competition. The paper proposes to analyze the influence of sports equipment manufacturing technologies on performance through a SWOT analysis, establishing the strengths, weaknesses, opportunities and threats of a certain type of equipment. We also propose a case study that has as objectives: the comfort of wearing equipment due to finishing technologies and the visual impact of colors. The results of the study will be processed statistically and the conclusions will be able to provide the necessary data for choosing a particular type of equipment that will lead to high performance results.

1. Introduction

Performance sport involves the use of equipment with specific psycho-sensory design and characterization. Waxing equipment from natural raw materials, usually 100% cotton is a matter of the past. Cotton knitwear offers the feeling of comfort while wearing it, but the hygroscopicity of the fibers is great, around 8.5%, and therefore the knitted structure, because of this it absorbs strongly the moisture from the skin but it transfers it relatively hard outwards, maintaining the feeling of moisture on the body [1,2,3]. Due to the rubbing of a wet material, whether or not of cotton, on the body surface, skin irritation occurs during exercise. When designing current equipment, unconventional thread making techniques are used, united or multilayer knitted fabrics for the face that comes in contact with the skin and finishing of knits so that the air and vapor permeability of knitted structures are maximal. Dimensional stability and shape for knitted fabrics from synthetic raw materials is clearly superior to cotton products. For all of these, synthetic yarns are used in the group of polyamides and / or polyesters with superior finishing properties.

1.1. Problem description

Research in the vast field of sports equipment materials has shown that equipment made with new generation technologies and materials can influence the outcome of a competition. Also, the colors, types of joints and / or material finishes can influence the outcome of a sports competition.
Classical or conventional materials and technologies are becoming less appreciated. Although it provides a feeling of comfort when wearing it, 100% cotton sport items have great hygroscopicity/inlay, about 8.5% and does not provide fast moisture transfer from the body to the outside, the product retaining absorbed moisture and in contact with the skin, friction can cause irritation. Of course, for a sports competition knitted garments are preferred for a small square meter. This leads to the use of planar, jersey structures, but which on the back has pointed the needle loops and platinum loops, the aspect being uneven, which can lead to discomfort when worn, especially after the product was moistened due to physical effort. One solution would be to use the 1:1 interlock structure, identical and even-looking structure on both sides. The inconvenience in this case is the high mass per square meter and the high compaction of the structure [4].

Classical technologies of merging by sewing of markers of clothing items are also less preferred by high performance sports wearers. The stitches, no matter how correct they would be, due to the arrangement of the surface of the yarns that make it, are spatially high, in the joining zones irregularities of the flatness of the surfaces occur, and during wearing the worn articles can cause irritation. It is well known that cotton knitted articles are sewn together with 100% cotton threads and the resulting joint is relatively rigid, even if the seam is flat or overlapped [5,6].

Figure 1 exemplifies the front and rear aspect of a glat structure and highlights the irregularity presented for the back part.

![Figure 1. The front and rear aspect of glat structure.](image1)

Knitted fabrics with new generation technologies, although synthetic 100%, knitted fabrics made of polyamide, polyester or polyamide polyester blends or microfiber yarns of synthetic raw materials of the same type, PA and / or PES, finished accordingly give the sports equipment superior comfort properties than cotton. One of the biggest advantages is the low hygroscopicity of polyamide or polyester yarns, 0.4-1%, depending on the relative humidity of the air, the rapid transfer of moisture from the body to the outside environment, so the feeling of comfort is maintained on the course of the competition [7,8].

![Figure 2. Front and rear aspect of an elastic joint with a uniform surface.](image2)
For the manufacture of these articles, modern technologies are "fully fashion", by which measuring and sewing operations are cut off, the items being knitted, structures are elastic by definition, and the seams being eliminated it is excluded the possibility of these being uncomfortable if worn. However, if any type of joint is required, eye-to-eye joints are used on KETT machines, the joint being elastic, flat, with elasticity properties superior to a seam joint with a sewing machine seam or even elastic.

For the attachment of articles to different parts of the body or for the spatial modeling of products, silicon strips applied by ultrasonic welding are used. Ultrasonic welding of knits is one of the most advanced technologies, the resulting articles having the elasticity of a knitted fabric, the edges of the silicone strip merging with the base material completely eliminates the possibility that the article may become defective during wearing.

Figure 2 presents the front and rear aspect of a joint portion between two different knitted structures.

This paper proposes a SWOT (Strength, Weakness, Opportunities, Threats) analysis to identify research opportunities and discover strengths, weaknesses, opportunities and threats for sports equipment. Closed questions have been used that have some advantages: considerably reduce the effort to give answers; allow coding of responses; allow respondents to consider some variants of response that they would not otherwise have thought of; are much easier to accept by respondents, limit the range of responses, etc [9].

Several requirements and rules have been complied with in formulating the questions so that they do not contain more questions in a wording, they are appropriate to the intended purpose, they are easy to understand by all respondents, they are not too technical, and they do not contain regionalisms, archaisms and not to use to many neologisms [10].

In the specialty literature, up to 50 questions are considered to be an acceptable questionnaire, in size. Being online questionnaires, very easy to answer, is not too much abuse of the patience and time of respondents. It is also considered [11] to be more important than the number of questions the duration and effort required to give the answers.

1.2. Sample volume determination

Three methods [12] are used to determine the sample volume: to "copy" the sample size used more frequently in certain types of study; starting from the number of analytical subgroups; and a statistical model was used for this study. According to the specialty literature indications [13] the following association was used:

\[ n = \frac{t^2 \cdot p \cdot (1-p)}{e^2} \]  

(1)

where:  
n - the sample size;  
t - the theoretical value of the accepted probability (t = 1.96 for a confidence level of 95%);  
p - percentage in which the population has the sampling feature (p = 0.50);  
e - tolerance limit for acceptable representativeness (values between 1% and 5% are accepted)

The research hypotheses were two: 1. Athletic equipment from natural raw materials made by classical technologies; 2. Equipment made of synthetic materials of new generations with unconventional technologies.

2. Material and method / experimental part

For the present case study, we chose the sample so that it answers a series of questions: who does the survey address to (who will answer), what will be the volume of the sample and what are the criteria applied to the sample (the sampling criteria).

The chosen method is a statistical survey organized to identify the population's preferences for a particular type of sporting equipment, aiming at identifying strengths, weaknesses, opportunities and threats regarding running equipment.
2.1. Strengths
Do you consider the material the sports equipment is made of is important? A. No, I only consider sporting training important; B. Yes, I think it is important for the material to be one of the new generations to give me safety, comfort and conditions for high performance.
From the graphical analysis of figure 3 results the material the sporting equipment is made of is likely to be of the new generations, the answers being 86.9% in this respect;
Do you consider the technology that made the sporting equipment important? A. No, I only consider the material important. It must be of cotton; B. No, I consider the material only important. It must be of new generation raw materials with superior comfort properties to classical materials; C. Yes, new-generation multi-layer knitted fabrics with superior finishes and welded, invisible assemblies, or flat and cover seams, I think is best suited.

![Figure 3](image1.png) The importance of the material the sport equipment is made of

![Figure 4](image2.png) The importance of the technology that made the sporting equipment.

From the graphical analysis of figure 4 results equipment manufacturing technologies are important for 47.8% of respondents, the other 52.2% being almost equally divided among those who only prefer cotton equipment and those who prefer equipment from new generation materials without according importance to technology.
Do you consider important research activities to obtain new generation equipment? A. Yes, research can lead to equipment from materials of new generations that can create the necessary mental comfort in a competition; B No, I do not think research is needed because the equipment has a minor influence in a sporting competition.

![Figure 5](image3.png) The importance of scientific research activities for the production of sports equipment.

From the analysis of the graphical representations of figure 5 result the importance of research activities for the achievement of high performance sports equipment.

2.2. Weaknesses
In the current economic situation, for price reductions, some manufacturers use dyed and dubious quality dyestuffs and auxiliary finishes. Do you consider this a threat to the health and psyche of the athlete? A. Yes, low-priced products are of poor quality and can lead to deficiencies in use (skin dye
loss that can lead to allergies, discoloration of the product); B. No, I think any manufacturer is responsible for the applied technologies, so I think the article should be qualitative.

![Pie Chart](image1.png)

**Figure 6.** The importance of chemicals used in finishing materials for sports equipment.

From the graphical representation analysis of figure 6 it is shown that a weakness of sports equipment is the low price that reflects a questionable decal product and which is rejected by 66.3% of the respondents.

2.3. **Opportunities**

On a scale of 1 to 5, what is the mark you attach to the importance of equipment worn in a sports competition? (1 means the least, 5 means the most)

![Bar Chart](image2.png)

**Figure 7.** The importance of the sport equipment in a competition.

From the graphical analysis of figure 7 results the sports equipment plays a decisive role in a sports competition, with 61.4% of respondents expressing this opinion; When choosing sports equipment, does it influence you its degree of promotion? A. Yes, it has an important influence in my decision when sports equipment has a high degree of promotion; B. No, it does not influence me; it only counts the degree of comfort the equipment gives me.

![Pie Chart](image3.png)

**Figure 8.** The influence of the promotion of sporting equipment.

![Pie Chart](image4.png)

**Figure 9.** The importance of "eco-friendly" finishing technologies for sports equipment.
Do you consider important “eco-friendly” finishing technologies for sports equipment? A. Yes, green finishing technologies are designed with the use of less aggressive chemicals for the environment; B. No, properly applied finishing technologies must lead to high quality equipment, regardless of the chemical, organic or classical chemicals used.

From the graphical representation analysis of figure 8 it is clear that a relatively small percentage of respondents, 30.1% are influenced by the level of promotion of sports equipment, most of them have their own opinion and from the analysis of the graphical representations of figure 9 result 75.3 percent of the respondents’ preference for environmental technology for finishing materials for sports equipment.

2.4. Threats
If you buy a “business” equipment which would you choose? A. The one which has the appearance that I think represents me; B. The one which is more comfortable to wear.

Analyzing the representation of figure 10, 73% of the respondents prefer the equipment that "represents them", so the dominance is the appearance, and the comfort of wearing passes into the second pit, which can be a serious inconvenience in a competition.

3. Conclusions
1. The importance of scientific research activities in the production of sports equipment is of major importance, sports equipment being a major factor in a sporting competition.
2. The strengths of sporting equipment can be considered the materials from which they are made and the technology through which they are obtained, which can always be improved through research.
3. The weaknesses of sporting equipment can be excessive product promotion and outdated technologies made with questionable quality chemicals.
4. An opportunity for research in the field of sports equipment is clearly highlighted by the preference for ecological finishing of materials.
5. A veiled threat is the appearance of a sporting outfit, an aspect that prefers comfort to wearing. Uncomfortable equipment can create serious problems in a competition, so this threat can be corrected by research activities leading to clothing articles with appearance and comfort features to wear at maximum odds.
6. Articles for sporting equipment made with unconventional technology are currently preferred because of the superior comfort properties offered to classic cotton items.
7. Developing upcoming sports equipment and technologies can be a success factor that complements the training of an athlete and can influence the outcome of a competition.
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