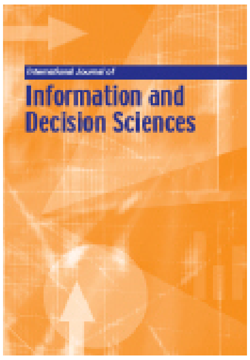

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D4SP – decision support system based on the use of the AHP method for science park selection

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Abstract: The literature reveals that science parks offer numerous benefits and support services to the activity of a technological startup. However, the decision of choosing the best science park for the startup tends to be an informal process, technically not very rigorous and planning, arising essentially by affinities with the research centre and university. In this study, a decision support system is presented to support entrepreneurs in the process of selecting a science park for the implementation of their startup. The AHP method is used to compare the importance of the criteria for selecting a science park, which includes factors such as location, activity sector, infrastructure, cost, and size. The findings reveal that the use of this decision support system helps entrepreneurs to find a science park that is suitable for the needs of their startup and allows them to comparatively identify the most relevant criteria when choosing a science park.

Keywords: entrepreneurship; decision science; analytical hierarchy process; AHP; startups; new venture; science park.

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1 Introduction

Entrepreneurship has been prominent due to its role in society and the opportunities it generates for economic and social development (Neumann, 2021; Zahra and Wright, 2016). It has been constituted as a differentiated and valued creation service, which involves the dedication of time, effort, and risk on the part of the entrepreneur. The concept of entrepreneurship means to undertake, to solve a problem or complicated situation (Hayes, 2021). It is a term that has a high application in the business field namely related to the processes of creating new companies or new products. Studies by Frederiksen and Brem (2017) and Shepherd et al. (2021) demonstrate that entrepreneurship is essential in societies because it is through it that companies seek innovation and transform knowledge into new products or services.

In the process of entrepreneurship, a key decision that entrepreneurs face is the location of their new venture. These new businesses, in an initial phase of activity, have limited resources and need support and constant monitoring, which leads to the existence of more favourable places to set up their activity. Several alternatives emerge, such as science parks, research parks, incubators, etc. Science parks offer services that support the entrepreneur from the stage when the business is just an idea to the market entry and growth stages. According to Lamperti et al. (2017), science parks promote a culture of innovation of companies in the region by connecting new entrepreneurs with other companies already consolidated in the market. Several services can typically be found in a science park, such as pre-incubation services, incubation, acceleration, co-working, event space, research space, etc. These services are offered directly by the science park or through ecosystem partners.

A key factor that differentiates science parks from traditional industrial clusters is their link with universities and research units (Cadorin et al., 2021). This view is confirmed by Almeida (2018) who emphasises the relationship between science park-based startups and universities. Therefore, science parks act as catalysts for economic growth through their contribution to innovation and, consequently, to the development of high-tech companies.

The contribution of science parks to startups is evidenced in several studies. Zeng et al. (2010) note that the environment and services offered by science parks foster innovation. In the same line of research, Jamil et al. (2015) mention that startups installed in science parks are more likely to carry out knowledge transfer with universities or other higher education institutions. McAdam and McAdam (2008) advocate that companies set up in science parks are encouraged to develop their business by including newer technologies. Finally, Harlin and Berglund (2021) state that the services provided by parks are relevant in helping startups become more sustainable in the long run. Therefore, it is through the improvement and creation of these services that science parks can grow.

Science parks play an important role in leveraging the capacity of startups in the region where they operate. However, choosing the right science park is essential to maximise the company's performance and extract its full potential. Hasty choices can lead to false expectations and unattained goals. Moreover, entrepreneurial activity is a high risk given the low survival rates of a startup in the first years of activity (Zapata-Guerrero et al., 2020). Offering a decision-making process supported by information technology has the potential to reduce this risk. Accordingly, decision support systems (DSS) can play a relevant role as shown in the studies conducted by Ghita (2014) and Martins et al. (2019) in the decision-making process in the entrepreneurship field. DSSs help in making an informed and clear decision since all the information is always available and allows an objective analysis. This study presents the development of a DSS aimed at entrepreneurs starting their business activity and who need help in choosing an ideal science park given the specificities of their startup. This approach is innovative and offers significant practical contributions since the process of choosing a science park is still too informal and can inhibit a startup from growing and succeeding in the market. This DSS employs the analytical hierarchy process (AHP) to capture the needs of each entrepreneur and involve the user in the decision-making process. The application also supports the inclusion of new science parks, editing and importing their technical attributes, performing simulations, and accessing the history of performed simulations.

The rest of this manuscript is organised as follows: First, a theoretical contextualisation on the decision-making process, and the role of a DSS for university management are performed. After that, the methodology of the study is described. Also, in this section, the architecture and requirements of the prototype are presented. Subsequently, the results are presented and discussed considering their relevance to entrepreneurial activity. Finally, the conclusions are summarised, and the implications of this work and its limitations are explored.

2 Background

Making decisions is part of our everyday life and we are constantly forced to make them, which have an impact in the short, medium, and long-term. Everything that is accomplished, consciously or unconsciously, results from a decision. Alvino and Franco (2017) state that decision-making is typically based on the relationship between emotion and reason. Rational and irrational decisions making have been addressed based on perfect rationality and bounded rationality theory in the case of incomplete information (Ransikarbum and Mason, 2016a, 2016b). Decisions are not easy to make because they entail risks, negotiations, costs, and dissatisfactions. Additionally, the decision-making process is influenced by the context (e.g., risk, uncertainty, ambiguity) in which decisions are made (Geisler and Allwood, 2018). However, more rational methods lead to more logical decisions, while emotional decisions are faster (Lerner et al., 2015).

DSS emerged motivated by the need to increase decision efficiency and assist managers in decision making. These are tools normally used in negotiation processes and that involve elements from top management to analysts and other intermediate elements of the negotiation chain. A key feature of a DSS is its role in supporting and not replacing the decision-making role of managers in solving problems (Chen and Koufaris, 2015). Therefore, the capabilities of decision-makers are extended through the use of DSS in situations of poorly structured decisions. In a DSS, the decision process occurs through the user's interaction with a special decision support environment created to find solutions to the decisions to be made. In finding these solutions, specialised knowledge bases and artificial intelligence models can be used.

A DSS is composed of several subsystems. Sauter (2011) organises these components into four areas:

1 data management subsystem
2 model management subsystems
3 knowledge management subsystem
4 user interface subsystem.

The data management subsystem includes the database that should contain the data relevant to the situation/problem at hand. The model management subsystem may include various models such as statistical, financial, and optimisation, which provides the system with fundamental analytical capabilities. The knowledge management subsystem is optional but is used as a tool to increase the capability and learning of a DSS. The user interface subsystem is responsible for managing user communication. It is an essential component due to the need to provide an environment with high interaction (Corso and Löbler, 2011).

Currently, companies are forced to improve and enhance their products and services, due to the degree of customer demands for more affordable and efficient products and services (Almeida, 2020; Gupta et al., 2016). DSS has been used in several domains such as manufacturing, logistic, and public transportation (Puchongkawarin and Ransikarbum, 2020; Ransikarbum et al., 2020). With the speed of information propagation, companies are forced to be able to keep up with this healthy competition, as this information can be received and perceived by competitors. The fear of choosing a wrong option may lead managers to try to justify their decisions, demanding more information or assessments, and thus the decision becomes more expensive, both in terms of time and financially. It is in this scenario that decisions should be made as quickly and efficiently as possible.

DSS can be used by universities at the management and administrative level. They can be used as a vehicle for dialogue between university managers, teachers, and students on socio-economic aspects. They can also prove useful in helping universities align their goals with classroom designs and directives, curricula, and pedagogy. Table 1 aims to summarise the various areas of incidence of DSS in university management. In Mansmann and Scholl (2007), they are used for the analysis of teaching load (e.g., lectures, tutorials, seminars, labs). In Kanojiya and Nagori (2016) a prototype of a DSS is developed for selecting an appropriate pedagogy to improve the teaching experience and student assessment in a course considering the formative and summative dimensions of learning. However, the adoption of a DSS may also cover other components of the university, namely the third mission, in which it is established that the pedagogical mission of universities should be complemented by its research and technology and knowledge transfer aspects. In this context, proposals for DSS in university management have emerged that include the research dimension. Gorgan (2015) proposes a modular structure of a DSS in which the components of scientific production evaluation and research grants appear; while Bresfelean and Ghisoiu (2009) introduce the component of scientific evaluation of the activity of PhDs and identify performance issues related to scientific research evaluation. Concerning the technology transfer component, some studies that address this phenomenon also appear. Aziz et al. (2012) suggest the adoption of a DSS for the management of intellectual property (IP), which includes several components such as the estimation of the duration of the IP's useful life, total cost of the process, degree of protection, among others; while Basnet (2006) proposes a DSS to help in the process of managing the costs associated with the payment of fees to protect the IP. The application of a DSS in the third mission of the university has privileged the management of IP. However, the third mission includes other components such as the management of business partnerships, advanced training specific to the business sector, or the creation of university spinoffs. However, in this last dimension, there is not a DSS to help universities and future entrepreneurs in managing this process, especially to assist them in finding science parks for the establishment of their startups.

Table 1 Adoption of DSS in the context of university management

Study	*Scope*	*Objective*
Aziz et al. (2012)	Technology transfer	IP management (e.g., protection, useful life, costs of the process)
Basnet (2006)	Technology transfer	IP management (e.g., costs management)
Bresfelean and Ghisoiu (2009)	Scientific	Evaluation of PhDs performance and identification of performance-related issues
Gorgan (2015)	Scientific	Evaluation of the scientific component and the use of scientific grants
Kanojiya and Nagori (2016)	Pedagogical	Improve teaching experience and assist teaching assessment
Mansmann and Scholl (2007)	Pedagogical	Management teaching loads

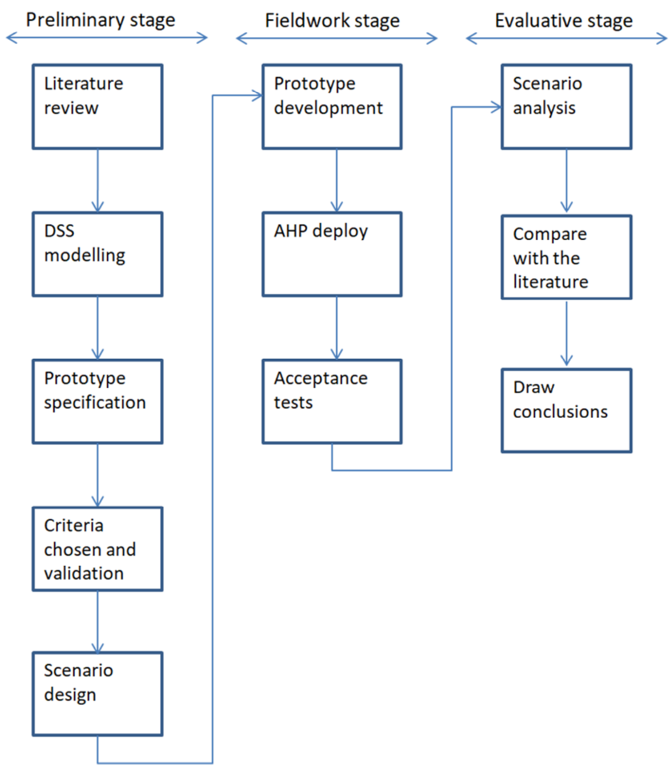
Although DSS have been applied in recent years in the context of academic management and in IP management, there is no study that presents a DSS to support an entrepreneur in the process of choosing a science park for the establishment of his/her startup.

3 Methodology

3.1 Research design and methods

The research design is organised into three main phases as depicted in Figure 1. In an initial phase, designated as the preliminary stage, a literature review is performed in the field of DSS and application of the AHP method. This is followed by the modelling of the DSS considering the various alternatives and criteria that are then mapped into the AHP method. Next, the prototype is specified considering its architecture, functional requirements, and non-functional requirements. Furthermore, the criteria for choosing the location of a science park were specified. Technology transfer officers from the universities and the science parks collaborated in this process by conducting two interviews in the initial identification phase of these criteria and in their final validation. The last stage of this phase involves the design of test scenarios that will be crucial in the evaluation phase to evaluate the project. The second stage involves the functional development of the prototype over a period of approximately three months. Also, in this phase, the AHP method in C# is deployed. Acceptance tests were defined and executed to assess the level of compliance with the previously established requirements. The last phase, entitled evaluative stage, is responsible for the analysis of the results of two application scenarios of this prototype, the results obtained are compared with the literature in the field, and the conclusions of the study are presented.

Figure 1 Phases of the research design (see online version for colours)



The grounded theory and action research were used as fundamental methods for the analysis of the results of this study. According to Abdel-Fattah (2015), the grounded theory allows knowing the reality from the knowledge of the perception that a certain context or object has for the person. The purpose of grounded theory is the construction of a theory based on the data investigated on a certain object of reality that is obtained inductively or deductively. Next, this data is settled into conceptual categories that, when established, can explain the phenomenon. Behaviours are studied at the symbolic and international level and must be observed in the environment, given that meanings are derived from social interaction (Timonen et al., 2018). Grounded theory was a key element in this study for capturing the functional and non-functional requirements of the prototype.

The action research was used as a complementary method to grounded theory to explore the relevance of the results obtained for the entrepreneur. It was considered an interpretative action research which according to Coghlan (2019) allows to interpret the entrepreneurial reality as socially constructed and considers local and organisational factors. These elements are key in this study as it allows consideration of various scenarios of prototype use. The evaluation of the prototype looked at two key functionalities:

1 inclusion, editing, and removal of science parks

2 performing a simulation that allows obtaining information about the most suitable science parks for the entrepreneur.

In the latter case, several criteria considered relevant by the entrepreneur were included. This evaluation is performed by the entrepreneur considering the AHP method, in which the relative importance of each criterion is subjectively evaluated by the entrepreneur. This is a fundamental element in a DSS and allows the suggestion of the best science parks to be dynamically adjusted considering the entrepreneur's opinion and perception.

3.2 The AHP method

Nowadays organisations deal with increasingly complex and unstructured problems. The number of variables is high, and it is not always easy to determine a priori the importance and priority of each of them. As a result, the current situation presented in several decision problems is subjective and difficult to solve. Considering these premises, it is fundamental to find a methodology capable of creating complex but organised structures that allow the interaction between factors, and that incorporates the user's thoughts about the various criteria and alternatives. The multicriteria decision model known as Analytic Hierarchy Process (AHP) is highly capable of solving this type of organisational problem (Kulakowski, 2020).

The AHP is a method that can be used to compare a set of alternatives that require user involvement with the goal of supporting decision-making in complex and real environments (Chaiyaphan and Ransikarbum, 2020; Khamhong et al., 2019; Ransikarbum and Kim, 2017). It is a relatively intuitive and easily applicable method that seeks to prioritise the various alternative solutions and makes it possible to structure a problem in a hierarchy. Comparisons are performed pairwise, producing a relative weight at each level of the hierarchy; the weights are then combined using an additive value model to produce a set of overall weights or priorities for the alternatives. In the end, the alternatives can be ranked based on their overall weights calculated by the AHP.

The AHP is divided into four main phases (Vaidya and Kumar, 2006):

1 formalisation of a structural hierarchy with several levels, according to the characteristics of the elements

2 binary comparison between criteria and subcriteria considering a given characteristic according to the fundamental scale

3 generation of priority vectors

4 verification of data consistency.

The binary comparison of the relative importance of each criterion and alternative can be performed using the Saaty scale. This scale proposed by Saaty (2000) determines the relative importance of each of the alternatives relative to another using a scale of 1 to 9 (i.e., equally preferred, moderately preferred, strongly preferred, very strongly preferred, and extremely preferred). Saaty suggests that the even numbers on the scale should only be used when there is a need for negotiation among the raters and when natural consensus is not obtained, thus generating the need to determine a midpoint as a negotiated or compromise solution. In this way, odd numbers are used to ensure a reasonable distinction between the measurement points.

The AHP begins by creating a comparison of the weights of the different criteria to create a comparison matrix *a*. The number of judgments needed to construct a generic judgment matrix *a* is $n.(n-1)/2$, where n is the number of elements belonging to this matrix. This matrix is symmetric considering the number of comparative judgments made using the Saaty scale. Each entry of the matrix (a_{jk}) is calculated as:

$$\overline{a_{jk}} = \frac{a_{jk}}{\sum_{l=1}^{m} a_{jk}} \tag{1}$$

The weight vector criterion w is determined by averaging the entries in each row, as shown below:

$$w_j = \frac{\sum_{l=1}^{m} \overline{a}_{jl}}{m} \tag{2}$$

Finally, the AHP method applies to each matrix the same two-step procedure described for matrix *a*. Finally, the scoring matrix *s* is obtained for each criterion. After obtaining the vector *w* and the score matrix *S*, a vector *v* with the global scores is obtained by:

$$v = s \times w \tag{3}$$

3.3 Prototype

In developing the D4SP, both functional and non-functional requirements were considered as proposed by Sommerville (2015). Functional requirements serve to indicate the functionality that a software system should provide, while non-functional requirements address limitations in the services or functionality offered by the system based on a set of parameters (e.g., number of transactions, processing time, security).

Table 2 presents the functional requirements implemented in the D4SP prototype. For each requirement, a brief description is presented, and the actors involved are indicated. Two actors were defined:

1. entrepreneur that assumes the customer perspective of the system
2. administrator that is responsible for the management of the science parks.

Two of the most innovative aspects of this application are the process of management and inclusion of new science parks that can be proposed by these entities or the users, and the simulation process of choosing the most appropriate science park for the inclusion of a startup. The choice of location considers both the personal preferences of its founders and the characteristics of a new business. As recognised in Cadorin et al. (2020) one of the missions of science parks is to attract talent and expertise in knowledge areas, hence they aim to attract startups in their main areas of expertise.

Table 2 Functional requirements

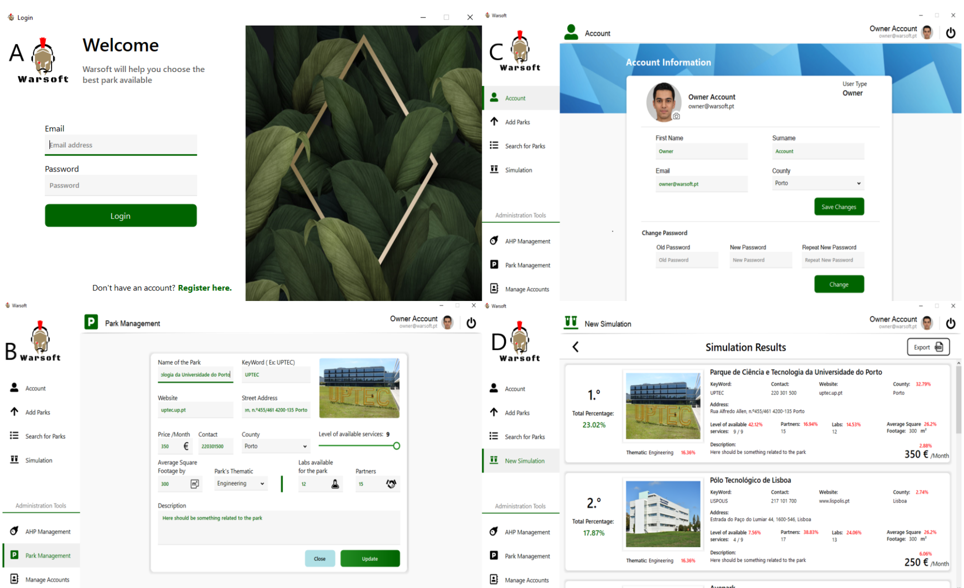
Requirement	*Actor*	*Description*
Authentication	Entrepreneur administrator	The entrepreneur logs into the application considering that he/she already has a valid account with the respective username and password.
Register	Entrepreneur administrator	The application supports the registration of new administrators. The requested data includes name, startup county, email, and password. The administrator validates the creation of new accounts.
Draw dashboard	Entrepreneur	The entrepreneur has access to system functionalities such as suggesting the inclusion of new parks, searching for parks, and performing a new simulation.
Profile access	Entrepreneur	The entrepreneur can change his personal data (e.g., name, password, county of the startup).
Management of science parks	Entrepreneur administrator	The administrator is primarily responsible for managing the data regarding the science parks (e.g., name, characteristics, location, costs). However, the entrepreneur can suggest to the administrator the inclusion of new parks. This allows the application to have up-to-date information about new parks that have appeared or whose conditions have changed in the meantime.
Perform simulation	Entrepreneur	The entrepreneur performs a simulation to find the most suitable science park for his/her startup. This process includes three steps: 1 selecting the criteria 2 comparing the importance of the criteria using the Saaty scale 3 visualising the results. Through this approach, the importance of each criterion is not predetermined by the application but is customised by each user. This customisation considers both the user's personal preferences and the characteristics of each business.
Export simulation	Entrepreneur	The entrepreneur can export each simulation performed to a '.csv' file.

Regarding the non-functional requirements, dimensions such as usability, reliability, security, scalability, and performance were considered. The access to the functionalities provided by the application should be intuitive and offer a pleasant user experience according to the framework proposed by Zarour and Alharbi (2017). Reliability should be guaranteed by providing updated and reliable data on science parks. The application should also permit the introduction of new functionalities without the need to restructure the application architecture. The simulations should be efficient and enable simultaneous access by multiple users. Finally, the security of access to the data stored in the database must be guaranteed. The framework proposed by Basharat et al. (2012) was adopted in which the security of an IT application is measured considering dimensions such as privilege evaluation, SQL injection, weak authentication, backup data exposure, among others.

The D4SP architecture is supported on several technologies such as Visual Studio 2017/2019 C#, Windows Presentation Foundation (WPF) and Windows Forms, Language-Integrated Query (LINQ), SQL Server 2017 Express, and XML, XML Schema Process, and DOM/SAX Parser. These technologies were chosen because they can be used in a Windows 8/10 environment. SQL Server was employed because of its ease and performance in integration with Visual Studio. LINQ technology was also used for application communication with the database, and XML/XSD and associated parsers were applied for reading and writing XML files with science parks.

Figure 2 shows four interfaces offered by the application. In the upper left corner (i.e, A label) is the login window, in which the user's email and password are requested as access credentials; in the upper right corner (e.g., C label) is the user account management (e.g., name, county, password); in the lower left corner (i.e., B label) is presented details about the science park (e.g., name, website, address, price per month, level of available services, number of labs, thematic fields); in the lower right corner (i.e., D label) is presented the simulation result, in which the parks are ordered decreasingly by their aptitudes towards the entrepreneurs' needs.

Figure 2 Interfaces of D4SP (see online version for colours)



4 Results

The prototype was tested considering the existence of several science parks in the database. Fifteen science parks associated with the Portuguese Association of Science and Technology Parks were included. However, a smaller number of parks were considered in the realisation of the scenarios for the purpose of this manuscript to facilitate the understanding of the decisions made by D4SP. Due to confidentiality reasons, the name of the science parks was omitted and replaced by the acronym 'SP' in the comparative performance assessment tables of the science parks. Two scenarios were considered:

- Scenario I: the existence of only two criteria, which allows us to easily explore the impact of the importance given to each criterion in the choice of the science park
- Scenario II: the existence of four criteria, which meets the recommendations of Russo and Camanho (2015), in which it is recommended that the number of criteria in the AHP method should be low, typically less than seven.

The number of alternatives considered in each simulation was equal to the number of alternatives to obtain square matrices of dimension n*n. A sensitivity analysis was also performed, which according to Wallace (2000) is fundamental for the effective implementation of quantitative decision models. Through this approach, it is intended to assess the stability of the solutions obtained in each scenario considering changes in parameters. The application of sensitivity analysis to the AHP method enables the identification of the most critical criteria and performance measures in the model (Sulistio et al., 2018).

4.1 Scenario I

Table 3 presents the three matrices that are loaded into the software and that enable comparison of the importance between the criteria and the relative performance of the science park on each criterion. The user has the possibility to select the criteria to perform the simulation. Two criteria were considered: location (LZ), and installation cost (IC). Two science parks were considered: UPTEC which is located in Porto, and Creative Science Park located in Aveiro. The distance between Porto and Aveiro is relatively short implying a travel time of less than one hour both by car and train. The entrepreneur lives in the city of Porto and considered that the LZ is slightly more important than IC. Considering this scenario, and regardless of the comparative evaluation in relation to IC, the choice always falls on SP1. The software determines the relative weight of the science parks as shown in Figure 3. The principal eigenvalue is equal to 2 and the CR is equal to 0% considering that it was only performed one comparison between the criteria.

Table 3 Scenario I

Criteria			*Alt. (criterion 'LZ')*			*Alt. (criterion 'IC')*		
	LZ	*IC*		*SP1*	*SP2*		*SP1*	*SP2*
LZ	1	3	SP1	1	3	SP1	1	1/9
IC	1/3	1	SP2	1/3	1	SP2	9	1

Figure 3 Decision for scenario I (see online version for colours)

4.2 Scenario II

Table 4 presents the matrix with the comparison between the criteria; and Table 5 with the comparison matrix between the alternatives for each criterion. Four criteria were considered: location (LZ), IC, level of services available (SL), and parquet size (PD). LZ is slightly more important than IC and SL, but significantly more important than PD; IC is equally important to SL, but slightly more important than PD; and SL is slightly more important than PD. Four science parks were considered: (SP1) UPTEC, located in Porto; (SP2) Creative Science Park, located in Aveiro; (SP3) Avepark, located in Guimarães; and iParque, located in Coimbra. The distance from Porto to Aveiro and Guimarães is identical, while for Coimbra the total distance increases by about 50%. In the remaining criteria, it was considered an extreme importance of all parks concerning SP1. The inputs of this scenario lead to the choice of SP1 as visualised in Figure 4 (case A). However, the assignment of two on the Saaty scale between LZ, IC, and SL changes the final decision in the choice of science park to SP2 and SP3, since both get the same final score as visualised in Figure 5 (case B). The principal eigenvalue is equal to 4.044 and the consistency ratio (CR) is equal to 1.6%, which is an acceptable value considering the vision of Liu et al. (2017) that recommend a CR below 10%.

Table 4 Scenario II – criteria comparison

Criteria				
	LZ	*IC*	*SL*	*PD*
LZ	1	3	3	5
IC	1/3	1	1	3
SL	1/3	1	1	3
PD	1/5	1/3	1/3	1

Figure 4 Decision for scenario II – case A (see online version for colours)

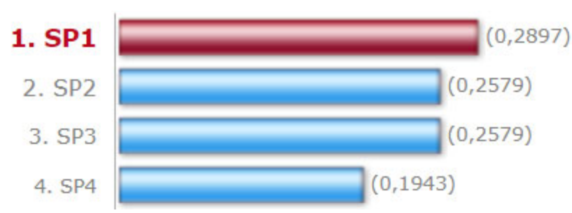


Figure 5 Decision for scenario II – case B

Table 5 Scenario II – alternative's comparison

Criterion 'LZ'					*Criterion 'IC'*				
	SP1	*SP2*	*SP3*	*SP4*		*SP1*	*SP2*	*SP3*	*SP4*
SP1	1	3	3	5	SP1	1	1/9	1/9	1/9
SP2	1/3	1	1	3	SP2	9	1	1	1
SP3	1/3	1	1	3	SP3	9	1	1	1
SP4	1/5	1/3	1/3	1	SP4	9	1	1	1
Criterion 'SL'					*Criterion 'PD'*				
	SP1	*SP2*	*SP3*	*SP4*		*SP1*	*SP2*	*SP3*	*SP4*
SP1	1	1/9	1/9	1/9	SP1	1	1/9	1/9	1/9
SP2	9	1	1	1	SP2	9	1	1	1
SP3	9	1	1	1	SP3	9	1	1	1
SP4	9	1	1	1	SP4	9	1	1	1

5 Discussion

Science parks do not always meet the expectations of entrepreneurs. When a new science park is created, high expectations arise from universities and incubators that look to the park as the solution to all existing problems and needs. Science parks involve a complex interaction of different factors that increase their ability to achieve their goals. The main factors highlighted in the literature are knowledge creation, value-added services, territorial influence in regions, and networks with other parks, companies, investors, etc. (Balle et al., 2019; Theeranattapong et al., 2021). These factors are instrumental in attracting new startups (e.g., corporate startups, university spinoffs) and developing the incubated companies. The DSS developed in this work addresses this phenomenon by offering a technological platform that can be used by entrepreneurs to know the main characteristics of science parks in their region and, through the use of the AHP method, they can be advised on the most suitable science park for their new venture. The adoption of this platform is an advantage over the isolated adoption of expert choice software that uses a multi-criteria decision process like AHP because one of the differentiating factors of this DSS is the inclusion of comparative information about science parks. Furthermore, it allows an entrepreneur to know the various science parks available in his/her geographic region and gather the relevant importance of the criteria for that entrepreneur considering his/her personal preferences and business characteristics.

The creation of a science park necessarily involves a decision of commitment by a set of public and private actors that are key to the economic development of the region where the science park is installed. These actors are very diverse, including both governmental agents and local, regional, or national agents. Universities and their technology transfer offices are also involved (Weckowska, 2015). However, the perspective of a new venture is typically not heard, and the attractiveness of a science park is typically only gauged after a few years of activity. This DSS can also be a relevant source of knowledge about the motivations of entrepreneurs in a science park and thereby increase the regional and national competitiveness of science parks. Therefore, the economic specificities of each region are recognised, so that the success factors of a science park in one region may be different from another.

When choosing a science park, several factors must be taken into consideration. Most of these factors are of subjective analysis and interpretation by each entrepreneur, often related to the particularities of their business (e.g., sector of activity, internationalisation, support services). Several factors emerge in the literature such as location, quality of environment created, and area of expertise (Helmers, 2019; Mansour and Kanso, 2018). The location of installation of a new venture is fundamental because from the moment it is decided to establish a new venture in a science park, the decision becomes irreversible. The choice of the location where a new venture will be installed goes through a set of physical, economic, and socio-cultural variables. When we talk about physical variables, we are considering aspects that involve not only the infrastructure of the park itself but also its surroundings (e.g., accessibility and transportation network that allows quick access to the park). In this sense, D4SP included criteria related to the park location and accessibility.

The cost of installation is another determining factor in the choice of a science park. This may be a factor that can inhibit a new venture from setting up in science parks with higher monthly costs. The IC are associated with the quantity and type of services offered by a science park. Science parks can be expected to offer a wide range of services including physical space, advisory services, business training, financial support services, research assistance, secretarial support, etc. (Lose and Tengeh, 2016). In line with these factors, two criteria were included in the D4SP:

1. the costs of setting up in the science park
2. the levels of services available.

These two factors were considered separately because the costs of setting up in a science park are not exclusively determined by the LS available.

Finally, and as evidenced by Lecluyse et al. (2019), science parks assume a key role in the development of R&D activities and knowledge transfer. In this sense, the area surrounding the science park must have a qualified workforce that allows it to develop these functions. Therefore, D4SP included a criterion related to the size of the park that groups several elements such as the existence of a qualified workforce, the attractiveness of the park, and the existence of higher education institutions in the region. The literature confirms the role of universities in a science park since they play a central role in the R&D activity and contribute to the functions of a science park (Benneworth and Ratinho, 2014; Farré-Perdiguer et al., 2016). However, this does not mean that a science park has to be integrated into a university campus, but the park must create conditions that allow it to attract higher education institutions, whether they are more or less distant from the chosen location.

6 Conclusions

Before setting up a new venture, entrepreneurs need to consider and make several decisions, among them the choice of where the company is to be located. This decision is not only for large industrial plants or traditional public service stores. Startups and technology-based enterprises need appropriate environments that stimulate innovation and the consequent improvement of processes. The idea of installing a new venture in a science park is precisely to meet specific needs, offering numerous benefits such as fostering collaboration between startups, a strong relationship with universities and R&D centers, generating qualified jobs, and promoting environments that stimulate innovative activity.

However, choosing the best science park to locate a startup is a complex decision with a high impact on the startup's future. Several relevant factors arise when choosing the most suitable science park for each startup, such as location, activity sector, infrastructure, cost, and size. The DSS developed in this work, called D4SP, allows the entrepreneurs of each startup to comparatively evaluate the importance of each of these criteria using the AHP method, and through the use of this technological application, it becomes possible to identify the most suitable science park for the startup.

This study essentially offers relevant practical contributions. Although the use of the AHP method is widespread in the industrial sector, its application in the field of entrepreneurship is still residual and emergent. Furthermore, this is an innovative project by offering entrepreneurs a DSS that allows them to reduce the risks associated with the initial phases of establishing a new venture. The D4SP can be used by entrepreneurs from two perspectives: in-depth knowledge about the science parks available in their country and region, and obtaining suggestions for locating their startups in science parks considering the opinion of entrepreneurs. Furthermore, this work is also relevant for university institutions and technology parks. Universities can adopt the D4SP to support students and graduates who want to create their own business. Science parks can also use this platform to learn about the characteristics of science parks that are most valued by entrepreneurs. This gives them information to improve the conditions and services offered. This work presents some pertinent limitations. Science parks need to be previously uploaded into D4SP and comparatively evaluated. In this sense, specialised knowledge is required to upload this information. Another limitation is that a sensitivity analysis of the presented solutions was not performed, i.e., the user does not have the perception of what is the relative weight of each criterion in the suggestion of the presented science parks. As future work, it is planned to adopt the D4SP in the technology transfer offices of universities. It is also relevant to adapt this project to a web and mobile application that can be accessed remotely by entrepreneurs.

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