It's a Match! A Knowledge based Recommendation System for Matching Technology with Events

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Abstract: The use of technologies to promote interaction and engagement at events is part of modern entertainment. In the different types of events, there are different technologies to increase this interaction. In scientific events, for example, organizers use voting platforms with the public; in music festivals, LED bracelets and the flash light of the smartphone are used; while in cultural and sports events, there are digital cheer leading thermometers. Considering the search by experts in the field of events and entertainment for new technologies, in this study, a recommendation system is proposed that relates different classification aspects of events in order to suggest a list of appropriate technologies for that event, based on knowledge bases built by the experience of experts. The proposed solution was evaluated through acceptance studies using the technology acceptance model (TAM), and interviews with six experts with experience in the area of production and organization of various events. Results indicate that users intend to use the platform to assist in the definition of technologies due to its innovative factor, among other information discussed in this paper.

1 INTRODUCTION

Events are unique experiential products that can produce a set of sensations, emotions and engagement with participants (Ayob, 2011). The event industry constantly seeks to provide differentiated, interactive and innovative experiences in order to engage its specific audience. Such events can be represented as individual celebrations, such as a birthday party, to music festivals, conferences or large sports events. In these events, visitors have the opportunity to experience unique moments, and this generates interest in new sensations, emotions, leisure and sociocultural experiences outside their daily routines (Jago, 1997; Getz et al., 1997).

In general, events have several distinct aspects that reflect their own characteristics, such as the category of the event (Getz et al., 1997), the type of audience or how they manifest themselves (Mackellar, 2013).

Recently, technologies that seek to take advantage of the qualities of these events in order to better or more fully engage or interact with the public have become popular. This can be observed at festivals or concerts of famous bands, events in which the interactive use of lights is common, whether through LED bracelets (Burns, 2016) or smartphones (Vasconcelos et al., 2018). While in educational events, the use of audience response systems (ARS) is predominant (Nelimarkka et al., 2016). In the case of cultural events, Martins et al. (Martins et al., 2020) designed a competitive and collaborative application for the dispute between two groups of supporters.

In this sense, in planned events there is always the intention to create and shape the individual and collective experiences of the public, in order to generate greater involvement among the participants (Getz, 2007). However, event organizers do not have a specific technological strategy, which allows them to gather the qualities of different types of events, and recommend technologies to achieve the objectives or meet the demands of a given event, while aiming for greater interaction with their audience.

Thus, the study presented in this paper aims to help event organizers to plan greater interaction with their audience through the recommendation of technologies. For this, we used a database with thirty five technologies obtained from the literature and industry reports [1]. These technologies were classified based on their own characteristics combined with the characteristics of the events where they can be used (Gomes

[1] https://doi.org/10.6084/m9.figshare.14050388.v2

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et al., 2020).

This database served as a support for the development of Techs4Events, a platform for recommending technologies that expand the participation, interaction and engagement of the public in different types of events. Techs4Events takes into account the characteristics of events and their audiences as factors in a calculation, and thus generates a compatibility rate between technologies for events.

In order to evaluate the platform, we conducted experimental studies with six experts with experience in the area of production/promotion of different types of events. For this, a questionnaire based on the technology acceptance model (TAM) was applied in order to validate aspects such as usability, ease and intention to use the platform (Davis, 1989). The result of the analysis of the responses using the TAM method indicated that the tool fulfills its role efficiently, but that the criteria that influence the recommendation need to be improved. In addition, it was found that the system is easy to use, thus generating satisfactory results for the tests performed.

2 BACKGROUND

In this paper, concepts related to event types, audience types, recommendation systems and different technologies were used to build on ideas and develop solutions for the problem. The following subsections detail these concepts further.

2.1 Events, Audience and Technology

An event is a meeting of a group of people, whether with specific interests or not. In the context of entertainment, there are several types of events, but in this paper, the types of events were based on the typology proposed by (Getz, 2007). The following types of events are considered in this work: arts and entertainment, cultural celebrations, private events, recreational events, commercial events, educational/scientific, political/state, and sports and competition events. Each type of event has unique particularities and provides distinct experiences for the public.

Given the distinct characteristics of the events, the audience that comprises and participates in these events also has distinct objectives. Every event has a corresponding audience type, seeking to enjoy the event in different ways. In the context of this paper, the audience is associated with the criteria of relationship with technology and event.

The type of audience used for this association was catalogued by Mackellar (2013). In it, Mackellar defines audiences based on their goals, for example, in *mass*, *special interest*, *community*, *incidental* and *media*. Consequently, different events can support audiences that rely on the nature of the event to engage, such as fans wearing the team shirt at football games or singing along to the crowd (Ludvigsen and Veerasawmy, 2010).

Technology has the potential to expand the possibilities of audience interaction with the various types of events. In the literature, studies that use the smartphone as a mediator between audience and event are increasingly common. As an example, the work of Sheridan (Sheridan et al., 2011), which aimed to analyze collaborative actions using measures of mutual engagement in festivals through an application called “Graffito”.

Another work that uses the smartphone for interaction is massMobile (Freeman et al., 2015).This consists of a web app (web application accessible by mobile devices) that allows the active participation of the audience of musical performances, sending texts, participating in voting, drawing and creating geometric figures, among other features.

The importance of highlighting these points reflects on how interactive experiences influence audience engagement and the role of technology in this process. In addition, technologies nourish the knowledge base used in this paper. In order to facilitate access to these technologies, the concepts of recommendation systems were used and are presented in the following subsection.

2.2 Recommendation Systems

This study proposes the development of a system capable of suggesting technologies for events. For this, we used the concept of recommendation systems, defined as software tools or techniques that provide suggestions of items that are useful to a user (Ricci et al., 2011).

The way these systems can provide these suggestions stems from the use of various data sources to be able to infer the interests of the individual to whom this recommendation is being provided. In the literature, there are several types of recommendation systems, however, according to Aggarwal (Aggarwal, 2016), there are five basic models: collaborative systems, content-based systems, knowledge-based systems, demographic systems, and hybrid models.

Based on the description of Aggarwal (2016) regarding knowledge-based recommendation systems and, specifically, the category of those that are

constraint-based recommender systems, it is important to highlight the similarity that it has with Techs4Events. First, both follow the same principle of requiring the user to specifically explain their requirements to be able to determine the restrictions to be applied on the items that will be returned to them. That is, both make use of knowledge bases that contain rules that map the consumer's requirements (which in this case would be the description of the event in the form) with the product attributes (which would be the recommended technologies).

However, the difference between the two is that while in constraint-based systems only results that fit the restrictions applied by the user are returned (Aggarwal, 2016), in Techs4Events, all results available in the knowledge base are returned and ordered in descending percentual order.

Regarding the category of case-based recommendation systems, the similarity is found in how the results are shown. Both recommendation systems return and rank items by similarity to user requirements. However, the difference lies in the user's ability to criticize the results in case-based recommendation systems. That is, these users can select one or more of the results and specify new searches for items that are similar to these, but specifying the attributes that they want to be different (Aggarwal, 2016). In the Techs4Events recommendation system, this user feedback is not possible.

Besides, the way the user interacts with the system resembles search-based interaction, which consists of a system in which the user's preferences are extracted using a predefined sequence of questions (Aggarwal, 2016). In the context of Techs4Events, this occurs through the form, in which there are predefined questions (a type of audience, type of event, among others), and the user explains the type of technology they will need when describing their event by selecting the answers to these questions.

3 METHODOLOGY

In order to obtain the knowledge to develop the solution to the problem presented in this paper, the methodology adopted was descriptive, since existing market data, scientific literature review and technological approaches are combined, with the aim of generating strategic information to support decision-making.

To carry out this research, we followed, as a mechanism for data collection, two phases, named here *(i) exploratory* and *(ii) experimentation*. To perform the analysis on the relationships of the object of study (events) with the recommendations of technologies of the proposed recommendation system, we used a phase here called *(iii) acceptance*. The objectives of this descriptive research consist in the representation of the relationship between technologies for engagement and their effectiveness in the application in different types of events. The phases described below represent the process to achieve the goal.

The exploratory stage (i) consists in reviewing the literature in order to accrue new technologies used for public engagement in events, and further the knowledge regarding the characteristics of different types of events, and the creation and classification of recommendation systems. An outline of this step is presented in Section 2, Background.

From the knowledge obtained, we proceeded to the stage of *(ii) experimentation*, which consists in the application of the knowledge obtained in order to generate the solution to the problem. In this paper, this step is summarized in the creation and refinement of a web application (Techs4Events). The experimentation step also represents the implementation of a set five heuristic rules as used in Gomes (Gomes et al., 2020), in which the criteria for classification of technologies are built into Techs4Events.

The *(iii) acceptance* stage consists of studies on six users with experience in organizing or producing events. Users were encouraged to use Techs4Events for a short period of time, and to evaluate acceptance via a questionnaire based on the technology acceptance model (TAM) (Davis, 1989) and, afterwards, an interview with three open-ended questions was performed. The results of this step are presented in Section 6.

4 TECHS4EVENTS: EVENT TECHNOLOGY RECOMMENDER

Based on the triad of event, technology and audience, we propose a solution that is also based on technology to recommend technologies capable of expanding the engagement and interaction of the audience in the different types of events. This solution comes from a recommendation system called Techs4Events, whose operation is based on identifying with the experts the characteristics of the event that they are planning and compare them with the characteristics of technologies intended for different types of event.

4.1 Criteria and Subcriteria

To guide each technology to a given event, we based our method on the existing proposal of Gomes (2020), which reports characteristics and relationship of different events in contrast to technologies. In it, each technology is classified according to a series of criteria, among them, the types of events (Getz, 2007) supported by that technology and types of audiences that can enjoy that technology (Mackellar, 2013). Other five criteria are focused on the behavior of the audience and the general context of the event. Additionally, these criteria have options (subcriteria) that represent this relationship in more detail.

In the context of events, there are technologies that can take advantage of the position of the audience in the event space. The **Audience disposition** criterion, deals with how the audience is organized in the event, being it in *fixed positions*, referring to an audience allocated in previously defined seats/locations (e.g. cinemas, theaters, seats marked in football games) or *random positions*, in which the audience does not have fixed positions in the event space, not occupying a specific space or seats (e.g., Times Square, Rock in Rio, music festivals in general).

On the other hand, the **Network infrastructure** criterion allows us to expand the possibilities of technologies, in the sense that there is the possibility of the event allows the public to download an application, for example. In this perspective, there are two possibilities whether it *has infrastructure*, referring to free access to the internet in the event or *does not have infrastructure*(not required), referring to the absence of internet access in the event.

The audience can behave in two ways in the event, in this sense, the **Audience behavior** criterion reflects precisely in this behavior, i.e., when the audience is *active*, when it demonstrates behavior that influences the event or when it has an interest in new experiences. It can also be *passive*, if we refer to the listening audience, or acting as a spectator, being there just to watch and enjoy the event (Mackellar, 2013).

Audience interaction is a criterion that defines when the interaction can or should happen during the event. Typically, technologies are seen as an instrument and not necessarily the center of attention, and are often designed to be used only at specific times. This is to be the decision of the organizer and, in this case, it can occur in two ways. It can be *planned*, in which the interaction with the event is previously combined or elaborated by its organizers. As such, the audience engages and interacts as foreseen in a script at previously defined moments of interaction. Or it can be *unplanned*; the audience interacts organically, since there is no specific script or moments for interaction. Reactions take place according to the degree of audience involvement with the event.

The **Venue** of the event presents an important point of view, due to the possibility of the event being interrupted. It is important to know the types of technologies that can be used in the chosen place, and the subcriteria of this category are *open*, referring to events that occur in open places, with a view to the sky and ample space for the circulation of the audience or *closed* places with a physical structure that has a covering to host the audience, without the possibility of suffering from adverse weather conditions that may cause a temporary pause, or permanent interruption of the event.

Each of these criteria was used to calculate the approximation that the event has with each technology. Such a calculation served as the basis for the creation of a prototype.

4.2 The System

From the idealization of the problem, prototypes were developed for a better visualization and evaluation of the proposed solution, and later a web application, which became the first version of Techs4Events. Figure 1 presents the home screen of Techs4Events in desktop layout.

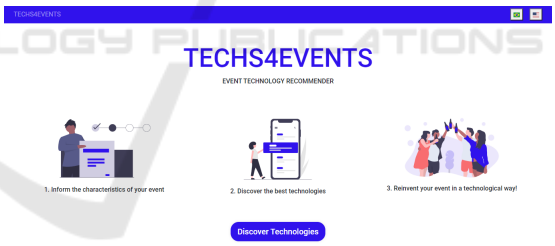

Figure 1: Techs4events home screen.

To use Techs4Events, the user follows a simple procedure that starts by accessing the system and clicking on the button “Discover Technologies” on the home page. After that, the user informs the name and type of the event and clicks the “next step” button. The second part of the form is presented, in which the user must inform the specific characteristics of the event, such as network infrastructure. Finally, the user clicks the “Search” button to check the recommended technologies.

At this point, the system calculates how many options (subcriteria) the user has selected and thus determines what the maximum score would be that a technology could get. After that, it is checked how many of these subcriteria each technology was as-

Table 1: Example of how the recommendation is made.

Criterion	Subcriterion selected by the user	Subcriterion that technology has	Score
Venue	Open	Open	1
Network infrastructure availability	Not required	Not required	1
Audience disposition	Fixed	Fixed, Random	1
Audience behavior manifestation	Active	Passive	0
Audience interaction	Planned	Planned	1
Type of event	Cultural celebration	Arts and entertainment, Cultural celebration	1
Type of audience	Mass, community, incidental	Mass, community, special interest	2

sociated with. For each subcriteria that the technology was associated with, 1 point is added to its total score. The only exception to the rule happens when the user selects the subcriterion "has" in the "network infrastructure" criterion, indicating that the place of the event provides internet connection. In this case, 1 point is added both in technologies that use the network infrastructure and in technologies that do not use it, considering that the presence of a network would not exclude tools that do not need it. An example of how the recommendation is made can be seen in the Table 1.

After this process, the ratio between the score obtained by the technology and the maximum score is calculated, and following this, the result is multiplied by 100 to obtain the percentage. At the end, all technologies are shown to the user in descending percentual order of compatibility, while the end user checks the list of recommended technologies by exploring their descriptions, websites, and compatibility percentage.

5 EVALUATION OF Tech4Events

The Tech4Events recommendation system followed the methodological path described in Section 3, consisting, for reasons of research organization, of three phases. This section describes Phase (iii), related to the descriptive research analysis, in the form of validation of Tech4Events by six entertainment experts.

5.1 Preparation

In order to prepare for the validation of the Tech4Events, several meetings were held for general improvement of the prototype before the studies, such as interface improvements and database adjustments. In addition, the questions for the acceptance questionnaire were defined based on the TAM model (presented in the evaluation section), and the informed consent form (ICF) was validated.

Basically, the TAM model is intended to analyze the behavior and motivation of users regarding the characteristics of the system (Davis, 1989). The model uses two factors to evaluate the user: perceived usefulness, which seeks to know how much the user believes that the use of the system will improve their performance; and perceived ease of use, which seeks to analyze how much the user believes that the use of the system will be effortless (Venkatesh and Davis, 2000).

The study participants were selected according to two criteria: they were older than 18 years and had experience in organizing or producing events. The participants answered two questions to evaluate the intention of use in order to understand the level of influence of the software in everyday life. Additionally, the questions follow the affirmative questions model, for this, users can express their answer following a Likert scale of agreement ranging from 1 to 7, where 1 corresponds to "strongly disagree" and 7 to "strongly agree". Due to the pandemic, the questionnaire was applied remotely, using the Google Forms platform. Also due to the pandemic and a conflict of schedules with users, the tests were scheduled days before, and carried out by Google Meet, an online platform for video calling.

5.2 Execution

All the surveys carried out followed a series of four steps. At each beginning of the survey, the consent of the users to record the meeting was requested. The first stage began with a short presentation by the mediator about the idea behind Techs4Events and how the stages of the surveys will take place. The second step is the use of Techs4Events by the user, in it the user is asked to share the screen of the device used during the test of Techs4Events. From this moment on, each user is free to express themselves, ask questions and make criticisms about the application. The third stage occurs after the test, where the user is asked to answer the acceptance questionnaire. The fourth stage consists of an interview with three open questions. The following questions were asked: 1 - What was the biggest problem you encountered when using it? 2 - Would you use the technologies recommended by this in an event? Why/Why not? 3 - What are the positive and negative points of the application?

6 RESULTS AND DISCUSSION

In this study, the target audience was people who already have experience in organizing or producing some type of event. In total, the study collected data from six people who work in this context. The Table 2 presents the data of each participant together with which category of events they usually hold.

Table 2: Demographic data of participants.

Participants	Age Group	Sex	Type of events they usually hold	Amount of experience
Participant 1	31 - 35	M	Arts and entertainment Private events	5 to 10 years
Participant 2	41 - 45	M	Arts and entertainment Educational and scientific events Private events Recreational events	more than 10 years
Participant 3	46 - 50	M	Arts and entertainment Educational and scientific events Private events Recreational events	more than 10 years
Participant 4	46 - 50	F	Educational and scientific events Private events	0 to 5 years
Participant 5	18 - 25	M	Educational and scientific events Cultural celebrations	0 to 5 years
Participant 6	41- 45	F	Educational and scientific events Private events	0 to 5 years

The TAM evaluates the acceptance of the tool in terms of aspects such as the usefulness and intention of use. The results of the application of the TAM are presented in Figure 2, where it is possible to see the percentage of how the participants scored a certain acceptance item. The colors in Figure 2 differ according to the points of the scale, in which the most positive variation is represented by the variation of the green color and the most negative tends to more reddish colors. When the answer is neutral, it is represented by the gray color.

The interesting thing that can be analyzed through TAM is the perspective of the positive and negative aspects of the response of users. The first step of the validation questionnaire corresponds to the topic "perceived usefulness - PU" of TAM and has four affirmative questions. The second stage of the questionnaire corresponds to the "perceived ease of use – PEU" of the model. The last step of the questionnaire sought to directly evaluate the "intent to use - IU" of Techs4Events.

In the acceptance study reported here, considering the TAM questionnaire approach to evaluate the acceptance of Techs4Events, some elements need to be highlighted in relation to the opinion of the experts. The participants mostly seem satisfied with the results of the Techs4Events, however, when questioned in the interview or during the study, they highlighted some characteristics of the system as being negative points.

The first of these is the list of recommended technologies, for which some comments highlight that the highest percentage of some technologies did not match the entered criteria of the event, and this can be seen in the quotes: U1- "So I think I had no problem with the interface itself,..., I think it was missing an option to define a little better the type of event that each holds in order to come up with a suitable tool", U4 – "I do not know what was the answer that led to these first two technologies, but I do not know if it combines". These comments may be associated with the item (PU1) of the figure, which stands out for being the only item with a reddish variance. Thus, it was expected that the ratings related to utility would be lower, since more than one user highlighted this aspect as a negative point.

However, mostly represents positive satisfaction of the public, since positive comments on the recommended technologies are also taken into account. For example, the comment of U3 highlights "Having this in one place is a wonder. It is great for those who are organizing events", while U4 claims "You have a place where these tools and these suggestions are concentrated and it's very cool, because it is a lot of stuff, technologies that you did not even know existed."

A large part of the users highlighted missing options to represent their event, in particular, to define the types of events and audience types in more detail, U1 exemplifies this with a particular event situation, the audience remains very dispersed in the environment of the event. U4 already addresses a different perspective, about considering a criterion to measure the amount of users for the use of certain technology in the event. This is an understandable point of view, since some of the technologies presented are intended for large crowds, while others are not.

In addition to the general perception about the utility of the tool, it is important to analyze the ease of use of the tool in relation to aspects, such as usability and user experience. From Figure 2, it is noted that these criteria are mostly positive, however the item PEU2 has variances that deserve attention.

This reflection must be made because many users find it difficult to visualize the technologies, and this item is reflected in the comments of the participants during the study, as can be seen in the quotes: U2 – "It's a very long list. What do I do with so many options?"; U4 – "I think the biggest problem was the way you showed the possible technologies. I think that long list doesn't make it easy". However, some users did not have this same difficulty. U2, for example, comments that it was super easy to use the tool and added "in just over 1 minute, you already have the possibilities that would be better for your event".

It is noted that the main reason is a usability problem, and that this problem has affected the user experience in viewing the technologies, thus hinder-

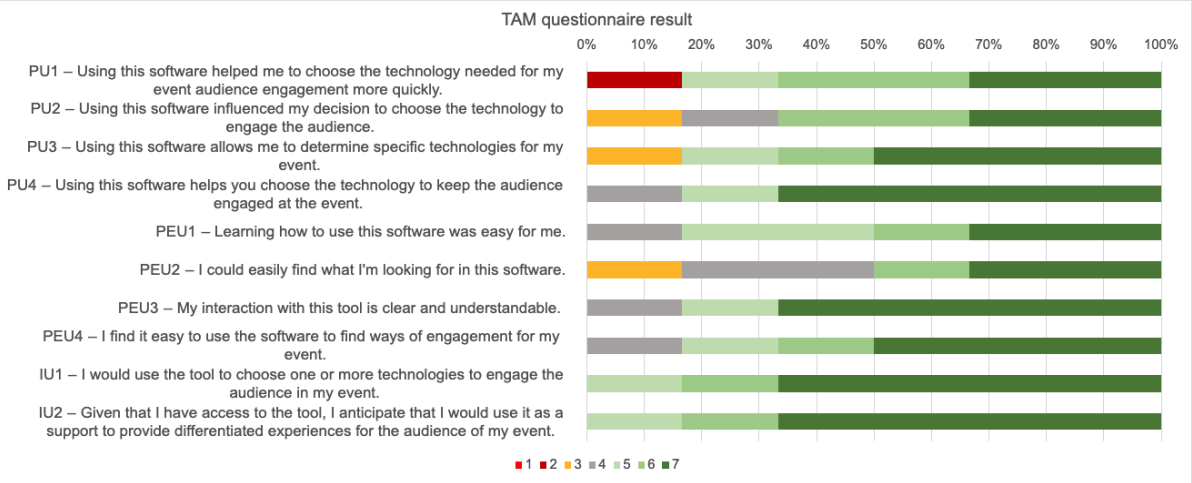

Figure 2: Acceptance questionnaire result based on the TAM model.

ing their satisfaction. From this issue, users suggested creating categories for technologies, or a filter where only technologies with compatibility above 70% would appear in the final results list.

On the other hand, it is noted that these results did not affect the intention to use the tool, since the attributes IU1 and IU2 received only positive marks, highlighting the tool as an interesting approach for experts.

Finally, although the interface was a confusing criterion from the point of view of some users, which was not the objective, the performance of the tool fulfills its role in recommending technologies, and is represented by the comments and acceptance of the tool using TAM. Among the improvements, the recommendation proposals need to be reviewed, as well as the implementing and improving new criteria for the relationship between events.

7 LIMITATIONS AND THREATS TO VALIDITY

The results presented in this paper reflect the experience of experts regarding the acceptance of a technology recommendation platform for events. Given this, a few necessary steps were followed in order to ensure that the research is completed correctly. However, during the acceptance process, possible limitations were identified.

The first reflects the current context of the COVID-19 pandemic, since when this study was conducted, event organizers spent a long period without holding physical events and were limited to only virtual events. This is also reflected in the application of the study, which was applied entirely online.

Besides, another limitation of this study refers to the low number of participants who evaluated the platform (six in total). However, the six were not ordinary users, all are specialists with experience in the production/organization of events.

Another limitation can be observed in the understanding of users regarding the presentation of criteria and problems in the interface, since some users had doubts about certain criteria and subcriteria, and highlighted problems in the description. To mitigate this limitation, researchers were available to answer any question from the users during the study.

8 FINAL CONSIDERATIONS

In the research presented here, we propose a triangulation of the classifications of technologies, events and audience, which is implemented in a functional prototype of a knowledge-based recommendation system, namely, Tech4Events.

The validation test was developed with six event promoters. At this stage of the process, we realized that the tool fulfills its proposed objective and that it had great acceptance by the target audience, which can be perceived in the data provided in Section 6. In addition, it was also possible to realize that improvements are still needed, with regard to the system interface, since a significant portion of the test participants pointed out this factor as something that should be improved. This will be the next stage of our research, and will be carried out with the development of an interaction model.

Despite the need, as predicted by the authors, for an interaction model, the objective of the validation

carried out in Phase (iii) was to verify that the recommendation met the demands of the organizers, a mechanism that was validated. Additionally, the experts participating in the survey classified the proposal as innovative and useful, thus revealing the potential of Techs4Events as an innovative system.

From the tests, it was possible to plan future goals, among them, improving the way the tool communicates with the end user and reorganizing the way the software provides the final information. (list of recommended technologies). Among the suggestions from the participants, grouping the technologies by common categories and improving the calculation of the compatibility of technologies with the event are high priority points in the list of future improvements.

Thus, Techs4Events was considered satisfactory, achieving great acceptance from the users participating in the tests and proved to be functionally effective and relevant.

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