



# The Internet of Things for Sport: Factors Influencing the Intention to use and the Mediating Role of Trust

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**Submission:** March 28, 2023; **Published:** May 22, 2023

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## Abstract

The internet of things (IoT) has revolutionized our daily lives. The need for these types of devices for sports is continually increasing as athletes seek to track and develop their personal performances. This study addresses the factors that reinforce the intention to use this technology. It focuses on several key elements such as optimism, perceived usefulness, and provider credibility that help build the athlete's trust and further attract them to use it. In the literature review, we tried to deal with all the variables mobilized, to build our theoretical model and to put forward the theoretical hypotheses. The empirical analysis was carried out with the help of a questionnaire addressed to the athletes. The results recommend working on the added value of IoT devices, communicating in a transparent and credible way and responding to the specific needs of athletes, especially concerning the security and confidentiality of the personal data collected.

**Keywords:** Consumer Trust; Perceived Usefulness; Internet of Things; Sports; Use Intention

## Introduction

The internet of things (IoT) is equipped with sensors capable of sending and receiving data via the Internet. It is about making the objects around us full-fledged actors through the interconnection between the Internet and physical environment. This technology represents the future that humanity will have to face and adapt to. The use of IoT devices for sports allows to enlarge Big Data. In this field, the quest to improve performance is a crucial need. The analysis of data collected by IoT devices allows athletes to better understand their performance level and detect opportunities to improve their activity. This new practice leads the user to become a "data scientist" of his own body, he collects and analyzes data to better develop himself. The connected sports market offers several advantages that encourage and attract investors and designers of IoT devices: the target of sportsmen is relatively large with diversified needs, positioning on very profitable sectors such as wellness and health that attract users and generate significant figures.

According to a study conducted by Statista, the number of Internet of Things devices for wellness and sports was expected

to reach 171.2 million units by 2025. The increased use of this technology brings to light very critical issues such as security, confidentiality, and user privacy. For Almutairi et al. [1], security refers to the obligation to implement a tool to protect the collected information, confidentiality is the obligation of personal data managers not to disclose it, and privacy refers to the user's right to make decisions regarding the handling of their personal data. According to Al-Fuqaha et al. [2], security and privacy are prioritized for IoT devices, followed by reliability, availability, scalability, interoperability, performance, and management, these elements need to be addressed effectively by IoT designers to build a comprehensive offering that earns users' trust.

In France, a study was conducted by IPSOS Mori on behalf of the Internet Society and Consumers International among 1.094 French adults aged 16 to 75. The study shows that 71% of respondents say they are afraid of the way IoT collects their personal data and 84% argue that IoT providers should guarantee data privacy and security. It also suggests that lack of usefulness, security and privacy issues are the main deterrents to buy IoT. Our research agrees with this finding and proposes to analyze

the impact of trust in IoT for sports with the intention to use this technology in relation to the usefulness of these devices and providers credibility. Thus, we will present the results of exploratory research. In the first part, we present a brief review of the variables that influence the intention to use. The second part presents the methodology adopted. In the third part, we empirically analyze our theoretical model. Finally, the last part presents a discussion of the results and research perspectives.

### Theoretical Framework

#### Optimism about new technologies

Several researchers have addressed the impact of openness and sensitivity to new technologies on perceived usefulness and adoption. For Mun et al. [3], optimism promotes the adoption of new technologies. This individual willingness to learn about new technologies positively influences the intention to use such technology [4]. Optimism refers to a positive perception of technology and a belief that technology enables users to become more efficient, flexible, and in control of their environment [5]. Optimism refers to an individual's belief in achieving the best results in life. Optimistic people adapt effectively and make the most of the environmental conditions to achieve positive outcomes. They focus more on the positive side of new experiences. In fact, the optimistic person is more likely to accept and use new technology [6]. He perceives it as useful and easy to use and gives less importance to the risk of use and possible adverse outcomes. According to the study by Munger and Loyd [7], optimism reinforces positive intentions and promotes the adoption of computers, which were a new technology at the time of the study. From the above, we argue that optimism plays a primary role in technology acceptance, and we advance the following hypotheses:

H1a: Optimism about new technologies promotes perceived usefulness.

H1b: Optimism about new technologies fosters trust in IoT devices.

H1c: Optimism about new technologies promotes credibility of IoT providers.

#### Perceived Usefulness

Perceived usefulness refers to the role of technology in improving the individual's performance. It has been treated as a cognitive belief essential to technological acceptance [8]. It is a global perception of the benefits that the user plans to obtain using a new technology. It translates into the role of technology in improving the individual's performance. In his TAM model, Davis [8] considered that perceived usefulness is a crucial variable that must be taken into consideration by technology providers to successfully launch and adopt it. Its major impact on the intention to use new technologies has been widely confirmed in several areas such as online shopping [9], mobile payment services

[10], instant messaging on the mobile [11] and by researchers interested in studying online health communities [12].

In the field of IoT, perceived usefulness depends on the degree to which these devices can improve users' daily lives [13]. This is a key determinant of the intention to use IoT [14]. According to a study conducted in the United States by Acquity Group, 36% of respondents to this survey believe that the negative perception of IoT usefulness prevents the decision to adopt this technology. Regarding IoT devices for sports, the perceived usefulness strongly determines the acceptance decision [15]. This discussion of perceived usefulness in different contexts leads us to deduce that this variable is fundamental in the process of IoT acceptance. Therefore, we advance the following hypotheses:

H2a: Perceived usefulness promotes trust in IoT devices for sport.

H2b: Perceived usefulness drives use intention of IoT devices for sport.

#### Perceived provider credibility

Perceived credibility reflects the individual's subjective perception of the trustworthiness, intent, and competence of the designer, media, and brand. It is not a vendor-specific attribute, but the result of an assessment made by the individual on the provider's image, reputation, and competence through available information and past experiences [16]. The credibility of the supplier depends on its experience, its skills in communicating with consumers. These skills help control the relationship, ensure the success of the exchange, and reduce the perceived risk of using the new product or service.

According to Souldard (2015), the credibility of the source is the set of elements transmitted by the sender that positively influence the decision of the receiver. For him, a credible source is persuasive. In the same sense, Clow et al. [17] consider that the persuasive force of the message favors the intention of use on the part of consumers. The credibility of the source plays a fundamental role, especially in a context marked by the lack of information and the difficulty of evaluation for decision-making [18,19]. Gurviez and Korchia [20] argue that supplier credibility is one of the fundamental components of consumer trust. As explained by Bendinelli and Riccio [21], trust is the result of the company's experience, reliability, and intentions. These two variables are both a belief, an expectation, and a decision-determining feeling especially in risky consumption situations marked by decisional uncertainty. Based on this discussion, we put forward the following hypotheses:

H3a: Perceived provider credibility enhances trust in IoT devices for sport.

H3b: Perceived provider credibility drives the intention to use IoT devices for sport.

**Trust in IoT devices**

Trust plays a fundamental role in the exchange process. It positively influences consumers' intention to use [22]. The added value of trust has been widely confirmed in several research fields such as information systems [23], economics [24], social psychology [25], and sociology [26]. It has also been the subject of several studies in marketing [27,28]. In the context of relationship marketing, trust is widely discussed and analyzed by several researchers and its importance has been widely confirmed in different contexts. For some, trust is considered a determining factor in the success and durability of the relationship between the customer and the company: [29-32].

For others it is a critical factor in the relationship between the consumer and the brand [33]. In the context of virtual exchange relationships, trust reinforces the decision to use. For Siau and Shen [34], Van der Heijden et al. [35], and Li and Yeh [36], a highly secure website promotes trust among Internet users and stimulates usage intention and loyalty. With respect to e-commerce, Suh, and Han [37] stated that trust reflects the individual perception of being able to rely on the promises of the online provider. Online trust is very sensitive because physical interactions with visitors are absent. It translates into the use of the website, the disclosure of personal data or the act of purchasing [38]. Several studies have shown that trust is a factor that stimulates purchases on the Internet [39]. It allows to moderate the perceived risk [40]. Indeed, its absence prevents consumers from proceeding online and providing their bank card numbers [41] or even to return to

the site again [42]. We consider that consumers who trust IoT devices will have a stronger intention to use them. Thus, we state the following hypothesis:

H4: Trust in IoT devices for sports positively drives use intention.

**The intention of use of IoT devices**

Intention of use is a fundamental concept in the theory of consumer behavior. It allows us to predict the consumers' actions regarding products or services. For Fishbein and Ajzen [43], it is a conative component that plays the role of an intermediary between attitude and behavior and translates the desire or the will to act. In the same sense, Davis et al. [8] argues in the TAM model of technological acceptance that the intention to use a system influences its actual use. It represents a motivating factor for the adoption of a new technology [44,45]. Intention of use is influenced by several variables related to culture, habit, aspirations, and previous experiences. According to the theory of reasoned action, this intention is determined by both personal values and social norms. In other words, it is defined by personal attitudes toward expectations and social pressure. Indeed, the intention of use does not automatically mean action on the part of the consumer, but the more strongly it is present, the greater the probability of action. As explained by Terrade et al. [46], a person may have a positive attitude toward the objectives pursued, but at the same time does not intend to act because of the social influence of his or her entourage or because of a perceived incapacity (Figure 1).

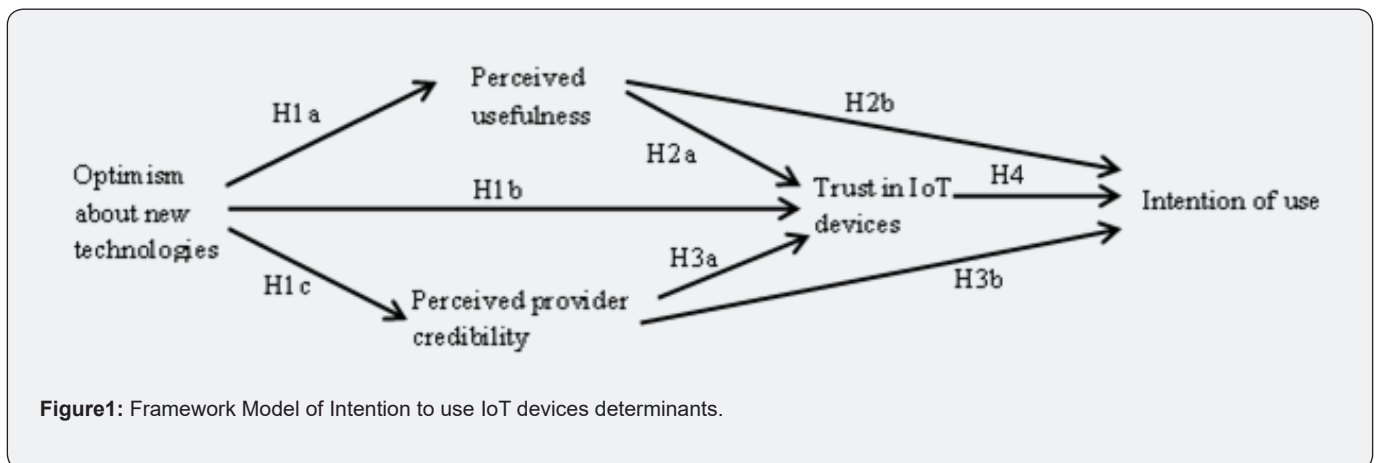


Figure1: Framework Model of Intention to use IoT devices determinants.

**Research Methodology**

**Instruments for measuring model variables**

To analyze optimism about new technologies, we chose the Parasuraman [47] scale. For perceived usefulness, Venkatesh, and Davis [48] scale and to measure perceived provider credibility, we adopt the scale developed by Samer (49). Finally, for trust in IoT devices and intention to use, we adapted the measurement scales

of Gao et al. (50). We asked respondents to report their agreement on a Likert scale with five modalities ranging from “strongly disagree” to “strongly agree”. The English measurement scales were translated into French, discussed with professionals in the field and researchers specialized in Marketing who are fluent in English to verify items meaning, and subsequently analyzed on a test sample to verify the reliability of the selected items.

### Target population and questionnaire administration

Depending on the context and resources available, we opted for data collection via an online questionnaire. This method of online administration is increasingly popular because it facilitates the development of interactive graphical presentation and guarantees the anonymity of respondents [51]. We began our questionnaire with an introduction that defines IoT devices for sport. The collection of answers to our questionnaire was done in three months through groups of sportsmen on Facebook.

### Statistical tool for empirical analysis

To analyze our model, we chose the second-order structural equation method with its Partial Least Square (PLS) algorithm, which is based on analysis of variance and optimization of the explanatory power of manifest variables (52). This method is suitable for complex models with multidimensional latent variables (Richter et al. 2016). Therefore, it is perfectly suited for

online collection of responses with the various biases that this process can present.

### Findings

In the following, we analyze all the results that affirm our theoretical hypotheses. The evaluation consists of four phases. In the first one, we examined the demographic profile of respondents. The next step presents the results of measurement model analysis. The third step consisted of structural model analysis. The last step used to be an evaluation of the mediator effect using the macro process on SPSS [53]. Our questionnaire contains questions about demographic and social characteristics of the respondents such as age, gender, and professional categories. The results of descriptive analysis of the demographic data collected are presented in (Table 1). According to the data in Table 2, our theoretical model is validated with all loadings above 0.6 [54]. Then, the composite reliability and Cronbach's Alpha are also verified with values above 0.7. which proves a high level of internal consistency [55].

**Table 1:** Personal characteristics of respondents.

		Nb	(%)
Gender	Men	149	47%
	Women	169	53%
	Total	318	100%
Professional category	Farmers, craftsmen, traders, entrepreneurs	13	5%
	Executives and Intermediaries professions	154	48%
	Employees, workers	58	18%
	Inactive	93	29%
	Total	318	100%
Age	Less than 25 years	70	22%
	25-39 years	159	50%
	40-54 years	65	20%
	55 years and more	24	8%
	Total	318	100%

**Table 2:** Reliability analysis of variables.

Variables	Scales	Loadings	Alpha Cronbach	AVE	Composite reliability	R2
Optimism about new technologies	OPT 1	0.6838	0.7519	0.5019	0.8341	
	OPT 2	0.7136				
	OPT 3	0.7521				
	OPT 4	0.7235				
	OPT 5	0.6659				
Perceived usefulness	UP 1	0.6862	0.8561	0.6403	0.8981	0.3235
	UP 2	0.849				
	UP 3	0.8728				
	UP 4	0.861				
	UP 5	0.7118				

Perceived provider credibility	CRD 1	0.8523	0.8938	0.6997	0.9209	0.084
	CRD 2	0.8326				
	CRD 3	0.8753				
	CRD 4	0.7806				
	CRD 5	0.8387				
Trust in IoT devices	CONF 1	0.7787	0.916	0.6297	0.9313	0.1666
	CONF 2	0.6791				
	CONF 3	0.7821				
	CONF 4	0.828				
	CONF 5	0.8387				
	CONF 6	0.8186				
	CONF 7	0.8369				
	CONF 8	0.7739				
Intention of use	IU 1	0.935	0.8401	0.8619	0.9258	0.3547
	IU 2	0.9217				

Finally, the average variance extracted (AVE) of the model is validated, with all values above 0.5 [56,55]. These results allow us to confirm the convergent validity of our model (Table 2). Discriminant validity is confirmed when the square root of AVE of each variable is greater than the variation shared with the other variables in the model [57]. From the results in Table 3, we can confirm this condition (Table 3). According to the results, our research model is significant. The intention of use is explained with an R<sup>2</sup> value=35% above the minimum threshold of 13% [58]. To test the theoretical hypotheses, we used the bootstrap analysis method on Smart Pls (n= 318 and 5000 iterations). According to the results in Table 4, all hypotheses are validated (Table 4). Validation of the mediator effect of trust in IoT In the following, we test the mediating role of trust in IoT for sport in the relationship between optimism, perceived usefulness, and perceived provider credibility, on the one hand, and use intention on the other.

**Table 3:** The square root of AVE and the correlation with other variables.

	CONF	CRD	IU	OPT	UP
CONF	0.7935				
CRD	0.2598	0.8365			
IU	0.4854	0.3538	0.9284		
OPT	0.3144	0.2898	0.3512	0.7084	
UP	0.3702	0.3806	0.4711	0.5688	0.8002

**Table 4:** Theoretical Hypothesis Testing.

	T Statistic	Vérification
OPT -> UP	11.0688	Validated
OPT -> CONF	4.243	Validated
OPT -> CRD	4.5031	Validated
UP -> CONF	2.9048	Validated
UP -> IU	6.1469	Validated
CRD -> CONF	1.8874	Validated*
CRD -> IU	3.7796	Validated
CONF -> IU	5.3497	Validated

We use the macro process on SPSS and proceed to run the Bootstrap technique as a first step. We evaluate the indirect relationship between optimism and intention of use. According to the results in Table 5, the relationship is significant with a p<0.001 [53] (Table 5). We subsequently calculate the confidence interval for the mediating role of trust. According to the results in Table 6, both bounds of the interval are greater than zero, so trust in IoT for sport is a mediating variable in this relationship [53] (Table 6). According to the results in Table 7, the indirect relationship between perceived usefulness and intention of use is significant with a p<0.001 [53] (Table 7). Next, we calculate the confidence interval for the mediating role of trust in this relationship. According to the results in Table 8, both bounds of the interval are

greater than zero, providing evidence that trust in IoT for sport is a mediating variable in this relationship [53] (Table 8). According to the results in Table 9, the indirect relationship between perceived provider credibility and intention of use is significant with a  $p < 0.001$  [53] (Table 9). We calculate the confidence interval for the mediating role of trust in this relationship. According to the results in Table 10, both bounds of the interval are greater than zero, providing evidence that trust in IoT for sport is a mediating variable [53] (Table 10).

**Table 5:** The total effect of optimism on the intention to use IoT for sport.

Effect	Se	T	P	LLCI	ULCI
0.4036	0.0622	6.4886	0	0.2812	0.526

**Table 6:** The mediating effect of trust in IoT.

	Effect	Boot SE	Boot LLCI	Boot ULCI
Trust in IoT	0.1407	0.0444	0.0584	0.229

**Table 7:** The total effect of perceived usefulness on intention to use IoT for sport.

Effect	Se	T	P	LLCI	ULCI
0.4899	0.0524	9.3514	0	0.3869	0.593

**Table 8:** The mediating effect of trust in IoT.

	Effect	Boot SE	Boot LLCI	Boot ULCI
Trust in IoT	0.1279	0.0412	0.0557	0.2158

**Table 9:** The total effect of perceived credibility on IoT usage intention for sport.

Effect	Se	T	P	LLCI	ULCI
0.3614	0.0563	6.4193	0	0.2506	0.4722

**Table 10:** The mediating effect of trust in IoT.

	Effect	Boot SE	Boot LLCI	Boot ULCI
Trust in IoT	0.0983	0.0378	0.0319	0.1798

## Discussion and Research Perspectives

### Discussion of the results

The results of the present research proved that optimism, perceived usefulness, and perceived provider credibility strongly influence the intention to use IoT devices for sport. This is in line with several research studies that focus on the adoption of new technologies such as the TAM model [8]. Optimism about new technologies is reflected in a positive view toward technology and the perception that it offers more flexibility and efficiency [59]. It is a positive feeling that allows the consumer to interact in good faith with the designers and reinforces trust. Our study sheds light on the fundamental role of trust as a factor in enhancing the intention to use IoT devices for sport. It mediates the relationship between optimism, perceived usefulness, and perceived provider credibility, on the one hand, and usage intention on the other. This result shows that trust in the technology promotes the perceived usefulness and the provider credibility in a way that promotes

the intention of use. The IoT providers must take care of their image, react in a credible and transparent way with consumers and invest in R&D to offer useful functionalities that promote trust and minimize the perception of fears related to the use of this new technology.

### Theoretical and Managerial Contributions

The present study allows us to advance several theoretical and managerial contributions. The results presented above prove the influence of optimism and perceived usefulness on the intention to use IoT where the personal data collected are sensitive. As it is a relatively new technology, it requires designers to listen to the market and communicate with users to gain their trust. In this sense, it seems important to ensure the security of data collected. Designers must take their time to test the object and make sure of its security level before launching it on the market. Therefore, it seems necessary to invest in cybersecurity research and introduce blockchain technology [60-62]. We addressed the mediating role of trust in IoT devices in the relationship between optimism, perceived usefulness, provider credibility, on the one hand, and intention of use on the other. This result is explained by the fact that the individual will have a strong intention to use IoT devices for sport if he is optimistic, perceives the usefulness of the technology and the credibility of its provider.

All these feelings reinforce trust in IoT. She perceives herself capable of benefiting from the use of this technology without major risk to her privacy and personal data. At this level, we believe that the design of IoT devices for sport is a crucial phase. Designers must give more importance to the usefulness and added value of this technology to try to change the image of the “gadget object” installed in the minds of athletes regarding IoT devices. Furthermore, we recommend that designers focus on developing the added value of existing devices rather than always trying to launch new ones. The present research deals with the determining factors of the intention to use IoT devices for sport with a sample of sportsmen and women who use this technology. It allows us to better understand this target group, to see how they perceive this technology and how they decide to adopt it. It considers the specificities of sport, the objectives and motivations of use and the nature and sensitivity of personal data collected. To the best of our knowledge, this research is the first to investigate the mediating effect of trust in the relationships between optimism, perceived usefulness, and perceived provider credibility, on the one hand, and the intention to use the IoT for sports on the other.

### Conclusion

The objective of this study was to analyze the relationship between the individual and the technology and to determine the factors that influence the intention to use IoT devices for sport. It allows to generate recommendations to the designers of this technology to strengthen and succeed the relationship with potential users. More clearly, the aim is to identify the major factors that promote trust and reinforce the intention to

use this technology. It focused on the primary and mediating role of trust in the relationship between perceived usefulness, provider credibility, and intention of use. Our research therefore recommends that companies prioritize gaining users' trust and fostering their perceived usefulness to encourage them to use this technology.

The designers of IoT devices must focus on functional compatibility and think of the connected object in an ecosystem, to facilitate communication between the different existing objects. Today, IoT devices for sport do not allow synchronizing data between objects of different brands. In this sense, it seems necessary to us to set up a unified system to allow connectivity between the various objects, which requires serious involvement

of the various actors on the market.

### Limitations and Perspectives

The present research is not free of limitations leading to new avenues of research. First, it is an exploratory study that aims to analyze the determining factors of the intention to use IoT devices for sport without distinguishing between brands or functionalities, which does not allow us to verify the impact of these elements (purpose of use, sensitivity of data collected and others) on our group of respondents who use different IoT devices. Moreover, our study did not consider the impact of gender and age on the variables of our theoretical model. It seems useful to us to enrich this model by adding socio-demographic variables and to test it in a different cultural context.

### Appendix

#### Appendix - Scales of Measurement

##### Optimism about new technologies [47]

- OP1- « Technology gives people more control over their daily lives ».
- OP2- « Products and services with newest technologies are much more convenient to use ».
- OP3- « You prefer to use the most advanced technology available ».
- OP4- « Technology makes you more efficient in your occupation ».
- OP5- « You find new technologies to be mentally stimulating ».

##### Perceived Usefulness [8,48]

- UP1 - « Using IoT devices for sport saves me time ».
- UP2 - « Using IoT devices for sport improves my performance ».
- UP3 - « Using IoT devices for sport increases my productivity ».
- UP4 - « Using IoT devices for sport enhances my effectiveness ».
- UP5 - « I find IoT devices for sport to be useful in my life ».

##### IoT provider credibility [49]

- CR1- « I think IoT devices for sport available in the market can be trusted ».
- CR2- « The companies that have made this choice control this activity well ».
- CR3- « Information provided by IoT providers are sincere ».
- CR4- « I do not doubt the intention of IoT providers ».
- CR5- « IoT providers do not lack professionalism ».

The trust in the internet of things [50]

##### I could use the IoT for sport...

- CONF 1 - « If I have a clear conception of the functionality ».
- CONF 2 - « If the IoT provider is widely acknowledged ».
- CONF 3 - « If IoT devices protect the privacy of its users ».
- CONF 4 - « If I feel confident that I can keep it under control ».
- CONF 5 - « If I feel confident that the data collected is reliable ».
- CONF 6 - « If I believe it is risk-free to use it ».
- CONF 7 - « If it is safe to use it ».
- CONF 8 - « If it is useful ».

##### Intention of use [50]

- IU1- « Assuming I have IoT device for sport, I intend to use it ».
- IU2- « Given that I have IoT device for sport, I predict that I would use it ».

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DOI: [10.19080/JPFMTS.2023.10.555783](https://doi.org/10.19080/JPFMTS.2023.10.555783)

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