








Development and Design of an Evaluation Interface for Taekwondo Athletes: First Insights

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Abstract. This paper focuses on the first research phase of the development and analysis of a support interface for Taekwondo athletes. This study aims to solve the existing gap in the time of analysis and feedback from the coach to the athlete. Through the creation of a platform supported by a system based on deep learning, it is intended to design a user interface that promotes the physical and theoretical development of the various athletes of this sport. Therefore, it became fundamental to perform the analysis of standard structures in which statistics and data concerning the athlete are often presented in a digital context. The first research phase consisted of analyzing content related to the importance of design and data structuring in sports. Consequently, the study and evaluation of similar applications began to understand the various tools and graphical user interfaces used to enhance and stimulate the performance of athletes. Since there is not a great diversity of applications inherent to Taekwondo, the research was extended to platforms of other sports categories, namely: Fitbit, HomeCourt and Strava. Based on the study undertaken there were identified relevant needs that trigger the necessity of development of a specific platform for Taekwondo athletes.

Keywords: Design process · UI/UX design · Taekwondo

1 Introduction

In the last years, the number of Taekwondo practitioners in Portugal has registered a continuous increase presenting in 2020 an increment of more than a thousand federated athletes [1]. This martial art, traditional from Korea, emerged in the 20th century and resulted from the combination of techniques from other disciplines such as Kung Fu and Karate.

In Taekwondo the development of technological solutions to support athletes' training and performance has been practically nonexistent. Data and evaluations are performed manually, which results in several limitations, namely:

- Inaccurate and low-fidelity performance evaluations;
- Delay in identifying difficulties experienced by the athlete;
- Difficulty in clarifying errors;
- and, slowdown in the athlete's evolution and progress.

Thus, this study aims to respond to this gap through the development of an interactive digital platform, where the coach and the athlete can monitor and analyze, in real time, a set of relevant data for the evaluation of the athlete, specifically force, speed and acceleration. In this context, it is possible to promote the theoretical and practical learning of Taekwondo, based on the access to information such as the values of the force applied in the strikes, the calculation of acceleration and speed of the movements performed. In this way, the creation of an appealing and objective interface is relevant, with the intention of reducing the athlete's analysis time and, simultaneously, contribute to the progressive performance of the athlete. The objective of the solution to be developed is that users, whether they are high competition athletes or beginners, can easily understand the structures and techniques of the sport.

This project is integrated in a work team whose focus is the development of the technological and design components. The elaboration of a system in which the basis is deep learning enables the access to information concerning the athlete's behavior. This technology analyzes the data in a similar way to what happens in the neural networks of the human brain. It is a method that drives autonomous learning on different devices by constantly processing data. Automating performance enables the ability to respond quickly to numerous adversities, such as perfecting positions characteristic of Taekwondo.

In short, with this study we pretend to develop an ergonomic solution, where all the components show their potential in contributing to the athlete's performance. With the help of methodologies focused on the optimization of the user's experience and in the objective analysis regarding the user's performance, we aim to consolidate the compatibility between new technologies and Taekwondo.

This paper is organized in 5 sections. Section 2 presents a description of the digital media in the Taekwondo; Sect. 3 presents the state of art of the main areas covered in this project; Sect. 4 details a benchmarking of available platforms dedicated to sports; and, Sect. 5 enunciates the main conclusions and suggestions of future development.

2 The Digital Media in Taekwondo

2.1 The Taekwondo Sport

Taekwondo is a combat sport originated in Korea. The word Taekwondo comes from the junction of three words: Tae, which means feet; Kwon, a term that symbolizes hands; and, finally, Do, which means path. The combination of these three words gives origin to the expression: the path of the feet and hands through the spirit. In summary, this sport is a combat technique where the objective is self-defense through the total use of the body and without the use of weapons. From the use of fists to foot movements its main differentiating factor from the others combat sports is the privileged use of the legs and the conjunction of kicking movements.

Taekwondo is a sport where the athletes' muscles are trained and exercised for long periods with a high level of intensity. Although Taekwondo has a vast number of practitioners in Portugal, the evaluation's methods of the athletes' activity and performance are essentially manual and rudimentary.

Therefore, the feedback process - a way to evaluate a certain action - from the coach to the athlete ends up not having the necessary speed and efficiency, which could be obtained with the support of technological means [2].

2.2 The Digital Influence in Sports

When feedback is presented and structured in the right way and at the right time, it plays a decisive role in the evolution of athletes. Several research led by authors such as Mike Hughes, have revealed that the more quantitative and pragmatic the feedback is, the greater the athlete's performance will be [3].

Currently, the adoption of technology in sports is increasingly recurring. Heart rate and running speed are just some of the values monitored by technological systems. The purpose is the acquisition of relevant data and statistics that later allow the coach or user to evaluate this information and based on it provide more accurate and consistent real-time feedback. This type of analysis covers a wide range of information: from strengths to weaknesses; assessment of unnecessary movements; speed; accuracy; and, strength levels. Through this type of knowledge it is possible to create individual and personalized workouts for each athlete considering their individual needs. In this perspective, one of the coaches' main objectives is to obtain as much information from the athletes as possible to make an effective evaluation. However, the vast amount of information, relative to the athletes' times and movements, requires technical support, so that it can later be consulted and analyzed. Thus, to meet this need, the concept of performance analysis, also known as performance notational analysis, was created for a better evaluation and more detailed observation of the various athletes. In other words, it is where a system, through advanced technologies such as artificial intelligence or deep learning, evaluates the numerous characteristics of athletes to produce specific and vital data about them [4]. In this way, according to a study conducted by Sports Tech Tokyo [5], which includes more than 30 countries (Fig. 1), we can observe that the "Training/Performance" category contains the highest overall percentage: 16.4%. The emergence of innovative strategies in sports with the use of technology has led to greater demand for athlete analysis platforms by coaches and athletes.

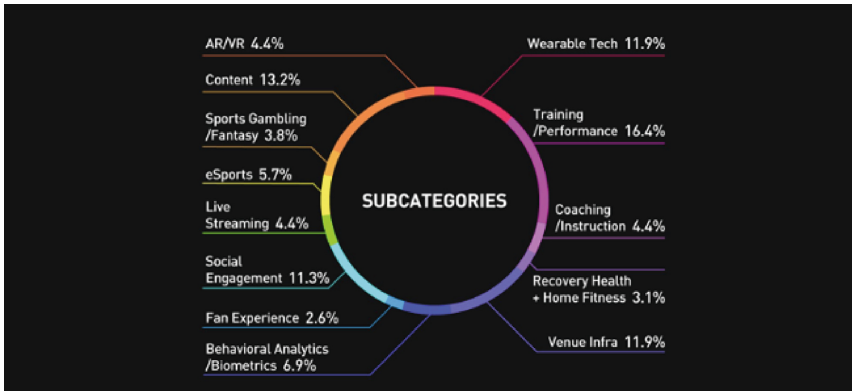


Fig. 1. Promising technologies in sports [5].

The determination to progress and display ever better performance results in a constant search for both current evaluation and analysis methods and new ways of training. Several systems of feedback between athletes and coaches are being studied with the premise that the adoption of these methodologies will contribute to a better performance be it of a team or of an individual athlete [6].

Briefly, the goal of the technologies is to record in detail the user's entire performance. New perspectives are portrayed, all information can be saved and consulted later. In this way, new knowledge is acquired, allowing a faster and more effective development of the athlete's performance.

3 State of the Art

3.1 Data Design and Structuring in Sports

The Importance of Data Visualization. Data and statistics assume a high importance in supporting the definition of strategies and exercises in martial arts [7]. In the case of Taekwondo, the relevant information focuses essentially on the speed, strength and acceleration of the athletes. However, to obtain this data, it is necessary to resort to a precise analysis of certain movements characteristic of this sport, such as the execution of a Miryio Tchagui: a kick used to push the opponent away.

For the athlete and the coach to understand the information about speed and strength, in the different phases of the movement for the execution of a Miryio Tchagui, it must be presented in a clear and objective way, for a correct and enlightening reading by the users. And this is a fundamental topic of Design, in guaranteeing the translation of the different data into a graphic solution that allows a simple and effective reading of the information. A data structuring is considered effective when it organizes all the information in a way that our brain can understand and our eyes can identify the different components. Stephen Few [8] has defined some effectiveness criteria to analyze to what extent the data presentation corresponds correctly to human perception. First, it is necessary to understand if it clearly indicates the type of content being presented. Then it is necessary

to pay attention to whether it represents the elements and their values accurately. The next step is observing if the user can quickly evaluate the differences between the different elements. The structuring of the data should be segmented in a logical order. And finally, the criterion of showing how the information should be used [8]. Few [8] also argues that one should always judge the competence of data visualization considering some factors such as ease, efficiency, and accuracy of information since the change of balance between perception and cognition are the premises for acquiring good results.

The orientation and hierarchy of information is important because of the speed of perception: the action of seeing something. While this action is something almost immediate and often used to evaluate and perceive different data; on the other hand, cognition is much less efficient and slow. That is, using visual properties, such as colors, different typographic styles and different patterns, it becomes possible to perceive content and information faster and without the use of conscious thought [8, 9].

As far as the science of human perception is concerned, one of the first contributions made to this study was Max Wertheimer's "Experimentelle Studien über das Sehen von Bewegung" in 1912 [10]. The main goal was to understand what kind of patterns are created when humans observe something specific, later resulting in the well-known Gestalt Principles.

The Gestalt Principles. The way users view and interact with a digital solution should be a simple and intuitive procedure. The more elementary it is for the user to perform the various functionalities to achieve his or her goal the greater the motivation for further exploration of the product or service. Gestalt principles are not entirely concerned with people. The goal is to create dynamics that apply to all users involved in a given action [11].

Gestalt principles were developed by German psychologists Kurt Koffka, Wolfgang Kohler and Max Wertheimer in the 20th century during a study of cognitive psychology [10]. The word "Gestalt" derives from German and means "form." This theory essentially consists of a set of rules that express how the human being, more specifically the human mind, reacts in the face of data captured in the real world. These principles consider that when a visual stimulus appears in our brain it gets a set of different and varied signals, eventually grouping all those it considers similar. That is, at first, we perceive the object in its entirety and then we perceive its details [10]. In this sense, even if unconsciously, Gestalt principles are constantly present in various aspects of everyday life, from the way we interpret posters on the street to the way we combine different types of clothing in everyday life. This study, which analyzes the laws of perception based on the data that the human being acquires from the real world, proves to be relevant when it comes to UX (user experience) and UI (user interface) Design, since these are principles that influence the perception that users have when facing an interface.

Therefore, the Gestalt principles (Fig. 2) state that nearby objects appear to be more related than more distant objects - Proximity. However, when objects appear similar, the tendency is to deduce that they have the same function - Similarity. Therefore, it is scientifically proven that human beings not only tend to put symmetrical objects together - Symmetry -, but also group, as a rule, the first four points of a set (such as a row instead of a column) - Enclosure. Furthermore, elements that are arranged in a straight line or curve are easily perceived as correlated to each other - Continuity. Moreover, when we observe a set of complex elements, we tend to establish a recognizable pattern between

them - Closure -, since humans can only focus on a single plane: the foreground or background - Figure & Ground. And finally, “Connectedness”, the principle that argues that there is a tendency to see connected elements as being of the same category [10].

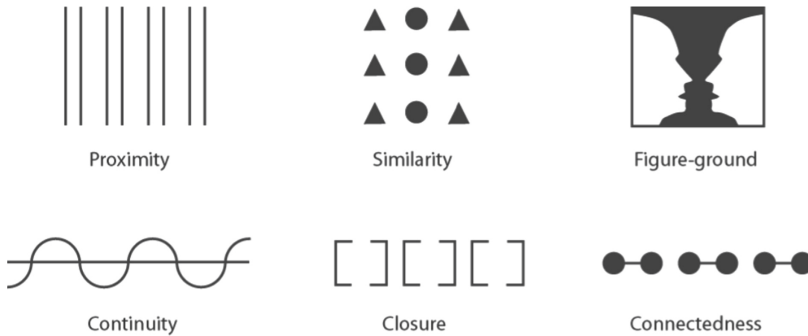


Fig. 2. The gestalt principles: proximity, similarity, figure-ground, continuity, closure and connectedness [12].

Thus, these principles show themselves relevant when it comes to Taekwondo and the perception of information and association of content. Several studies have already proven that a poor understanding of the exact position in which a technique should be executed can lead to a decrease in speed or performance of athletes [13].

However, this methodology also correlates with UX and UI Design. Nowadays, users evaluate a website in a short period of time which leads to the fact that the first impact of the user interface must be good and intuitive. This is because this first impact with the website supports the decision to continue browsing or close the browser window. In this way, a positive first moment can lead to the following impressions also being positive [14]. For example, the first principle - Proximity - is represented in filling the digital fields, where we regularly find the designation close to the space reserved for completing the information. The same happens with the second principle - Similarity - because in the case of forms, sometimes the fields and buttons are similar, but the fact that the button has a different color shows the user that it is a different component. However, not only design, but also gamification, an area focused on game development, often uses these principles. Since games are activities that make use of our mental capacity and quick thinking, we are constantly forced to assimilate sets of elements and extract visual or theoretical information from that interpretation.

3.2 Gamification

The premise of gamification is not only to understand what experience we want to pass to the user, but also to identify the type of content, elements and mechanisms that will be necessary to create this approach [15].

Currently, there is an attempt to understand and develop new ways to attract customers, with gamification emerging as a result. This area focuses on the use of elements

and mechanisms divergent from games, whose main purpose is to contribute and encourage users to achieve one or more goals. The use of these methods aims to transform complex issues into more perceptible and easy-to-understand topics. They act as a stimulus to arouse interest and, at the same time, enhance creativity and imagination.

Gamification methodology, according to Yu Kai Chou [15], is subdivided into eight categories: Octalysis (Fig. 3). This structure is supported by 8 Core Drives and was developed with the purpose of identifying the basic psychology of human motivation and how it operates. Games are fun because they activate specific motivations within each individual, which make them want to repeat the experience. Although not all Core Drives need to be present in a single action, at least one of these categories should be evident. Each Drive has a different nature, from emotions, such as obsession and power, to feelings such as creativity and personal fulfillment [15].

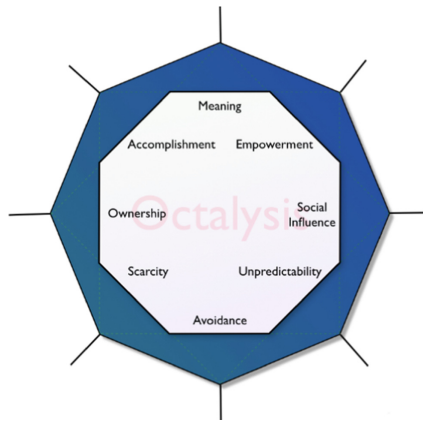


Fig. 3. Octalysis [15]

In this way, the most relevant Core Drives for the present study were analyzed. Firstly, Accomplishment, whose focus is personal achievement, that is, the main motivation comes from the user himself to progress and develop his skills (the will to overcome the imposed challenges). This category is generally intertwined with rewards and rankings where the player can visualize his constant progress. Next, the core that includes all social components: Social Influence. In this Core Drive, content that recalls childhood memories, as an example, ends up encouraging and arousing interest to participate or compete in something. Nevertheless, the seventh Core Drive, Unpredictability, is driven by the unknown factor, the curiosity to find out what the next challenges are. The user is curious about something, which leads them to think about it several times throughout its day. And finally, the eighth, and last Core Drive, Avoidance, where the focus is on the motivation to avoid certain actions that could cause further damage in the future - as is the example of games that force the player to do daily missions to earn points.

Gamification is increasingly used in design, since by understanding and identifying the Core Drive in which the target audience fits, it is possible to solve numerous issues related to UX. Thus, it allows to analyze, in detail, not only the best mechanisms to use,

but also the type of motivation that attracts users. In summary, both gamification and design have the same goal: to make the user experience as pleasant and engaging as possible.

3.3 UI/UX Design

UX and UI are two distinct but complementary areas. UX Design embraces the entire spectrum of user experience, also evaluating factors such as usability and utility. While UI Design is the way in which this same experience is achieved, being the junction of various types of elements and components, such as menus, search fields, videos, and images. Therefore, UX is the process that covers the entire user journey on a specific platform - from analysis of the various user behaviors to the elaboration of various scenarios and flows. This process is fundamental to ensure a user-friendly experience in the use of an online platform. UX Design consists, in essence, in identifying problems and difficulties of the user, to improve and optimize the operation, ensuring in the same way the quality of the interface. The primary objective is to meet the particularities and needs of the user, since each small interaction with the platform will have a different type of experience associated with it. This is an extremely important issue, since sometimes that experience and interaction are mostly fragments of our memory, which may or may not correspond to the total reality [16].

The first contact of the user with the platform is crucial, since in that very instant an initial perception is created, which evolves successively the greater the proximity or use of it. Thus, seven essential factors for creating a good user experience have been established, namely: valuable, useful, accessible, usable, desirable, credible, valuable, purposeful, and easy to identify. In other words, there must be a balance between these numerous areas to create the best possible experience [17].

The UI is the process that allows the user to control a device, software or application, and this management can be performed through menus, buttons or any other type of functionality that provides interaction between the user and the device in question. In other words, it is based on the improvement and optimization of interactive systems that allow fewer problems and errors affecting the user [18].

Accordingly, Dan Saffer [19] established five elements - motion, space, time, appearance, and sound - as the infrastructure of interaction design. Although it is not necessary to use all these elements together, at least one of these components must be present. This way, a connection will be created, even if unconsciously, between the designed interface and the user, developing in consequence an emotional connection that will benefit both, brand/product, and consumer.

UI Design is then responsible for developing a product, anticipating obstacles, and making sure that the interface has usable elements that allow the user to achieve his goal in the fastest and most effective way. This process requires continual refinement in terms of design, based on usability testing.

In the past only technology experts used computers. Thus, in the 1980s the term usability emerged to replace the term ease of use. Therefore, within the scope of evaluating the ease of interaction and understanding of a platform, this term emerged and was portrayed as a hemisphere represented by the human being and the system. That is, an area that analyzes whether the interface provides the user with a pleasant and easy

way to interact without having to engage in complex processes that result in a negative experience [20].

3.4 Usability Heuristics

Jacob Nielsen [21] developed some general rules that became known as heuristic evaluation. Nielsen's heuristics, a set of principles developed with the goal of optimizing various usability-related issues, act to promote an efficient experience. Usability heuristics are generally applicable to any type of device. Using these principles, it is possible to evaluate and develop an interface quickly, collecting large amounts of information regarding the needs of the interface [21]. Although they do not replace usability testing, these parameters make it possible to create a platform with a smaller number of errors and premature adversities. The application of these rules proves to be a fundamental procedure in the development of a digital solution allowing users to navigate the platform in an intuitive way. In this context, the following heuristics were relevant in this study and were later applied in the benchmarking analysis following the collection and comparison of data on competing platforms.

Based on the principle that all information and content should be arranged logically and cohesively to be easily understood by the user, the heuristic "Match between system and the real world" arises. In these situations, it is evaluated whether concepts are being used that are familiar to the user rather than complex and confusing terms. Thus, it will be simpler for users to learn how the interface works. On the other hand, the "User control and freedom" heuristic states that the user should be given control over the system they are using. Therefore, a user may select the button to delete some content in an unintended movement. This type of action should always coexist with a confirmation notification or the ability to reverse the action. However, it is necessary to understand which elements of the interface can have a negative character resulting in future inconvenience to the user: "Error Prevention". The designer must foresee which buttons or content may mislead the user. The interaction process between the user and the interface must be facilitated guided by the main aspects of the system: "Aesthetic and minimalist design". Interfaces, as a rule, should only contain information relevant to the user or give greater prominence to the main content [21].

Through these principles it is possible to develop more comprehensive interfaces focused on usability and the user. The goal is to prevent the user from feeling lost in the designed interface, since the user's path should be fluid and immediate with no gaps or deviations from the destination [22].

4 Benchmarking: Digital Platforms in the Sports Category

Benchmarking is a procedure where the main competitors are analyzed with the purpose of gathering information that describes the user experience in the time of use of the platform in question. By performing this analysis one can more easily establish benchmarks for future improvements. The purpose of this strategy is to compare the various platforms to outline which functionalities and features should be incorporated or developed to better meet the user's needs.

Nowadays, there are several platforms that work as a complement to the athletes' training, helping them to develop faster and more efficiently. Nonetheless, in Taekwondo, no similar platforms have been developed. Therefore, platforms from other sports were analyzed, such as Fitbit, HomeCourt and Strava (Fig. 4).



Fig. 4. Platforms: FitBit, HomeCourt and Strava [23–25]

These are applications used by brands and reference athletes, such as the NBA - National Basketball Association - one of the most important basketball leagues worldwide. Later and with the purpose of gathering information about digital methods developed for Taekwondo practitioners, the applications Mastering Taekwondo, Taekwondo Trainer, Dojanga and Taekwondo WTF (Fig. 5) were also considered, which despite not evaluating the athlete in real time, are platforms whose purpose is the learning and training of this martial art. Following this, a comparative analysis was prepared to analyze the functionalities of platforms for athletes.

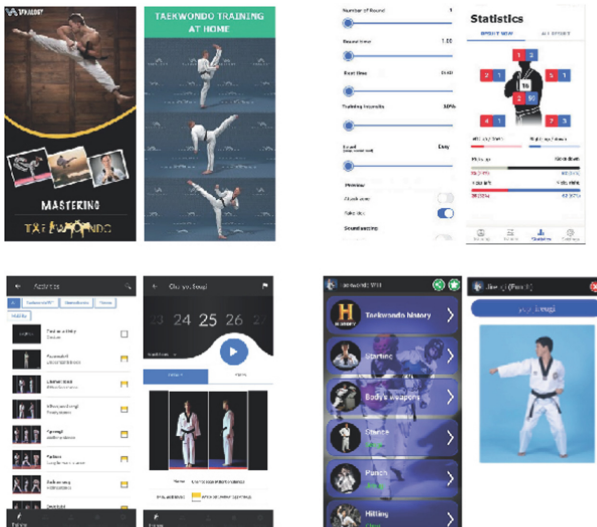


Fig. 5. Platforms: Mastering Taekwondo, Taekwondo Trainer, Dojanga and Taekwondo WTF [26–29]

In Table 1 and Table 2 are evaluated relevant issues such as the versatility of platform use in various devices, the way the training and exercises are presented to users and an analysis based on usability heuristics.

Table 1. Comparative analysis of functionality of platforms for athletes.

Platforms	Fitbit	Homecourt	Strava	Taekwondo trainer	Mastering taekwondo	Dojanga	Taekwondo WTF
Desktop	x	x	x				
Mobile	x	x	x	x	x	x	x
Login/Logout	x	x	x			x	
Different types of users					x		
Training	x	x	x	x	x	x	x
Training videos/Animations	x	x			x	x	x
Monitoring (Data and Statistics)	x	x	x	x			
Challenges/Events	x	x	x				
Extra Services	x						x
News Feed (from other users)	x	x	x			x	
Notifications	x	x	x	x	x	x	x
Camera's function utilization	x	x	x				

Table 2. Comparative analysis based on the heuristics studied

Platforms	Fitbit	Homecourt	Strava	Taekwondo Trainer	Mastering taekwondo	Dojanga	Taekwondo WTF
Match between system and the real world	x	x	x	x	x	x	x
User control and freedom	x	x	x	x	x	x	x
Error prevention	x	x	x		x		
Aesthetic and minimalist design	x	x	x			x	x

Regarding the platforms analyzed, it is noted that only three - Fitbit, HomeCourt and Strava - offer the athlete the versatility to be used in various types of devices, such as desktop, tablet, mobile and smartwatches. Although these platforms display a complete and more organized interface in terms of content, Mastering Taekwondo (the most indigent and devoid of content application of the interfaces present) ends up differentiating itself from the others, presenting a feature that the others do not have: the distinction between users. This interface was designed so that users can train and perform exercises according to their level of experience. This type of function provides users with continuous progress according to their current ability, distinguishing between beginners and seniors. Even without the profile feature, there is a wide range of pre-defined workouts according to the color of the user's belt (level of expertise).

The development of goals and challenges can be observed in the first three platforms, which demonstrates an active strategy of loyalty to its users, thus motivating them to use the interface regularly. One of the common points between all the platforms is the sending of notifications to remind users of training schedules or the occurrence of some momentary event. The clear backgrounds are a predominant factor in all platforms, highlighting the use of contrasting bright colors, such as oranges and blues, showing simultaneously the concern in the perception of information and clarity in reading. Following this and according to the effectiveness criteria defined by Stephen Few [8], regarding the presentation of data, it can be observed that the four platforms that monitor the athletes' data follow all the basic rules.

From the identification of the character of the information to the ease in identifying the order and classification of the values, all interfaces present a functional and direct data structuring. Thus, it becomes clear how essential it is for the athlete to have a quick perception of the various information relating to training. A small detail that makes it difficult to understand a specific value can complicate the whole exercise for the user, since a poor interpretation of the results will influence the athlete's future performance in the long term.

5 Conclusion

The inclusion of technology in sports is a fundamental procedure for the physical and mental development of athletes. The perception of the main adversities of Taekwondo was crucial in this phase of the project development, as well as the understanding of the relevance of design in the presentation and organization of relevant information. The correct digitalization and hierarchy of information allows athletes to explore new ways of improving their performance. Thereby it was necessary to explore interfaces allusive to other sports. With a perspective centered on user analysis and evaluation, examples like FitBit, HomeCourt, Strava, Taekwondo Trainer, Mastering Taekwondo, Dojanga and Taekwondo WTF were considered. Thus, through the study of complementary platforms to athletes' training (using technologies such as computer vision) the global panorama of the state of the art, benchmarking research and the main objectives of the interface were defined.

As a conclusion, the purpose of this first stage of the project was to explore the potential of technology in combination with design to optimize and develop the performance of Taekwondo athletes. Thus, the following needs were identified in relation to Taekwondo and its technological means:

- non-existence of evaluation systems for the athletes;
- absence of a database to store information related to the athletes' training;
- lack of organization regarding the learning content of the different techniques of the sport.

The next step will be to develop a solution that matches the needs of different users. To this end, personas focused on potential users will be developed, as well as the structuring of the information architecture to hierarchize the relevant information. Subsequently, usability tests will be developed to validate the prototype.

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