ROPE TETHER USABILITY EVALUATION WITH VISUALLY IMPAIRED ATHLETES IN PARALYMPIC RACE TRACKS

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Abstract:

Visually impaired make the use of touch as a sensorial substitute to perform a task on the mode. According to normative technics of the International Paralympic Athletics, the visually impaired athlete performs activities, such as sprint, has, as orientation instrument, a rope tether that is tied between the athlete and a leader, known as sighted guide that points out the actions that should be taken during the track. In the literature conducted to date, there is not scientific publication related to the athlete visual impaired performance on the use of the rope tether into sprint modality and its usability. Although the rope tether allows the activity execution, the sighted guide presence reflects on the athlete's performance, since the mistakes committed by the guide can injure or even disqualify the athlete on competitions. In this paper, the rope tether usability in relation to the visually impaired athlete and the sighted guide is covered. This experiment was conducted by the analysis of 273 samples of official sprinting videos extracted from Paralympic site. The paper's main goal is identifying problems related to the rope tether use during paralympic sprint. It was identified serious failures related to the rope tether use. False start, break down, disqualifying was aggregated totalizing, on average, 57,09% of serious failures in three sprinting events (100m, 200m and 400m). Esses resultados impactam na criação de novas tecnologias aplicadas ao esporte paraolímpico, minimizando as ações do guia.

Keywords: Visually impaired; Usability, Accessibility

I. INTRODUCTION

According to the World Heath Organization (WHO), about 314 million people are visually impaired worldwide and 45 million of which are visually impaired. About 90% of the visually impaired live in developing countries. According to the Brazilian Institute of Geography and Statistics (IBGE,2013), in the 2010's census, there were 45.6 million people that have at least one type of the surveyed deficiencies (visual, auditory, motor and mental), corresponding more than 24% of the population.

The Paralympic Sport is a relatively recent sport segment, from 1940, with the initial need to promote the social inclusion of injured soldiers during the World War II (IPC handbook, 2015). On Latin America, this practice began on the following decade. In the current context, the Paralympic events has increasingly focusing more people to practice sports, best results in terms of the athlete's performance, technological inclusion on the sport modality, increase on the number of sponsors and the number of spectators. (Vanlandewijck and Thompson 2011).

The Paralympics is an example of sport segment that presents the society the potential of the impaired, in addition to relativize its limitations, since it values and disseminates their physical abilities, and enable society a collective awareness about social inclusion, overcoming prejudice and issues related to solidarity (Woods, 2008; Winnick, 2005). Among its modalities, there's athletics for visually impaired athletes which consists basically all events that make up the official rules by the International Association of Athletics Federations (IAAF,2015), except for pole vault, hammer throw and hurdling. The events are divided by degree of visual impairment. The general structure used for the classification of athletes with a visual impairment consists of three sport classes: B1: Athletes with a B1 sport class have a very low visual acuity and/or no light perception; B2: Athletes with a B2 sport class have a higher visual acuity than athletes competing in the B1 sport class and/or a visual field of less than five degrees radius; B3: Athletes with a B3 (or equivalent) sport class have the least severe visual impairment eligible for para-sport. They have the highest visual acuity and/or a visual field of less than 20 degrees radius. Although these are the three standardized sport classes for athletes with a visual impairment the naming of the sport classes will differ by sport(International Paralympic Committee, 2016).

Several authors related the benefits of the practice of sport activities for people with disabilities, which includes the motor, cognitive, psychological, physical, physiological and social development, factors that are impacting the extent that provides communication, personal achievement, self-image or self-concept and autonomy, considering all age groups (Rechineli et. al., 2008; Pereira, 2008; Bodas, et al., 2007; Vieira, 2006; Garcia; Lemos, 2005; Winnick et al., 2005). For instance, there's the research of (Monteiro, 1999), which the author conducted an experiment with twenty four visually impaired people, dividing into two groups, practitioners and non-practitioners, and he found out that practitioners presented better spatial orientation and better knowledge of their bodies. Yet, (Ribeiro, 2003), relates that the practice of sports also reduces the level of depression and anxiety. Pereira et al., 2013 observed that the practice of high performance sports was an important tool in the daily life of Benjamin Constant Institution's athletes in Rio de Janeiro, resulting in improved self-esteem and motivation.

On Paralympics rules is considered that the visually impaired athlete and the sighted guide as a single individual, and according to the guide's behavior, it can result on the athlete's classification or declassification. The current rules for Paralympics sprint race for visually impaired are specific for the double athlete and sighted guide (IPC handbook,2015). Performed a series of physical and physiological assessments with visually impaired athletes, but there's no evaluation records of the rope tether usability, as well as records of the use of vibrating devices that allow the visually impaired athlete to perform sport activity with autonomy.

The main goals of this study was to examine the usability of the rope tether between the athlete and the guide.

An experiment was conducted over the analysis of official championships videos in order to identify the impact caused by the use of the rope tether, whereas in the bibliographies researched to date had not been found any research related to the biopsychosocial impact of this procedures. Previously, it was identified that

the assistive technology available for the athletic sprint race for visually impaired are very restrict in relation to the rope tether. When performing a preliminary assessment of the usability of this feature, we proposed to produce a line of action to broker information to the visually impaired athlete and that even resize its performance, self-fulfillment and autonomy.

1.1. Background

On the practice of sport activity for the visually impaired must be considered factors related to sensorial substitution. These factors should be in accordance with the concept of accessibility which provides conditions for the use with security and autonomy, full or assisted, of spaces.

Accessibility of a product or service can be expressed in terms of achieving the goals of a task. This concept, shown in part 171 of ISO 9241 (ISO 2008), is consistent with the concept of "design for all" or "universal design", which aims to access to the diversity of users, regardless of their intellectual level, language, culture, environment or disability. It does not mean that every product should be usable by all users. There will always be a minority with severe disabilities or multiple that need adaptation or specialized products.

Usability can be expressed by the scope of action of a product and can be used by specific users with specific goals with effectiveness, efficiency and satisfaction in a specified context of use. According to (Nielsen,1993), the usability of a system is a concept that refers to the quality of the interaction between systems and users. This concept can influence the acceptance of a product and applies to all aspects of the system with which one can interact, including the procedures for installation and maintenance. The usability of a system must be measured for certain users running certain tasks ISO 9241-11 (ISO 1997).

Most assistive technologies developed for the market has been centered in the development of prosthetics and orthotics that allow the practice of sports for people with physical disabilities (Cowan et al., 2012), while little has been done for the visually impaired. Even in the specific literature about the visually impaired (Hersh and Johnson, 2008), the subject of contribution of vibrating components is not widely cited.

Visually impaired people can dispose different types of devices for mobility indoors and outdoors with identification of obstacles, but the research presented with the application of devices for internal and external environments do not display evaluation mechanisms of its accessibility and usability, as well there's no registration to date on periodic, institutions of intellectual propriety and commercial electronic sites of some electromechanical device of tactile stimulation developed in order to allow visually impaired athletes to run a race walking without any help and assistance of another person, there is a limited framework designed specifically for evaluation and monitoring of athletes biomechanics as exemplified by (Mello et al., 2014).

The National Academies of Science, Engineering and Medicine has documents for ETAs as follow: distant object and cardinal direction information for projection of a straight line; information enabling self-familiarization and mental mapping of an environment, operate with minimal interference with natural sensory channels, reliable, low power, easily repairable, etc. However, there are no specific records for athletic sprint.

In the patent databases, there are documents in which are described methods for transmitting emotions to people through stimulating tactile in garments. On the (Sony patent, 2012) it is presented a method of information transmission to a human body through standard codes. Each code is associated with a predefined pattern of activation of at least one actuator designed to convey emotion, taking the skin as tactile interface from biomedical sensors or from the environment. In the (Koninklijke Philips N.V. patent ,2008), it is presented an emotion transmission method to a person exposed to a multimedia material (a video, for example), in which actuators can stimulate several body parts, synchronized with the information exposed in this material. In both patents, the actuators are in an accessory worn by the user. The obtained information is transmitted by touch via wireless technology. Even though these patents use tactile communication in a garment, these are limited to the transmission of information about physical and emotional expressions, having no relevance for applications related to sport.

(Lima,2012) presents the adaptation of a methodological approach, and an experimental protocol, to evaluate the usability of accessibility features developed to help individuals with visual impairments, at different levels, use the computer in a simple and effective way; promoting their social inclusion. To validate the adapted methodology and protocol, a study was conducted which evaluated the following aids:

screen readers and Braille keyboard, typically used by the user community, with limited vision. The contribution in regard to scientific and technological production are on the fact that assistive products targeted to sensory disabled people should be tested for their usability and accessibility to validate the product in actual terms of marketing. The author presents the results of the usability evaluation of the accessibility aids under different product evaluation points of view of: the user, the expert, and the application of standards available in the literature.

Another importance of the system is the applicability of touch as additional sensory resolution to vision and audition, for cases in which the system can be added to the athletic race modality as an information transmitter and spacial location for the athlete. For every received information, the system generates data network. The same data can be used as analysis parameters and improving the user's performance, as speed analysis, initial acceleration, critical points of the athlete's performance on the track, among others.

II. METHOD

2.1. Subjects

The study is a descriptive feature with lineation case series. We conducted an experiment based on the analysis of 74 videos of official championships (Worldwide, Paralympic Games and in national and regional events) involving 67 athletes male and female, totaling 273 samples. With the purpose of identifying the impact of the use of the rope tether during the sprint, whereas in the researched bibliographies were not found, to date, researches related to the impact of the use of the rope tether in the performed tasks. The criterion for inclusion of the athlete in the study was to belong to sports classes T11 to T13 in the sprint race categories of 100, 200 and 400 meters. The description of this taxonomy is described in (IPC handbook, 2015). Data collection was made during the period of one year and five months (from August 2014 to January 2016).

The research was based on theories that explain and guide the interpretative and interactional method and symbol referring to the actions between the athletes, guides and the visually impaired, documented in a publication of the Paralympic Committee, as well the concepts of accessibility and usability.

In order to organize the descriptive statistics it was used the free software R Project for Statistical Computing to calculate average, relative and absolute frequencies. To analyze the bivariate association between independent variables and the three modes (100, 200 and 400 meters) speed racing, it was used chi-square test (X^2).

2.2. Protocol

It was chosen to adapt a usability evaluation protocol research portrayed above, which is evaluating the usability of the rope tether resource, focusing on the analysis of common access videos, as to be in the public domain and do not requires the planning of an experiment nor prior authorization of the competent authorities. The motivation for this research is at the heart of a prior assessment of whether there is a need for further research in this direction.

The usability assessment of the rope tether resource in the relation between the athlete and the sighted guide was based on the use of an existing protocol, in which were designed to evaluate the products usability. The protocol is described in (Lima et al.,2012). The artifacts inherent in the protocol have been adapted to accommodate the specificities of the evaluation of the usability of accessibility features, as described in (Lima et al.,2012). The protocol was adapted to perform the usability test to be applied on videos already available

on electronic Brazilian and International Paralympic Committee database. The device (document defined in the protocol adaptation) was used to conduct the evaluation of usability.

The usability test consisted on the execution of planned steps taken after due review of a pilot test, making the use of resources and material elaborated and aimed at collecting data. These data had as purpose to support the hypotheses verification formulated and presented in section 7 of the research and issuing an opinion on the usability of accessibility resources (rope tether/sighted guide).

Based on this protocol, an experiment was conducted in two phases: preparation and analysis. On the preparation phase, an specialist identifies who are the athletes and the sighted guides. These are evaluated by referencing the analysis of the user's profile, which are recorded the variables of gender and physical differences between guide and athlete - biotype statures (muscle mass).

The evaluation of usability methodology adopted on this research is based by a protocol that was adapted based on the rules of the International Association of Athletics Federations (IAAF,2015) and the adjustments made by the IPC - Athletics, a organ from the International Paralympic Committee, that manages and stamped international competitions and that ratifies the rules and the classification of the modality.

In the analysis phase, the specialist exam the actions executed by the athletes and their guides, considering the following analysis variables: ray invasion, attraction, athlete's boost and imbalance (both in direction and in laterality), influence of the guide in relation to the athlete's performance on the traction's effect of the rope tether that will provide probable falls, clashing of members and the guide/athlete's acceleration on the race course dimensioned for control of the accessibility features. Nesta fase todas as amostras foram analisadas por quatro especialistas and all participants worked and were observed individually. A modalidade olímpica de corrida de velocidade no atletismo é dividida em etapas (semifinal 1, seminal 2, semifinal 3, etc), desta forma cada atleta pode ter sido analisado em videos distintos.

2.3. Procedure

The rules of the modality allow the practice of sport in conditions of equality among its practitioners, without having them to obtain advantages for their equipment adjustment conditions or as a result of their disabilities.

The observance of Paralympic rules applied to a usability evaluation protocol is necessary to ensure the principle of equality between the practitioners without them to obtain advantages for their equipment adjustment condition or conditions due to their disability, as justified in (Mello and Filho, 2012) and respecting the criterion that there must have an adequate fit between the athlete/guide's arms and wrists. If the resource does not provide a better frictionless movement or shock condition, this will limit the athlete's performance in asserting the indicative disadvantages of (Conde et al., 2006) as mobility, dynamic and static balance, motor coordination and laterality.

User analysis conducted on quantitative and qualitative aspects, based on official paralympic sprints videos obtained on internet, in order to notice significant findings related to feasible situations during sprint, on the rope tether use.

It was defined an approach in order to evaluate influence or contribution of some aspects, according to Lima (2012) protocol, aiming to establish quantitative nexus (statistical) regarding sprint progress status (100, 200 e 400m).

From evaluation aspects, the following variables are considered:

Dos aspectos de avaliação indexam-se as seguintes variáveis:

V1. Sighted Guide gender (if the athlete is male or female);

V2. Visually impaired athlete gender (if the athlete is male or female);

V3. Gender equality/difference (if visually impaired athlete and sighted guide have same or different gender);

V4. Visually impaired athlete height in face of sighted guide (when it is visually perceptible that athlete's height is greater, smaller or equal to sighted guide);

V5. Visually impaired athlete biotype in face of sighted guide (when it is visually perceptible that athlete's muscle mass is greater, smaller or equal to sighted guide);

These inferences are justified according as a statistical analysis based on Chi-Square Method, which classifies the correlation degree between above aspects and sprint status.

Goal 1: Investigate the athlete's behavior regarding rope tether traction during sprint

Case 1.1. When visually impaired athlete is pulled or pushed by sighted guide.

The indicative of the occurrence of events was defined according to rules presented (IPC handbook, 2015): "the sighted guide athlete can never move more than 50 centimeters from the leading athlete, as little pull, push it or propel him".

Case 1.2. When visually impaired athlete pulls sighted guide.

This condition is directly related to the use of rope tether, since the same can provide the athlete an injury. The specifics related to this condition are: traction, lack of synchrony and the collision between the athlete and the guide.

Objetivo 2: Investigate incident impact that can occur when rope tether is used during sprint.

Case 2.1. When visually impaired athlete is disqualified

Official rule defined by (IPC handbook, 2015) in which the sprint test, "the athlete must cross the finish line ahead of his guide; in case the athlete cross at the same line or behind his guide, the athlete is declassified.".

This case concerns the condition when using the rope tether can cause overload to the athlete; in these terms, the visually impaired athlete in higher physical condition is has a better potential and a higher performance than the sighted guide. In this context, it runs in a dynamic and evolutionary way to track achievement of proof.

Objetivo 3: Investigate sprint status when rope tether is used.

Case 3.1. When sprint is not concluded successfully.

This proposition is related to the incidence of error in the use of the rope tether resource, which allowed to change the athlete's performance in the competitive environment, generating penalties, failures, disqualification and possible injury.

III. RESULTS

At first, it is shown on Table 1, a descriptive statistics regarding samples in terms of variables such as: athlete's gender according to sprint modality, considering that same athlete competes in several modalities in different official events as noted on video analysis. It was considered in this observation on Table 1 that Situation 1 refers to all athletes that participated in each sprint modality. For Situation 2, it is considered all performed sprints by these athletes (when athlete participates in more than on official event). In the *Total Race* column it was shown all sprint quantity that was performed by these athletes.

Table 1

	Situation 1		Situation 2		
	Female	Male	Female	Male	Total race
100 meter race	18	29	53	69	122
200 meter race	20	18	53	34	87
400 meter race	15	21	27	37	64

Four cases are interesting to exploration this research as shown in section 2.3. On Table 2 a descriptive statistic including average, relative and absolute frequency for each case.
Table 2

	Frequency						Média
	100 meter race	%	200 meter race	%	400 meter race	%	%
Case 1.1	45	36,8	36	36,7	24	37,5	38,4
Case 1.2	17	13,9	14	16,0	6	9,37	13,5
Case 2.1	24	19,6	15	17,2	9	14,1	17,9
Case 3.1	69	56,5	59	67,8	29	45,3	57,5

The results for bivariate analysis which comprises an association between observed cases and sprint, in face of analyzed independent variables, are described on the following table.

Table 3. Case 1.1.

Variables	100 METERS		200 METERS		400 METERS	
	X^2	*p*-value	X^2	*p*-value	X^2	*p*-value
V1	0,400	0,818	3,676	0,055*	0,651	0,722
V2	23,453	0,875	0,064	0,799	2,183	0,335
V3	11,818	0,159**	5,596	0,347	24,736	0,001*
V4	7,893	0,443	8,680	0,033*	11,761	0,162**
V5	22,015	0,165**	0,115	0,733	1,707	0,425

*p<0.06.
**p<0.17.

A significant difference on V3 it was found in case 1.1, between sprint modalities of 100 meters (X^2 = 11.818, 0<0.17) and 400 meters(X^2 = 24.736, p<0.05). V4 was noted in sprint modalities of 200 meters (X^2 = 8.680, p<0.05) and 400 meters (X^2 = 11.761,p<0.17) whilst variables V1(χ2 =3,676, 0<0.06) just for 200 meters sprints and V5(X^2 = 22,015, p<0.17) for 100 meters sprints. V2 variable was not associated with modalities.
Table 4. Case 1.2.

Variables	100 METERS		200 METERS		400 METERS	
	X^2	*p*-value	X^2	*p*-value	X^2	*p*-value
V1	0,810	0,666	0,040	0,841	0,124	0,939
V2	0,179	0,914	1,471	0,225	2,606	0,271
V3	7,099	0,525	8,948	0,111**	26,471	0,0008*
V4	6,108	0,635	3,805	0,283	5,182	0,737
V5	0,065	0,967	0,663	0,415	2,359	0,307

*p<0.06.
**p<0.12

On Table 4 it was noted that all variables do not have association with 100 meters sprints. On the other side, gender equality/difference variable did not influence in 200 meters (X^2= 8.948, p<0.12) and 400 meters (X^2 = 26.471, p<0.05) sprints.

Table 5. Case 2.1

Variables	100 METERS		200 METERS		400 METERS	
	X^2	*p*-value	X^2	*p*-value	X^2	*p*-value
V1	1,065	0,957	5,364	0,251	0,166	0,982
V2	6,534	0,257	2,797	0,592	7,642	0,054*
V3	13,342	0,862	8,775	0,985	30,870	0,002*
V4	13,943	0,833	8,075	0,779	13,690	0,320
V5	5,496	0,358	4,894	0,298	7,165	0,066*

*p<0.07

In a failure occurrence viewpoint, a prevalence was noted specially on 400 meters sprints when it comes gender athlete variable (X2=7.642,p<0.07), gender equality/difference and athlete's biotype (X2=30.870,p<0.07), described on Table 5.

Table 6. Case 3.1

Variables	100 METERS		200 METERS		400 METERS	
	X^2	*p*-value	X^2	*p*-value	X^2	*p*-value
V1	0,496	0,973	3,730	0,443	0,841	0,839
V2	9,335	0,053**	5,642	0,227	8,731	0,033*
V3	15,765	0,469	15,058	0,773	17,082	0,146**
V4	16,421	0,423	12,871	0,378	18,059	0,113**
V5	8,846	0,065**	9,528	0,049*	8,116	0,043*

*p<0.05

**p<0.15

On Table 6, athlete's gender and biotype variables interfere in both sprints, whilst gender equality/difference (X2 = 17.082, p<0.15) and athlete's height (X2= 18.059, p< 0.15) just interfere on 400 meters sprints.

IV. DISCUSSION

In this section are presented some considerations about the obtained results. Com base nos dados apresentadas nas tabelas faz-se as seguintes inferências:

1. In a perspective of descriptive statistical as a first approach analysis, it is notable in case 1.1, averages related to 100, 200 e 400 meters sprints vary approximatelly between 36% e 38% in cases in visually impaired athlete is pulled or pushed by the sighted guide. In these cases may have an occurrence of events which might cause injuries for the athletes (visually impaired and guide). This is a relevant fact because the rope tether relation as a tool of accessibility, the sighted guide athlete can injure athelete on attempt to help him/her to win the sprint or take some advantage. This result has a direct impact in the development and research in assistive technologies, inasmuch as fractures chance can be improved by the visually impaired dependence to sighted guide. This fact can be avoided using equipments that enables visually impaired athlete his own independence and security. Within a sporty athletic form specifies, as the Paralympics, the athlete's autonomy and Independence should be safeguarded. For exemplification purposes, it is the 3:03 min of evidence observed in the video (Youtube, 2016 April 11), the athlete Jia Juntingxian is driven by the sighted guide near the finish line at the moment his guide loses its motor control, which visually observed its imbalance followed by your motor recovery. In the event of an injury, such as falling, the athlete suffered consequences on their race. Another example that worth mentioning is the athlete José Armando, at 1:15 min of evidence observed in the video (Youtube, May 09 2016) note that the fitness guide and athlete with accessibility features, ie spacing between the upper limbs, caused the clash between them. Consequently there was a different performance between the athlete and the guide, causing imbalance and athlete's commitment to recover his posture.

2. In case 1.2 (when the athlete is pulled by the guide) the average on all the modalities is relatively low, varying between 13% and 16%, but this result means a strong impact in the New Technological Products Engineering, seeing that there are cases where the athlete has a better physical preparation than the guide, the impossibility to continue the sprint and failures (lost chance to win or even tough do not conclude the sprint).
The athlete Daniel Silva at 1:05 min of proof (Youtube, 2016 May 09), experienced an occurrence related to a synchronization lack between him and the guide, arrested by rope tether. It is clearly noted the burden that the athlete suffers for his guide, limiting it by the speed reducing, compromising their motor coordination and the interaction between them. In a second instance, the athlete Xavier Porras to 2:33 min of proof (Youtube, 2015 September 14) undergoes changes in its performance during the route, caused by your guide fails to track their performance and break the accessibility features of the link to the same as biomechanical results in losses in the athlete's motion and disorientation performance indices of athletes to the finish line. In this way, we can highlight another aggravating regarding autonomy and the athlete's independence dynamic as the driving conditioning was broken, compromising the rationality of the race in such cases, new technologies could not only enable independence to the athlete but ability to overcome their physical limits examples of records. Proves the need to rethink the rope tether use.

3. In the case 2.1, when there is athete’s disqualification, the occurrence average for analyzed modalities is between 17% and 20%. This indicative is relevant, considering an official sprint, these errors must be minimized to the maximum, mainly when there is rope tether interference that can injury the athlete in the following situations which are according to Paralympic Committee Rules: false start, athlete fall, streak invasion and when sighted guide cross finish line at the same time or front of the athlete. An disqualification example by false start occurred to Timothee Adolphe (on 02:40 min of a video (Youtube, 2016 January 12)). The sighted guide burnt race start causing disqualification in the event finals. The rope tether failure impacts negatively, weakening confidence, security, independence e depreciating the athlete’s image while visually impaired athlete.On Youtube video at 04:02 min, it was noted an extremely serious situation, when the athlete Gerard Desgarrega hindered sighted guide slowdown, in opposite of Paralympic Committee recommendation: “visually impaired athlete must cross finish line always being in front of the guide; if this athlete cross the finish line together or behind the guide, he/she will be disqualified”. If these failure hadn’t occurred the athlete would have won the gold medal on 400 meters sprint.

4. In Case 3.1, it was observed errors occurrence on rope tether use during sprint events such as: faults, flunk, disqualification and eventual injuries. The average of these occurrences for the analyzed modalities is between 45%-68%. This result is extremely negative for sprint events, acting as a limiter including, considering Paralympic is a social inclusion event. As an example, Lucas Prado's sprint video at 00:17min

(Youtube, 2016 June 10), fall off because bad movement conduction caused by the rope tether, impeding conclusion of final sprint in Paralympic. A similar experience occurred with the athlete Elvina Vidot's sprint video at 03:38min (Youtube, 2016 June 11). At the time to finish the sprint and win gold medal, she fell off, due to sincronization lack between the visually impaired and sighted guide athlete. This kind of error wouldn't have happened if if there was a technology to get the athlete independent from rope tether.

The results reported on Tables 3, 4, 5 e 6 which is considered variables related to athlete's profile like visually impaired and sighted guide gender, gender difference between visually impaired and sighted guide, height difference between visually impaired and sighted guide, as well as the biotype, are considered in section 2.3.

In this acceptation, considering significance fator of 0,05, it is possible to infer that there is a greater correlation in terms of association between variables and the cases 1.1, 1.2, 2.1 e 3.1 of 400m sprints, with an observation in V2, V3, V4 and V5 variables. On 200m sprints, an observation in V1, V4 variables was noted and no one on 100m sprints.

In a greater error perspective, considering significance fator of 0,16 it's noted na additional association on 200m sprints with an observation on V3 variable. On 100m sprints it was noted association with and observation on V3 e V5 variables.
This fact can be explained by the condition that the greater the distance race (400m), more rope tether interference can mean a loss mechanism for visually impaired athlete in the sprint execution.
It is also observed that considering both significance factors of (0.05 and 0.16) covered in this research, the predominant variable in terms of association is V3 related to gender difference between visually impaired and sighted guide, occurring association on six separated occasions case, specifically in the case 1.1 in the tests of 100 and 400m, case 1.2 in the tests of 200 and 400m, case2.1 and 3.1 in the test of 400. Followed by V5 variable which has 5 associations for the case 1.1 the proof of 100m, in the case 2.1 in 400m race, in the case 3.1 in the test of 100m, 200m and 400m; and subsequent to V4 variable that has three associations for the case 1.1 in the tests of 200 and 400 meters and 3.1 if the test 400. The V1 variable has only one association for the case 1.1 in the 200m sprint, the V2 variable has two associations for cases 2.1 and 3.1 both in the 400m sprint. According to these results, it can be stated that the rope tether use has a direct impacto on sprint execution, mainly when there is gender difference between visually impaired and sighted guide, biotype and height difference.
The results reported can contribute to Engineering, specially in New Sporting Products. Another contribution can be noted, for Paralympic Sports in order to evaluate diferences between visually impaired and sighted guide. Facts like these are considered really important for sprint can be executed succesfully by visually impaired athletes.

4.1. Implications of the study

The products usability evalution is an important area of Engineering, because researches in this approach can contribute for new products development as well as existing product project. As a contribution in this area, the research focus on Product accessibility that can be expressed through its usability level as perceived by all its potential users.
At first glance the accessibility concept appears to contrast with that of usability which precepts the efficacy, efficiency and satisfaction of a user with specific goals for a specific task context ISO 9241-11 (ISO, 1997), however, according the ISO 9241-171 (2008), the accessibility is related to usability of product, service, environment or facility by people whit the widest range of capabilities. The concept of accessibility addresses

the full range of user capabilities and is not limited to users who are formally recognized as having a disability. The ISO 9241-171 (2008) also notes that usability-orientated concept of accessibility aims to achieve levels of effectiveness, efficiency and satisfaction that are as high as possible considering the specified context of use, while paying particular attention to the full range of capabilities within the user population.

Another important thing do consider is on the fact that accessibility describes the most important aspects of the user´s ability to accomplish task. Accessibility is not a single or multi-dimensional measure for characterizing the attributes of an interactive system (typically seen as a product or as a delivered service), but a concept that relates to the interaction between the user and product or service, expressed in terms of the achievement of task goals. This means that produces, organization users and end-users have to take responsibility for defining the purposes of the interactive system in question (mostly expressed in terms of tasks or groups of tasks, and their associated goals), and to agree on the design objectives expressed in terms of accessibility. In some cases, legislative requirements will provide the framework in which both task goals and accessibility targets are set (ISO 9241-171).

The change impact in paralympic athletics must be accompanied by research to contribute socially and inclusion of new technologies that are tied to the use of science in the performance of athletes.

As the rope tether accessibility features is directly related to touch and despite the results that there is occurrence of serious flaws in the use of this device, but is a mechanism that ensures touch is a reliable mechanism for communication and learning. In this sense, the new technological resources that can guarantee the independence of visually impaired people in the scene of major athletic competitions or even in training and social inclusion should consider touch as modern communication mechanism, ie, use of appropriate tactile terminals.

Another indication of this statement is proven by the authors (Qian et al, 2011;. Kuber et al, 2010;. Zhu et al, 201;. Copeland et al, 2010;. Khatchatourov et al, 2009;. Visell, 2008; Ishizuka et al, 2015;. Gual et al, 2015;.. Baima et al, 2016) that attest to feel like an efficient communication mechanism with the use of haptic interfaces is the use of tactile or electro tactile terminals.

The Technological Innovation Center Nilton Lins in partnership with the Faculty of Technology at Nilton Lins University developed a new assistive product in the hope that blind athletes can have autonomy in sprints. This product has already been registered with the innovation requirements, embodied in two patents and brings impact on the market and in society with the development of assistive technology, which is worth quoting: The benefits and advantages of validated product will mean for athletes: Feasibility social inclusion in sport; ability to increase performance; ease and simplification of participation in athletics mode; possibility of using an athletics track pattern with eight rays, rather than limit the activity execution only four athletes in order to mimic the guide, and consequently the cost reduction in infrastructure; standardization of track information for all athletes obtained in real time.

This study provides an impact not only new assistive products on Engineering to highlight the failures in current rope tetheruse and it should be a reference tool to the scientific community and the general community to draw attention on the need to develop new research on the use of new materials and technology applied to sports, mainly to Paralimpico sport, where the man with physical restrictions overcome these problems for the sport.

Given that the computing environment prevails in ordinary, intellectual, social, cultural and communication activities, many resources have been made available to promote accessibility for the blind by sensory substitution such as screen readers, tactile interfaces using Braille and voice interfaces. But there is no references in the researched literature until this date an experiment that correlates efficiency variables of a widely used resource in sports like the rope and the need to propose technological solutions to minimize negative interference that the sighted guide can promote the conduct of the visually impaired athlete.

The results presented are of a social nature, arouses interest not only nationally, but also internationally in the process of social inclusion in sport is also one of the government's goals in almost all human aspects. The impact on education is directly linked to the training of the athletes who will be with the use of technology, so that the technology described herein is for the paralympic athletics as well as the Braille method is in the process of reading and writing.

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