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Original

ANÁLISIS DE LOS FACTORES EXPLICATIVOS DEL USO DE TECNOLOGÍAS DISRUPTIVAS DE COMPETICIÓN POR ATLETAS AFICIONADOS CON EL MODELO UTAUT. EL CASO DE LAS ZAPATILLAS VAPORFLY

WHY DISRUPTIVE SPORT COMPETITION TECHNOLOGIES ARE USED BY AMATEUR ATHLETES? AN ANALYSIS OF VAPORFLY SHOES WITH AN UTAUT MODEL

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RESUMEN

Objetivos: La tecnología Vaporfly (TVF) ha supuesto una disrupción en las zapatillas de fondo en ruta. La literatura sugiere que VFT mejora el rendimiento, al menos, en atletas de élite y sub-élite. Este artículo evalúa los factores que influyen en la aceptación esta tecnología por parte de deportistas aficionados.

Material y métodos: Analizamos una encuesta a 252 deportistas aficionados españoles (214 hombres y 38 mujeres). Nuestra investigación utiliza la Teoría Unificada de Aceptación y Uso de Tecnología (UTAUT), a la que añadimos el juicio moral y los ingresos del atleta como variables explicativas de la aceptación.

Resultados: El modelo explicativo propuesto explica la mitad de la intención de uso (UI) de la TVF en todas las regresiones. El modelo de ecuaciones estructurales señala que los factores que influyen significativamente en la UI son la facilidad de uso, cuyo coeficiente de incidencia (ci) es 0.467 ($p<0.01$), la expectativa de rendimiento (ci=0.203, $p<0.05$), el juicio ético (ci=0.298, $p<0.01$) y el nivel de ingresos del atleta (ci=0.123, $p<0.01$). Sorprendentemente, la influencia social muestra una incidencia no significativa en IU. Las regresiones de Poisson arrojan resultados similares.

Discusión: Este artículo combina el modelo de comportamiento del consumidor como UTAUT y la dimensión de equidad moral de una escala ética para explicar la intención de utilizar TVF. La metodología propuesta se puede utilizar para evaluar tecnologías disruptivas de competición en cualquier otro deporte.

Conclusiones: Como esperábamos y también lo ha demostrado la literatura revisada relacionada con la tecnología deportiva el modelo UTAUT se ha revelado como un marco teórico útiles para explicar la aceptación de las tecnologías competitivas deportivas disruptivas. Asimismo, el juicio ético también debe ser considerado en su análisis.

Palabras clave: TAM, UTAUT, ética deportiva, tecnología Vaporfly, fondo en ruta.

ABSTRACT

Objectives: The Vaporfly tech (VFT) for road running shoes has supposed a disruption in distance running shoes. Academic research suggests that VFT improves performance, at least, in elite and sub-elite athletes. This paper assesses empirically factors influencing the acceptance of disruptive competition technologies, focusing on the perceptions about the VFT shoes by amateur athletes.

Material and methods: We analyse a survey over 252 Spanish amateur athletes (214 men and 38 women). Our research uses Unified Theory of Acceptance and Use of Technology (UTAUT), including ethical awareness of athletes that is measured by means of their judgement on moral equity (ME), and athlete income.

Results: The proposed model explains almost half of the intention to use (IU) disruptive technologies by athletes. Adjusted structural equation model (SEM) shows that significant influential factors on IU are easiness expectation whose path coefficient (pc) is 0.467 ($p<0.01$), performance expectancy (pc=0.203, $p<0.05$), perception on ME (pc=0.298, $p<0.01$) and athlete's income (pc=0.123, $p<0.01$). Surprisingly, social influence has a weak influence on the IU. Similar results are attained with Poisson regression.

Discussion: This paper applies a theoretical framework that combines findings in consumer behaviour (UTAUT model) and moral equity dimension of a multiple ethical scale to explain intention to use VFT. Of course, proposed methodology can be used to evaluate a disruptive tech within the context of any other sport.

Conclusions: Findings have important implications in the sport industry. As we expected and also has shown by reviewed literature linked to sport tech, conventional UTAUT has been revealed useful theoretical framework to explain the acceptance of disruptive sport techs in the competitive arena. In addition, ethical aspects also should be considered in their development.

Keywords: TAM, UTAUT, ethics in sports, Vaporfly tech, road distance running

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INTRODUCTION

Disruptive technologies change the nature of competition. The famous case of Oscar Pistorious opened a new debate about the potential of technology to enhance human innate capabilities (Richard, Issanchou and Ferez, 2020). The technological pace of disruption in professional sports is an emerging research topic. The Breaking2 project done by Nike in 2017 is an excellent example. This project was the first serious attempt by a human, despite non-homologated by World Athletics, to finish a marathon under 2 hours. It was a historical day for Athletics despite could even be considered a failure. Kipchoge stayed 26" from his goal. It was not until 2019, that the same athlete, in the Ineos 1.59 challenge, broke that barrier. A major objective of that event was presenting Vaporfly technology (VFT) by Nike that previously was exhibited in Hookgamer et al. (2017). It has been widely proved that VFT enhances older previous running shoes. Fuller et al. (2015) suggested that until 2017 choosing a distance running shoe supposed a traded off between better biomechanics (those from more weighted shoes) and a lower running energy cost (from light shoes). VFT broke that dichotomy since lets improving athlete's biomechanics (Hunter et al., 2019; Hoogkamer, et al., 2019b), and energy cost (Hoogkamer et al. 2018b; Barnes et al., 2019; Hunter et al., 2019).

Quealy and Katz (2018) and Guinness at al. (2020) showed with Strava data that indeed, the improvement produced by the VFT is statistically significant. Likewise, in 2017, of the 36 possible podiums in the Majors (Tokyo, London, Boston, Berlin, Chicago and New York Marathons) 19 were with Nike Vaporfly 4% (Hutchinson, 2018). In 2018 and 2019 results were much more favourable for VFT. Perhaps, the clearer example about how much VFT is disruptive was Hakonen Ekiden held at the beginning of 2020 in Japan, a country where distance running is a religion. In that edition statistical records were shaken (Larner, 2020). The first two teams lowered the record by more than 7 and 4 minutes respectively and at a pace less than 3' per kilometer. The athletes of both teams had committed the "sin" of giving up wearing footwear of Japanese origin (Asics and Mizuno) to wear Nike Vaporfly Next%. It can be considered a revolutionary change from the Japanese perspective. In fact, 85% of the Ekiden runners wore such a model.

At year 2020 were introduced several shoe models with a tech similar to Vaporfly from brands as Adidas, Hoka Hoka One, Brooks, Asics, New Balance, Reebok and On. Likewise, although 2020 has been scarce in competitions, the few that have been held report a notable decline of Nike dominion. The male and female podiums of the Valencia (Adidas 3 and Nike 3) and London (Nike 4, Asics 1 and Adidas 1) marathons, the Valencia half marathon (Adidas 4 and Nike 2) and the world half marathon held in Poland (Nike 3 and Adidas 3), prove this fact.

After establishing that the improvement provided by the VFT is real, it must be identified where exactly this advantage lies. In fact, of the two key elements, the carbon fibre plate and the new Pebax foam, it was the plate that focused all the attention. It has been assimilated from several instances as a spring (McGuire, 2020). However, it was already at the beginning of the 21st century that Adidas had released the Pro Plate model, the first in which a carbon plate was integrated. That shoe had not shown an additional advantage over other shoe models. Hoogkamer et al. (2018b) made it clear that in addition to the carbon plate, its design and position on the midsole, which was novel, its revolutionary foam had to be added. Although the sole was much thicker than that of other models, it weighed half that of these and provided a 33% higher energy return (Woodward, 2020).

The objective of this paper is to analyse the most influential factors on the intention to use a disruptive sport technology for competition purposes. We based our study in the VFT as a representative product in this market. To do this, we analysed a survey on 252 Spanish athletes carried out within March 2021. The theoretical framework used in this paper is Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003), which is grounded on Technology Acceptance Model (TAM) by Venkatesh and Davis (2000). It is complemented by introducing ethical awareness of athletes and their income.

Three first variables tested in the paper are grounded in UTAUT models: performance expectation, easiness expectation and social influence. These constructs are commonly used in marketing research to explain the consumers' attitude towards new techs and innovative products. It is also true in sport tech.

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So, examples in this sense are Talukder et al. (2020), Reyes-Mercado (2018), Lee and Jeon (2014), Kim and Chiu (2019), and Aksoy et al. (2019) for sport wearables, and Ibrahim (2014), Byum et al. (2018), Kim and Jang (2016), Kim et al. (2017), Mohamhadi and Isanejad (2018) and Ndayizigamiye et al. (2020), Kunz and Santomier (2020), Angosto et al (2020) and Ferreira-Barbosa et al. (2021) in the case of other intelligent techs as sport apps.

The improvement of athletic performances in distance running races since 2018 is seen in many instances unusual (Dyer, 2020) and the reason is attributed to the use of VFT. So, some authors such as Muñiz-Pardos et al. (2021), consider that VFT allows performance enhancements comparable to blood doping in such a way that it has been qualified in a lot of forums as technological doping (Woodward, 2020; Ross, 2020). This fact leads us considering ethical awareness relevant to explain the acceptance of VFT.

Last control variable is athlete's monthly income. Notice VFT price can be up to 500% of the average price of a running shoe and so it can generate unequal opportunities of access (Dyer, 2020). This variable can be also understood as a proxy variable of UTAUT model "facilitating conditions" since, obviously, a greater monthly income makes easier acquire VFT shoes.

MATERIAL AND METHODS

Variables in the study

We are interested in testing the influence of variables outlined above, that are grounded on UTAUT with the addiction of ethical perceptions on intention to use running shoes with Vaporfly tech. All items, constructs and their theoretical foundation are listed in Table 1. So, explained variable, that is, the attitude toward the measured with the scale for intention to use (IU) new techs in the Technology Acceptance Model (TAM) by Venkatesh and Davis (2000).

The first variable to consider, *performance expectation* (PE), is the degree of perceived usefulness by a potential user, i.e., it is the intensity with which a person believes that the new product will improve his/her expected utility. In elite/sub-elite athletes VFT shoes allow improving performance (Dyer, 2020; Guinness et al., 2020) and this fact does not can be only explained by a hypothetical placebo effect (Muniz-Pardos, 2021) or the significant drafting effect in Breaking2 and Ineos 1.59 challenges demonstrated in Hoogkamer et al. (2017, 2019a). As far as popular runners are concerned, analysis of data from Strava by Quealy y Katz (2018) suggests that also, in average, their performance may be improved by using VFT.

Likewise, it is also possible that VFT shoes diminish the muscular pain and injury probability after intense sessions. In fact, principal improvements in running shoes are usually linked to the diminution of injuries (Sailors, 2009; Vermeulen et al., 2021). At this respect prominent Spanish international athletes report that they experienced faster muscular recoveries after intense training sessions and competitions and have suffered fewer injuries since they started using VFT (Jiménez, 2020). However, these statements cannot be generalised in the case of advanced popular runners neither for less fitted ones (Kuzma, 2020; Herbert-Losier et al., 2020).

Bae et al. (2017) in their meta-analysis found that performance expectancy is the most influential variable on intention to use a new sport tech. In this regard Talukder et al (2020), Reyes-Mercado (2018), Lee and Jeon et al. (2014), Kim and Chiu (2019) and Aksoy et al. (2019) found PE relevant to explain IU sport wearables whereas Ibrahim (2013) found so for fantasy sports and Byun et al. (2018), Kim and Jang (2016), Kim et al. (2017), Mohammadi and Isanejad (2018), Kunz and Santomier (2020) and Ferreira-barbosa et al. (2021) in other applications of intelligent techs on sports.

Venkatesh and Davis (2000) point out that if users perceive a technology/product difficult to use, this drawback underrates its advantages. Therefore, TAM and UTAUT suppose a positive influence of a second variable, *easiness expectation* (EE) on IU. VFT might need an adaptation period. Jiménez (2020) exposes the opinion by Spanish elite runner Daniel Mateo in this sense "the first time I used Nike Vaporfly next% was not precisely the best work out of my career. I definitely had not great feelings". Kuzma (2020) also documents feelings in this way by advanced amateur runners. Notice that VFT supposes a change in ankle biomechanics (Hoogkamer et al., 2019b). So, it seems logical supposing that when starting to use VFT, the sensations in first sessions

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might be at least, different to those from classical flat race shoes. At this respect Sharper (2020) outlines that Vaporfly is not a comfortable running shoe.

In this regard, Talukder et al (2020), Lee and Jeon (2014), Aksoy et al. (2019), Ndayizigamiye et al. (2020), Mohammadi and Isanejad (2018) or Ferreira-Barbosa et al. (2021) have proved the influence of EE on IU in the context of new sport techs.

The third variable used in UTAUT models is *social influence* (SI). Endurance sport practitioners are usually members of groups as running clubs, WhatsApp or Facebook groups, internet forums, etc. Likewise, there are a lot of magazines in the marked devoted to endurance sports with many readers. So, it comes clear that SI could be an explanatory factor of IU VFT. At this respect whereas Mahan III et al. (2015) and Littlejons et al. (2019) show a significant influence of social networks in running engagement, Ndayizigamiye et al. (2020) found that SI is the most important variable to explain the acceptance of sport apps. Also, Talukder et al. (2018), Aksoy et al. (2020), Kunz and Santomer (2020) and Ferreira-Barbosa et al (2021) found also significant that variable to explain the acceptance of sport wearables. Notice that Breaking2 and Ineos1.59 Challenges were events that among of other objectives, an important one was influencing athletes to use Nike Vaporfly.

When a disruptive technological rise in a sport one of the consequences is a deep ethical discussion about the ethics of its use (Dyer, 2020). Dyer (2015) shows a panoramic description on this matter in several sports. That paper outlines two controversial linked to distance running: chip control of time and Oscar Pistorius' legs. Ethical awareness has been proved relevant in the acceptance of disruptive tech in diverse fields as education (Jung, 2009), electronic commerce (Leonard and Jones, 2017) or the use of cyborg technologies (Murata et al., 2019; Pelegrín-Borondo et al., 2020 and Olarte-Pascual et al., 2021). Our paper uses as indicator of ethical evaluation, moral equity (ME) items in the in multiple ethical scale (MES) by Reidenbach and Robin (1990) revised in Shawver and Sennetti (2009).

Likewise, running magazines acknowledge that one of the greatest cons of this kind of shoes is their high price (Sharper, 2020) and this fact might be viewed as an ethical drawback due to low-income athletes are excluded of the use of these shoes (Dyer, 2020). So, the income (INCOME) of athlete may seem to be relevant to explain acceptance of VFT and can be understood as a proxy variable for facilitating conditions in UTAUT models.

Hypothesis

From the exposition of explanatory variables, those from UTAUT but also moral equity and monthly income and from reviewed empirical findings, it is fair to conclude that five variables theoretically must influence positively IU Vaporfly shoes. Therefore, the explicit formulation of hypotheses to test is as follows:

Hypothesis 1 (H1): A positive performance expectation of VFT influences positively its intention to use.

Hypothesis 2 (H2): A positive easiness use of VFT influences positively its intention to use.

Hypothesis 3 (H3): A positive social influence about VFT influences positively its intention to use.

Hypothesis 4 (H4): A positive ethical perception of VFT influences positively its intention to use.

Hypothesis 5 (H5): Income level of athlete influences positively intention to use VFT.

Sample

In our study we use a cross-sectional survey over a set of 254 Spanish amateur runners and triathletes completed entirely by digital means. The information was obtained from March 4th, 2021 to March 20th, 2021. The number of valid responses was 252 (214 men and 38 women). Surveyed athletes were completely contacted by digital means (basically WhatsApp, Facebook and e-mail) and answers were done on-line. We have contacted some athletes individually but others through their athletic and triathlon clubs. To check that all the questions were understandable, the questionnaire, which was originally written in Spanish, was tested in 10 athletes with different profiles (licenced vs non-licenced, distance runners vs triathletes).

With regard to ethics approval: (1) all participants were given detailed written information about the study and procedure; (2) no data directly or indirectly

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related to the subjects' health were collected and, thus, the Declaration of Helsinki was not generally mentioned when the subjects were informed; (3) the anonymity of the collected data was ensured at all times; and (4) no permission was obtained from a board or committee ethics approval, it was not required as per applicable institutional and national guidelines and regulations (5) voluntary completion of the questionnaire was taken as consent for the data to be used in research, informed consent of the participants was implied through survey completion.

The questions on IU, PE, EE and SI were responded in an 11 level Likert scale that vary from 0 (complete disagreement) to 10 (complete agreement). In the case of ME the questions also were answered in a 11 level Likert scale that vary from 0 (completely unfavourable judgement) to 10 (completely favourable judgement). INCOME is a dichotomous variable whose value is 1 for monthly incomes greater than €2,499 and 0 otherwise.

We are aware that original UTAUT applied 7-point Likert scale and reviewed papers use scales that oscillate between 5 and 7 grades. In fact, that is the current mainstream in psychometric scales (Bisquerra and Pérez-Escola, 2015). However, in the revision of literature on scales by Bisquerra and Pérez Escola (2015) it is stated that those with 5 and 7 points do not allow collecting completely human capability to discern nuances. Usually, people refuse to use extreme values. Therefore, in a five (seven) point scales there are only one (two) viable option(s) to express agreement or disagreement for many surveyed people. Likewise, punctuation in lower point scales tends to be higher than in those with greater grades. These reasons lead to several authors to indicate that 11 level scale is more suitable that those with less points. It also allows an "indifferent" answer, and the responses can be done in a very intuitive manner since decimal numerical systems is very common in ordinary situations (Bisquerra and Pérez-Escola, 2015). Let us remark that UTAUT has been also implemented with 11-point scales. An example is Pelegrín-Borondo et al (2017) that used that theoretical framework to explain technology acceptance of cyborg techs.

Details on descriptive statistics of items can be consulted in Table 2. Notice that the mean/median responses show that VFT has an average ethical favourable evaluation. With the exception of question "ME2=VFT is unfair/fair" all ethical items present mean/median values clearly above 7 (they oscillate between 7 and 8). In the question ME2, the mean/median value also shows a favourable (but less) ethical perception.

Data analysis

At the first stage we check possible existence of more than one dimension in scales. To do so we exploratory factor analysis (EFA) and Varimax rotation. We have also measured convergent validity of scales to assess internal consistency of constructs and divergent validity measures.

In a second stage we quantify PE, EE, SI and ME by means of their standardized loadings and then, we adjust two regression equations on two responses on IU (IU1 and IU2), whose form is:

IU =exp(a0 +a2* PE+a3*EE+a4*SI++a1*ME+ a5*INCOME) (1)

The difference between two regression equations is the reflective item (IU1 or IU2) quantifying IU. Notice that the responses are discrete numbers that vary from 0 to 10 and therefore expression (1) is fitted by running a Poisson regression. So, the usage rate ratio (URR) will be >1 if variable influences positively acceptance of VFT and URR<1 if this influence is negative. The subsequent assessment of five hypotheses comes straightforward.

In a third step we fit by means of a structural equation model (SEM) the magnitude the direct effect of explanatory variables on intention to use construct. It is estimated with partial least squares (PLS). Finally, we accept or reject the hypotheses by from the sign and significance of the coefficient paths (pc) fitted for the model

RESULTS

Table 3 shows results of EFA. All items in scales are loaded above 0.7. Table 4 shows that Cronbach alpha, composite reliability index and ρA measures are above 0.7. Likewise, average variance extracted (AVE) is greater than 0.5. So, we can accept that all constructs have internal consistency. Matrix in Table 5 shows that explanatory variables have discriminant power. Principal diagonal (squared root of the AVE

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of variables) is always greater that their correlation with the others (see values below principal diagonal). Likewise, Heterotrait-Monotrait ratios (values above principal diagonal) are always under 0.9.

Table 6 shows the results of Poisson regression on IU items (IU1 and IU2). Following patterns are found:

(1) Adjusted R2 of both regressions is about 50%. Likewise, LR measure informs that regressions models are statistically significant ($p<0.01$).

(2) EE and PE are always significant to explain IU. In the case of EE we have found URR=1.287 for IU1 and URR=1.332 for IU2 with $p<0.01$. Likewise, we have detected a weaker but also quite consistent significance of PE explanatory power (URR=1.076 and $p<0.1$ for IU1 and URR=1.105 and $p<0.05$ for IU2) So, hypotheses 1 and 2 are accepted.

(3) Regressions results suggest that SI presents a negative impact on IU (URR<1 in both questions on IU). This fact contradicts H3. Likewise, the results of the regression over IU1 cannot reject that URR=1. However, in the adjustment of IU2 it can be rejected that URR is the unity at a 5% significance level.

(4) We have found a relevant influence of ethical concerns about VFT on its IU. Results suggest that H4 can be accepted. In both regressions we fitted an URR for ME >1 with $p<0.01$. Likewise, we have also found a significant impact of INCOME over IU VFT. However, this statistical significance is weaker than that of ME (URR=1.134 and $p<0.05$ for IU1 and URR=1.082 and $p<0.1$ for IU2).

Table 7 shows the results of SEM-PLS estimation. They are practically identical to those from Poisson regression. The greater path coefficient (pc) is that of EE (pc=0.467, $p<0.01$). PE is also significant PE (pc=0.203, $p<0.05$). In both cases H1 and H2 are confirmed. We have found a negative but not significant influence of SI over IU. Therefore, H3 is rejected. Likewise, ME (pc=0.298, $p<0.01$) and INCOME (pc=0.123, $p<0.01$) have also a significant influence on IU with the same sign, positive, as we expected. So, H4 and H5 are accepted. Likewise, the values of R2 and Q2, which are above 50%, suggest that the SEM has an acceptable adjustment and prediction capability (Hair et al., 2014).

DISCUSSION

VFT have become a disruptive tech in long distance running. Academic literature reviewed suggests that it improves performance in elite and sub-elite athletes about 2%-4%. In accordance, their use in elite long-distance runners is nowadays practically a must. Likewise, there are solid evidence suggesting that a great part of amateur runners may benefit their performances with VFT.

This paper applies a theoretical framework that combines findings in consumer behaviour (UTAUT model) and moral equity dimension of MES to explain intention to use VFT. Despite this focus has been applied in the study about the influence of ethical perceptions on IU disruptive techs as e.g. wearables its application in sport competition tech field supposes, to the best of our knowledge, a novelty. Of course, proposed methodology can be used to evaluate a disruptive tech within the context of any other sport.

We have found that VFT had, in average, a positive ethical evaluation. The use of Poisson regression on IU1 and IU2 have led us detecting a solid positive link between easiness use and acceptance (URR=1.287, and URR=1.332 for questions IU1 and IU2 respectively where in both cases, $p<0.01$). Likewise, the relation between PE and IU is, although also relevant, weaker. Likewise, our results suggest that clearly moral equity perceptions on this tech affects significantly on IU (URR=1.234 and 1.093 for questions IU1 and IU2, $p<0.01$). Surprisingly social influence has shown a negative but weak link with IU. Results suggests a fair positive relation between the use of VFT and INCOME (URR=1.134, $p<0.05$ for IU1 and URR=1.0836, $p<0.1$ for question IU2). So, athletes with lower income are less likely to use VFT and so they may be forced to compete in disadvantageous conditions. This fact may suppose an ethical drawback of VFT shoes. SEM-PLS regression confirms conclusions of Poisson regression analysis.

Notice that despite we have found PE relevant to explain acceptance of VFT, it is less relevant than EE. This fact supposes a slight deviation from mainstream findings. In meta-analysis by Bae et al.

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(2017) it is outlined PE as the most relevant variable to explain attitude towards new sport techs. We have also observed this fact in the literature reviewed in this paper. Only Ndayizigamiye et al. (2020) in the analysis of the attitude towards mHealth applications found that PE is not a relevant explanatory factor. Similarly to us, Kim and Chiu (2019) in their assessment of sport wearables acceptance found that PE is significant to explain IU but less than EE. On the other hand, despite EE is also often stated sugificant to explain IU, there exist a relevant deal of papers that did not observe so (Kunz and Santomier, 2020; Lee and Jeon, 2014; Kim and Jang, 2016, Kim et al., 2017).

We have checked that the impact of SI on IU Vaporfly shoes is not significant and, moreover, its sign is not as we expected. This construct is only tested in UTAUT and UTAUT2 models but not in those based on TAM. Although SI has usually revealed a positive and significant impact on IU (Kunz and Santomier; 2020; Ferreira-Barbosa et al., 2021; Ndayizigamiye et al., 2020; Kim and Chiu, 2019; Talukder et al. 2020) on the other hand, some authors have not found that construct to be relevant at standard levels (Aksoy et al., 2019; Reyes-Mercado, 2018).

We feel that the main facilitating condition to use VFT shoes is having enough income to buy them. Our finding about the relevance of income is according to the relevance of facilitating conditions to explain IU shown in several studies as Ferreira-Barbosa et al. (2021), Aksoy et al. (2019) and Reyes-Mercado (2018).

Assessments on sports tech from technology acceptance models view is so wide as can be checked in systematic reviews by Bae et al. (2017) and Angosto et al. (2020). The mainstream of evaluated techs has usually different objectives than be used in competitions as e.g., promoting health, fitness or simply leisure with no more nuances. However, there is little work on the attitude towards disruptive sport tech linked with competition. We have shown that in that context ethical perception about the fairness and equity of these techs could be as relevant to explain IU as UTAUT variables.

CONCLUSIONS

Findings in this paper have important implications in the sport industry. As we expected and has shown in reviewed literature UTAUT has been revealed useful theoretical framework to explain the acceptance of disruptive sport techs for competition purposes. But, in addition, ethical aspects also should be considered in their development. The perception about what is wrong or right should be considered as an essential factor of the intention to use a new sport technology to be used in competitive events.

Review by Dyer (2015) shows that disruptive sport techs for competition purposes is not an exception. Periodically all sports try to introduce new techs and this fact generates ethical controversial. Therefore, we can also use approach in this paper to assess attitude of athletes and consumers about different sport techs in other competitive disciplines. Let us outline several possible applications:

* A natural extension consists in a similar analysis for running track races since in this kind of disciplines VFT is also a disruptive tech.

* It could be interesting using our framework assessing the possible application of VAR (Video Assistant Referee), that nowadays is basically used in elite team sport competitions, to amateur and formative leagues.

* Bike tech is in fast and continuous evolution. There are several disciplines linked with bike cycling: track cycling, mountain-bike, road cycling, BMX… and in these disciplines there is nowadays a significative deal of disruptive technical advances: new materials, disc brakes, automatic gear changers, etc. Any of these innovations are susceptible to be analysed with the proposed framework.

* Sport supplementation and nutrition is nowadays a growing, dynamic, and innovative industry. Some of their products are designed to improving performance in competition. In our opinion, the combination of UTAUT and ethical perceptions can be useful to explain attitude toward these nutritional goods.

* As far as we are concerned, we feel stimulating the case of wearables and insideables that allow

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overcoming human capacities, performing over human innate skills. In the sport field, ethical concerns of these future technologies should require further analysis that could be fruitful by using the framework in this paper.

We are aware that the survey and its soundness present several limitations that may incentive further research. Firstly, the sample is wide enough to obtain significant statistical results, but it is not so great. Secondly, despite the proportion men/women 85/15 is approximately in accordance with rates in running and triathlon races in Spain, we feel that a more balanced proportion would be preferable. Likewise, this research is circumscribed to a sample of amateur Spanish athletes. It would be interesting obtaining responses from professional distance runners and triathletes and so comparing the attitude and perception between both type of users, amateur and pro athletes. It must be also outlined that our results might vary if questionnaire had a wider geographical extension or if it were answered by athletes from another country/continent.

This paper uses a cross sectional survey, and so, conclusions are basically concerned to the moment of its implementation. To obtain a more complete vision about how VFT is perceived throughout time, a longitudinal study must be done. Moreover, our survey has been completed in year 2021. That is, after the set of norms on running shoes developed by World Athletics at year 2020. In 2021 Nike was not the unique brand that commercialised shoes with this kind of tech. On the other hand, to the best of our knowledge, there is not any study of VFT like ours before running shoes were regulated by World Athletics and simultaneously Nike owned a monopolistic position on VFT (i.e., between years 2017-2020). Consequently, conclusions for that period in which VFT was extremely novel cannot be obtained and compared with those in our research.

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Table 1. Scales used in this paper

Factor/construct	Source
Intention to use (IU)	
IU1=I intend to employ VFT running shoes	Adapted from Venkatesh and Davis (2000)
IU2=I predict that I will employ VFT running shoes	
Performance Expectancy (PE)	
PE1=Using VFT running shoes will be useful to reach important goals for me	Adapted from Venkatesh et al. (2012)
PE2=Using VFT running shoes will increase opportunities to achieve important goals for me	
PE3=Using VFT running shoes will help me achieve my goals more quickly	
PE4=Using VFT running shoes will help me achieving goals with less effort and undesirable effects (as, e.g. injuries)	
Easiness expectancy (EE)	
EE1=It will be easy for me to learn about using VFT running shoes	Adapted from Venkatesh et al. (2012)
EE2=Using VFT running shoes will be easy to understand to me	
EE3=Using VFT running shoes will be easy for me	
EE4=Becoming adapted to VFT running shoes will be easy for me	
Social Influence (SI)	
SI1=People important to me will think that I have to use VFT running shoes	Adapted from Venkatesh et al. (2012)
SI2=People who influence me feel that I have to use VFT running shoes	
SI3=Persons whose opinions I appreciate would like me to use cryptocurrencies	
Moral equity	
ME1=VFT running shoes is unjust/just	MES by Shawver and Sennetti (2009)
ME2= VFT running shoes is unfair/fair	
ME3= VFT running shoes is not morally right/morally right	

Table 2. Descriptive statistics in this paper

Factor/construct	Mean	Med	SD	Q1	Q3	IV
Intention to use (IU)						
IU1=I intend to employ VFT running shoes	6.66	8	3.38	5	10	5
IU2=I predict that I will employ VFT running shoes	7.20	8	3.06	6	10	4
Performance Expectancy (PE)						
PE1=Using VFT running shoes will be useful to reach important goals for me	6.78	8	3.01	5	9	4
PE2=Using VFT running shoes will increase opportunities to achieve important goals for me	6.53	8	3.10	5	9	4
PE3=Using VFT running shoes will help me achieve my goals more quickly	6.54	7	2.98	5	9	4
PE4=Using VFT running shoes will help me achieving goals with less effort and undesirable	6.22	7	3.10	4.25	9	4.75

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effects (as, e.g. injuries)						
Easiness expectancy (EE)						
EE1=It will be easy for me to learn about using VFT running shoes	6.57	7	2.69	5	8.75	3.75
EE2=Using VFT running shoes will be easy to understand to me	7.54	8	2.58	6	10	4
EE3=Using VFT running shoes will be easy for me	7.25	8	2.80	5	10	5
EE4=Becoming adapted to VFT running shoes will be easy for me	5.89	6	2.70	5	8	3
Social Influence (SI)						
SI1=People important to me will think that I have to use VFT running shoes	5.50	6	3.00	3	8	5
SI2=People who influence me feel that I have to use VFT running shoes	5.76	6	3.06	4.25	8	3.75
SI3=Persons whose opinions I appreciate would like me to use cryptocurrencies	6.11	7	3.02	5	8	3
Moral equity (ME)						
ME1=VFT running shoes is unjust/just	7.20	8	2.82	5	10	5
ME2= VFT running shoes is unfair/fair	5.76	6	3.20	3	9	6
ME3= VFT running shoes is not morally right/morally right	7.09	8	2.94	5	10	5
Income						
INCOME=Monthly income ≥€2500	Proportion=47%					
Composition by sex	86% men and 14% women					
Composition by sport	70% athletes and 30% triathletes					
Composition by dedication	59% athletes have license and 41% does not					
Composition by ages	15% are under 35 years; 42% between 35 and 45; 36% between 45 and 55; 6% were between 55 and 65 years and 1% were over 65 years.					

Table 3. Results of factor analysis

	Loaded	KMO	Barlett
Intention to use (IU)		0.5	287.695***
IU1=I intend to employ VFT running shoes	0.956		
IU2=I predict that I will employ VFT running shoes	0.956		
Performance Expectancy (PE)		0.794	604.319***
PE1=Using VFT running shoes will be useful to reach important goals for me	0.834		
PE2=Using VFT running shoes will increase opportunities to achieve important goals for me	0.921		
PE3=Using VFT running shoes will help me achieve my goals more quickly	0.919		
PE4=Using VFT running shoes will help me achieving goals with less effort and undesirable effects (as, e.g. injuries)	0.739		
Easiness expectancy (EE)		0.806	600.847***
EE1=It will be easy for me to learn about using			

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VFT running shoes	0.811		
EE2=Using VFT running shoes will be easy to understand to me	0.818		
EE3=Using VFT running shoes will be easy for me	0.917		
EE4=Becoming adapted to VFT running shoes will be easy for me	0.902		
Social Influence (SI)		0.743	773.52***
SI1=People important to me will think that I have to use VFT running shoes	0.929		
SI2=People who influence me feel that I have to use VFT running shoes	0.969		
SI3=Persons whose opinions I appreciate would like me to use cryptocurrencies	0.957		
Moral equity (ME)		0.728	698.55***
ME1=VFT running shoes is unjust/just	0.961		
ME2= VFT running shoes is unfair/fair	0.904		
ME3= VFT running shoes is not morally right/morally right	0.956		

Note: KMO, Barlett %Var stand for Kaiser-Meyer-Olkin measure, Barlett statistic respectively.

"*", "**" and "***" denote statistical significance at 10%, 5% and 1% level respectively.

Table 4. Convergent validity indicators

	Cronbach-alfa	ρ_A	Composite reliability	Average variance extracted (AVE)
IU	0.907	0.907	0.956	0.915
PE	0.876	0.918	0.915	0.730
EE	0.885	0.890	0.921	0.745
SI	0.948	0.958	0.966	0.906
ME	0.934	0.968	0.957	0.883
INCOME	1	1	1	1

Table 5. Divergent validity matrix

	PE	EE	SI	ME	INCOME
PE	**0.854**	0.837	0.803	0.560	0.171
EE	0.749	**0.863**	0.807	0.659	0.027
SI	0.728	0.737	**0.952**	0.652	0.097
ME	0.535	0.610	0.617	**0.939**	0.125
INCOME	0.153	0.025	0.098	0.122	**1**

Note: Principal diagonal is squared AVE. In inferior triangle come correlations between variables and in upper triangle heterotrait-monotrait ratios

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Table 6. Results on regression model (1) for questions IU1 and IU2

Variable output	IU1		IU2	
Variable input	URR	t-ratio	URR	t-ratio
Constant	5.755	47.24***	6.488	53.23***
PE	1.076	1.72*	1.105	2.36**
EE	1.287	5.52***	1.332	6.66***
SI	0.972	-0.72	0.925	-2.06**
ME	1.234	6.13***	1.093	2.78***
INCOME	1.134	2.51**	1.082	1.63*
	Adjusted R2=51.24%		Adjusted R2=44.83%	
	LR=262.02***		LR=188.65***	

Note: URR is usage rate ratio and "*", "**" and "***" denote statistical significance at 10%, 5% and 1% level respectively.

Table 7. Results of SEM-PLS estimates

Path	Coefficient path	Student's t
PE -> IU	0.203	2.137**
EE -> IU	0.467	6.195***
SI -> IU	-0.121	1.540
ME_ -> IU	0.298	3.822***
INCOME -> IU	0.123	3.589***

Note: "*", "**" and "***" denote statistical significance at 10%, 5% and 1% level respectively