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Tri-Collab: A Machine Learning Project to Leverage Innovation Ecosystems in Portugal

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Abstract: This project consists of a digital platform named Tri-Collab, where investors, entrepreneurs, and other agents (mainly talents) can cooperate on their ideas and eventually co-create. It is a digital means for this triad of actors (among other potential ones) to better adjust their requirements. It includes an app that easily communicates with a database of projects, innovation agents and their profiles, and the originality lies in the matching algorithm. Thus, co-creation can have better support through this assertive interconnection of players and their resources. This work also highlights the usefulness of the Canvas Business Model in structuring the idea and its dashboard, allowing a comprehensive view of channels, challenges and gains. Also, the potential of machine learning in improving matchmaking platforms is discussed, especially when technological advancements allow for forecasts and match people at scale.

Keywords: innovation; machine learning; digital platform; collaboration; co-creation

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1. Introduction

This business project consists of the development of a digital platform, named "Tri-Collab", where a main triad of actors—investors, entrepreneurs and talents—receive support for closer and assertive collaboration with potential for co-creation. Other innovation agents could be thought of and included. This work also intends to make known the Canvas Business Model (CBM) for fast innovative project assessment. And it appraises the potential of machine learning in improving its underlying algorithm.

Its name (Tri-Collab) has to do with the fact that the platform is a means for those three main types of innovation agents to collaborate and/or co-create more assertively in the development of ideas. This kind of digital support to entrepreneurship and innovation can be applied to any sector (e.g., tourism, services, health, etc.). A brief description of the main triad is as follows:

- Investors (private, incubators, etc.), who want to find projects to support and/or invest in them;
- Entrepreneurs with ideas/projects, who need investors and/or other agents with the desired skills;
- "Talents", which can be, for example, students or researchers, who would like to integrate projects that match their experience and skills.

Other related works [1,2] have explored this multidimensional construct in terms of platform dependence, scalability and need of algorithmic governance, but not in terms

of matching processes. Hence, the proposed project aims to fill some gaps in this regard, namely to integrate resources and agents more assertively to leverage innovation and the creation of high-value services. Therefore, for assertive collaboration and eventual co-creation, the platform and supporting technologies must safeguard the algorithm so that it prepares an effective matching between the stakeholders involved and their profiles/requirements. This will open various paths of their resources' combination to nurture co-creation, co-investment, among other forms of entrepreneurship and service innovation.

1.1. The Portuguese Entrepreneurial Ecosystem

The Portuguese entrepreneurial ecosystem has shown clear signs of growth in recent years and is increasingly seen as a priority public investment for the development of the country's economy. There remains, however, a lack of knowledge on how to access all the existing opportunities in the ecosystem. One reason is related to a considerable lack of digital literacy [3,4], the ability to effectively use digital technologies to access, manage, evaluate, and create information. The existing digital illiteracy is higher toward the most recent technological developments, such as IoT (Internet of Things), cloud computing, ubiquitous computing, AI (Artificial Intelligence), AR (Augmented Reality), among others. Another issue also includes the often non-consideration of the national/global innovation indexes by the entrepreneurs and other innovation agents [5].

The present work resulted from detecting the aforementioned issues, as an opportunity to create a digital platform that can bring together, in a single place (online), all the intervening agents—entrepreneurs with their ideas/projects; public/private investors; and other people who wish to integrate and collaborate in the chosen projects according to the adequacy between their capabilities and the requirements of those projects. The originality here is associated with the matching between the profiles of the actors involved and with the technological characteristics of the supporting platform, especially the underlying algorithm for adequate automatic correspondence between them.

1.2. The Summary Innovation Index (SII)

An important aspect for Portuguese entrepreneurs and investors (among other involved agents) to consider is the national profile of innovation so that, for instance, the new ideas can be adjusted to the country's major needs on the matter. Some indexes that can provide this information are the GII (Global Innovation Index) and the SII (Summary Innovation Index). These are both used to measure a country's innovation performance, but they differ in their focus and scope. GII is a broad global index published by the World Intellectual Property Organization (WIPO), focusing on a wide range of innovation indicators across various economies (ranking the innovation performance of around 130 economies). The SII, on the other hand, is a more focused index, often used within specific regions like Europe or within a specific country like Portugal. The EIS (European Innovation Scorecard) results can help reveal which dimensions of national innovation systems are weak or strong, helping entrepreneurs and policy makers to adapt their strategies. As in previous years, [5] categorizes countries into four innovation groups based on their scores: Innovation Leaders (performance above 125% of the EU average), Strong Innovators (100% to 125%), Moderate Innovators (70% to 100%) and Emerging Innovators (below 70%).

Denmark is the most innovative Member State, ahead of Sweden. Portugal is still positioned among the Moderate innovators. Table 1 shows the referred dimensions of SII for Portugal and their values. This brief contextualization is important for business managers to know what challenges and opportunities there are to better guide their projects.

Table 1. Indicators that make up the SII (Portugal).

Portugal—SII (Summary Innovation Index)	=91.8 (Moderate) Rank:23
Human resources	97.6
Attractiveness of research systems	115.7
Digital transformation	129.0
Financing and support	97.3
Private investments	56.1
Use of technologies	99.3
Internal Innovation	101.7
Connections	99.2
Intellectual assets	76.7
Employment impacts	88.2
Sales/exports impacts	63.6
Environmental sustainability	31.4

Source: [6].

In this composite index of national innovation, the strongest dimensions or variables of the Portuguese innovation ecosystem are direct/indirect government support of business R&D; public–private co-publications; and foreign doctorate students as a % of all doctorate students. However, other important dimensions must be analyzed and improved, as they are the most "fragile" in this innovation ecosystem, such as air emissions by fine particulates; innovation expenditures per person employed; and knowledge-intensive services exports. Other insights derived from this index are the strong increases since 2023, which occurred in the variables of employment in innovative enterprises; innovative SMEs collaborating with others; and sales of new-to-market and new-to-firm innovations. On the other hand, the strong decreases since 2023 occurred in the variables of job-to-job mobility of human resources in S&T (science and technology); knowledge-intensive services exports; and environment-related technologies.

Portugal has been offering a favorable environment for innovation and the attraction of talent. However, it is lagging in converting the acquired knowledge into sales and exports. On the other hand, there is a growing propensity for collaboration (links between companies and university–businesses links), but it needs to evolve especially at the level of public–private co-investment. Private investment in R&D has been low, making this activity more dependent on public incentives. In addition, it is lagging in terms of developing technologies related to climate change [5,6]. The technological convergence that projects related to smart platforms allow, like the present idea, can stimulate improvements in these metrics.

Additionally, the situation of startup companies can be a barometer of the entrepreneurship level in Portugal. A startup is an innovative company in its initial phase, with great potential for growth, usually related to technology. This type of company is of particular interest to Portugal, whose business environment focuses on small- and medium-sized enterprises (SMEs), given the current challenges around business digital transformation. A startup usually presents a creative solution to solve a certain problem/need and manages to grow quickly without increasing expenses proportionately.

Portugal had 4719 startups in 2024, 16% more than in 2023, which had a combined turnover of EUR 2602 billion. These are some of the first data from the report "Mapping Portugal's Startup Landscape 2024", developed by the market consultants IDC and Informa D&B, in partnership with Startup Portugal [7]. During the Web Summit in 2024, in Lisbon, Portugal was represented by a delegation of 125 startups, with more than half operating internationally. This represents an increase of 10 companies compared to the previous edition. In terms of areas of activity, the Information Technology sector is dominant with

63% of the startups. Startup Portugal highlighted this outcome, describing Portugal as a country that is becoming a hub for entrepreneurship in Europe and a magnet for talented digital nomads [8].

In terms of their geographical distribution, the districts of Lisbon (34%) and Porto (17%) concentrate most of all startups and their turnover. Setubal, Braga and Aveiro complete the top five districts [9]. Only younger companies, which have been in business for less than 10 years, have growth close to that seen in startups. In terms of activity, the segment of services represents more than 2/3 of startups' turnover, employees and exports, having their focus on consultancy and computer activities.

1.3. Identification of Problems in the Ecosystem

The previous analysis, in some of the main dimensions/variables of the national and regional innovation system, allowed us to identify problems that raised the opportunity to launch and develop the present project. To distinguish those problems according to the triad of actors that the project will relate and integrate, we highlight here the main reasons based on the consultation of the previous references.

Entrepreneurs refer to difficulties such as the following:

- Access to funding opportunities and investors;
- Lack of a network of contacts;
- Failure to gather technical and management skills that are crucial.

Investors report problems such as the following:

- Projects do not arrive in sufficient quantity and quality;
- Financial and digital illiteracy;
- The calls for projects receive applications below expectations.

The present project, "Tri-Collab", resulted from the detection of these challenges and, therefore, from the opportunity to create a digital platform that can bring together, in a single place (digital), the main agents involved—entrepreneurs with their projects/ideas; public and/or private investors; and other agents who wish to integrate and collaborate within the chosen project(s) according to the fit of their abilities/talent in its required profile of action (Figure 1).

Figure 1. Identification of the opportunity for this project (own elaboration).

Once the opportunity was identified, the project business plan was outlined, whose key steps are the application of the Canvas Business Model (CBM), followed by the design and development of the intended platform and app, for entrepreneurial collaboration and/or co-creation.

2. Materials and Methods

CBM is an innovative planning and management tool that helps entrepreneurs to develop their business models, using a visual representation of its main components. According to the research in [10], CBM has been widely used as a facilitating tool that allows for obtaining a holistic view of the business model and of opportunities for innovation. Although it is easier to prepare than a traditional business plan, it addresses all the elements that need attention.

Its structure consists of nine interconnected blocks that represent the fundamental elements of a business project, presented in a logical sequence of analysis—customer segments; value offer; channels; relationship with customers; income sources; key resources; key activities; key partners; and cost structure [11,12]. Figure 2 shows the CBM obtained, based on the specific characteristics and objectives of the present project.

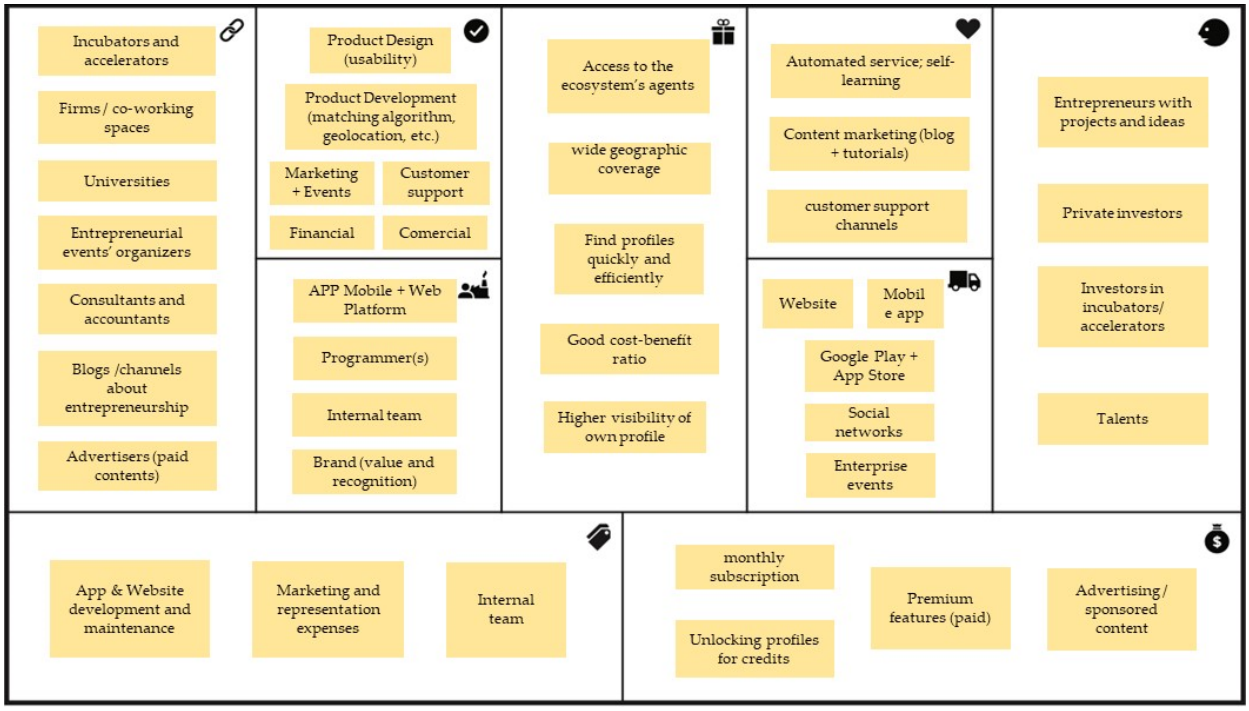

Figure 2. CBM for the present project's business plan (own elaboration).

Figure 2 shows the main strategic elements in terms of customer segments, value offers, channels, relationships, income sources, costs, key resources, activities and partners for this specific business model. These elements resulted from the analysis of similar ideas and underlying platforms and of aspects related to these kinds of stakeholders and activities. By focusing on these key components, the project can gain a holistic understanding of its operations, potential issues, and levels of integration and, thus, develop a more effective and flexible tool [13].

The present solution (Tri-Collab) consists of a web platform designed to support and manage the integration of investors, entrepreneurs and talents (people interested in joining the project teams). Its original characteristic is enabling automatic and efficient correspondence between those agents' profiles through a specific algorithm that aids in

the matching of their preferences/needs. Once this process is well designed, co-creation can have better support to be developed with consistency and legitimacy. In terms of technological support, we clarify that this is not a ready-made product but the development of its prototype, whose final objective is the platform and a mobile app (Figure 3).

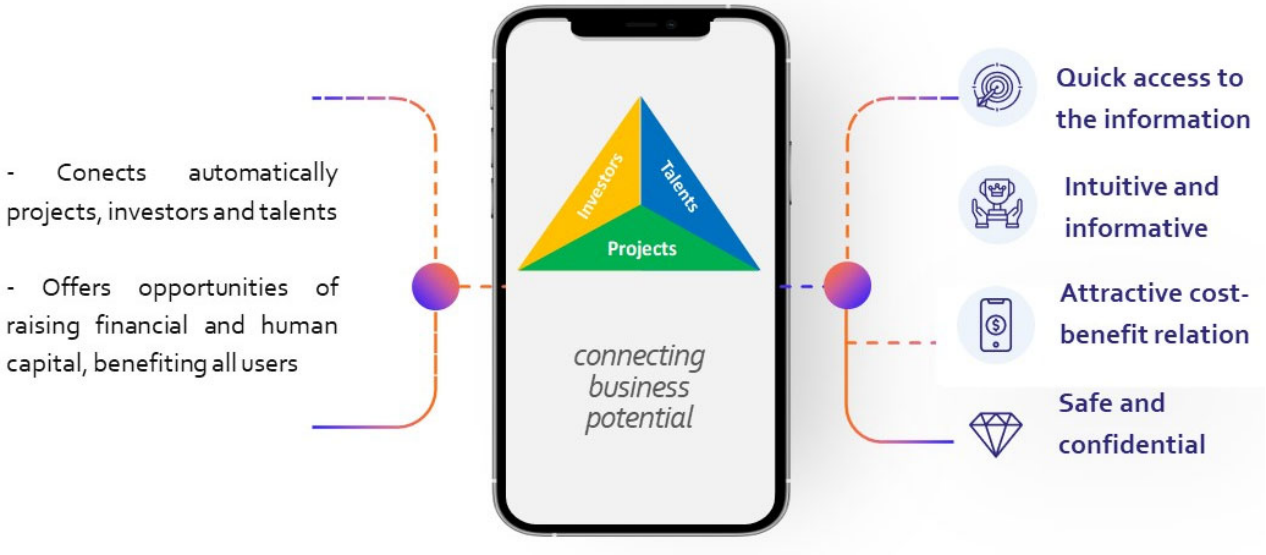

Figure 3. The resulting platform and mobile app.

Based on the skills of this project's co-authoring team, free and open-source platforms (and their languages) were explored and used:

- PostgreSQL database manager, known for its high scalability that makes it good for growing companies like startups given its robust, fast and reliable performance. It becomes ideal for large-scale use due to its versatility. From its version 9.4, PostgreSQL supports JSON and JSONB documents, in addition to other features, which allows the database to function as SQL or NoSQL type.
- Python 3.10 (or later) programming language allows one to write code intuitively without worrying about low-level or machine programming. This allowed the team to focus on understanding the data needed and producing meaningful results. There are many programmers of this language, both in academia and in the market, so we have team elements with knowledge of this language.

2.1. Profiles of the Agents Involved

To better understand the profiles involved and the necessary data (Table 2), we recall here the triad of main actors referred to and their objectives: the investors (individuals, public/private entities) who mainly look to invest in projects (through capital, contacts or incubation processes) and claim for greater reach of project calls; the entrepreneurs who mainly look for investors to help them launch and/or expand their business projects, and also talents with specific skills to integrate them; and the talents (individuals with relevant skills) who mainly look for projects in order to integrate their teams, and for applying/developing their skills and ideas.

Table 2. Profiles of main actors and data required (own elaboration).

Agents/Data	Data to Create the Profile	Connection Parameters
Investors	Name; Logo/Photo; Location; Type of entity; VAT Website link/social media Short text of professional profile, experience, and aim	Location of project headquarters Phase of the project Type of activity/sector Maximum investment
Entrepreneurs/projects	Name/title; Logo; VAT; time of activity, headquarters; Activity/sector Website link/social media Short text to present the business, vision, objectives, future needs	Investors: Location; capital amount; support/investment asked Talents: Location; competences; academic and professional background; possible capital inflow
Talents	Name; photo; Location; birth date; VAT; labor situation Website link/social media Short text about academic, professional profile, interests and skills	Project headquarters Areas/activities/sectors of interest

Figure 4 illustrates an example of a sequence of related steps in the proposed platform/app.

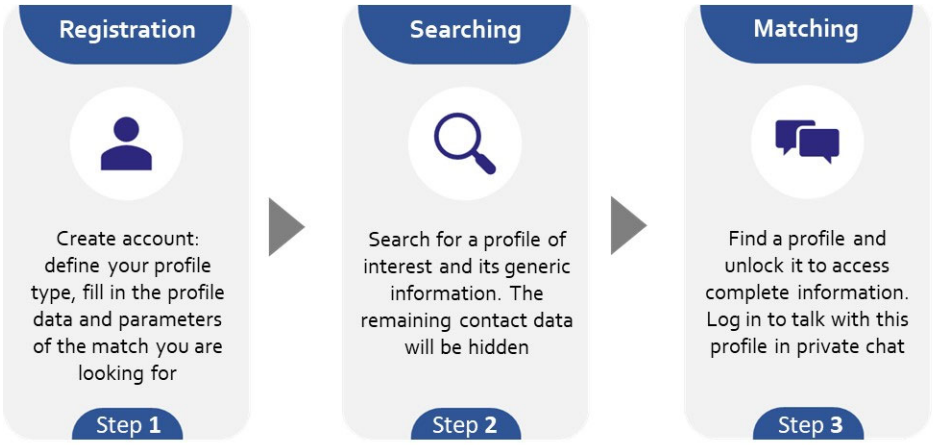

Figure 4. Example of related operations in the app (own elaboration).

2.2. The Matching Algorithm

Regarding the algorithm, the intention is to use the Pandas library (https://pandas.pydata.org/) (accessed on 18 May 2024) for analysis and creation of the code. This choice is because it is a library widely used in data science, which utilizes the same programming language as the rest of the project. Below is a simple script of the algorithm, which uses Python to match the data from investors and entrepreneurs considering that both have a data structure (*DataFrame*) with the columns name, age, profession, and city:

```
# Creating the dataframes of investors and entrepreneurs
investors = pd.DataFrame({
'name': ['João Fonseca', 'Maria do Rosário', 'Pedro Bernardes Filho'],
'age': [30, 35, 45],
'profession': ['Entrepreneur', 'Lawyer', 'Engineer'],
'city': ['Loulé', 'Évora', 'Lisbon']
})
entrepreneurs = pd.DataFrame({
'name': ['José Afonso', 'Ana Maria Braga', 'Mariana Gimanes da Silva'],
'age': [28, 32, 40],
'profession': ['Engineer', 'Designer', 'Entrepreneur'],
```

```
'city': ['Porto', 'Lisbon', 'Loulé']
})
# merge dataframes using as key the columns city and profession
match = pd.merge(investors, entrepreneurs, on = ['city', 'profession'])
```

The match result will be a DataFrame with the columns name_x, age_x, profession x, city x, name y, age_y, [. . .], indicating investors that have city and profession in common with entrepreneurs. A more developed script, involving more aspects to match, is as follows:

```
data = {
"profile_id": [1, 2, 3, 4, 5, 6],
"role": ["investor", "entrepreneur", "talent", "entrepreneur", "talent", "investor"],
"description": [
"Interested in fintech and AI startups",
"Building AI-powered investment tools",
"Skilled in machine learning and backend systems",
"Working on blockchain for finance",
"Expert in data visualization and UX",
"Looking to fund health tech and AI projects"
],
"region": ["US", "US", "Europe", "Europe", "Asia", "Asia"]
}
df = pd.DataFrame(data)
# Vectorize profile descriptions
vectorizer = TfidfVectorizer()
X = vectorizer.fit_transform(df['description'])
# Compute similarity between all pairs
similarity_matrix = cosine_similarity(X)
# Build candidate pairs across roles
pairs = []
for i in range(len(df)):
for j in range(len(df)):
if i != j and df.loc[i, 'role'] != df.loc[j, 'role']:
pairs.append({
"source_id": df.loc[i, 'profile_id'],
"target_id": df.loc[j, 'profile_id'],
"source_role": df.loc[i, 'role'],
"target_role": df.loc[j, 'role'],
"similarity": similarity_matrix[i, j],
"same_region": int(df.loc[i, 'region'] == df.loc[j, 'region']),
# Placeholder label (1 = good match, 0 = bad match); In real life, this comes from historical data
"match_label": int(similarity_matrix[i, j] > 0.2 and df.loc[i, 'region'] == df.loc[j, 'region'])
})
pair_df = pd.DataFrame(pairs)
# Training a simple ML model to predict good matches
features = pair_df[["similarity", "same_region"]]
labels = pair_df["match_label"]
X_train, X_test, y_train, y_test = train_test_split(features, labels, test_size = 0.3, random_state = 42)
```

```
clf = RandomForestClassifier()
clf.fit(X_train, y_train)
print("Model accuracy on test set:", clf.score(X_test, y_test))
# Predict matches for all pairs
pair_df["predicted_match"] = clf.predict(features)
# Show top predicted matches
top_matches = pair_df[pair_df["predicted_match"] == 1].sort_values(by = "similarity", ascending = False)
print("\nTop matches:")
print(top_matches[["source_role", "target_role", "similarity", "same_region"]].head())
```

Other enhancements can be developed, such as adding sentence-transformers (Python frameworks for text and image embeddings) for richer representations; fairness-aware ML models to mitigate regional or gender bias; and more roles such as startup categories, funding stages, or talent experience. Each of these classes is weighted so that they all contribute to the training process with the amount of importance considered appropriate. ML model bias can be mitigated by removing bias from training data and monitoring ML model performance in the real world [14].

3. Results

3.1. 'Envisioned' Success Factors

As acknowledged before, the CBM approach helped to give a holistic view of the operations involved in the present project, which can help to envision/think about the main critical factors that should guide its testing and implementation:

- Intuitive user experience: an easy-to-use, intuitive interface will be essential to attract and, most importantly, keep users.
- Trust and security: building trust and ensuring the security of user data are essential; it protects confidential information and promotes a safe environment for transactions and negotiation.
- Customer support and continuous feedback: providing excellent customer support and being open to user feedback are crucial, to gather information for constantly improving the offer.
- Relevant functionalities and resources: to facilitate the connection between the interested parties, where updates and orientation to user expectations are very important.
- Effective marketing: services need to be advertised assertively and effectively to the target audience; marketing strategies such as target advertising campaigns, social media presence and partnerships will be relevant for brand awareness
- Strategic partnerships with other companies, incubators or investors will bring benefits to the credibility and visibility of the brand.
- Price: must be compatible with the brand image, perceived quality and amounts charged by competitors; it is essential that the price is consistent with the benefit and quality offered.
- Sustainability and social responsibility: actions aimed at environmental sustainability and social responsibility will be relevant; they influence the company's growth, culture and image.
- Process control and quality: internal management and the image perceived by customers will depend on process control and quality tools.

Considering the business characteristics and critical success factors mentioned above, an internal and external diagnosis was then carried out (Table 3).

Table 3. SWOT analysis of internal/external factors for successful implementation.

Strengths	Weaknesses
- Team: made up of members with multidisciplinary skills and experience, and a solid knowledge of management and entrepreneurship - Platform: strong investment in an efficient intuitive interface that facilitates navigation and communication between interested parties - Marketing: this is a priority function (with a responsible internal coordinator) as a way of promoting the brand and building customer loyalty - Contact network: participation in events and business visits are planned as ways of networking and creating a network of partners	- Limited resources: the implementation requires an external investor to finance an initial part of the operation costs, implying a loss of certain decision-making control - Dependence on the adoption of the idea: since this is a less known business concept, there must be a clear transfer of the benefits this solution brings so that users choose to pay for the product - Brand: still unknown, lacking visibility and recognition, which makes it difficult to initially attract users and investors - Location: although the region (Algarve) offers good conditions, it is geographically far from other cities, forcing some higher costs
Opportunities	**Threats**
- Increase of entrepreneurship: driven by a culture of innovation and the search for professional autonomy, savings and direct incentives for activity - Investors looking for opportunities: there is a growing number of investors that want to invest in startups and innovative projects - Internationalization: the expansion to other European countries will offer opportunities for growth and access to a larger user base	- Competition: other platforms with similar offers that may turn it difficult for some users to be successful - Regulations: the firm must monitor regulatory changes and adapt to avoid negative impacts and restrictions on its activity - Economic instability: fluctuations in the economy can affect investor confidence and reduce the availability of capital to invest

Source: own elaboration.

Tri-Collab can be considered a competitive strategy of concentration with differentiation (according to Porter's competitive advantage matrix [15]). This approach means a concentration of efforts towards a specific market niche, where different benefits and resources are offered to each type of user with the main objective of standing out from competition.

Its Value Proposition is essentially focused on the experience of each user, based on the principle that the platform should be used in a simple, fast and interactive way, in addition to an affordable cost in view of the benefits obtained. It was designed to respond to customer expectations through functionalities, such as quick search (by parameters and filters) of various types of profiles, extra options of verified profiles, notifications for calls of acceleration/incubation programs, or tutorials on entrepreneurship.

As key benefits, it stands out from the competition for integrating a wide geographic coverage, which leads to resource savings and greater profile visibility and the aggregation of ecosystem agents on a single platform connecting investors, entrepreneurs and talent in a simple, fast and secure way. As Figure 5 illustrates, we envision the Tri-Collab solution as follows:

- The reference channel of the national entrepreneurial ecosystem;
- The main facilitator between businesses, talents, and investors.

In the medium–long term, we envision it as a tool that:

- Involves all national institutions that support startups and a considerable share of professional and private investors, including university projects and talents;
- Has official support from relevant public entities (such as Startup Portugal or Portugal Ventures);
- Is specialized in consulting and intermediation services to raise financing.

Figure 5. Perspectives of app usage and expansion (own elaboration).

The main values of entrepreneurial behavior that will help to attain these perspectives are as follows:

- Integrity, which prioritizes ethics and transparency in all interactions and processes;
- Trust and security, which are promoted among our users;
- Customer orientation, seeking to generate value and drive the success of our users;
- Sustainability and social responsibility, to align our strategies and create more value for the business environment and society;
- Excellence, from the quality of the application to customer service, improving it constantly;
- Collaboration, which allows one to promote the exchange of knowledge, experiences and opportunities to create an environment conducive to mutual growth and success.

To guide the medium-term strategy, and control the results, the objectives for the first 4 years of activity of the project are as follows:

O1: Reach a minimum number of 1500, 2500 and 3500 monthly users by the end of 2025, 2026 and 2027, respectively;

O2: Maintain a maximum investor rejection rate of 80% (during the first 3 years), measured by the number of investors creating an account and completing their profile but not investing in any project;

O3: Increase the conversion rate from active users to paying users by 10% year over year, measured by the number of active users that maintain a paid subscription plan;

O4: Attain, in the first year, and maintain, in the following years, an average satisfaction score of at least 4 (on a scale of up to 5) on the different distribution platforms;

O5: Obtain positive net results after the first year of operations;

O6: Visit at least 70% of national incubators by 2027, promoting the brand and service and establishing partnerships with at least 50% of these entities;

O7: Start the internationalization plan in 2027 (for Spain and France) with at least 20% of new users from these markets.

Specific strategies (technical and commercial) were defined for the acquisition and retention of users, scalability and monetization of the platform:

(i) Acquisition and retention of users through:

- Digital marketing actions using a specialized agency and internal coordination by the Chief Marketing Officer (CMO);
- Participation in events and business fairs, nationally and internationally;
- Strategic partnerships, which will provide access to a network of potential users, allowing for more effective market penetration and greater credibility.

(ii) Platform scalability through:

- Robust infrastructure: a continuous analysis and update of the platform's infrastructure will be carried out, ensuring that it can handle a significant increase in the number of projects, investors, and talent. It will include the adoption of scalable technologies such as cloud computing and high-performance processing services on demand.
- Performance optimization: intended to avoid the unnecessary costs of early optimization by constantly monitoring and improving the platform's performance, ensuring that it is agile, responsive and capable of handling a growing volume of transactions and simultaneous interactions. This will be achieved through on-demand code optimization, load testing and regular system performance assessments.
- Dedicated technical team: specifically, an internal Chief Technology Officer (CTO) from 2025, and from 2026 onward, depending on the increase in users and traffic or on the addition of new functionalities; also, the possibility of subcontracting services of software development is foreseen.

(iii) Monetization of the platform through:

- Monthly subscription with or without limit of unlocks (depending on type of user).
- Extra options: additional unlocks; seal verified profile; profile boost; deactivation.
- Advertising: open calls/Idea contests; B2B targeted Ads.

In summary, by combining different marketing strategies with a continuous focus on the technical scalability of the platform and the integration of a dedicated team, Tri-Collab seeks to attract and retain a solid base of users, allocating the fundamental resources that guarantee the efficiency and quality of the service provided, particularly in view of an increase in the volume of activity. In turn, the gradual geographic expansion plan will make it possible to consolidate the brand's presence in an effective and controlled way, first in the domestic market and later in international markets.

For the expansion of the platform, the prospects for internationalization involve entering the markets of Spain and France. This choice is due to what is considered as relevant aspects for a greater probability of entering these markets: their geographical proximity to Portugal; a similar culture; regulation under common European Union guidelines; and the existence of previous commercial ties between these countries. Furthermore, these countries have good indexes of national innovation and an increasing number of startups [5].

For greater internationalization, it will be important to participate in major business and technology events such as the South Summit in Madrid and VivaTechnology in Paris, which allow for a better understanding of the size and dynamics of these two markets. Also, we can know their regulatory and cultural aspects and their local competition. It will also be essential to establish local partners as well as contacts with specialized consultants and other relevant professionals.

3.2. Project Validation

The validation of this project was carried out in two main ways: questionnaires (Figure 6) and expressions of support from two main incubators of the region—CRIA (Division of Entrepreneurship and Technology Transfer, University of Algarve) and QRIAR (Creative Incubator of the Algarve).

The questionnaire had, as respondents, students of a master's course in Management, Entrepreneurship, and Innovation (Faculty of Economics, University of Algarve) and a postgraduate technician in digital business development (23% of Portuguese participation). The other participants were foreigner programmers who answered it via social networks. It was available online for a month, and its main questions are illustrated in the figure. This is the Supplementary Material used for the project's first validation phase, i.e., the survey made downloadable in the link: https://forms.gle/FGFcQ1kPv22gxVtU9 (accessed on 19 May 2024).

Figure 6. Answers to the questionnaire.

In total, 71 answers were obtained, where the majority had/have some connections to entrepreneurship. Among the participants, 70% still have their projects at the idea stage, and 60% are looking for investors and other agents to collaborate. Regarding the importance of an app like TriCollab, 70% of the participants consider it highly important.

The second way of validating the present idea consists of its recognition by two main incubators in the region—CRIA and QRIAR. CRIA states that this project meets a real need of the innovation ecosystem (investors, entrepreneurs and support entities like incubators, legislators) toward enhancing their business opportunities and KPI (key performance indicators). In addition, it reinforces the need to define criteria, data and technical structures, which the proposed platform must meet. In its turn, QRIAR recognizes the interest of this project as it is relevant for the incubation initiatives it promotes as well as for the companies it can support in this matter.

4. Discussion

Particularly with the pandemic (but not only), the need for rapid advances in terms of technology, sustainability and active involvement of citizens and customers has contributed to growing and varied collaboration. Examples of that are innovation spaces, living laboratories, transition laboratories, etc. [16]. Hybrid or cyber–physical contexts for education, tourism or health have led to the automatic integration of resources and then to co-creation processes involving citizens and other agents. Co-creation is usually defined as the customer's participation in the creation of products or services, applying resources such as their time, effort or skills [17]. Consumers now use more platforms or networks to interact.

Several studies refer to multiple tools and actors in co-creation, making this mechanism increasingly complex [16,18,19]. However, the co-creation of value remains a more theoretical issue, lacking greater empirical operationalization [20]. There are several digital platforms related to supporting the relations between entrepreneurs, investors and 'talents' belonging to the following categories: crowdfunding (Kickstarter, SeedInvest, GoFundMe); venture capital networks (Gust, Crunchbase, F6S); startup pitch (StartEngine, CircleUp, Republic); idea validation platforms (LinkedIn, IdeaDrop, IdeaScale); and platforms for finding talent (CoFoundersLab, Wellfound, Upwork) [21]. However, if more deeply analyzed, these cases are more specialized either in the relation between entrepreneurs and investors/investment sources or between investors and ideas/projects. They usually lack the whole integration of potential agents, including talents and multidimensional assertive matching.

The present project aims to be a contribution in this direction, from an identified opportunity for the Portuguese innovation ecosystem. Managers plan to involve consumers at different touchpoints, but, in many cases, this is not giving the expected results or is not

being applied in an effective way. One of the reasons is related to the lack of knowledge or understanding about the potentials of co-creation, which, in addition to involving multiple agents, involves the integration of their resources (time, effort, experience, skills, etc.). If co-creation is not properly managed and evaluated, it can affect the expected value of the stakeholders involved [22–24].

Consumers are now more demanding and often act like producers or digital influencers. The processes of co-creation can explore this trend. It can be a competitive advantage, since a co-creative company learns to manage collaborative and integrative processes. Consequently, it learns to orient itself more efficiently to include outside agents in its internal processes, train employees in this regard and invest in interactive technologies. Its focus is more on the concept of value and all its dimensions (real and virtual) to meet preferences effectively and co-create value for all parties [25,26]. The whole mechanism involved in co-creation may not link customers permanently, or other agents, but it is difficult for competitors to imitate. Linkages can be enriched in terms of exchanging information, experience, and knowledge during the collaboration process. Therefore, managers and other stakeholders must realize the business value of this new approach. This can help companies to rethink their product/service portfolio as well as their innovation, recruiting, training, and reward processes [27].

5. Conclusions

Due to the pandemic context, digital business models have been accelerating in a way never seen before. Therefore, digital transition is an essential instrument of the Portuguese strategy, in line with European objectives. It is one of the six priorities of the mandate Preparing Europe for the Digital Age, which aims to ensure that technology serves people and adds value to their daily lives. Portugal is aligned with the strategy defined to face the challenges inherent to digital evolution. However, it is important to know if it is prepared to respond to the accelerated process that requires changing people's behavior.

The country has been offering a favorable environment for entrepreneurship and innovation. However, more than 50% of its citizens still have only basic digital skills [28]. Therefore, the country still has a low conversion of the acquired knowledge into offering/exporting highly innovative products and services. Furthermore, the private investment in R&D has been low, making this activity more dependent on public funding. The technological convergence that innovation acceleration programs allow can stimulate changes in this reality. By aiming to create innovative technology-based services, they can stimulate economic development and generate new talent and employment [29].

A very recent study [2] developed a validated 23-item scale for digital entrepreneurial platform capabilities and analyzed the impact of digital platforms on entrepreneurial performance. However, regarding new insights into optimizing digital platform use, it does not explore this support in terms of matching processes. Hence, the proposed project aims to fill some gaps in this regard, namely to integrate resources and agents more assertively to leverage innovation and creation of high-value services. The degree of originality here is in the matching process (between the profiles of actors involved) and the technological characteristics of the supporting platform, especially its algorithm, for the automatic matching of profiles and their requirements. The underlying algorithm is based on the unsupervised machine learning (ML) mode, which involves a data-driven process. Unlike supervised learning, the algorithm is not explicitly told what patterns or features to look for. Instead, it uses its own internal logic to explore the data to uncover hidden structures, relationships, or anomalies. The most common unsupervised learning tasks are clustering, density estimation, feature learning, dimensionality reduction, finding association rules, etc. For instance, an unsupervised algorithm analyzing traffic patterns

in a smart city might detect unusual congestion, which could signal an accident, road blockage, or other events. Since it does not rely on pre-defined patterns, the algorithm has the flexibility to detect novel behaviors that might not be part of typical training data [30,31]. In addition to collective intelligence, crowdfunding and scalable networking [1,2], what holds the most interest is the assertive matching of profiles and projects.

5.1. Practical Implications

As ML uses experience to recognize trends and create models that help predict future behavior and events, it has become a crucial technology for modern applications. Product/service recommendation is one of the most widely used applications, and it is one of the most prominent features of almost any e-business website today. ML technology can assist businesses in analyzing profiles and making customized suggestions based on their behavior. Predictive modeling, based on ML techniques, can help online players to better manage and optimize several processes. Furthermore, ML enables companies to create content that is tailored to the needs of the agents involved. This potential can be used to enhance the performance of the proposed platform.

Matching algorithms have been studied across numerous issues, due to the large amount of data involved. However, an aspect to deal with is the lack of flexibility to match patterns. Thus, computer programmers need to adjust these algorithms or create new specialized ones in order that the matching semantics of the algorithm respond to different needs [32,33]. Turing-complete programming can help as it is an approach that can be used for any algorithm, regardless of its complexity. Today, profile matching is an exception rather than a base as, globally, hiring people overemphasizes hard skills at the expense of crucial soft skills. Most interviewing procedures are generally unstructured and subject to the interviewer's whims. Biased hiring techniques lead to biased decision making. Thus, it is critical to use predictive evaluations and data-driven techniques, especially when technological advancements allow us to forecast, comprehend, and match people at scale. When emerging technologies increase the capacity to match the appropriate person with the right job or the right project profile, both organizations and people gain significantly. An example is Turing's Intelligent Talent Cloud, which uses ML efficiently to source, match, and manage over 3 million developers worldwide [34].

5.2. Limitations and Future Work

CBM was a useful tool for the initial structuring of this business idea. The analysis of the interaction between its various blocks allowed us to obtain a comprehensive view and create strategies for the key activities. Mainly, understanding the customer needs and associated gains was essential to discern features and benefits. A challenging block of this model was the income as it led to benchmarking the profitability of competitors and concluded that the project will not be profitable if only based on a monthly subscription. Thus, it is necessary to diversify the sources of income. Although the objectives around the design and validation of the platform/app have been met, there is still a lack of a robust business plan, which will be the object of future work.

Additionally, Ref [33] reinforces the notion that integrating ML in startup matchmaking has significant relevance, leading to a paradigm shift in the entrepreneurial ecosystem. Future research could explore the long-term impacts of ML adoption on startup success rates and investigate the role of technological advancements and their acceptance level over time to provide deeper insights into the evolving nature of startup matchmaking.

Supplementary Materials: The following supporting information (survey used for the project validation) can be downloaded at: https://forms.gle/FGFcQ1kPv22gxVtU9 (accessed on 19 May 2024).

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