

ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

**STARTUP EVALUATION CRITERIA
AND STARTUP SELECTION MODEL FOR CORPORATE INCUBATORS**



M.Sc. THESIS

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Department of Management Engineering

Management Engineering Programme

JULY 2024

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ

**KURUMSAL KULUÇKA MERKEZLERİ İÇİN
GİRİŞİM DEĞERLENDİRME KRİTERLERİ VE GİRİŞİM SEÇME MODELİ**

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To my dear family



FOREWORD

I would like to use this chance to express my gratitude for my supporters in life, making it possible to create this thesis. Starting with Mustafa Kemal Atatürk, who is the founder of our country, he made it possible for an ordinary boy like me from an extremely rural area to get educated well and attend the best schools in the country, which are METU and ITU. This would never even be possible to dream about without the foundation of our great republic.

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ABBREVIATIONS

AHP	: Analytic Hierarchy Process
ANP	: Analytic Network Process
CI	: Consistency Indicator
CR	: Consistency Ratio
CVC	: Corporate Venture Capitals
DEA	: Data Envelopment Analysis
FAHP	: Fuzzy Analytic Hierarchy Process
IRR	: Internal Rate of Return
IVC	: Independent Venture Capitals
MCDM	: Multi Criteria Decision Making
MVP	: Minimum Viable Product
NIS	: Negative Ideal Solution
NPV	: Net Present Value
PIS	: Positive Ideal Solution
PROMETHEE	: Preference Ranking Organization Method for Enrichment Evaluation
R&D	: Research and Development
RI	: Random Index
ROI	: Return on Investment
SAW	: Simple Additive Weighting
SME	: Small and Medium sized enterprise
TOBB	: Union of Chambers and Commodity Exchanges of Türkiye
TOPSIS	: Technique for Order Preference by Similarity to Ideal Solution
TRL	: Technology Readiness Level
VC	: Venture Capitals
VIKOR	: VIseKriterijumska Optimizacija I Kompromisno Resenje
WOS	: Web of Science



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STARTUP EVALUATION CRITERIA AND STARTUP SELECTION MODEL FOR CORPORATE INCUBATORS

SUMMARY

The main goal of this thesis is to develop a thorough evaluation system for choosing entrepreneurs to receive support from corporate incubators. A methodical approach is taken in the design of the research, which combines material from academic research with input from external sources to develop a specialized evaluation procedure with the assistance of industry expertise.

An in-depth literature review was the first step in the methodology, during which keywords are utilized to locate research that is pertinent to the evaluation of startups. The results of the search are sorted according to the subjects, and then they are further narrowed by the examination of the titles and abstracts. The selection is narrowed down to a final set of 28 articles for the purpose of conducting in-depth reading and analysis as a result of this approach. Following the selection of articles, the process of data extraction and refining is carried out in order to extract a full set of criteria from the articles. The elimination of duplicates and criteria that are similar results in the compilation of a list of 65 separate criteria. Criteria that are excessively specific are grouped together, which ultimately results in the consolidation of 46 criteria into a more refined form. In order to determine which criteria are the most important, a frequency analysis is carried out, which ultimately leads to the establishment of a total of 38 critical criteria. This set of requirements are broken down into five distinct categories: the team, the market, the idea or product, the finances, and the strategy.

For the purpose of obtaining the perspectives of specialists from the Turkish entrepreneurship ecosystem regarding the significance of each evaluation criterion, surveys are carried out with the assistance of experts. A survey that is conducted via Google Forms is devised, and information is gathered from professionals who have specialized experience in the evaluation of startups. After that, the data that was collected is examined in order to determine which criteria received low scores and then eliminate them, another intermediate step is added that is corporate expert interviews to refine the criteria and move the perspective from general to corporate, completing the collection of evaluation criteria. In the end, 29 distinct criteria had been listed within 5 groups.

Fuzzy Analytic Hierarchy Process (Fuzzy AHP) is utilized as a multi-criteria decision making method in order to carry out the process of weighting the evaluating criteria. A selected group of experts from various corporations' entrepreneurship and innovation departments, conducted pairwise comparisons to determine the relative importance of each criterion. This stage ensures that the evaluation criteria are weighted appropriately, reflecting the nuanced perspectives of individuals who have extensive

expertise in the field. Finally, the team criteria category had a weight value of 31%, the market criteria category had a weight value of 25%, the idea/product criteria category had a weight value of 21%, the finance criteria category had a weight value of 8%, and the strategy criteria category had a weight value of 15%.

In the selection and ranking stage of the model, the TOPSIS method is utilized to rank the startups based on the predetermined framework of evaluation criteria. At this stage, it is possible to determine which alternative is the most suitable by calculating the degree to which it is similar to both the positive and negative ideal solutions.

In general, the thesis offers a thorough and expertly validated methodology for the evaluation of startups that is specifically suited to meet the startup selection requirements of corporate incubators and accelerators. Within the context of the evaluation process, the systematic approach maintains the integrity and relevance of the review process by taking into account the various elements that contribute to the success of startups. In the context of business incubation and acceleration, the framework provides a comprehensive and individualized solution for selecting entrepreneurs through combining the theoretical framework and the practical knowledge accumulated in the industry.

In conclusion, this thesis makes a contribution to the startup evaluation topic within the entrepreneurship research field by offering a structured startup selection criteria framework that includes the methodological process of multi-method MCDM-based startup selection model. Incorporating a review of the relevant literature, data extraction and refinement, expert surveys, criterion weighting, and the implementation of the TOPSIS approach are all components of the methodology. In order to provide a comprehensive evaluation of startups, the evaluation framework that was developed takes into account a variety of criteria, including the team, the market, the idea or product, the finances, and the strategy categories. It is possible for corporate incubators and accelerators to make use of this framework in order to choose and support promising entrepreneurs in an efficient manner. As for the practical implications, these criteria set and selection model can serve as a guide for startups to use it as a self-assessment tool to point their weak spots in the eyes of incubators or investors etc. Also for the policy implications; in the national and industrial level, this study can shed light on the prioritized specialities among the startups in the field so that governmental entrepreneurship support mechanisms or entrepreneurship education curriculum can be improved.

KURUMSAL KULUÇKA MERKEZLERİ İÇİN GİRİŞİM DEĞERLENDİRME KRİTERLERİ VE GİRİŞİM SEÇME MODELİ

ÖZET

Girişimcilik ve girişimlerin finanse edilmesi son yıllarda oldukça öne çıkan bir konudur. Dünya ekonomisinin paradigma değiştirerek talep tarafından arz tarafına kayması sonucu girişimciliğin ve girişimlerin önemi hızla arttı. Ülkemizde de KOBİ'ler ülke ekonomisi ve istihdamının bel kemiğini oluşturmaktadır. Bu bakımdan girişimciliği desteklemek ve teşvik etmek, girişimcilerin başarılı olmasına vesile olmak büyük önem arz etmektedir. Kurumsal kuluçka merkezleri de son yıllarda önem kazanan girişimciliği destekleyen önemli mekanizmalardan birisi haline gelmiştir.

Kurumsal kuluçka merkezleri geleneksel kuluçka merkezlerinden farklı olarak finansal getirinin yanısıra girişimlerden elde edebilecekleri stratejik faydalara da oldukça önem vermektedirler. Bu sebeple geleneksel kuluçkalarda kullanılan değerlendirme yöntemleri de kurumsal kuluçka merkezlerinde değişikliğe gidilmeden kullanılamamaktadır.

Bu tezin ana hedefi, kurumsal kuluçka merkezlerinin destek vermek üzere seçeceği girişimleri değerlendirme aşamasında kullanabileceği kapsamlı, öznellikten olabildiğinde arınmış ve sistematik bir değerlendirme modeli geliştirmektir. Araştırmanın tasarımında sistematik bir yöntem benimsenmiş ve akademik araştırmalarla sektörden edinilen bilgiler kaynaştırılarak sahadan gelen uzmanların da katkısı ile üç kanaldan desteklenmiş bir model geliştirilmiştir.

Araştırmanın ilk adımı, derinlemesine bir literatür incelemesi olup, bu aşamada "girişim seçme" "girişim değerlendirme" gibi anahtar kelimeler kullanılarak girişimlerin değerlendirilmesiyle ilgili yapılmış bütün araştırmalar gözden geçirilmiştir. Daha sonra başlıkların ve özetlerin incelenmesiyle; derinlemesine okuma ve analiz yapmak üzere 28 makaleye kadar indirilmiştir.

Makalelerin seçilmesinin ardından, makalelerden tam bir kriter seti çıkarmak için veri çıkarma ve rafine etme süreci gerçekleştirilmiştir. Aynı veya benzer olan ve kriterlerin elenmesi sonucunda, 65 ayrı kriter içeren liste derlenmiştir. Aşırı detaylı kriterler gruplandırıldıktan sonra 46 kriter içeren listeye ulaşılmıştır. Frekans analizi sonucu düşük frekansa sahip kriterler elenerek 38 kriter içeren son liste anketler aracılığıyla değerlendirilmek üzere hazırlanmıştır. Bu kriterler takım, pazar, ürün/fikir, finans ve strateji olmak üzere beş kategoride toplanmıştır.

Türk ekosistemindeki uzmanların her bir değerlendirme kriterinin önemine ilişkin bakış açılarını elde etmek amacıyla, uzmanların görüşlerinin toplandığı çevrimiçi bir anket tasarlanmıştır. Google Formlar aracılığıyla yapılan bu anket çalışması sonucu

girişim değerlendirilme konusunda özelleşmiş deneyime sahip profesyonellerden bilgi toplanarak liste geliştirilmiştir. Daha sonra, kriter setinin kurumsal kuluçka merkezlerinin bakış açısına yaklaştırılması amacıyla kurumsal tecrübesi bulunan uzmanlar ile yapılan birebir görüşmeler sonucu kriter listesi 5 kategori 29 kriter ile son halini almıştır.

Kriterlerin ağırlıklandırılması işlemini gerçekleştirmek için Bulanık Analitik Hiyerarşi Süreci (Fuzzy AHP) yöntemi kullanılmıştır. Kurumsal kuluçka merkezi tecrübesi bulunan seçilmiş bir uzman grubu, her kriterin göreceli önemini belirlemek için kriterlerin ikili karşılaştırmalarını yaparak kriter ve alt kriter ağırlıklarının belirlenmesine katkıda bulunmuşlardır. Ortaya çıkan sonuçların, öncelikle kendi içinde, sonrasında ankete cevap veren uzmanlara göre, sonrasında iyimserlik indeksi değişkenine göre ve son olarak bulanıklık faktörü değişkenine göre hassaslık analizleri yapılarak sonuçların tutarlı olduğu doğrulanmıştır.

Bu analiz sonucunda, takım 31% ağırlık değerine, pazar 25% ağırlık değerine, fikir/ürün kategorisi 21% ağırlık değerine, finans kategorisi 8% ağırlık değerine ve strateji kategorisi 15% ağırlık değerine sahip olmuştur.

Bu sonuçlar ile literatür karşılaştırıldığında verilen ağırlıkların literatür çalışmalarıyla da uyumlu olduğu gözlemlenmiştir. Takım birçok yatırımcı da dahil paydaşlar için en önemli kriter olarak belirtilmiş olmakla birlikte yapılan analizde de en yüksek ağırlık değerine sahip olmuştur. Örneğin Finansal kriterler de literatür çalışmalarında ve uzman görüşmelerinde değerlendirmesi zor ve erken aşama girişimler için riskli olabilecek kriterler olarak değerlendirilmesine karşılık bu çalışmada ortaya çıkan modelde de en düşük ağırlığa sahip olmuştur.

Ayrıca literatürde de sıkça dile getirilen ilgili endüstri deneyimi kriteri modelde de en önemli kriter olarak göze çarpmaktadır. Bununla birlikte global ekosistemden farklı olarak globalleşme potansiyeli kriterinin oldukça yüksek bir ağırlık değerine erişmiş olması ülkemiz ekosisteminde başarılı olmak için küresel pazarda iş yapabilme yeteneğinin gerekiyor olması sonuçlarda göze çarpmaktadır.

Son olarak modelin seçim aşamasında kullanılmak üzere bir grup alternatif içindeki sıralamayı yaparken pozitif ve negatif ideal alternatiflere olan yakınlık prensibini kullanan TOPSIS yöntemi tercih edilmiştir. Bu yöntem sayesinde bir başvuru döneminde gelen bütün başvuruları tek model kullanarak değerlendirerek kuluçka merkezinde mevcut olan kapasiteyi bu grubun içindeki en iyi girişimler ile doldurmak, kaynakları verimli harcamak açısından önem arz etmektedir.

Son olarak hazırlanan model bir teknoloji sektöründe yer alan bir kurumsal kuluçka merkezine bir yıl önce başvuru yapmış 10 girişimi değerlendirerek ortaya çıkan sıralamaları, değerlendirilen girişimlerin mevcut başarıları ve ulaştıkları hedefler özelinde karşılaştırarak geliştirilen modelin potansiyeli yüksek girişimleri belirleme konusundaki başarısı doğrulanmıştır.

Genel olarak, tez, kurumsal kuluçkalar başta olmak üzere küçük özelleştirmelerle hızlandırıcıların, özel kuluçkaların veya diğer paydaşların gereksinimlerini karşılamak üzere kullanılabilecek bir model olarak geliştirilmiştir. Ayrıca girişim kurucuları da bu modeli kendilerini birer yatırımcı gözüyle değerlendirerek geliştirmek üzere zayıf yönlerini tespit etmek amacıyla kullanabileceklerdir.

Sonuç olarak, bu tez hem kapsamlı hem de sistemli bir strateji sunarak girişim değerlendirmesi konusuna bir katkı sağlamaktadır. İlgili literatürün gözden geçirilmesi, uzman anketleri ve birebir görüşmeleri, kriter ağırlıklandırma ve TOPSIS yaklaşımının uygulanması, metodolojinin tüm bileşenlerini oluşturmuştur. Kapsamlı bir girişim değerlendirmesini sağlamak için geliştirilen değerlendirme modeli, takım, pazar, fikir veya ürün, finanslar ve strateji olmak üzere 5 kategoride 29 kriteri dikkate almaktadır. Kurumsal kuluçkalar ve hızlandırıcılar, bu çerçeveyi, potansiyeli yüksek girişimcileri etkin bir şekilde seçmek ve verimli bir biçimde desteklemek için kullanabilir.





1. INTRODUCTION

The concept of entrepreneurship emerged throughout the 17th century. The promotion of entrepreneurship has been driven by the increase in supply-side economics and industrial downturn, starting in the 1970s [1]. The relationship between entrepreneurship and economic growth has been extensively researched during the past two decades. An entrepreneurial culture is believed to have a substantial and favorable impact on economic growth, but this impact may vary over time. Moreover, the impact of the ecosystem varies between developed and developing countries. According to Doran et al., necessity entrepreneurship is more prevalent in underdeveloped or developing countries. This refers to entrepreneurs who establish businesses due to a scarcity of alternative employment options. Consequently, he proposes that the policies in these countries should be modified to promote economic expansion [2].

In Türkiye, Small and Medium-Sized Enterprises (SMEs) play a significant role in the economy and growth [3]. Hence, it can be asserted that the implementation of more sophisticated entrepreneurship policies, encompassing diverse support mechanisms, will yield a substantial and favorable impact on the whole economy. Additionally, it can contribute to addressing income inequality by enhancing the economic standing of lower-income demographics. Several academics have emphasized that companies involved in development projects may experience significant setbacks due to resource constraints. During the initial phases of growth, startups frequently encounter significant challenges, such as a financial shortfall that restricts the company's capacity to innovate and bring its products to market [4] [5].

Furthermore, startups sometimes face challenges in terms of organizational capabilities, client validation, and the conversion of technologies into viable economic ventures [6]. Initial financial support and non-monetary donations from relatives facilitate the day-to-day functioning, investments, pre-financing of deductible

value-added tax, and other regular operational expenses. However, these businesses continue to encounter numerous obstacles [7] [8].

There are several mechanisms available that are formed to support entrepreneurs in the early stages including governments, universities, corporations, venture capitalists, angel investors, technoparks, and incubation centers. All of these stakeholders have similar support mechanisms and similar assessment and selection processes [9]. Since it would result in a fair and logical allocation of available resources, aiming for an accurate selection of promising startups is both a practical and theoretical goal [10]. The failure rate of startups is around 90% therefore it is vital for anyone who invests resources in startups to achieve the remaining 10% to get higher returns on investment. [11]. Most venture capitalists and accelerators are burning money or struggling to break even, top 2% of the VC funds are collecting almost 95% of the return in the ecosystem [12].

Accelerators and incubators are providing the most basic forms of non-financial support for entrepreneurs. Entrepreneurs can benefit from the many services and support options provided by these institutions like networking services, providing mentorship, various related seminars and workshops, training sessions, and direct funding are examples of support means. Nonetheless, the goals of accelerators in providing these resources are comparable. They will assist entrepreneurs in developing high-growth start-ups by guiding them through the risky process of startup founding process. [13]. As Mian (2021) defined; a business incubator is a dedicated institution or establishment that offers assistance and assets to nascent startups and entrepreneurs, aiding them in the process of building and expanding their enterprises. These incubators provide a variety of services, such as physical work-spaces, mentorship, access to funding and investment networks, aid with business development, networking opportunities, and access to research and technological resources. The primary goal of these business incubators is to expedite the growth and prosperity of startups by furnishing them with essential assistance and resources to surmount typical obstacles and enhance their likelihood of survival and sustained profitability [14].

Incubators around the world believe that carefully choosing which applications to accept is a necessary part of a project's success. One example is that in 2012, the Central-European Innovation Center in Europe chose 28 startups from 263 that applied. To put it another way, only 9% of applications were accepted [15]. Business accelerators differ significantly from business incubators in that they are intensive, time-limited programs that disseminate a lot of information, knowledge, and know-how to increase a startup's chances of survival and hasten its growth. Admissions to acceleration programs are frequently cohort-based and fiercely competitive to ensure that the startups taking part are of the highest caliber. Therefore, the selection process is even tougher in accelerators than in incubators. [16]. For example, many accelerators reject between 80% and 90% of all applicants, and the best accelerators are even more picky, only accepting 1%–3% of all applicants. [13] Therefore, it is essential to have a reliable assessment procedure to ensure a fair allocation of the resources available. [17]

Corporations are also supporting startups with various mechanisms including Corporate Venture Capitals and Corporate Incubators and Accelerators. After the first formal venture capital firms succeeded in the mid-20Th century, corporate venture capitals (CVCs) and corporate incubators became crucial startup support vehicles. In around early 1970s, 25% of Fortune 500 companies established corporate venture programs after early venture capitalists financed Digital Equipment and Memorex. Gompers(2000) describes these initiatives as direct investments in startups or funding for other venture capitalists, adapted to corporate aims and requirements. Unlike Independent Venture Capitals (IVCs), CVCs prioritize innovation with longer investment horizons and a higher tolerance for failure, resulting in improved patent production and quality in backed companies [18] [19]. Corporate venture capital helps established companies access external knowledge and innovation to improve internal processes. This investment approach leads to new technology development and product expansion, boosting business competitiveness [20].

Similarly, a corporate incubator is a separate department within a firm that supports the creation and development of startups while also enhancing the technological capabilities of their organization. It provides resources such as monetary assistance,

advice, and physical infrastructure to support the innovative efforts of entrepreneurs or intrapreneurs. The main goal of a corporate incubator is to foster the growth of businesses and diversify the range of products or services provided by the company, thus improving its competitive position in the market. Corporate incubators can be structured in several styles, ranging from full integration inside a business unit to complete separation and independence from the corporate parent [21].

Corporate incubators play a crucial role in nurturing innovation, stimulating growth, harnessing an entrepreneurial attitude, improving competitiveness, nurturing talent, fostering innovation, expediting growth, enhancing corporate entrepreneurship, accessing external innovation, retaining talent, and minimizing risk. They offer a well-organized and encouraging atmosphere for employees to cultivate and experiment with new concepts, promoting an entrepreneurial mindset that can result in sustained achievement. Incubators also foster an entrepreneurial culture within the firm and enable companies to access external sources of innovation. Furthermore, they have the ability to allure and keep highly skilled individuals and assist firms in making more knowledgeable choices regarding the allocation of resources [22].

The body of research on startup evaluation criteria is vast, encompassing several categories of investors including venture capitalists, angel investors, and private incubators. Nevertheless, there is a lack of research that expressly addresses corporate incubators and their distinct requirements for evaluation. This discrepancy impedes corporate incubators from implementing a uniform and unbiased method for choosing entrepreneurs to be incubated. In addition, current body of research sometimes lacks sufficient explanation of the specified criteria used to evaluate startups, resulting in ambiguity when interpreting and applying them. The objective of this research is to overcome these limitations by creating a specialized model and set of criteria for evaluating corporate incubator startups that is specifically designed for the Turkish startup ecosystem. The methodology will enable corporate incubators to make more knowledgeable and unbiased investment decisions, promoting the development of innovative entrepreneurs. To fill this field this thesis aims to elevate the precision, reliability, and applicability of startup evaluation methodologies, with a particular

focus on corporate incubators. The endeavor is structured around four pivotal objectives:

1. **Identification of startup evaluation criteria for corporate incubators:** By conducting a systematic literature review and consulting with industry experts, a comprehensive set of startup evaluation criteria will be established. This effort ensures the inclusion of pertinent factors critical to the possible success or failure in the context of startups within the specific context of corporate incubators.
2. **Weighting of identified startup evaluation criteria for corporate incubators:** The importance of each criterion will be quantified using expert opinions and quantitative methods, such as online surveys and Fuzzy Analytic Hierarchy Process (FAHP). This approach allows for a nuanced evaluation that accurately reflects the unique dynamics of startup ecosystems within corporate incubators.
3. **Development of a complete decision-making model using weighted criteria for corporate incubators:** A decision-making model, tailored for corporate incubators and based on the weighted criteria, will be developed. This model will offer a systematic and objective process for evaluating startups, with the methodology being selected to suit the criterion's nature and the desired level of complexity.
4. **Validation of the decision making model with a real life case study in a corporate incubator:** To verify its validity and utility, the model will be applied to evaluate a real-world case study within a corporate incubator setting. The outcomes of this case study will not only demonstrate the model's effectiveness but also identify potential areas for refinement.

These objectives are designed to contribute significantly to the field of startup evaluation, providing corporate incubators with a robust framework for assessing startup potential and facilitating more informed decision-making processes. Addressing these objectives involved using a mixed-method approach that combined quantitative and qualitative analyses at various stages. At the beginning, a systematic literature review has been performed to examine the existing literature on startup assessment criteria. Mapping out the research landscape, identifying key studies, and discerning

emerging trends within the domain were essential steps in the process. Subsequently, pertinent criteria for evaluating startups were derived from the gathered studies. The extraction process was guided by the frequency of criteria mentioned in the literature and their relevance to the assessment process, ensuring that the criteria set was based on academic research and mirrored current industry practices. Afterwards, the original list of criteria went through a data cleansing process to remove duplicates and closely associated criteria. This refinement was crucial to uphold the uniqueness and significance of each criterion in the set. Conducting a frequency analysis on the refined criteria set revealed the most frequently mentioned criteria, allowing for their prioritization based on how often they appeared in the literature. For the purpose of enhancing the criteria set and determining their significance, a structured online survey have been designed with the findings from the literature review phase and sent out to experts in the field. Professional from various stakeholders in Turkish entrepreneurship ecosystem such as incubation center experts, academicians, acceleration program experts etc. were requested to rate the significance of each criterion on a 5-point Likert scale, from "Not Important" to "Extremely Important". Also along with the online survey, a set of interviews have been performed with corporate entrepreneurship and innovation experts have been carried out with the goal of refining the criteria set towards the corporate perspective. By involving field experts, the final criteria set included only the most significant criteria. Another structured online survey have been designed, with the final set of criteria that have been created in the previous section, for incorporating the weighting process of the criteria for experts to participate in pairwise comparisons of the remaining criteria to determine the weight of each criterion using the fuzzy Analytic Hierarchy Process (AHP) method. A group of experts from various corporations working in entrepreneurship and innovation departments have been asked to response to the survey so that it is valid for corporations standpoint. This step was crucial in establishing the relative importance of each criterion, which helped in developing a more detailed and structured assessment framework.

The third objective focused on developing a two-stage evaluation model for corporate incubators to evaluate startups. Utilizing a weighted set of criteria, this model incorporated the Technique for Order Preference by Similarity to Ideal Solution

(TOPSIS) method to evaluate and rank startups. This method provides relative comparison between the startups in the batch to select the best among them. As for the last objective, validation of the model have been done using a case study from a corporation' in the technology sector. For revealing its applicability and practicality, a set of startups have been assessed using the model proposed in this thesis and their milestones and current status have been compared with the rankings.

This research study provides significant theoretical and practical insights into startup evaluation, especially in the realm of corporate incubators, startups, and the larger entrepreneurial ecosystem. This model aims to bridge the research gap in evaluating startups for incubators by offering a comprehensive assessment framework that recognizes the evolving significance of criteria sets over time.

From practical point of view, the study provides corporate incubators with a structured assessment model, improving the effectiveness and outcomes of their selection procedures. Startups can use the model to define clear success metrics, which can help them assess their progress more accurately and attract investors more effectively. Moreover, the wider ecosystem can gain from an increase in number of early-stage startups that have been thoroughly evaluated for greater chances of success. This thesis serves as an essential tool in enhancing the survival and growth prospects of emerging enterprises by aligning the interests of all stakeholders towards identifying startups with a high chance of success.

Following the introduction section where the aim of the study and research gap in the literature have been pointed out, the rest of the thesis is structured as literature review, methodology, application of the method and results, findings and discussion and finally conclusion. In the literature review section, theoretical backgrounds and definitions of the concepts used in the thesis is explained. In the methodology section, methodology for criteria set formation and selection model design have been explained, then in the next section application and the results of the method have been presented. In the findings section, the literature and the results of this study have been compared and explained. in the final part, the summary of the thesis is presented and explained.



2. LITERATURE REVIEW

2.1 Corporate - Startup Relations

New technologies are advancing quickly, which is causing new kinds of corporate - startup collaborations to arise and spread. Large corporations are now using strategic technological alliances to get knowledge and access to these growing technologies. These collaborations enable the utilization of new innovations and the cooperative advancement of knowledge. [23]. Corporations and startups have different needs and goals. Startups need to be able to handle risky situations and grow, while corporations offer stability, resources, and reputation but are often held back by rigid cultures and a focus on small, incremental improvements. [24] These differences in power, structure, and decision-making make it harder to make links that are good for both sides. Corporations offer resources and size, while startups offer new ideas, flexibility, and a desire to grow. Even though their skills compliment each other, cultural differences make it harder for them to work together. [25]. The ways in which corporations and startups collaborate can vary, from short-term partnerships like corporate hackathons, to more permanent arrangements like mergers and acquisitions. [26]. Among these various mechanism for them to collaborate, Corporate Venture Capitals and Corporate Incubator & Accelerators is being used the most. [25]

2.1.1 Corporate venture capitals

Nesner et al. (2020) defines Corporate Venture Capital (CVC) as a strategic body used by corporations to invest in young companies by providing long-term, unlisted risk capital. They state that unlike traditional Venture Capital endeavors that solely seek financial rewards, Corporate Venture Capital divisions pursue both financial and strategic objectives. From a financial perspective, it is anticipated that these investments will provide substantial profits based on the amount of capital at risk.

This is due to the competence of the established corporations in both the market and technological sectors. [27]

From a strategic standpoint, Schulte (2021) claims that engaging in corporate venture capital (CVC) activities allows established organizations to gain entry into novel technologies and markets, contribute to their diversification goals, and actively search for viable startups to acquire and by that, corporations can enhance their own operations by investing in startups, as this allows them to access a valuable knowledge base and facilitate the transfer of entrepreneurial knowledge. Corporate Venture Capital (CVC) facilitates a symbiotic partnership between corporations and startups, where firms obtain strategic and financial benefits, while startups receive crucial capital and business assistance. [28]. Startups that possess crucial technologies for a company's main operations may opt for the CVC approach to ensure exclusive access to these innovations. [29]

2.1.2 Corporate incubators and accelerators

To improve their ability to deal with innovation, companies have put in place organized programs to make working together with startups easier. Corporate accelerators and incubators are two well-known examples of these. Because they act as a bridge, these programs make it easier for companies and new businesses to talk to each other. [30] Both incubators and accelerators help startups in important ways, but they do so at different times of their development and for different lengths of time. Incubators help new businesses grow from an idea to a prototype over a longer period of time. Accelerators, on the other hand, use funding and partnerships to help startups that already have goods that can be sold quickly grow their markets. [31] Even though they are different, the main goal of both frameworks is to help startups grow and come up with new ideas. Whether a startup should go with a corporate incubator or a corporate accelerator relies on its needs, the resources and networks it has access to, and the strategic goals of the corporate body that is supporting it. Latouche (2019) correlates the corporate incubators and accelerators as "cousins". [32]. Kanbach et al. (2016) defines corporate accelerators as short-term programs that established companies set up to work with new businesses in order to make money and gain strategic benefits

and in contrast to corporate venture capital, these programs offer all-around help, such as funds, mentoring, training, and networking over the course of three months. They want to increase the value of the main company, learn about new technologies and market trends, encourage people to become entrepreneurs, and look into new ways to run a business. [33] Similarly, corporate incubators are specialized, for-profit organizations set up by parent companies to help new businesses grow and develop, mostly by using the parent company's existing technology base. Their major goal is to facilitate technological progress within the company by either providing non-financial support to outside startups that have new business ideas or technologies. [34] Corporate incubators are set up to make money, so their operations, methods, and resources are all geared toward starting up businesses that will make money. They usually work as separate teams or units within the parent company and have a lot of freedom in how they do their jobs. As part of the incubation process, new businesses that show promise are chosen and given full support, such as teaching, feedback, and management advice. [21] Corporate incubators provide many benefits, such as financial support, office space, necessary equipment, and connections with many experts in the field and possible investors. The main goal of corporate incubators is to make money by quickly starting new businesses, incorporating successful projects into the main business of the company, or creating new technologies that make more people want to buy the parent company's goods. [35]

2.2 General Admission Procedures of Incubator and Accelerators

The typical procedure for a startup to get admission to an incubator or accelerator program typically involves several steps, as presented in Figure 2.1. The program normally begins with the submission of a startup application. The application phase can be completed within a designated time-frame, or it can be open for submission at any time, depending on the structure of the program. Due to the progress in digital technology, the majority of incubators now utilize an online application form for entrepreneurs. [36]. In light of the complexity of the comprehensive evaluations, decision-makers are required to reduce the number of startup applicants after the applications have been submitted. Consequently, the majority of incubators employ

a screening process in order to reduce the number of startups before proceeding to the stage of thorough assessment. [37].

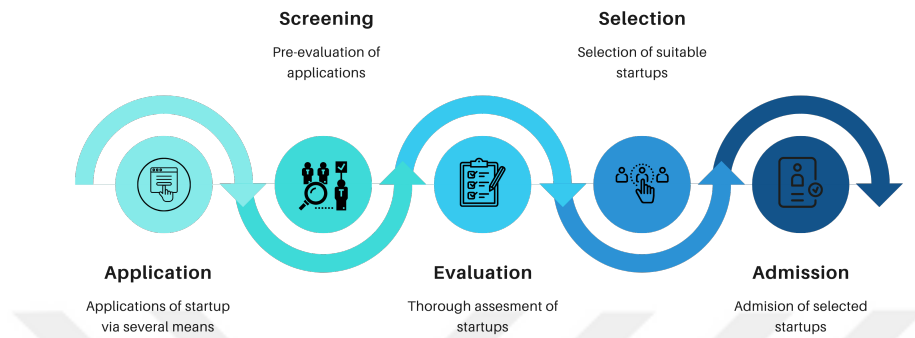


Figure 2.1 : General structure of incubator’s application processes.

Source: Authors own work adapted from Butz (2021) [16]

2.2.1 Startup evaluation

Identifying the characteristics of successful startups is highly valuable in terms of both economic and social impact, as it enables the effective allocation of funding to the most promising projects [38]. Nevertheless, the existing standards for choosing projects demonstrate a significant rate of failure, for example, as a considerable proportion of startups financed by venture capital cease operations within five years. These figures emphasize the uncertainty of startup success and emphasize the necessity for more precise assessment approaches to enhance startup selection and funding results. [10]. Assessing startups, especially in their early stages, is inherently subjective due to the limited data and higher unpredictability. Moreover, investor interest tends to be concentrated both in specific regions and stages of development, making it challenging to accurately predict a startup’s success, let alone determine its fit within an investor’s investment strategy. Consequently, investors may weigh various factors, both quantitative and qualitative, when evaluating an early-stage startup [12]. For example, the assessment of a startup team’s qualifications significantly influences the decision-making process; however, there is a lack of detailed understanding regarding

the specific criteria that are used to evaluate teams. This gap in knowledge arises primarily from the fact that previous research has primarily focused on evaluating entire proposals, resulting in broad criteria rankings. [39]. selection criteria or the importance ratings of the criteria changes during the stages of evaluation, Yin and Luo (2018) looked at the different stages of the accelerator selection process. Their research showed that accelerator managers use a small set of implicit decision criteria. Using these key criteria to guess what will happen with more startups, they show early signs that the criteria in the first stage are more important for understanding "rejection" decisions, while the criteria in the last stage are more helpful for understanding "selection" decisions. Which means that accelerator managers first eliminate the worst of the ideas and then select the best ones from the remaining ones [40]. In addition, evaluation processes vary from country to region. For instance, the primary distinction between the incubator policies of the United States and Europe appears to be the emphasis placed on financial factors in the United States, as opposed to the more "soft" criteria, such as the management team and market fit, in Europe [41]. Therefore, it is important to consider regional conditions when creating an evaluation framework.

2.3 Startup Evaluation Criteria

2.3.1 Team

Pintado et al. (2007) showed that there is a clear hierarchy of investment influences distinguishing the Spanish venture capitalists (VCs). As to evaluation criteria, they found clear evidence that the Spanish VCs place an emphasis on the criteria referring to entrepreneurs, manager backgrounds, and management team experience compared with market and product criteria. This pecking order means that, in the eyes of the Spanish VCs, the human factor, which includes the characteristics of the entrepreneur and experience of the management team, is more important than the definite market or product's characteristics [42]. In their study, Bai and Zhao (2021) tapped into the power of machine learning algorithms to predict the factors that would have the greatest influence on startup investment decisions. One consistent revelation across various models was the paramount importance of team management as a key criterion.

Regardless of the specific algorithm employed, the findings consistently placed team management within the top five criteria deemed crucial for effective investment decisions. This underscores the significance of a well-managed and cohesive team in the startup ecosystem, suggesting that investors should prioritize assessing the quality and dynamics of a startup team when considering potential investments. [12]. By building on this notion of importance of team characteristics, Franke et al. (2008) examined the investment process of German VCs. Their observation also highlighted that, as for German VCs, heterogeneous teams with different industry experience, education, and experience of leadership became the top three factors influencing investment decisions. The insight focuses on how German VCs appreciate diversity and collective expertise within a team of startup owners. Recognition and knowledge of these team-related criteria may prove helpful to the Spanish and German VCs alike in optimizing their investments as they transform over time. [39].

2.3.1.1 The team's experience in the relevant industry

Erdogan and Koohborfardhaghighi, in their research, emphasize a consensus among managers engaged in the startup selection process. According to their findings, there is a unanimous agreement among these managers that two critical factors, namely team experience and the startup's position within its network, are intricately linked to the future success of the startup. The managers involved in the selection process recognize the pivotal role that a seasoned and skilled team plays in shaping a startup's trajectory. Additionally, the strategic placement of the startup within its network is identified as a key determinant of future success. This is also consistent with the prior research of Munoz (2015) on significant positive effect of industry experience of the team on startups' likelihood of securing investment. [43] [11].

2.3.1.2 The entrepreneurial experience of the team

Dimov conducted an extensive investigation utilizing data from solo, nascent entrepreneurs, and his discerning analysis revealed noteworthy insights. Specifically, Dimov posited that harboring confidence in forthcoming opportunities exerts a positive influence on the emergence of a venture. In contrast, the impacts of entrepreneurial

experience and early planning on the initiation of a venture were found to be more indirect in nature. Conversely, the influence of industry experience demonstrated a more direct correlation, significantly and positively affecting the establishment of a venture. Notably, industry experience proved to be a strong deterrent against quitting, as it made it much less likely that a business would fail when faced with problems. In the end, Dimov's research shows how entrepreneurial experience and industry knowledge interact in the complex process of starting a business [44]. When Pierrakis (2022) looked at the investment criteria of angel investors and accelerators, he pointed out an important difference: angel investors are more likely to invest in a team or entrepreneur who has already been an entrepreneur, while accelerators are less likely to do so. However, the study states that for both parties, past experience in venture building has a positive effect on investment. His research indicates that angel investors favor businesses run by people with a proven track record in entrepreneurship. With this new information, you can see how important previous business experience is to angel investors when they are looking at possible investments [45]. Taweasangrunroj conducted research on a proposed model of decision-making that government agencies employ when choosing technology ventures. His model emphasizes the importance of entrepreneurial experience in this process. His research indicates that government organizations give preference to projects headed by people who have a track record of successful entrepreneurship. This emphasizes how important it is for entrepreneurs to have experience in the business world when it comes to government agencies' choices and support of tech firms [46].

2.3.1.3 Personal characteristics of the leading entrepreneur (leadership, dedication, coaching, etc.)

Kubikcova et al. (2013) identified founders' management capabilities and problem-solving skills as essential factors in the assessment of startup success. As the study shows, founders' leadership and strategic skills are very important. The study stresses that a founder's management skills and ability to deal with problems are big factors in figuring out how successful a startup could be overall [47]. Cesausu (2018) studied the accelerators in Romania and found out that The qualitative attributes

of the founder, as well as education, prior experience, age, and expertise, play a pivotal role in the performance of a new venture. These qualities translate into strategic assets for the business, guiding the development of strategies and effective coordination of resources. Additionally, the founder's capabilities serve as crucial resources in establishing a competitive advantage and facilitating the early growth of the startup. On the contrary, research indicates that excessive pro-activeness, defined as the ability to identify opportunities and take initiative, may have a limited impact on performance. An excess of pro-activeness can potentially divert the entrepreneur's focus and unnecessarily prolong the time-to-market [?]. The research done on fin-tech accelerators, by Bondarekno et al. emphasized that a startup team should have a leader who possesses not only charismatic qualities but also demonstrates strong entrepreneurial acumen. This assertion underscores the dual role expected of the leader, highlighting the importance of both inspirational leadership qualities and practical business skills [48]. In summary, it is widely acknowledged that the founder plays a critical role in shaping investment decisions. The general belief is that a competent founder has the capacity to inspire confidence in investors. When evaluating the early stages of a company, the due diligence conducted can be primarily limited to verifying the founder's competency and integrity. [49]

2.3.1.4 Diversity of talent within the team

Franke's (2006) study elucidates the dynamics of team composition, particularly in the realm of education. He emphasizes that the relative benefit contribution of various parameter values aligns with the idea that a heterogeneous team, blending technical and management skills, is highly sought after. Notably, a team exclusively focused on management is deemed unviable, an expectation given the technical nature of the business model under examination. Surprisingly, even though the model is focused on technology, teams made up of only engineers still face problems, and their contributions are not very helpful. This suggests that this factor could stop teams from moving on to the next stage of the evaluation process. Franke's research shows how important it is for teams to have a balance of technical and managerial skills in order to get good evaluations from investors [50]. Similarly, Majumdar (2023) pointed

out that, for investors, a heterogeneous team with diverse industry experience ranks among the top three criteria. This underscores the importance investors place on teams with varied backgrounds, emphasizing their pivotal role in influencing investment decisions [51]. The analysis of startup team performance produced insightful results in a notable field experiment by Hoogendoorn et al. (2017). The study revealed that diversity among team members was found to be more effective in achieving success than individual level of ability. This underscores the importance of considering the collective dynamics and varied perspectives within a startup team, suggesting that a diverse mix of skills, backgrounds, and expertise contributes significantly to the overall effectiveness and success of the venture. The findings thus highlight the relevance of team-level attributes, particularly diversity, in the evaluation of startups for investment [52].

2.3.1.5 Work experience of the team

Hashai and Zahra (2022) examined how founders' employment experience affects startup performance. Different pre-entry knowledge specialization affected startups and how it interacted with experiential knowledge in early and later high-tech startups. They propose and demonstrate that founders' previous job experience in a firm or industry affects their early and later success. Their findings show that founders' prior company and industry experience boosts early growth. This same firm-similar industry experience negatively impacts growth in later phases as companies gain experience. Finally, the data demonstrate that having a mix of founding team experience, such as with the same firm and in other industries, helps startups grow, regardless of their stage. Research indicates that founders with diverse prior business and industry backgrounds have a stronger impact on startup success. [53]. Onetti (2015) categorized founders by their uniqueness and global perspectives to research how job experiences affect company growth. Diverse prior experiences among founding teams frequently boost startup growth in early and later stages. The study also reveals that job experience and international orientation greatly affect their capacity to acquire resources, adjust to entrepreneurship, and secure funding. The study highlights the significance of

work and foreign experience for startup success, validating competence-based theories linking founders' skills and expertise to growth [54].

2.3.1.6 Educational and academic background of the team

Franke's research on the assessment of startup teams by venture capitalists provided some fascinating new information, especially about the team's educational background. The study highlights how crucial it is for the team to have a strong academic background. It's interesting to note that there is almost any difference between teams where all members have a university background and those where only a few have. Although a team consisting of some university graduates is marginally favored, this difference is not statistically significant, indicating that venture capitalists see founders with a university degree as a positive signal. However, this positive signal is not amplified, but rather decreases as the team's graduation rate rises from "some" to "all". Alternatively, a mixed team contributes important variability, and a "all university" team may indicate a better average level of human capital. As can be shown, both situations contribute equally to the apparent benefits when these two impacts are comparable. [50].

2.3.1.7 Number of members of the team

Although four members is stated as a common size for startups [50], there are also studies indicating that an increasing number of members in a startup team could potentially result in a better chance of survival because the increasing size of the team can contribute to the diversity of talents within the startup [16]. In contrast, according to the study conducted by Esen et al (2023) number of the members in the top management team negatively effects the likelihood of investment in startups [55]. According to a case study by Ceausu et al. (2018), team size is also an important factor in the selection process of the Romanian accelerators. However, they did not say what kind of effect team size has on being selected [36]. Pasayat et al. (2022) used a machine learning algorithm to decide the top ten features that lead to success of a startup and stated that the number of employees and the number of co-founders have a significant effect on pulling investors [56].

2.3.1.8 Ages of team members

Franke (2008) emphasized the significance of founder and employee age as influential factors in investment decisions, suggesting that their impact is notable up to a certain threshold. Specifically, the age range of 35–45 emerged as particularly advantageous in the evaluation of startups for investment. This insight underscores the relevance of considering age demographics within the entrepreneurial team when assessing the potential of a startup for investment purposes [39]. According to Pierrakis and Owen (2022), research findings underscore the positive and statistically significant correlation between founders' age and investment backing, holding true for both accelerator and angel-funded startups. This observation highlights the universal importance of founders' age as a favorable factor in attracting financial support from various sources [45].

2.3.1.9 Qualitative characteristics of the team members

Franke (2006) acknowledged the significance of qualitative attributes such as perseverance and stress resistance in the selection process for startup investments. However, it was highlighted that assessing these qualities poses a challenge, particularly in the short term. Although the study suggests that these factors do affect investment decisions, they are hard to measure and quantify in the short amount of time available for the evaluation process. This recognition underscores the complexity of incorporating certain qualitative aspects into the immediate investment criteria for startups [50].

The study done by Jaki et al. (2022) underscores the significant impact of lead entrepreneurs' and teams' character, particularly their managerial capabilities, on the investment decisions of investors. While managerial capabilities take center stage, commitment, background or experience, and the ability to assess risk also hold considerable sway. The study focuses on person-specific skills, pointing out four important traits of the management team: gaining investors' sympathy and interest, showing dedication to the business, being genuine in their expertise, and possessing

financial knowledge. They found out that even with the other features being good enough, a lack of sympathy can lead to failure in securing investment [7].

2.3.1.10 References, network and reputation

Entrepreneurs reputation has been considered significant even in the earliest studies done on startup assessment [57]. Raz and Gloor's (2007) study, which focused on the viability of startups, produced significant findings by examining the size of the entrepreneurial network. The research conducted examined a total of 82 unique startups located in Israel. The findings of this study indicate that the magnitude of an entrepreneur's business network has a significant role in determining the likelihood of survival for companies. This highlights the importance of the relational dimension of entrepreneurship, highlighting that the scale and depth of an entrepreneur's network have a crucial impact on the sustainability and feasibility of new businesses. [58]. Yin and Luo (2018) underscored the importance of securing strong references as an assessment criterion in the evaluation of startups. The inclusion of positive references from influential figures emerged as a notable factor contributing to the overall evaluation process. This finding suggests that the endorsement and support from established and reputable individuals play a significant role in shaping the perception of a startup's credibility and potential for success [40].

Ferrati and Muffatto asserted that references from external sources and the reputation of the founder are highly sought-after criteria in the assessment of startups by equity investors. Their claim emphasizes the significance placed on external validation and the perceived credibility of the founder in the evaluation process. This implies that investors place considerable value on recommendations and the reputation of the entrepreneur when gauging the potential of a startup for investment [59] [49]. Simoes et al. (2020) categorize the reputation of startups as a discernible indicator of their growth potential. This perspective underscores the recognition that the perceived standing and recognition of a startup within its industry or market can serve as a valuable signal for its future growth trajectory. By associating reputation with growth potential, they suggest that a positive public image and acknowledgment within the business community can contribute to the attractiveness of a startup for potential

investors [60]. Erdogan and Koohborfardhaghi (2019) claim that not only the reputation of the startup but also the reputation of their partners has significant positive effect on assessment [11]

2.3.2 Market

For startups to achieve success, it is imperative that their products or services be sold. Consequently, market conditions unquestionably exert a critical influence on the evaluation of startups [61]. In the evaluation of startups, market conditions constitute a fundamental component. They furnish an all-encompassing comprehension of the milieu in which the startup functions and aspires to expand. These factors encompass the competitive environment, the regulatory framework, the potential for scalability, and the current and projected demand for the product or service itself. A favorable market condition is indicative of a higher probability of the startup's success, making it an attractive prospect for accelerators and incubation centers [62]. Therefore, understanding market conditions can provide valuable insights into a startup's potential for success and is an important criterion for accelerators and incubation centers when assessing early-stage technology startups. [63]

2.3.2.1 Market and target market size

Since it is the strongest indicator of the extent of a potential customer base, the financial size of the market has a big impact on the success of companies. A larger market offers more prospects for growth and profit [10], enabling startups to reach a wider consumer base and grow their businesses. On the other hand, smaller markets might restrict expansion opportunities and impede the startup's ability to attain lasting success. Thus, analyzing the market's size and growth potential is essential when evaluating the feasibility and potential success of a startup company. However, while a large market offers potential, intense competition within it can hinder startup success. Market saturation and fierce competition may make it challenging for startups to establish themselves and sustain profitability. Therefore, it's crucial to assess not only market size but also competition levels and a startup's ability to differentiate itself within the market. [64]

2.3.2.2 Market risk

The ease of market entry is defined by Scillitoe (2022) as the relative simplicity with which a new startup can establish itself inside a market, overcoming barriers relating to information, skills, regulations, networks, and social norms that are prevalent in the market. [65]. Therefore, it is connected with several aspects, from culture to regulations. Entrepreneurs, in their market entry strategies, must systematically identify and acquire information about various possible markets. This requires allocating resources to thoroughly explore the market, including understanding customer preferences, assessing market profitability, and identifying strategic opportunities for market entry. Therefore, startups that can identify different market opportunities may have an advantage in finding entry points with less competition or barriers. [66].

2.3.2.3 Market growth rate

The rate of market growth is an important indicator of the level of profitability that the market is now achieving. Strong demand and an extensive number of potential customers are both indicators of a market growth rate that is comparatively high [67]. Because of this, it is utilized in many instances to evaluate startups [68] [69].

2.3.2.4 Competition conditions in the market

According to Eisenmann's (2020) study, startups with a lot of rivals, particularly well-financed late-stage ventures, are likely to experience difficulties because of their limited resources in comparison to their competitors. Despite the threat that large, established organizations pose, startups may have a competitive advantage over them due to their agility and innovation. Yet other fledgling firms and smaller businesses are perceived as less menacing because of their limited resources. [70] Milkova et al. (2018) categorized competition into two main groups: newly-arrived entrants and a substitute products. They emphasized the significance of competition as a crucial factor that investors consider when evaluating ventures. [37]

2.3.2.5 Globalization potential

Globalization gives startups a number of possibilities. It opens up bigger marketplaces, enabling them reach customers worldwide [71]. However, globalization has obstacles. International competition, complex regulations, and cultural differences will challenge startups. Startups require a global mentality from the outset, thorough market research, strong networks and alliances, a focus on localized experiences, and the agility to adapt to a changing global scene to succeed in globalization. [72] [56]. Globalization increases the amount of competition that startups are exposed to. It poses a threat; however, it also offers the opportunity to learn from and adjust to more formidable opponents. The global marketplace is continuously changing. Startups that operate worldwide must consistently monitor their environment and adapt their strategy to remain pertinent. Globalization provides entrepreneurs with opportunities for substantial expansion, although it also presents obstacles that require creativity and adjustment. [73]

2.3.3 Idea/Product

A study done by Scott et al. in 2015 emphasizes that the concept of a startup is crucial, but its significance may differ based on the business. The study indicates that the original concept is particularly important for startups in industries that largely depend on research and development (R&D). In these industries, the concept is frequently associated with certain intellectual property and has limited flexibility for modification. Evaluators can more accurately analyze the commercial potential of the proposal at an early stage since it is less likely to undergo significant changes. Startups in businesses not necessitating considerable research and development may find the initial idea to be less crucial. These enterprises typically revolve around the entrepreneur's expertise and background, providing greater leeway to modify the business idea as required. In these situations, the entrepreneur's capacity to implement and adjust is more crucial than the original idea. In R&D-driven sectors, a great idea is crucial as it serves as the fundamental basis for the startup's success. Conversely, in industries that may adjust

easily, an entrepreneur's skills and capacity to adapt may be more crucial for sustained success [74].

2.3.3.1 Innovation

The connection between startup innovation and survival is complicated. Innovation can bring benefits but can also raise risks for new businesses because of uncertainty, scarce resources, and challenges in obtaining capital. Hyytinen et al. (2015) conducted a study on startups, employing an ex-ante measure of innovativeness, and discovered a negative correlation between innovation and survival. Founders, especially those with a high-risk tolerance, must balance the long-term rewards of innovation with the obstacles it can pose in the early phases of a firm. [75]. In the industry type context, less innovative industries have lower requirements for improvement. Therefore, a slightly original concept from a new business can make a substantial difference by distinguishing itself from the less original rivals. Due to the limited number of competitors in certain industries, there is reduced competition, increasing the likelihood that the startup's product will meet a significant market need. This might result in quick acceptance and significant expansion for the firm [76].

2.3.3.2 Importance of the problem solved

Brevery(2017) defines the need as a problem that needs to be solved for a customer. Emphasizing the importance of addressing a "burning need" is crucial for the success of a startup. Startups tackling these significant issues show solid market validation since customers are very willing to pay for a solution. By ensuring a strong alignment between the problem and the solution, it can result in faster product adoption and increased customer loyalty over time. [77] Understanding the customer's pain point is crucial to the point where it becomes essential. Understanding the difference between addressing a critical need (painkiller) and addressing a secondary need (vitamin) is essential. Startups focusing on mission-critical, pain-point issues have a greater likelihood of success and the potential to dominate the market. This method guarantees a solid product-market fit and boosts customer willingness to pay, given that the urgency of the problem necessitates immediate solutions. [78]

2.3.3.3 Scalability

In their article, Rasmussen and Tanev (2016) states that scalability is a crucial determinant of startups' success. Scalability refers to a startup's ability to expand and increase its operations without facing restrictions or limitations. Startups with a business strategy that can be expanded or increased in size are more likely to achieve long-term success because they can readily adjust to changing market conditions and fulfill the needs of a growing client base. The article recommends that entrepreneurs prioritize the validation of their business model and ensure its successful scalability. Startups can enhance their likelihood of attaining sustainable growth and long-term success by giving priority to scalability and embracing a lean startup approach [79].

2.3.3.4 Ease of imitation or substitute

The success and growth potential of startups are greatly impacted by their being hard to imitate and limited alternatives. These characteristics provide a competitive edge by creating obstacles for new entrants, allowing startups to capture a significant portion of the market and sustain a solid market presence. Highlighting the distinctiveness of a product or service can set a startup apart from competitors and draw in customers, investors, and partners. This, in turn, helps in establishing a sustainable competitive advantage, boosting bargaining power, and contributing to the long-term success and profitability of the startup. [80] [81].

2.3.3.5 Intellectual property rights

Intellectual property is crucial for the success of startups, giving them a competitive advantage by securing exclusivity over their innovations and inventions. This exclusivity sets startups apart in the market and safeguards their market share and revenue by deterring imitation. Moreover, intellectual property enhances a startup's attractiveness to investors and potential partners by showcasing its uniqueness and potential for profitability. Intellectual property rights can serve as tangible assets that are valuable for securing funding and partnerships, as well as fostering additional innovation and investment in research and development. [82] It is crucial for startups to strategically handle their intellectual property, making sure their innovations are

distinct and safeguarded, and aligning their intellectual property strategy with their broader business objectives. Essentially, successful IP management is essential for attracting investment, promoting innovation, and establishing a startup's position in the competitive ecosystem. [83]

2.3.3.6 Idea/Solution verification

The importance of product validation, particularly during the ideating stage, lies in its role as a foundational step towards transforming a concept into a viable business. It ensures that the product being developed is aligned with market demands and needs, which is crucial for the product's success and the company's sustainability. [13] Validating ideas is important for the success of startups, playing a key role in confirming the viability and market need for a product or service. This process helps startups navigate the uncertainties that come with early business stages by allowing them to fine-tune their business models and product offerings using concrete feedback from potential customers. Validating ideas early on helps startups pinpoint technical or market-related challenges, enabling them to make timely adjustments or pivots to their strategies. By taking a proactive approach, the risk of investing in products without market demand is minimized, increasing the likelihood of success by ensuring the product meets the needs and expectations of its target audience. [84] Furthermore, validating ideas allows for a more profound interaction with customers and stakeholders, offering crucial insights to guide product development and improve market alignment. By utilizing minimum viable products (MVPs) and actionable metrics, startups can validate their assumptions and make rapid adjustments in response to feedback, reflecting the core concepts of the Lean Startup approach. By following this process, resources are conserved by avoiding unprofitable products and identifying potential opportunities that can enhance the startup's likelihood of success. Essentially, idea validation is crucial for startups as it provides them with the necessary insights to make well-informed decisions, pivot quickly, and pursue the most feasible and lucrative business opportunities in a dynamic and effective way. [85]

2.3.3.7 The current stage of the product (idea, prototype, final product, etc.)

It is essential to consider the product's maturity as it indicates the product's progress and readiness for the market. A product that has reached maturity has been extensively tested, gone through numerous iterations, and received enhancements to guarantee its reliability and stability. [40] At this level of maturity, the product is equipped with the essential functionality and features to meet customer needs and expectations, enhancing its competitiveness and chances of success in the market. In addition, a mature product demonstrates the startup's ability to meet its obligations, and it is one of the most important signals to time to market prediction which affect the selection of startups in accelerators. [86].

2.3.3.8 Sustainability of competitive advantage

Evaluating startup teams for incubation or acceleration periods requires a thorough understanding of their competitive advantage. It plays a crucial role in setting a startup apart from its competitors and creating a distinct value proposition in the market. Obtaining a competitive advantage can stem from different sources, such as proprietary technology, intellectual property rights, innovative business models, or exclusive partnerships. This advantage not only positions the startup more favorably in the eyes of investors and partners but also enhances its potential for market success. [68]

2.3.3.9 Technology readiness level

NASA developed the Technology Readiness Level framework (TRL) to evaluate space deployment technology maturity. The US Department of Defense adopted it in 1999 after an internal study. After the Kinnaird Defense Procurement Review, the Commonwealth of Australia and other government, military, and space agencies like the European Space Agency adopted it. This paradigm is used across sectors to assess technology development. [87]. Startups often include technologies that are typically classified within the range of Technology Readiness Levels (TRL) 5 to 7. TRL 5

signifies that a technology has undergone validation in a pertinent industrial setting, indicating a certain degree of assurance in its practical implementation. At Technology preparation Level (TRL) 6, a technology is showcased in a relevant industrial environment, demonstrating greater advancement and preparation for real-world application. TRL 7 is attained when a technological prototype has been effectively showcased in a functional setting, signifying a significant level of development and preparedness for implementation. [88] Startups that successfully travel through the "Valley of Death", a crucial phase characterized by difficult transitions from concept to marketable product, generally achieve Technology Readiness Level (TRL) 7 during their establishment. Therefore TRL can be considered as a strong indicator of a potential success of the startups. [89].

2.3.3.10 Technical feasibility

Assessing technical feasibility is crucial in determining the ability to tackle a technical issue within specific limitations. It assesses the solvability of a technical challenge and the feasibility of its solution, taking into account the objectives and constraints involved. This assessment is an essential part of the early stages in the product development process, carried out before examining the project's economic feasibility. [90] For startups, assessing technical feasibility is a crucial factor in determining their chances of success or failure. Failing to validate technical feasibility can greatly increase the risk of the venture failing to become successful. [91]

2.3.4 Financials

In the past, the assessment of organizational success mostly emphasized short-term financial concerns. After 1970, there was a change in approach when non-financial measurements, such as operational and strategic indicators, were used to examine all aspects of the business in a holistic manner [6]. Financial assessments of startups are necessary for supporting entities during the selection phase and often serve as a key criterion for decision-making. [92] Nevertheless, assessing the financial aspects of early-stage startups can be quite challenging due to the intricate nature of the subject matter and the possibility of inaccuracies. [51]The future financial performance of

these ventures depends heavily on factors such as firm resources, external relations, and market opportunities, which are inherently uncertain and challenging to forecast. Given this uncertainty, it is crucial to adopt alternative approaches that consider these dynamic and unpredictable factors in valuation and decision-making processes. This shift recognizes the limitations of traditional financial assessments and emphasizes the necessity for more nuanced methods in evaluating early-stage startups. [93]

2.3.4.1 Key financial indicators

Fundamental metrics like Return on Investment (RoI), Internal Rate of Return (IRR), and Net Present Value (NPV) stand out among other financial signs that should be looked at closely [94]. The fact that the financial performance of early stage startups will be relatively thin [95], may affect the judgement towards startups, nonetheless several studies suggested these metrics as important performance measures [94], [96] [80].

2.3.4.2 Regular cash flow

Cash flow is seen as a measure of both the profitability and managerial achievements of startups [10]. However, like other financial indicators, assessing cash flow in startups can be challenging due to the absence of historical data [97]. A few studies listed cash flow as an indicator to be assessed in startups [98] [17].

2.3.4.3 Profitability

The success of startups is considerably impacted by their profitability. Startups that generate profits during their initial years have a greater likelihood of surviving and achieving long-term success. Profitability acts as an inherent criterion for selection, since the environment chooses enterprises that can generate profits [99]. Nevertheless, the correlation between profitability and the success of a business may not be linear, as certain startups may initially have negative financial performance [36].

2.3.4.4 Realism of financial forecasts

Numerous start-ups have been prone to failure or succumbed to financial pressures and inadequate financial preparation [95]. Due to the limited financial history of startups, their evaluation is primarily based on their projected expectations. Hence, the reasonableness of their financial plans is crucial in the evaluation process [98].

2.3.5 Strategy

Assessing companies merely based on historical performance becomes problematic due to the lack of detailed data on past accomplishments, financial benefits, and validation. Therefore, it is crucial to have a forward-thinking framework that considers their future plan while still recognizing their past achievements [12].

2.3.5.1 Vision

A crucial determinant that differentiates prosperous startups from other endeavors is in the founders' enduring strategic vision and objectives [11]. Their steadfast vision for the future expansion of the startups acts as a guiding principle, directing strategic choices and promoting resilience. These visionary leaders effectively manage the ever-changing landscape by integrating their goals with practical actions, turning difficulties into opportunities [38]. Therefore vision is considered to be an important criteria by various researches [61] [59] [96].

2.3.5.2 Business plan

A common piece of advice taught in business schools around the world is that making a strong business plan is important when launching new goods or starting up new businesses. People think that this careful process is one of the best ways to make sure that the launch goes well [79]. The concept is so common that there are competition based on just business plans for startups [100]. Well written business plan is an indicator of a successful startups in terms of market opportunity exploration therefore it is considered an important factor for several stakeholders [40] [96] [48] [10].

2.3.5.3 Realistic risk analysis

Several experts have also pointed out that risk is one of the most important things to think about when it comes to start-ups. Risk management involves finding and coming up with ways to lower risks [95]. It is especially suggested that people making decisions carefully weigh the pros and cons of reducing risk, making sure that they take a fair approach. By managing risk wisely, businesses can build resilience and improve their chances of long-term success [101] [6].

2.3.5.4 Marketing strategy

Startups need to establish their brand presence in a fiercely competitive market. Efficient marketing facilitates the establishment of a robust brand identity and enhances knowledge regarding their distinctive services. Brand recognition is crucial for achieving sustained success. Moreover, marketing facilitates startups in establishing connections with a wide range of potential customers, targeting certain market segments, generating leads and sales, cultivating loyalty, and gathering vital consumer data. Startups can achieve growth and sustainability by strategically investing in a well-planned marketing strategy. [46] [12]

2.3.5.5 Financial strategy

In fact, the financial part of a startup's plan is one of the most important ways to guess how well it will do financially in the future. Because of this, it makes sense to look at the current financial arrangement. Startups can prepare for problems ahead of time and set themselves up for long-term growth by carefully reviewing their financial plans [37]. Startups need to plan their finances carefully if they want to be financially stable, deal with problems, and get ahead of the competition. Startups can expect, plan for, react to, and adapt to changes and shocks with its help. Liquidity planning is important for knowing cash flows and making changes when times get tough [102].

2.3.5.6 Operational strategy

The operational plan of a company matters for several reasons. It facilitates the efficient allocation of resources, enhances efficiency and productivity, enables scalability, improves customer happiness, provides a competitive edge, and drives financial performance [103]. Moreover, a clearly defined operational strategy enables a company to optimize its procedures, anticipate future expansion, distinguish itself in the market, adjust to changes, allocate resources efficiently, and mitigate risks. In summary, the operational strategy establishes the basis for effective operations and aids the startup in attaining its strategic objectives [104].

2.3.5.7 Current and planned strategic partnerships

Startup strategic alliances involve a complex network of suppliers and collaborators that operationalize the business strategy [105]. These partnerships shape the startup's trajectory, foster synergies, and boost their competitiveness. Startups gain resources, experience, and market reach through strategic alliances, propelling them to lasting success [106]. Many researcher adopts partnerships as an indicator of successful startups [11] [36].

2.3.5.8 Sensitivity to political and economic fluctuations

The economic and political environment directly affects startup success by shaping market circumstances. Politics affect state rules, business support, legislative environment, bureaucracy, and education. Startups especially need good politics to succeed. Supportive rules, efficient administrative processes, accessible funding, and skilled labor are examples [107]. Sensitivity to these political or economical issues directly results in lack of resilience of startup company meaning high risk [108]. Therefore a number of studies considers the sensitivity as an important risk factor while assessing startups [109] [68] [88].

2.3.5.9 Strategic compatibility

Strategic fit for accelerators means their goals, objectives, and capabilities match those of the startups they pick for their programs. The process comprises finding businesses that match the accelerator's objectives, priority areas, and resources. When selecting startups, accelerators should prioritize strategic fit to improve program effectiveness, create value for both parties, foster synergistic partnerships, differentiate the accelerator in the market, and ensure long-term success. Accelerators can customize assistance, coaching, and resources to entrepreneurs with strategic fit, enhancing success and building a mutually beneficial ecosystem [110].

Due to the fact that the literature on startup selection criteria is limited and the variation of criteria set across different regions, this study examines startup evaluation models for different stakeholders, such as venture capitalists, business angels, incubators, and accelerators. The final set of criteria is determined through surveys conducted with local experts.

2.4 Multi-Criteria Decision Making

Decision-making analysis has been studied throughout history, including how people should make decisions. Many of these assessments did not follow the rigorous scientific methods found in the literature today. It is not at all surprising that decision-making literature is vast and growing. Developing a perfect decision-making strategy for logical real-life decision-making remains a challenging task [111]. Incorporating the decision maker's preferences is crucial in distinguishing among options, especially in situations where finding a single optimal solution is difficult for these challenges. [112]. Most decision making problems include basic elements like alternatives to choose from, criteria to evaluate the alternatives accordingly, scoring the alternatives based on decided criteria and ranking of the alternatives based on their evaluations. [111]. Therefore, multi-criteria decision making (MCDM) problems consist of several general steps, as presented in Figure 2.2. There are a number of methods performing the basic steps with different

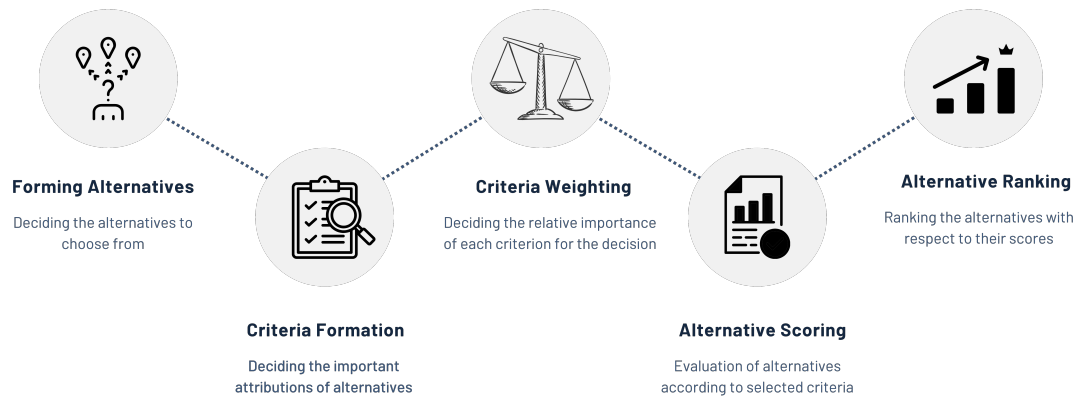


Figure 2.2 : General steps in multi-criteria decision-making problems.

Source: Author's own work adapted from Kabak (2017) [114]

mechanisms to improve the process further, most commonly used methods in the literature can be listed as Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Analytic Network Process (ANP), Fuzzy AHP, Fuzzy TOPSIS, Fuzzy ANP, Data Envelopment Analysis (DEA) and ViseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) [113].

2.4.1 Analytic hierarchy process (AHP) and fuzzy AHP methods

Saaty introduced the Analytic Hierarchy Process (AHP) in 1970s, a well-known method for complex decision-making problems. This approach deconstructs a decision-making issue into a hierarchical structure consisting of objectives, qualities (or criteria), and alternatives. A hierarchy in the Analytic Hierarchy Process (AHP) can be extended to include several levels as needed to comprehensively depict a particular decision scenario [115]. The effectiveness of AHP as a methodology is attributed to its distinct functional qualities. These features include the ability to handle choice situations involving subjective judgments, include several decision-makers, and provide indicators of consistency for preferences. The AHP methodology is specifically created to accurately reflect the cognitive processes of humans, which is why it is often regarded as the most acclaimed and commonly used approach

for decision-making. AHP excels at managing both objective and subjective characteristics, especially in situations where the subjective evaluations of different individuals have a substantial impact on the decision-making process. [116] For decision makers, it can be hard to figure out the essential important weights for many factors at the same time. The problem can be solved more quickly by turning it into a series of pairwise comparisons as the number of characteristics grows. The Analytic Hierarchy Process (AHP) makes the procedure easier by breaking down the difficult problem of attribute weighting into the more manageable job of comparing two attributes that are competing with each other. This process is summed up in a "matrix of pairwise comparisons," where the person making the decision has to say which of two traits is more important. The person making the decision has to answer the question, "Considering the overall goal, by what magnitude is Attribute A more significant than Attribute B?" for each pairwise comparison. [117]. Here is the step by step AHP process adopted from Saaty (1990) is explained ; [115]

1. **Model the Problem as a Hierarchy:** This involves structuring the decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently.
2. **Establish Weights of Criterion:** Set the priorities for the elements of the hierarchy by making pairwise comparisons of each element. This process is carried out for each of the decision hierarchy's levels. The pairwise comparison matrix is denoted as $A = [a_{ij}]$, where a_{ij} represents the importance of criterion i over criterion j . If criterion i is equally as important as criterion j , then $a_{ij} = 1$. This step is performed using the priority values tabulated in table 2.1.
3. **Calculate Weight Vector:** The weight vector is calculated by normalizing the pairwise comparison matrix. The normalized value n_{ij} is calculated as follows:

$$n_{ij} = \frac{a_{ij}}{\sum_{k=1}^n a_{kj}} \quad (2.1)$$

The weight of each criterion is then calculated by averaging the normalized values in each row:

$$w_i = \frac{1}{n} \sum_{j=1}^n n_{ij} \quad (2.2)$$

4. **Consistency Ratio:** Check the consistency of the judgments. This is done by calculating the Consistency Index (CI) and the Consistency Ratio (CR). The CI is calculated as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (2.3)$$

where λ_{max} is the maximum eigenvalue of the pairwise comparison matrix, which can be approximated as:

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^n \frac{\sum_{j=1}^n a_{ij} w_j}{w_i} \quad (2.4)$$

The CR is then calculated as:

$$CR = \frac{CI}{RI} \quad (2.5)$$

where RI is the Random Index, which depends on the number of criteria. Values of RI is tabulated in Table 2.2 If the CR is greater than 0.10, the judgments are inconsistent. In this case, revise the judgments or improve the hierarchy's structure.

5. **Pairwise Comparisons of Alternatives:** For each criterion, the decision maker compares the alternatives pairwise in terms of how they meet the criterion. This results in a matrix for each criterion, denoted as $B_k = [b_{ij}^k]$ for the k^{th} criterion, where b_{ij}^k represents the preference of alternative i over alternative j with respect to the k^{th} criterion.
6. **Aggregating Scores:** The scores of the alternatives are aggregated by multiplying the priority of each criterion with the corresponding priority of the alternatives with respect to that criterion, and then summing these up for all criteria. The final score of the i^{th} alternative is calculated as follows:

$$s_i = \sum_{k=1}^n w_k b_{ik}^k \quad (2.6)$$

7. **Result:** The alternative with the highest score is the best one.

Table 2.1 : Saaty's fundamental scale of absolute numbers

Source: Adopted from Saaty (2008) [118]

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals	If activity i has one of the above non-zero numbers assigned to it when compared with activity j , then j has the reciprocal value when compared with i	A reasonable assumption

2.4.1.1 Fuzzy AHP

In classic Multi-Attribute Decision Making (MADM) approaches, it is commonly assumed that all criteria and their accompanying weights are defined with exact, unambiguous values. This assumption enables the direct evaluation and ordering of different options. Nevertheless, when it comes to making decisions in real-world situations, the use of traditional Multiple Attribute Decision Making (MADM) approaches might be hindered by practical constraints arising from the lack of precise or clear criteria information. Frequently, the evaluation of criteria can only be expressed in a subjective or linguistic manner, requiring a method that can effectively

Table 2.2 : Random index values.

Source: Adopted from Golden (1989) [119]

Order of Matrix (n)	RI
1	0
2	0
3	0.52
4	0.89
5	1.11
6	1.25
7	1.35
8	1.40
9	1.45
10	1.49

handle this uncertainty [117]. To model this uncertainty in human preference modeling, fuzzy sets can be integrated with pairwise comparison as an extension of AHP. Fuzzy AHP is a modified version of AHP that addresses the limitations of the compensatory approach and the AHP's inability to handle linguistic variations. The fuzzy Analytic Hierarchy Process (AHP) enables a more precise depiction of the decision-making process [120]. The structure of fuzzy AHP method is quite similar to classical AHP with fuzzy sets instead of crisp number. A step-by step explanation is adopted from Chang (1996) and presented below; [121]

• **Definition 1** Let $M \in F(R)$ be called a fuzzy number if:

1. exists $x_0 \in R$ such that $\mu_M(x_0) = 1$
2. For any $\alpha \in [0, 1]$, $A_\alpha = [x, \mu_{A_\alpha} \geq \alpha]$ is a closed interval.

A Fuzzy set $\tilde{a}$ in a universe of discourse X is characterized by a membership function $\mu_{\tilde{a}}(x)$ which associates with each element x in X , a real number in the interval $[0,1]$. The function value $\mu_{\tilde{a}}(x)$ is termed the grade of membership of x in $\tilde{a}$ [?]. The present study uses triangular Fuzzy numbers. A triangular Fuzzy number, $\tilde{a}$, can be defined by a triplet (a_1, a_2, a_3) . Its conceptual schema and mathematical form are shown by Eq. (1) [?].

- **Definition 2.** Membership function $\mu_M(x)$ is equal to;

$$\mu_M(x) = \begin{cases} \frac{x}{m-l} - \frac{l}{m-l} & x \in [l, m] \\ \frac{x}{m-u} - \frac{u}{m-u} & x \in [m, u] \\ 0 & \text{otherwise} \end{cases} \quad (2.7)$$

After these definitions, basic operations with fuzzy numbers can be calculated as follows;

For multiplication of $M_1 \times M_2$

$$[M_1 \times M_2 = (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2)] \quad (2.8)$$

For addition of $M_1 + M_2$

$$[M_1 + M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2)] \quad (2.9)$$

For multiplication of $M_1 \times \lambda$

$$[M_1 \times \lambda = (l_1 \times \lambda, m_1 \times \lambda, u_1 \times \lambda)] \quad (2.10)$$

For inverse of M_1

$$[M_1^{-1} = (1/u_1, 1/m_1, 1/l_1)] \quad (2.11)$$

- **Definition 3.** Fuzzy synthetic extent values are defined as;

$$S_i = \sum_{j=1}^m M_{g_i}^j \odot [\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j]^{-1} \quad (2.12)$$

where: M_{ij} : TFN representing the importance of criterion j over criterion i , where n : total number of criteria

- **Definition 4.** Degree of possibility of $M_1 \geq M_2$ is defined as;

$$[V(M_1 \geq M_2) = \sup_{x>y} [\min(\mu_{M_1}(x), \mu_{M_2}(y))]] \quad (2.13)$$

When a pair (x, y) exists such that $x > y$ and $\mu_M(x, y) = 1$, then we have $V(M_1 \geq M_2) = 1$. Since M_1 and M_2 are convex fuzzy numbers, we have that

$$V(M_1 \geq M_2) = 1 \quad \text{iff} \quad m_1 \geq m_2,$$

$$V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_M(d), \quad (2.14)$$

where d is the ordinate of the highest intersection point D between μ_{M_1} and μ_{M_2} (see Fig. 1). When $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, the ordinate of D is given by:

$$V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}. \quad (2.15)$$

To compare M_1 and M_2 , we need both the values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$.

- **Definition 5.** The degree possibility for a convex fuzzy number to be greater than k convex fuzzy numbers $(M_i (i = 1, 2, \dots, k))$ can be defined by

$$\begin{aligned} V(M \geq M_1, M_2, \dots, M_k) &= V[(M \geq M_1) \text{ and } (M \geq M_2) \dots \text{ and } (M \geq M_k)] \\ &= \min V(M \geq M_i), \quad i = 1, 2, \dots, k. \end{aligned} \quad (2.16)$$

Assume that

$$d'(A_i) = \min V(S_i > S_k), \quad \text{for } k = 1, 2, \dots, n; k \neq i. \quad (2.17)$$

Then the weight vector is given by

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T, \quad (2.18)$$

where A_i (for $i = 1, 2, \dots, n$) are n elements. Via normalization, we get the normalized weight vector

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T, \quad (2.19)$$

where W is a nonfuzzy number.

Using these definitions, the fuzzy AHP method proposed by Chang (1996) is presented step by step in the following section. [121].

1. **Construct the pairwise comparison matrix for criteria** First, the pairwise comparison matrix R is constructed as described in The elements R_{ij} can be interpreted as the degree preference of i th criterion over j th criterion. If there are more than one decision maker, the fuzzy preference information can be aggregated using the fuzzy algebraic equations as described in Equations 2.9 and 2.10. Final form of a fuzzy comparison matrix will be looking like the matrix below.

$$R = \begin{bmatrix} r_{11} & r_{12} & r_{13} & \dots & r_{1n} \\ r_{21} & r_{22} & r_{23} & \dots & r_{2n} \\ r_{31} & r_{32} & r_{33} & \dots & r_{3n} \\ \vdots & \vdots & \vdots & \ddots & \\ r_{n1} & r_{n2} & r_{n3} & \dots & r_{nn} \end{bmatrix}$$

2. **Calculation of fuzzy synthetic extent values** After formation of the pairwise comparison matrix, fuzzy synthetic extent values should be calculated using the Equation 2.12 for each criterion.
3. **Calculation of the degree of possibility values** (V_i) To get weight values for criteria, degrees of possibility values using the Equations 2.14 2.15 2.17.
4. **Formation of Weight Vector W'**

Finally after these calculations, weight vector W' is formed using the Equation 2.18.

5. **Normalization** Normalizing the W' vector, the final form of weight values will be presented in normalized W vector.

2.4.2 Technique for order of preference by similarity to ideal solution (TOPSIS)

The methodology that is used to rank and determine the best performance in multi criteria decision making is proposed by Hwang and Yoon in 1981. They describe the method as: TOPSIS is a multi-criteria decision-making method that is used to determine the best alternative from a set of alternatives evaluated based on multiple criteria. The TOPSIS method assumes that each criterion has a utility that either increases or decreases in a consistent manner. This simplifies the identification of positive and negative ideal solutions. The Euclidean distance approach is used for evaluating the relative closeness of alternatives to the ideal answer. By comparing these relative distances, we may determine the preferred order of the choices. TOPSIS begins by converting the different dimensions of the criteria into criteria that do not have any units or dimensions. [122] The fundamental principle of TOPSIS is that the chosen alternative should be in close proximity to the positive ideal solution (PIS) and far away from the negative ideal solution (NIS). This methodology is used to rank and determine the best performance in multi-criteria decision making [112]. Here's a step-by-step breakdown of TOPSIS adopted from Ceballos (2016) [123]:

1. Normalization: The decision matrix is normalized by replacing every x_{ij} by n_{ij} using the formula:

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (2.20)$$

where $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

2. Weighted Normalization: The weighted normalized values are calculated as

$$v_{ij} = w_j * n_{ij}, \quad (2.21)$$

where w_j corresponds to the weight of the j^{th} criterion.

3. Ideal Solutions: The positive ideal solution (PIS), A^+ , and the negative ideal solution (NIS), A^- , are calculated as follows:

$$A^+ = \{v_1^+, v_2^+, \dots, v_j^+, \dots, v_n^+\} \quad (2.22)$$

$$A^- = \{v_1^-, v_2^-, \dots, v_j^-, \dots, v_n^-\} \quad (2.23)$$

where $v_j^+ = \max_i(v_{ij})$ and $v_j^- = \min_i(v_{ij})$ if the j^{th} criterion is benefit; and $v_j^+ = \min_i(v_{ij})$ and $v_j^- = \max_i(v_{ij})$ if the j^{th} criterion is cost.

4. Distances: The distances from every alternative to the ideal solutions are calculated. d_i^+ is the distance to A^+ , and d_i^- is the distance to A^- :

$$d_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad (2.24)$$

$$d_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad (2.25)$$

5. Relative Closeness: The relative closeness to both ideal solutions is calculated as follows:

$$R_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad (2.26)$$

If $R_i = 0$, then $d_i^- = 0$ means that it is the worst possible case. On the other hand, if $R_i = 1$, then $d_i^+ = 0$ means that it is the best possible case. In general, $0 \leq R_i \leq 1$.

6. Ranking: The alternatives are ranked according to R_i in descending order. The best alternative is the one with the highest R_i .

2.4.2.1 Fuzzy TOPSIS

As presented in the work of Sun et al. (2010): The Fuzzy TOPSIS approach is a decision-making methodology employed to assess the performance of options in a fuzzy setting. The proposed method is an expansion of the conventional TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) approach. This method operates on the principle that the preferred alternative should have the minimum distance from the positive-ideal solution and the maximum distance from the negative-ideal solution. The Fuzzy TOPSIS technique employs linguistic variables to express the subjective viewpoints of decision-makers, while fuzzy numbers are utilized to address the ambiguity and imprecision in the evaluation process. The procedure entails creating a fuzzy decision matrix, standardizing the matrix, identifying the fuzzy positive-ideal and negative-ideal solutions, computing the distances of each alternative from these solutions, and ultimately, determining the closeness coefficients and ranking the alternatives according to their resemblance to the positive-ideal solution. [124] [125].

2.4.3 Analytic network process (ANP)

Saaty (1996) suggested that: some decision-making scenarios present challenges in organizing problems hierarchically because of the complex interactions and dependencies between higher-level and lower-level components. In contrast to a conventional hierarchy, where criteria determine the importance of alternatives, in this case, the significance of the alternatives is mutually influenced by the relevance of the criteria. When comparing two bridges, it is important to consider both their strength and aesthetics. Even if one bridge is stronger but less visually appealing, it may still be chosen as the preferred option unless we assess the criterion in relation to the bridges themselves. In such instances, the importance of strength may be reduced, while the significance of appearance is heightened. Feedback mechanisms provide us with the ability to integrate future thoughts into our current activities, allowing us to navigate towards our intended results. Hierarchies are organized in a linear top-down manner,

while networks expand in various directions, including cycles between clusters and loops within the same cluster [126].

2.4.4 Data envelopment analysis (DEA)

Data envelopment analysis (DEA) is a nonparametric method developed by Charnes et al. (1978) in the field of operations research [127]. Charnes et al. states that it is used to evaluate the efficiency of decision-making units, such as companies or government agencies. DEA, unlike classic parametric methods, is a relative and technically-oriented approach that uses operations research methodologies to automatically determine the weights assigned to input and output factors in the production units being evaluated. DEA generates efficiency scores by multiplying the actual input/output data values with the estimated weights. DEA acts as a nonparametric multiple criteria technique, eliminating the requirement to estimate production, cost, or profit functions from the data [117].

2.4.5 Višekriterijumska optimizacija i kompromisno rešenje (VIKOR)

Similar to TOPSIS, this method calculates the ranking list that represents a compromise between several options, the compromise solution itself, and the intervals that indicate the stability of the weights used to generate the compromise solution. These weights are first given. This approach prioritizes the process of evaluating and choosing from a group of options when there are conflicting factors to consider [123]. The optimal choice is determined by increasing the utility of one group and reducing the regret of another group. The VIKOR technique computes the ratio between the positive and negative ideal solutions, resulting in a compromise solution that offers an advantageous rate. Nevertheless, the performance rating is measured using precise numerical values. In numerous scenarios, precise data is insufficient to accurately represent real-world situations. Furthermore, when faced with competing scenarios or criteria, a decision maker must also take into account imprecise or confusing evidence [116].

2.4.6 Startup evaluation frameworks

Evaluation stage is the most complex stage of the whole process, it requires deep understanding of the proposal submitted by the startup. It requires expert assessments from different aspects like financial or technical. Beyhan et al. (2021) stated that accelerators tend to use a selection of experts from different fields to overcome this uncertainty. [86]. Due to high complexity of evaluation criteria, in practice, some incubator managers tend to use more implicit decision criteria in a flexible scheme and more rely on the experience in the field. [40]. Since the startup evaluation framework studies specifically for incubators are quite limited, evaluation frameworks from various stakeholders that assess startups for any propose has been included in this study. Summary table for the selected frameworks is presented in table2.3.

Since startup selection is a MCDM problem, the process begins with the formulation of criteria. There are a number of research that concentrate on these criteria [92], , however the majority of these studies rely more on literature than they do on actual application. For the purpose of localizing the criteria, certain researchers combine the literature review with the opinions of experts, which results in the creation of an original set of criteria that can be utilized [68] [108] [128].

After formation of the criteria, evaluation frameworks moves to criteria weighting to determine the relative importance of the criteria applied in the selection process. Multiple subjective and objective approaches exist for allocating weights to criteria. Subjective approaches rely on expert opinions and judgments, whereas objective methods employ mathematical models and statistical analysis. Integrated weighing methods utilize a combination of subjective and objective factors to ascertain the weights of criteria. Common weighting methods encompass point allocation, pairwise comparisons, ranking methods, and statistical variance procedures [129].

In the research conducted on frameworks for evaluating startups, only a limited number of studies specifically examined the importance assigned to different criteria. Among these studies, many methodologies for assigning weights were explored. The applied methods include exploratory factor analysis (EFA) [95], fuzzy analytic hierarchy

Table 2.3 : Summary of literature on startup evaluation frameworks.

Article	Selection Focus	Criteria Source	Weighting Method	Selection Model
Arshi(2021) [95]	Mixed	Adopted	EFA	SECURE
Dhochak(2019) [130]	VCs	Adopted	Fuzzy AHP	None
Kelemen(2019) [131]	Mixed	Adopted	Fuzzy AHP	Neuro-Fuzzy
Salomon(2018) [61]	Mixed	Adopted	None	Basic 3-Step
Litau(2020) [15]	Incubators	Original	None	MDP method
Lin(2021) [41]	Mixed	Adopted	Dynamic	HFLIEA
Beyhan(2021) [86]	Accelerators	Original	None	Basic 2-Step
Ross(2021) [128]	VCs	Original	MLN Set	ML Neural Set
Yin(2018) [40]	Accelerators	Adopted	None	2-Step RWW
Mello(2022) [105]	Accelerators	Adopted	Fuzzy QFD	Fuzzy QFD
Mohammadi(2022) [68]	Accelerators	Original	None	SAW
Nikolodois(2017) [108]	Mixed	Original	Simos	Promethee II
Milkova(2018)] [37]	VCs	Adopted	ANP	ANP

process (AHP) [130] [131], machine learning neural sets [128], fuzzy quality function deployment (QFD) [105], Simos method [108] and analytic network process (ANP) [37]. In addition, other researchers incorporated expert opinions at the weighting stage by simply calculating the average of the points assigned by experts in interviews [57] [51] [98].

In the selection phase, various methods have been used including Neuro-Fuzzy Network [131], hesitant fuzzy linguistic information envelopment analysis (HFLIEA) [41], machine learning neural sets [128], fuzzy QFD [105], promethee II [108] and ANP [37] as well as some researchers created their original framework with the use of varying algebraic calculations like SECURE [95] or different step-wise scoring methods like Management of Developing Projects (MDP) [15]. But as presented in Table 2.3, most frameworks suggest employing simple scoring schemes with weighed or unweighted criteria sets [61] [86] [40] [68].

Even if there are studies that have been conducted on these frameworks, they differ in terms of geographies, stakeholders, the source of the criteria, the weighting, and the selection phases. This highlights the necessity of a comprehensive evaluation framework for corporate incubators that includes both original and targeted criteria sets.

3. METHODOLOGY

3.1 Introduction

The primary aim of this thesis is to create a thorough assessment framework for entrepreneurs to be selected by corporate incubators. Due to the limited amount of research available and the fact that startup evaluation criteria differ depending on factors such as region, stakeholder interests, developmental stage, and company strategy, it is important to use a systematic approach that combines information from academic research and input from local industry professionals. This comprehensive approach guarantees that the assessment process is strong, applicable, and customized to the particular requirements and circumstances of the corporate incubation or acceleration setting.

3.2 Research Design

This thesis adopted a systematic approach to refine and validate a set of criteria for startup evaluation, particularly within the context of corporate incubators. The research methodology unfolded in several structured phases, the process is presented in Fig 3.1 as well as outlined below:

- 1. Systematic Literature Review** The initial phase involved performing a literature review analysis to identify relevant studies. This was accomplished by searching databases such as Web of Science (WoS) and Scopus with the keywords “startup evaluation” or “startup assessment”. The search resulted in a preliminary collection of studies, from which unrelated papers were excluded based on their topic, language, and abstract content.
- 2. Criteria Extraction and Refinement** A thorough set of criteria was derived from the examined papers. The list underwent a meticulous process of eliminating any duplicate or closely similar criteria, resulting in a collection of distinct criteria.

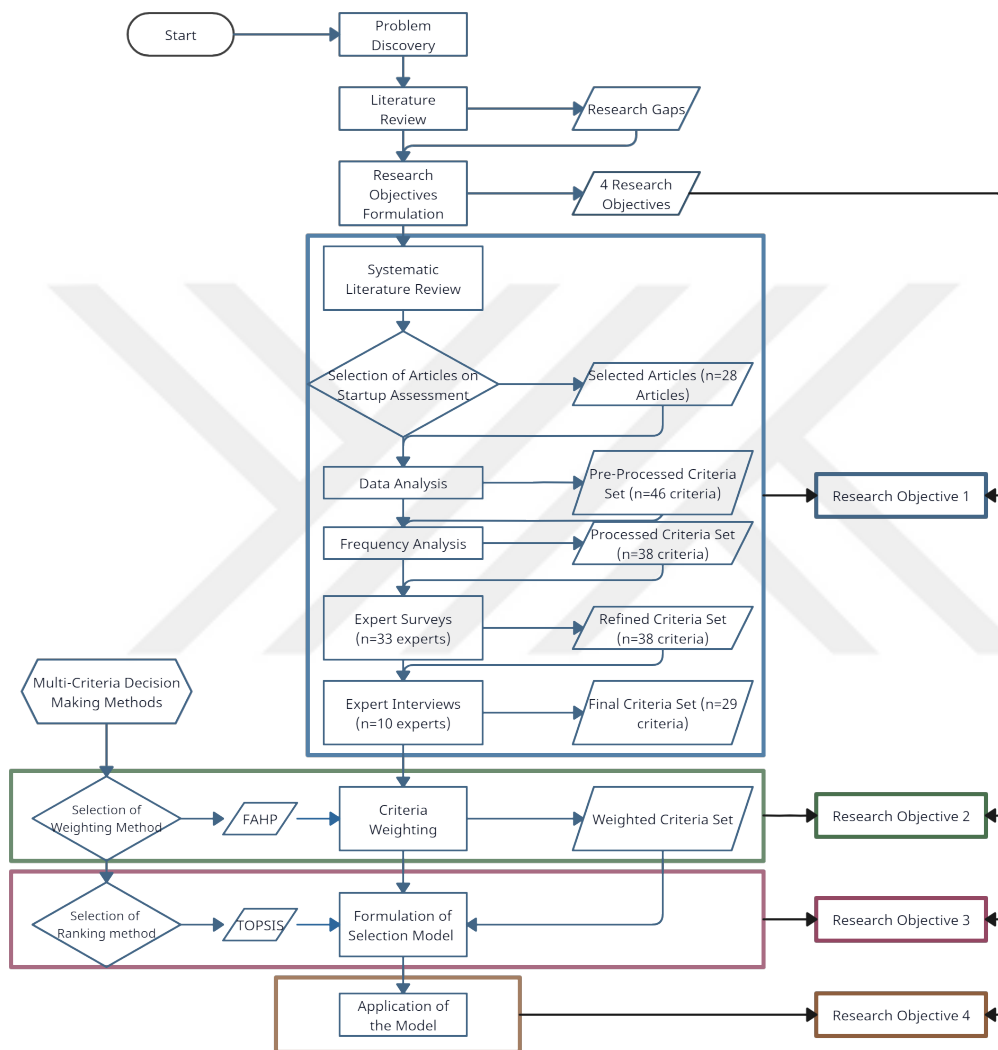


Figure 3.1 : Research design process.

Additional improvement was condensing excessively specific criteria into a more succinct roster. Subsequently, a frequency analysis was performed, resulting in the elimination of the factors that were stated less frequently. This ultimately resulted in a condensed list of essential criteria for evaluating startups. This process ensured that the most pertinent and consequential criteria were established for the purpose of effectively assessing startups. The selected criteria were organized into five primary categories to establish a structured framework for a thorough evaluation of startups. These categories encompass Team, Market, Idea/Product, Financials, and Strategy. This classification is designed to ensure a holistic assessment of startups by covering all critical aspects of their operation and potential for success.

3. **Expert Survey and Data Collection** A web-based survey was designed to gather the viewpoints of specialists regarding the significance of each assessment criterion. Data was collected from a cohort of experts that possess specialized knowledge in startup evaluation. These individuals evaluated the criteria using a standardized rating scale. The poll considered the respondents' knowledge and professional positions by assigning coefficients to their ratings, which reflected their experience and position within the sector. This methodology guaranteed that the information provided was given the correct amount of importance, accurately reflecting the experienced professionals' nuanced opinions in the industry.
4. **Data Analysis and Criteria Finalization** The collected data underwent analysis to identify and eliminate criteria with low scores, leading to the formulation of the final set of evaluation criteria.
5. **Criteria Weighting via Fuzzy AHP** For the weighting of criteria, a selected panel of experts conducted pairwise comparisons, enabling the application of the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) method for criteria weighting. This phase concluded with the determination of weights for each criterion, finalizing the set of weighted evaluation criteria.
6. **Design of the Selection Phase with TOPSIS** For the selection phase, TOPSIS method is employed to rank the startups using the established framework of evaluation criteria.

This comprehensive methodology facilitated the development of a nuanced, expert-validated framework for startup evaluation, tailored to the needs of corporate incubators.



4. APPLICATION OF METHOD AND RESULTS

4.1 Systematic Literature Review

To construct a baseline criteria set for the model, the systematic literature review on startup evaluation criteria was conducted through a series of methodical steps, utilizing the Web of Science (WOS) and SCOPUS databases:

1. **Keyword search:** A search was initiated using the keywords “startup selection OR startup evaluation OR startup assessment”. This broad keywords are used to ensure reaching all relevant studies done on this topic. This yielded a total of 4835 results in WOS and 1561 results in SCOPUS.
2. **Topic filtering:** The search results were then filtered by the topics “Management” or “Business”. This filtering process reduced the number of relevant articles to 199 in WOS and 206 in SCOPUS.
3. **Title and abstract filtering:** Further refinement was performed based on the titles and abstracts of the articles. This step narrowed down the selection to 31 articles in WOS and 19 articles in SCOPUS.
4. **Removing duplicates:** After combining the filtered articles from both WOS and SCOPUS, duplicates were removed. This left a total of 47 unique articles for detailed reading and analysis.
5. **Detailed reading:** In this step, after reading the remaining 47 unique study done on startup evaluation criteria, 28 of them were selected for data extraction.

Each step in this process was crucial for ensuring that the most relevant and high-quality articles were selected for the criteria extraction, providing a solid foundation for the research on startup evaluation criteria. The meticulous approach

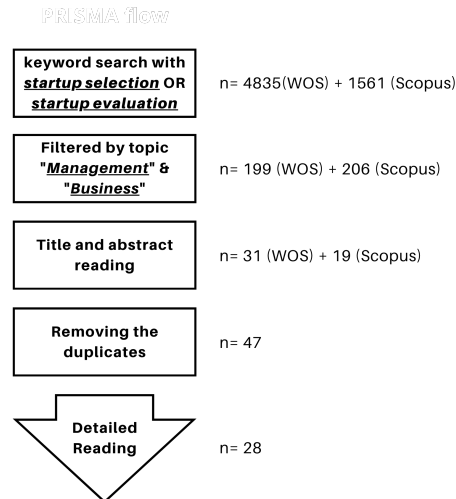


Figure 4.1 : Systematic literature review process.

to filtering and refinement ensured the integrity and relevance of the literature base for the study. The review process is presented in a PRISMA Flow Diagram in 4.1. [132]

4.2 Data Extraction and Refinement

The data extraction process for the study was meticulously designed to distill a comprehensive set of criteria from an initially unstructured collection. Initially, a total of 500+ criteria were identified from the PRISMA results without any specific structure. The first step in refining this dataset involved the elimination of duplicates and criteria with close similarities, which streamlined the list to 65 distinct criteria. Grouping together overly specific criteria allowed for further refinement, producing a more manageable set of 46 consolidated criteria. A subsequent frequency analysis helped to identify the most pertinent criteria, further narrowing down the list to 38 key criteria. These were then thoughtfully categorized into five distinct groups, maintaining a refined total of 38 essential criteria. This systematic approach ensured that the final dataset was both comprehensive and focused, providing a robust foundation for subsequent analysis within the study. The steps of this process is presented in Figure 4.2.

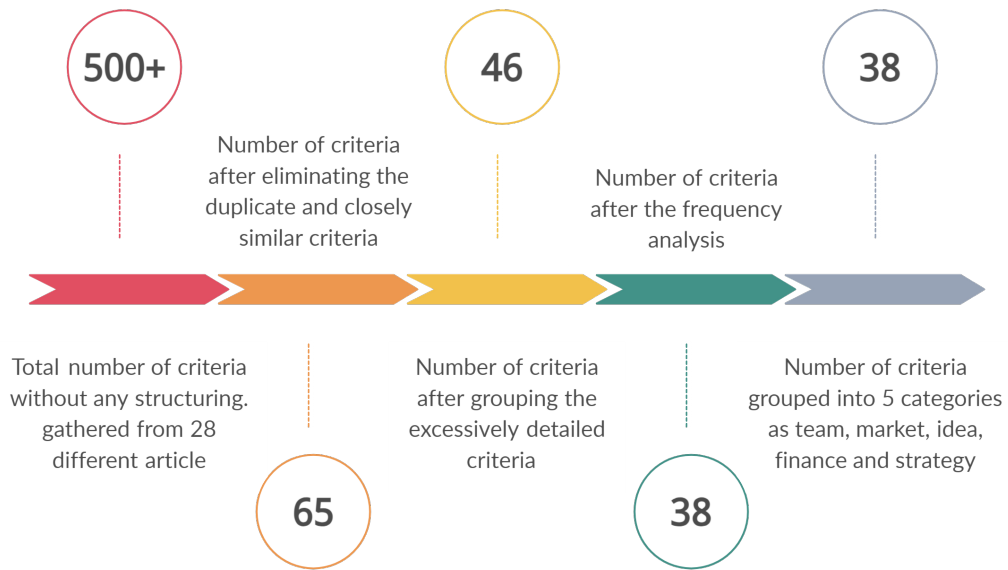


Figure 4.2 : Refinement process of criteria.

4.2.1 Result of systematic literature review

In the first part of this study, a comprehensive literature review on startup evaluation criteria has been performed using Web of Science and SCOPUS as data sources. The results of this study is presented in the following part. As stated in Section 4.1, the final number of 28 papers has been examined thoroughly, and 517 individual criteria have been extracted before any further operation. Then, the aforementioned operations resulted in 38 different criteria within 5 groups. The results of the frequency analysis is presented in Table 4.1

4.3 Expert Survey and Data Collection

In order to alleviate participants' concerns about disclosing their institution's confidential information, the poll was designed to be anonymous. Thus, in order to guarantee the accuracy of the obtained data, the survey was exclusively distributed to experts who had been privately contacted on the LinkedIn site. When choosing these experts, three criteria were implemented. Firstly, they had to be employed at a reputable institution, which is defined as one that has been established for a minimum of three years, their portfolio should include at least ten startups and at least three of

Table 4.1 : Frequency analysis results on startup selection criteria from the literature.

Criteria	Fq	Criteria	Fq
Team's qualitative characteristics	21	Importance of problem of question	8
Relevant industry / market experience	16	Validation of solution	8
Market size and target market	16	Strategic partnership	8
Competitiveness	16	Technology readiness level	7
Innovativeness	16	Marketing strategy	7
Founder's characteristics	15	Financial strategy	7
Intellectual property	15	Sensitivity to external issues	7
Basic financial indicators (ROI, NPV, IRR)	15	Strategic compatibility	7
Market risk & Ease of market entry	12	Globalization potential	7
Entrepreneurial experience	12	Work experience	7
Market growth rate	11	Scalability	6
Market and target market size	11	Current stage of the product	6
Diversity of talents of the team	11	Realistic financial forecast	6
Sustainable competitive advantage	10	Vision	6
Business plan	10	Technical feasibility	5
Educational background of the team	10	Operational strategy	5
Ease of imitation & substitution	9	Number of team members	5
Profitability	9	Ages of team members	4
Risk assessment	9	Product quality and efficiency	4
References & network and reputation	8	Quality of the proposal	4
Steady cash flow	8	Tax relief opportunities	3
		Level of impact on the environment	2
		Offered equity	2
		Collaboration opportunities	2
		Public relevance	1

the startups in their portfolio should have received funding, for the purpose of this study. Second, the experts must possess a minimum of 3 years of expertise in the startup ecosystem and lastly, they should have actively participated in the assessment of startups inside their institution. Using this criteria, the survey was sent out to 65 experts, and 33 of them participated in the survey. Contacting the experts privately before sending the survey resulted in such a high response rate. To ensure a robust evaluation of the criteria, an online survey was meticulously designed and disseminated via the Google Forms platform. The survey was structured into seven distinct sections, encompassing a total of 55 questions. In the first part, participants were asked to provide basic demographic information to prove the reliability and usefulness of their knowledge. This included their role in the ecosystem, the length of time they had worked in both the ecosystem and startup evaluation, and whether they possessed an academic degree in the field. A concise summary of these demographic characteristics is delineated in Table 4.2.

Commencing with the second section, respondents were requested to appraise the significance of each criterion on a five-point scale, determining its inclusion in the assessment framework. The complete form of the survey is presented in Appendix A.

4.3.1 Results of expert surveys

By collecting data from 33 experts with diverse backgrounds, a plethora of important insights have been incorporated into the established criteria. The survey findings are displayed in Table 4.3 to Table 4.8. Since the sample size for the survey exceeds 30 which defined as the lower limit for the central limit theorem by Kwak (2017), considering averages is valid in this case [133]. The category averages range from a low of 3.60 in Financials to a high of 4.26 in the Market, based on the survey scores. The score of 4.00 places Strategy in second position, while Idea has an average score of 3.96 and follows closely behind. The team category had a score of 3.72 on the surveys, indicating that it is less significant compared to the categories stated earlier.

Table 4.2 : Characteristics of the experts surveyed.

No	Role	Ecosystem Experience(yr)	Evaluation Exp. (yr)	Academic Exp
1	Academician - Researcher	7-9	7-9	Yes
2	Venture Capitalist	4-6	1-3	Yes
3	Venture Capitalist	4-6	4-6	No
4	Accelerator Program Expert	4-6	4-6	No
5	Accelerator Program Expert	7-9	1-3	No
6	Incubation Center Expert	4-6	1-3	No
7	Incubation Center Expert	4-6	1-3	Yes
8	Incubation Center Expert	1-3	1-3	No
9	Incubation Center Expert	4-6	4-6	No
10	Incubation Center Expert	7-9	1-3	No
11	Academician - Researcher	7-9	4-6	Yes
12	Incubation Center Expert	4-6	1-3	No
13	Angel Investor	4-6	4-6	Yes
14	Venture Capitalist	4-6	1-3	No
15	Incubation Center Expert	7-9	4-6	No
16	Accelerator Program Expert	7-9	7-9	No
17	Accelerator Program Expert	7-9	7-9	Yes
18	Accelerator Program Expert	4-6	1-3	No
19	Incubation Center Expert	4-6	4-6	Yes
20	Incubation Center Expert	4-6	4-6	No
21	Accelerator Program Expert	7-9	7-9	Yes
22	Accelerator Program Expert	10+	10+	No
23	Venture Capitalist	4-6	1-3	No
24	Accelerator Program Expert	1-3	1-3	No
25	Accelerator Program Expert	4-6	4-6	Yes
26	Incubation Center Expert	1-3	1-3	No
27	Incubation Center Expert	4-6	4-6	No
28	Incubation Center Expert	7-9	7-9	Yes
29	Incubation Center Expert	7-9	7-9	No
30	Incubation Center Expert	4-6	1-3	Yes
31	Incubation Center Expert	4-6	1-3	Yes
32	Venture Capitalist	7-9	7-9	No
33	Incubation Center Expert	10+	10+	No

4.3.1.1 Criteria under team category

The category of team attributes received an average score of 3.72; however, the criteria of ages of team members received an exceedingly low score in comparison to other criteria, which resulted in a decrease in the average total. The experience in the relevant

Table 4.3 : Average scores of categories.

Category	Average
Market	4.26
Strategy	4.00
Idea/Product	3.96
Team	3.72
Financials	3.60

sector received a score of 4.52, which is one of the highest among all other scores. This suggests that decision makers place a major weight on the experience; however, it must be in the same industry as the startups because the average work experience received a score of 3.78, which is rather lower. When it comes to decision-makers, the entrepreneurial experience is also deemed to be of minimal importance. Qualitative aspects of the squad, such as harmony, coachability, innovation, or adaptability, were rated as somewhat important, receiving a score of 4.06 out of 5. Next in line is the diversity of the talents that are present within the team, which received a score of 4.03; the references, network, and reputation of the team received a score of 3.87; and the academic backgrounds of the members received a score of 3.46. All of these attributes are considered essential; however, the number of members and the other two low-scoring attributes can be excluded from the list.

Table 4.4 : Average scores of criteria under Team Category.

Criterion	Score
The team's experience in the relevant industry	4.52
Personal characteristics of the leading entrepreneur	4.23
Qualitative characteristics of the team	4.06
Diversity of talent within the team	4.03
References, network and reputation	3.87
Work experience of the team	3.78
Educational and academic background of the team	3.46
Number of members of the team	3.38
The entrepreneurial experience of the team	3.20
Ages of team members	2.65

4.3.1.2 Criteria under market category.

It is possible that the low number of sub criteria contributed to the fact that the market as a primary category obtained the highest average score from the experts, which

was 4.26. The size of the market and the target market had a score of 4.45, which is relatively high in comparison to other scores, indicating that the market size is an important factor for startups. The potential for globalization received a score of 4.30, which suggests that maintaining a global presence in business is essential for the survival of startups. The market growth rate, which received a score of 4.16, is the final attribute associated with the market. Market risk, the ease of entering the market, and the circumstances of competition are all deemed to be essential, rating 4.22 and 4.20 accordingly. It can be deduced from this that the market in which the companies are operating has a significant influence on the success of those startups.

Table 4.5 : Average scores of criteria under Market Category.

Criterion	Score
Market and target market size	4.45
Globalization potential	4.30
Market risk / Ease of market entry	4.22
Competition conditions in the market	4.20
Market growth rate	4.16

4.3.1.3 Criteria under idea/product category.

The criteria for the Idea/Product Category are analyzed, and the results show that there is a clear focus on businesses that have a strong potential for growth. Scalability comes in first place with a score of 4.62, closely followed by the significance of the problem that is being resolved with a score of 4.48. An indication of a preference for ideas that address pertinent concerns and have the ability to reach a big audience is provided by this expression. Technological feasibility (4.33) and innovation (4.23) are also highly appreciated, with the latter highlighting the need of incorporating innovative ideas and the necessity of having a development strategy that is grounded in reality. The low score for hard to mimic (3.32) shows that ease of competition would not be a major worry, despite the fact that sustaining a competitive edge is deemed to be of moderate importance (3.91). However, there appears to be an openness to early stages with high validation (verification: 3.68), despite the fact that development progress is prized (current stage: 3.88). The scores for intellectual property (3.58) and technology

readiness (3.56) are not as significant, which suggests that they may be necessary but do not necessarily determine the success or failure of a commercial enterprise.

Table 4.6 : Average scores of criteria under Idea/Product Category.

Criterion	Score
Scalability	4.62
Importance of the problem solved	4.48
Technical feasibility	4.33
Innovation	4.23
Sustainability of competitive advantage	3.91
Current stage of the product	3.88
Verification of the solution produced	3.68
Intellectual property rights	3.58
Technology readiness level	3.56
Difficulty to imitate	3.32

4.3.1.4 Criteria under financial category.

After doing an analysis of the ratings for the Financials Category, it becomes clear that the credibility of financial planning is prioritized over quick financial results. There is a priority placed on the realism of financial projections (3.97), which highlights the significance of estimates that are founded on reasonable assumptions. IRR, NPV, and ROI are examples of traditional financial measures that have a modest amount of weight (3.64), which indicates that they are taken into consideration but are not the primary focus. Given the relatively lower ratings for regular cash flow (3.42) and profitability (3.36), it may be inferred that decision-makers place a higher priority on the credibility of the financial road-map than they do on the short-term profitability of the business.

Table 4.7 : Average scores of criteria under Financials Category.

Criterion	Score
Realism of financial forecasts	3.97
Key financial indicators (IRR, NPV, ROI)	3.64
Regular cash flow	3.42
Profitability	3.36

4.3.1.5 Criteria under strategy category.

The examination of the Strategy Category suggests that there is a considerable preference for new businesses that have a distinct vision (4.20) and well-developed plans (business: 4.16, operational: 4.09, marketing: 4.05). This emphasis on strategic direction is underlined even further by the significance that is put on doing a risk assessment that is grounded in reality (4.01). The value of collaboration through partnerships is moderate (4.17), whilst the importance of strategic alignment with investors appears to be less important (3.68). There is a consensus that financial strategy is significant (3.94), but it may be considerably less significant than core strategic planning. In conclusion, although it is accepted that sensitivity to external factors such as swings in the political and economic climate is a concern (3.38), it appears to be a less major concern in the overall review process.

Table 4.8 : Average scores of criteria under Strategy Category.

Criterion	Score
Vision	4.20
Current and planned strategic partnerships	4.17
Business plan	4.16
Operational strategy	4.09
Marketing strategy	4.05
Realistic risk analysis	4.01
Financial Strategy	3.94
Strategic compatibility with investors	3.68
Sensitivity to political and economic fluctuations	3.38

4.4 Data Analysis and Expert Interviews

In calculating scores for each criterion, two distinct coefficients were attributed to each expert: one coefficient was associated with their experiential depth in the field which is the experience factor e_i , while the second coefficient pertained to the relevance of their role within the ecosystem to the topic at hand, which is the role factor r_i . Utilizing a weighted average approach to score aggregation, criteria with lower scores were systematically excluded. Since the participants had diverse backgrounds, an additional step of expert interviews has been added to the process in order to make the criteria set

closer to the corporate focus. 12 corporate entrepreneurship executives from various sectors, including energy, defense, textiles, communication, etc., had been interviewed in one-on-one online meetings and their feedback on the criteria list had been collected and the criteria list had been finalized with their perspective.

4.4.1 Results of expert interviews

During the individual interviews, it was required of the experts that they evaluate the results of the surveys and provide feedback on the accuracy of the ratings from the perspective of the company. In addition, it was expected of them to either submit new criteria that were not already present or to eliminate a criterion that looked to be of little significance in the corporation's interest. In addition, some criteria have been modified to better reflect the corporate perspective on the evaluation. Combining both expert survey results and one-on-one interviews, the criteria set has been improved, as explained in the following section.

Under the team category, the number of team members and age of team members criteria have been removed since they both got low scores on survey and the interviewed experts suggested that they might not be that important for the incubation stage. Despite scoring low on the survey, entrepreneurial experience is considered to some extent of importance, according to corporate entrepreneurship executives that have been interviewed. Moreover, the work experience criterion has been considered to have less importance and might overlap with the relevant industry experience, by the corporate experts, so it is eliminated from the list. Therefore, at the end, the team category has seven sub-criteria left in the framework. For the market category, all criteria have scored above average and are considered important by the corporate experts; therefore, no criteria have been removed or added to the list. To ensure simplicity, the market risk/ease of market entry criteria has been changed to market risks. In the idea/product category, technology readiness level and difficulty to imitate criteria scored low compared to the rest and corporate experts suggested that it might be closely related to other criteria, so it is removed from the set. Also, the intellectual property rights criterion has been changed to the intellectual property strategy to

encompass different ways of defending intellectual property, like trade secrets, and it has been moved to the strategy category where it fits better.

For the financial category, all criteria scored low on surveys except for the realistic forecasts. Therefore, with the corporate expert's suggestions, the regular cash flow criterion had been removed since it is considered too early for an incubatee. With similar intentions, the profitability criterion has been changed to profitability potential to represent future potential for the startups. In addition, corporate experts have stated that the current shareholding structure might be an important attribute on the list since it may pose some risks for the corporation. Finally, the financial category consists of four sub-criteria.

In the last part, which is the strategy category, all criteria scored fairly high except for the last two, which are strategic compatibility with investors and sensitivity to political and economic fluctuations. In line with the feedback from corporate experts, the strategic compatibility with investors criterion has been changed to strategic compatibility with the corporation to better reflect the relationship between them. Then this criteria has been broken into two attributes: compatibility with corporate resources to ensure the corporation has the ability to impact the startup significantly and compatibility with the corporation's strategic goals to provide future harmony. The sensitivity to political and economic fluctuations criterion has been removed since it is stated to be related to market conditions more than the startup itself by the corporate experts. Moreover, it is indicated in the interviews that operational, marketing, and financial strategies, as well as risk analysis, should be included in the business plan, and they might overlap as distinct criteria. So they have been removed to simplify the criteria set for the clean assessment of startups. At the end, the strategy category has been left with six different sub-criteria, with the intellectual property strategy moving from the idea section.

Finally, the decision tree for the Fuzzy Analytic Hierarchy Process has been formed, as illustrated in Figure 4.3

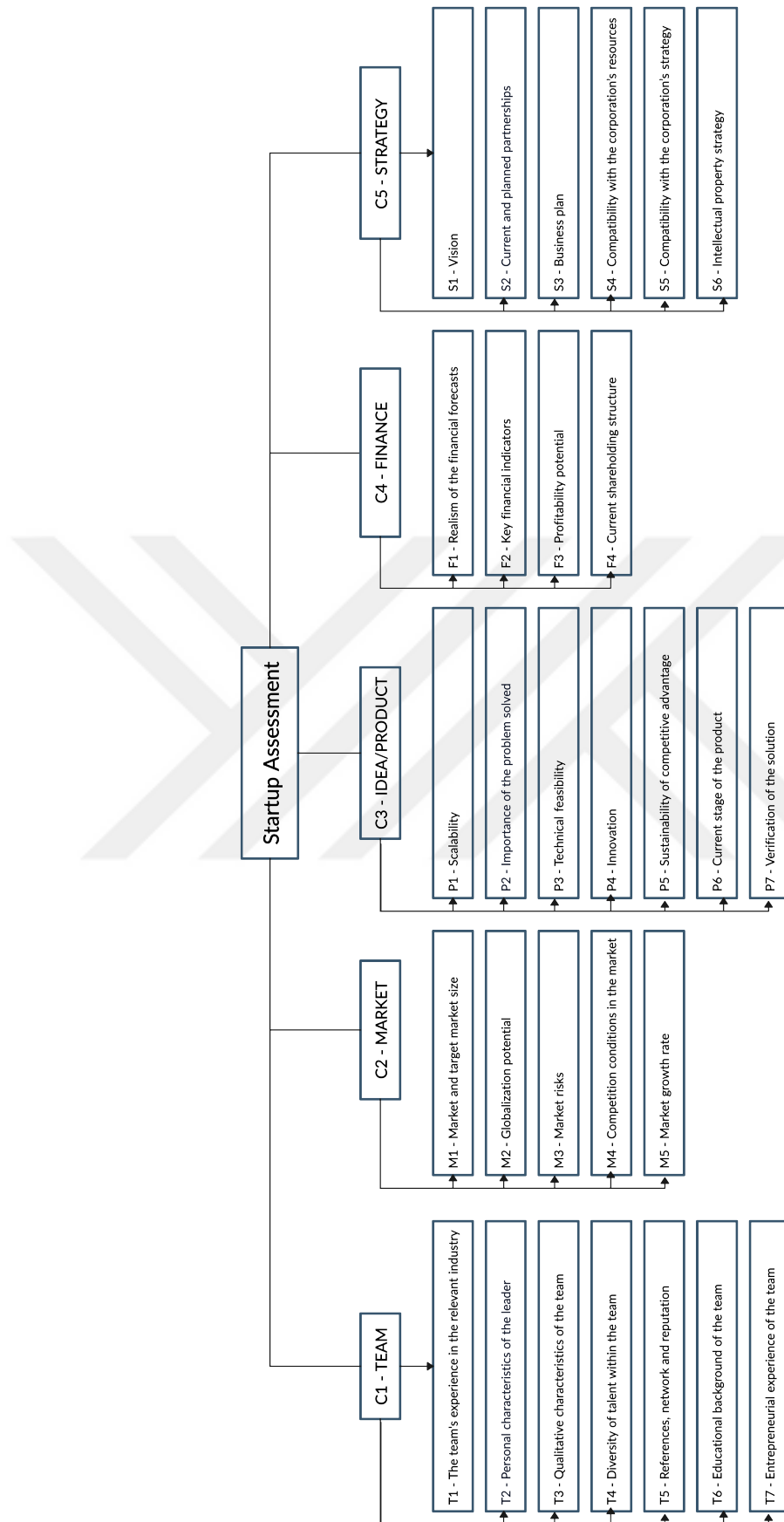


Figure 4.3 : Decision-making tree structure.

4.4.2 Criteria weighting via fuzzy AHP

After finalizing the collection of criteria, the next step is to determine the relative relevance of these criteria. In order to achieve this, a fuzzy Analytic Hierarchy Process (AHP) is utilized for numerous reasons. Firstly, it is a highly prevalent method in the field of Multiple Criteria Decision Making (MCDM) [113]. Additionally, it allows decision makers to make decisions in a systematic manner, ensuring the reliability of their choices [112]. The survey involved our panel of experts who actively engaged by conducting pairwise comparisons in two separate stages. First, the primary criteria were evaluated at the top level of the hierarchy, and then the sub-criteria were analyzed at the second level. The technique, as described in Section 2.4.1.1, directed the determination of the ultimate weights allocated to each criterion.

In this study, the fuzzy AHP methodology proposed by Chang(1996) [121] has been used, however, due to the limitations of Chang's method in calculations for degree of possibilities which sometimes results in null weight values or inconsistencies in weight values, there is a need for modification to solve this problem [134]. Fortunately there are several methods to overcome this problem including the use of optimism index proposed by Liou (1992) [135] or center of area defuzzification method [136]. The index of optimism modification has been employed in this study, which is explained in the following section.

This method developed by Liou in 1992 and used also in the study done by Sen and Cinar in 2010 [137]. The weight vector of the weight values can be derived with the following equations where α is the optimism index valued between [0,1] which implies more pessimistic evaluation when it approaches 0 and more optimist evaluation when it approaches 1. The α value set to be 0.5 in this study which represents unbiased evaluation is done by decision makers. S_i values are evaluated with Chang's approach with the Equation 2.12.

$$I_T^\alpha(\tilde{S}_i) = \frac{1}{2}\alpha(m_i + u_i) + \frac{1}{2}(1 - \alpha)(l_i + m_i) = \frac{1}{2}[\alpha u_i + m_i + (1 - \alpha)l_i] \quad (4.1)$$

$$W_i = \frac{I_T^\alpha(\tilde{S}_i)}{\sum_{k=1}^n I_T^\alpha(\tilde{S}_k)} \quad i = 1, 2, \dots, n \quad (4.2)$$

With the modifications employed; the complete process of criteria weighting is explained step by step in the next part.

Step 1: Corporate experts' surveys

First, a survey consisting of pairwise comparisons between criteria and sub-criteria has been prepared in qualtrics website to ease the process. 12 different corporate innovation and entrepreneurship executives had been surveyed, 9 of whom were incubation experts and 3 acceleration experts. The survey was performed anonymously to ensure personal or corporate data protection, however, all the respondents were chosen and contacted specifically via LinkedIn, and the survey was sent out privately. 20 different survey links have been sent out and 12 responses have been gathered, including the author.

Respondents required to do 83 pairwise comparisons between criteria and sub-criteria, as shown in Figure 4.3. The comparison has been done with 9 point scale from "extremely important" to "extremely less important".

Step 2: Fuzzification of the linguistic terms

After collecting the responses, the linguistic terms for comparisons needs to be fuzzified to be used in the model. For this step, Excel software had been used. Fuzzy conversion table is presented in Table 4.9. This fuzzy scale is suggested as an improvement to Saaty's 1-9 scale by Hossain et al. in 2014 [138] and it is also used in many studies such as Wang (2009) [139].

Step 3: Aggregation of experts pair-wise comparisons

After the converting the preferences, aggregation operation is done in Excel using the equations 2.9-2.10.

Step 4: Construction of aggregated fuzzy comparison matrices

Table 4.9 : Fuzzy conversion table.

Linguistic Term	Fuzzy Triangular Number (l,m,u)
Extremely Important	$(\frac{9}{2}, 5, \frac{11}{2})$
Very Important	$(\frac{7}{2}, 4, \frac{9}{2})$
Moderately Important	$(\frac{5}{2}, 3, \frac{7}{2})$
Slightly Important	$(\frac{3}{2}, 2, \frac{5}{2})$
Equally Important	$(1, 1, 1)$
Slightly Less Important	$(\frac{2}{5}, \frac{1}{2}, \frac{2}{3})$
Moderately Less Important	$(\frac{2}{7}, \frac{1}{3}, \frac{2}{5})$
Very Less Important	$(\frac{2}{9}, \frac{1}{4}, \frac{2}{7})$
Extremely Less Important	$(\frac{2}{11}, \frac{1}{5}, \frac{2}{9})$

With aggregated fuzzy comparison numbers are calculated, the matrices consisting of fuzzy comparisons for each criteria and sub-criteria separately. In total 6 matrices had been formed in Excel software. The matrix for the general criteria comparison is presented in Table 4.10 as an example. The remaining part of the fuzzy comparison matrices are presented in the Appendix B

Table 4.10 : Fuzzy comparison matrix for general criteria.

	C1	C2	C3	C4	C5
C1	(1,1,1)	(1.38,1.61,1.85)	(1.65,2.08,2.52)	(2.86,3.29,3.72)	(1.53,1.88,2.26)
C2	(0.53,0.62,0.72)	(1,1,1)	(1.36,1.62,1.88)	(2.9,3.29,3.68)	(1.18,1.43,1.69)
C3	(0.39,0.48,0.6)	(0.52,0.61,0.73)	(1,1,1)	(2.62,3.08,3.54)	(1.3,1.53,1.77)
C4	(0.26,0.3,0.34)	(0.27,0.3,0.34)	(0.28,0.32,0.38)	(1,1,1)	(0.43,0.51,0.61)
C5	(0.44,0.52,0.65)	(0.59,0.69,0.84)	(0.56,0.65,0.76)	(1.62,1.93,2.29)	(1,1,1)

Step 5: Calculation of fuzzy synthetic extent values In this step, the fuzzy synthetic extent values (S_i) has been calculated using MATLAB software. The script for the operation has been published in MathWorks forum by Demet Cilden Güler and Doğuş Güler and has been tested using the values in Chang's (1996) paper. The MATLAB script used in this study is presented in the Appendix C. The fuzzy synthetic extent values for general criteria is presented in Table 4.11 and the rest of the tables are presented in the Appendix D

Step 6: Calculation of weight vectors

Similar to previous step, weight vectors for the criteria had been calculated using the MATLAB software with using the equations 4.1 and 4.2. The weight values for the general criteria is presented in Table 4.12. The weight vectors for the sub-criteria is

Table 4.11 : Fuzzy synthetic extent values of general criteria.

Criteria	Fuzzy Synthetic Extent Value
C1 (S_1)	(0.2326, 0.3104, 0.4092)
C2 (S_2)	(0.1933, 0.2504, 0.3235)
C3 (S_3)	(0.1616, 0.2110, 0.2755)
C4 (S_4)	(0.0623, 0.0769, 0.0969)
C5 (S_5)	(0.1164, 0.1513, 0.2000)

presented in tables 4.13 to 4.17. The values presented in the tables are rounded to fourth decimal but the exact values are used in the model.

Table 4.12 : Weight values for general criteria (W_C).

Criteria	Weight
Team	0.3101
Market	0.2499
Idea/Product	0.211
Finance	0.0769
Strategy	0.1521

Table 4.13 : Weight values for team attributes (W_T).

Criteria	Local Weight	Global Weight
The team's experience in the relevant industry	0.2887	0.0895
Personal characteristics of the leading entrepreneur	0.1565	0.0485
Qualitative characteristics of the team	0.1419	0.0440
Diversity of talent within the team	0.1615	0.0500
References, network and reputation	0.1034	0.0320
Educational and academic background of the team	0.0866	0.0269
The entrepreneurial experience of the team	0.0613	0.0190

Table 4.14 : Weight values for market attributes (W_M).

Criteria	Local Weight	Global Weight
Market and target market size	0.2792	0.06977
Globalization potential	0.3071	0.0767
Market risks	0.1715	0.0428
Competition conditions in the market	0.1512	0.0377
Market growth rate	0.091	0.0227

Table 4.15 : Weight values for idea/product attributes (W_P).

Criteria	Local Weight	Global Weight
Scalability	0.2027	0.0427
Importance of the problem solved	0.2393	0.0504
Technical feasibility	0.1823	0.0384
Innovation	0.1173	0.0247
Sustainable competitive advantage	0.1148	0.0242
The current stage of the product	0.0605	0.0127
Verification of the solution produced	0.083	0.0175

Table 4.16 : Weight values for financial attributes (W_F).

Criteria	Local Weight	Global Weight
Realism of financial forecasts	0.4483	0.0344
Key financial indicators	0.2556	0.0196
Profitability potential	0.1938	0.0149
Current shareholding structure	0.1023	0.0078

Table 4.17 : Weight values for strategy attributes (W_S).

Criteria	Local Weight	Global Weight
Vision	0.2065	0.0314
Current and planned strategic partnerships	0.1572	0.0239
Business plan	0.1602	0.0243
Compatibility with the corp's resources	0.1931	0.0293
Compatibility with the corp's strategic goals	0.2155	0.0327
Intellectual property strategy	0.0676	0.0102

4.4.2.1 Sensitivity analysis

To validate the results from the FAHP analysis, 4 different sensitivity analysis is performed. For the expert sensitivity and the criteria sensitivity; Leave-One-Out methodology is used as described by Vehtari (2016) by simply removing an element from the model and recalculating the results [140]. For the fuzzification factor and optimism index sensitivity, different scenarios are created to check their values, as described by Balusa in 2019 [141].

Sensitivity of criteria weights with respect to experts

To measure how sensitive the weight values are with respect to expert preferences, the model reevaluated the weights with 13 different scenarios, where in each of them one of the experts is excluded except for the first one, which is the normal case. Naming is made with abbreviations due to the high number of variables, where "E1 abs" means that in that scenario, expert 1 is excluded and the results are presented in the y axis. The whole results are presented in Figures 4.4 through 4.9. As it can be seen from the graphs, there is a smooth trend in weight values, which shows that the criteria weights are not biased towards an expert. There are infinitesimal changes in the weight values and there are only minor changes in the local ranks of the criteria under strategy and product category in which the weight values are significantly close to each other.

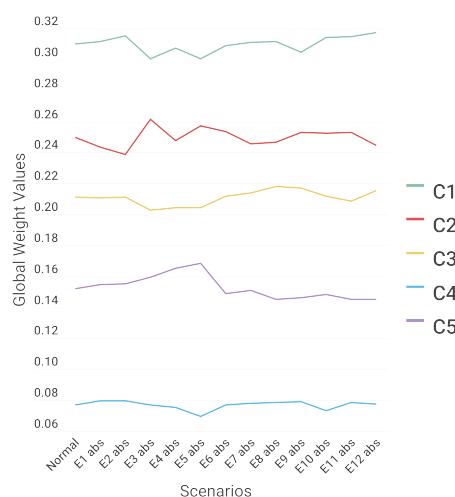


Figure 4.4 : Sensitivity analysis of general criteria with respect to experts.

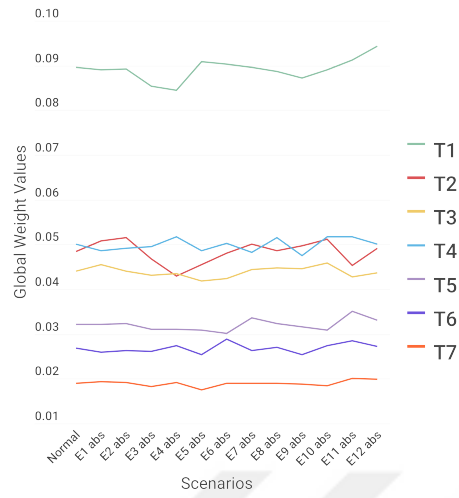


Figure 4.5 : Sensitivity analysis of team criteria with respect to experts.

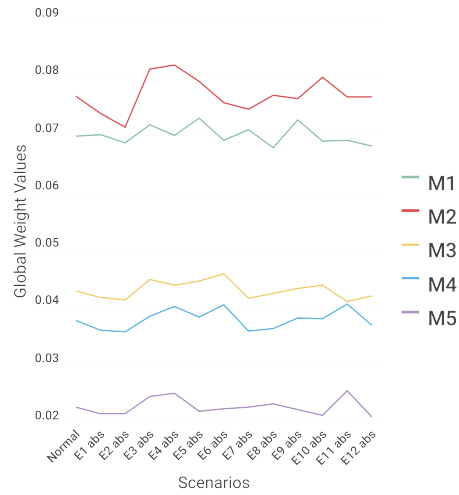


Figure 4.6 : Sensitivity analysis of market criteria with respect to experts.

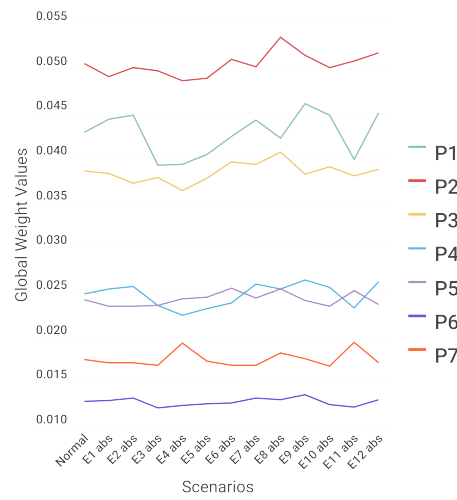


Figure 4.7 : Sensitivity analysis of idea/product criteria with respect to experts.

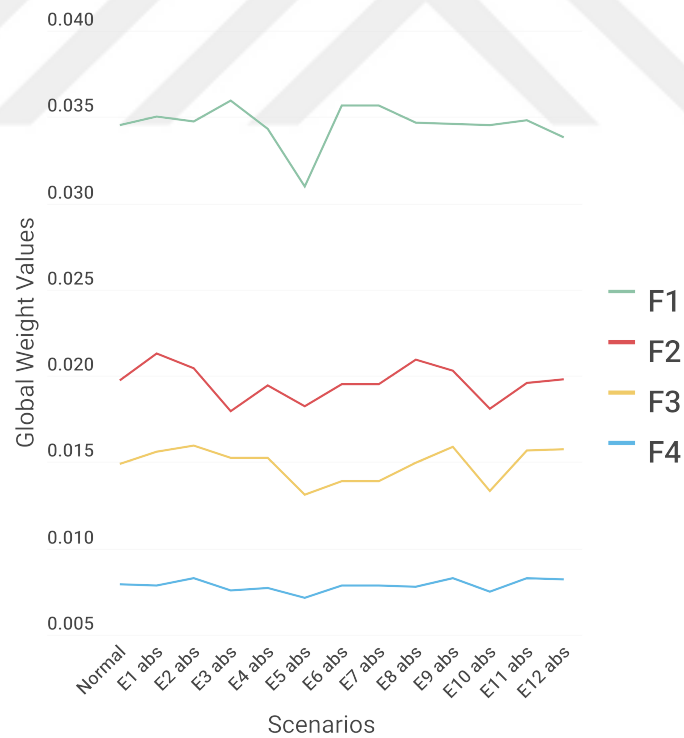


Figure 4.8 : Sensitivity analysis of financial criteria with respect to experts.

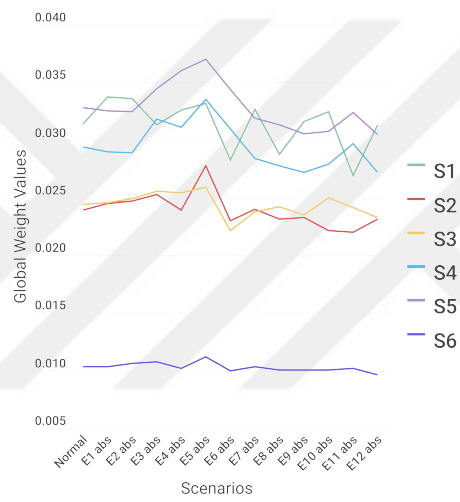


Figure 4.9 : Sensitivity analysis of strategy criteria with respect to experts.

Sensitivity of criteria

In order to determine the degree to which the model is sensitive to the criteria, this investigation began by generating 29 different scenarios for the calculation. In each of these scenarios, a particular criterion was removed from the model, and the weights were recalculated. Similar to previous analysis, naming made with abbreviations to deal with high number of variable. As "C1 abs" means that the criteria C1 is removed from the matrix and the weights are recalculated. Whole results are presented in the Figure 4.10 through Figure 4.15. It can be seen from the graph that the weight values keeps the same order throughout the process, Although the values are changed due to the missing criteria, the relative importance order remains the same almost in all cases except for four occasions in all 175 occasions. This analysis shows that the criteria set is consistent within itself.

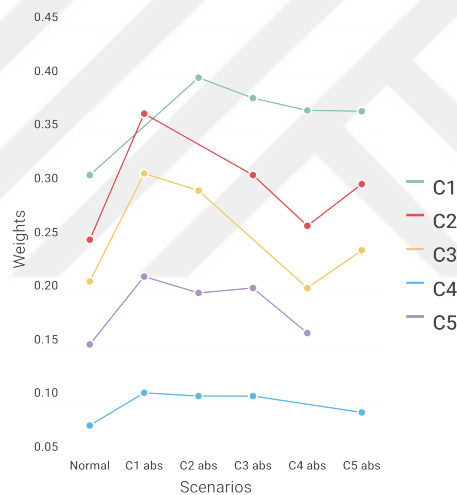


Figure 4.10 : Sensitivity analysis of general criteria.

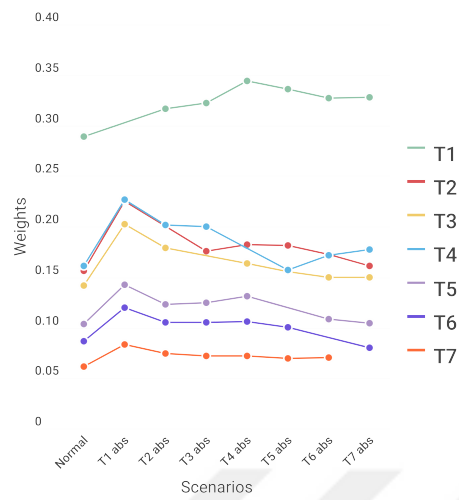


Figure 4.11 : Sensitivity analysis of team criteria.

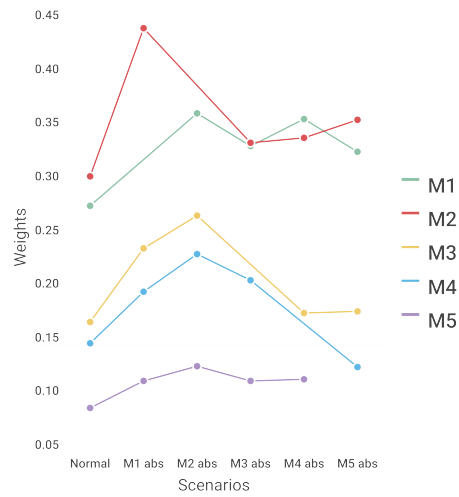


Figure 4.12 : Sensitivity analysis of market criteria.

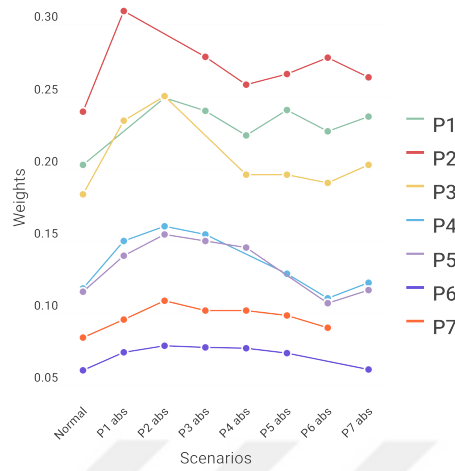


Figure 4.13 : Sensitivity analysis of idea/product criteria.

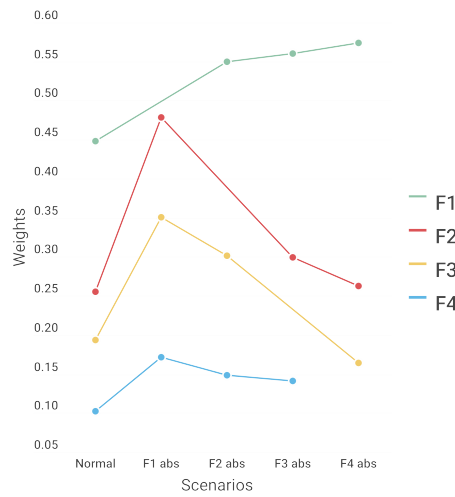


Figure 4.14 : Sensitivity analysis of financial criteria.

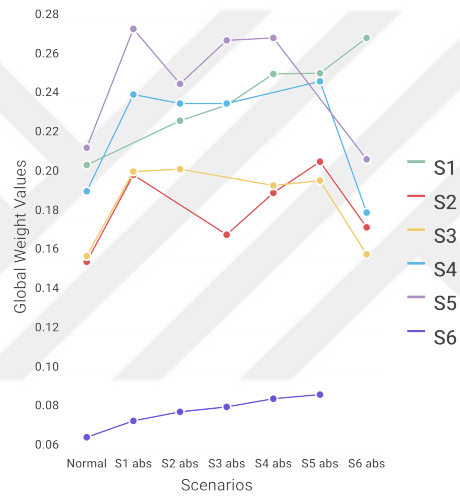


Figure 4.15 : Sensitivity analysis of strategy criteria.

Sensitivity of criteria with respect to fuzzification factor

In order to determine the degree to which the model is sensitive to the fuzzification factor used in the fuzzifying stage. This investigation began by generating 4 different scenarios for the calculation. In each of these scenarios, a particular fuzzification factor is used, and the weights were recalculated. Similar to previous analysis, names were made with abbreviations to deal with high number of variable. As "FF=0.25" means that the fuzzification factor in the fuzzification stage is 0.25 which means that the fuzzy triangular number for 5 is (4.75,5,5.25). Whole results are presented in the Figure 4.16 through Figure 4.21. It can be seen from the graph that the weight values kept almost constant throughout the process, This analysis shows that the criteria set is not sensitive to used fuzzification factor.

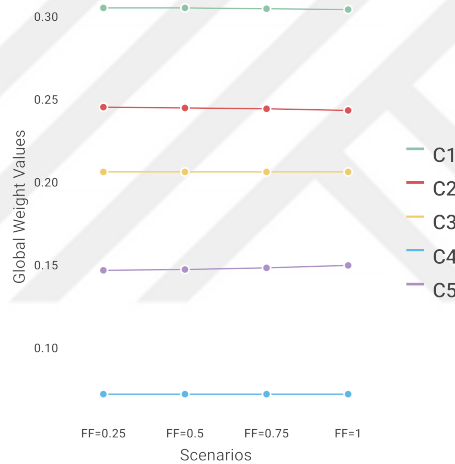


Figure 4.16 : Sensitivity analysis of general criteria.

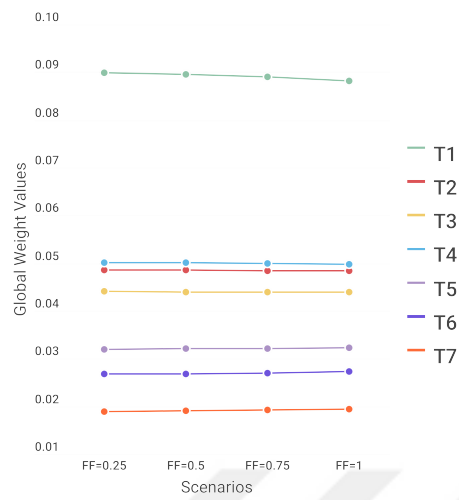


Figure 4.17 : Sensitivity analysis of team criteria.

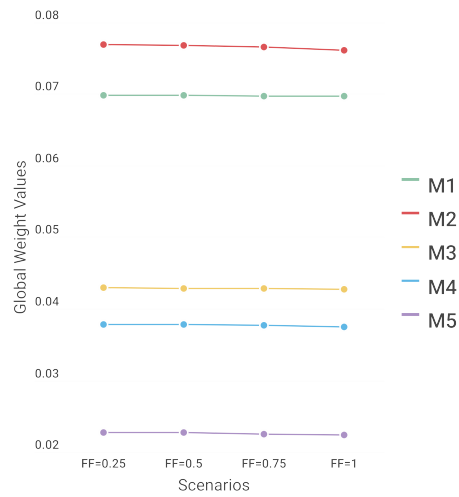


Figure 4.18 : Sensitivity analysis of market criteria.

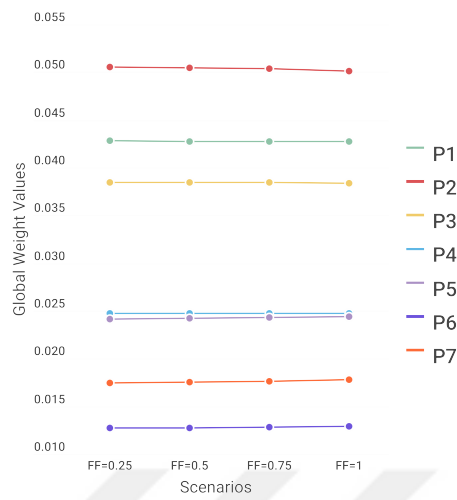


Figure 4.19 : Sensitivity analysis of idea/product criteria.

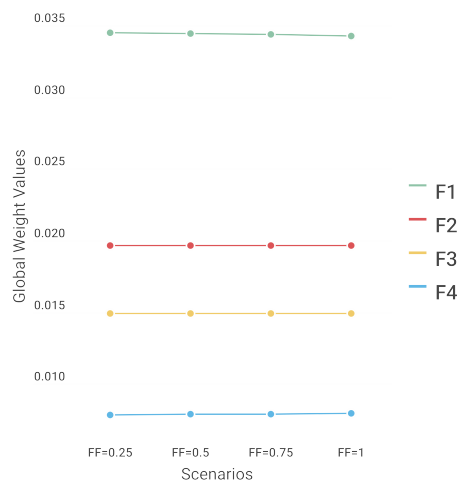


Figure 4.20 : Sensitivity analysis of financial criteria.

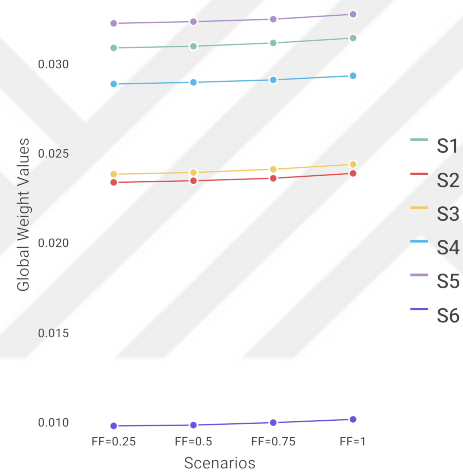


Figure 4.21 : Sensitivity analysis of strategy criteria.

Sensitivity of criteria with respect to optimism index.

As defined earlier, optimism index (OI) is used in Liou's (1991) method to consider the experts behaviour in evaluation. It is set 0.5 for unbiased evaluation in this study. To determine whether the model is sensitive to the selected optimism index, 3 different scenarios are created with 0, 0.5 and 1 optimism index values and the weight values are recalculated for each case. Similar to the previous analysis, names were made with abbreviations to deal with high number of variable. As "OI=0.5" means that the optimism index is selected as 0.5 for that scenario. Whole results are presented in the Figure 4.22 through Figure 4.27. It can be seen from the graph that the weight values kept almost constant throughout the process, This analysis shows that the criteria set is not sensitive to used fuzzification factor.

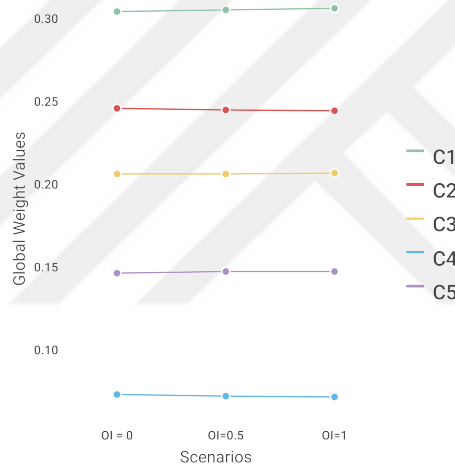


Figure 4.22 : Sensitivity analysis of general criteria for optimism index.

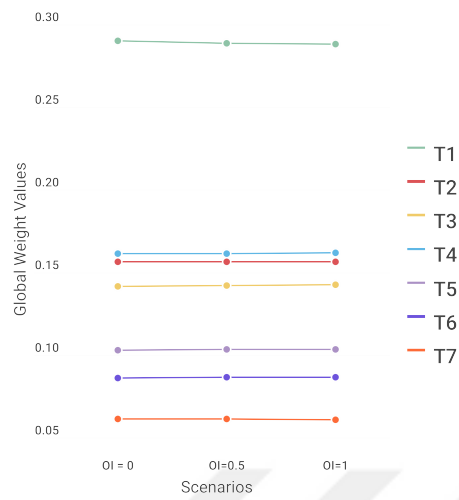


Figure 4.23 : Sensitivity analysis of team criteria for optimism index.

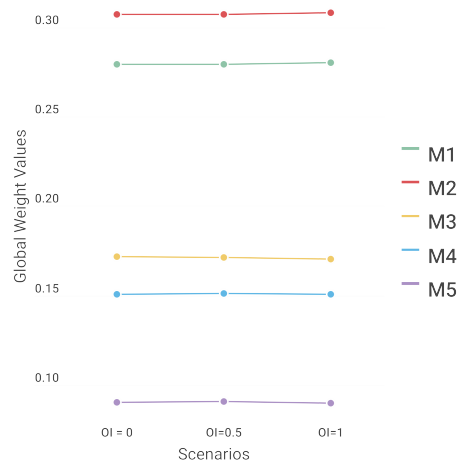


Figure 4.24 : Sensitivity analysis of market criteria for optimism index.

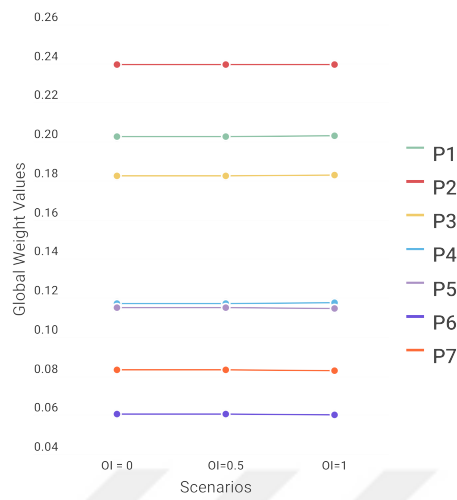


Figure 4.25 : Sensitivity analysis of idea/product criteria for optimism index.

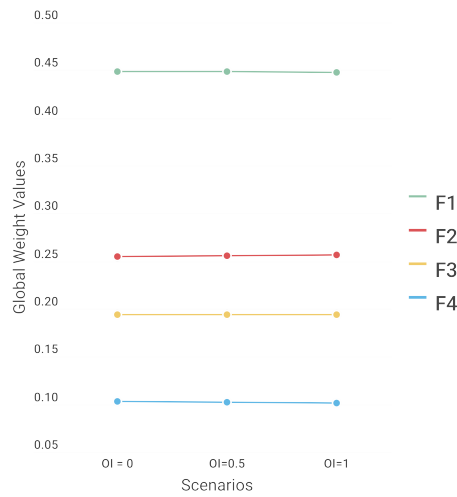


Figure 4.26 : Sensitivity analysis of financial criteria for optimism index.

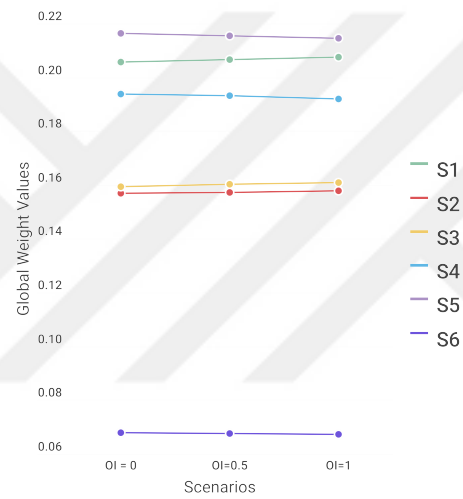


Figure 4.27 : Sensitivity analysis of strategy criteria for optimism index.

4.4.3 Design of the selection phase with TOPSIS

Once the criteria set and their corresponding weights have been finalized, the next step is to select the startups. During this crucial stage, the TOPSIS approach is utilized to prioritize the applied alternative startups. In order for this strategy to be applicable, it is crucial that all the possibilities are present from the beginning. Therefore, the utilization of TOPSIS becomes illogical in situations where programs consistently receive applications and evaluate them simultaneously. Many incubators and accelerators use a batch-wise admission process [40], which makes the TOPSIS technique a practical option for ranking startups within a batch. The direct implementation of this application simplifies the review process, assisting decision-makers in finding promising proposals. The application steps of the TOPSIS method are defined in detail in Section 2.4.2.

The preceding sections have methodically completed a number of crucial procedures in pursuit of the third objective of this study, which is the thorough construction of an end-to-end decision-making process for startup selection within corporate incubators. The development of the criteria set involved a comprehensive methodology, which included systematic literature studies, expert surveys, and one-on-one expert interviews. This process resulted in a final and strong set of criteria. Afterwards, the Fuzzy Analytic Hierarchy Process (FAHP) was utilized to determine the relative significance of these criteria. In this final stage, two more steps are needed to complete the decision making process that are; scoring the startups within the batch, and aggregating the scores for ranking. For this part, nine step process is designed as;

Step 1: Scoring the startups

This step include evaluating the startups within the application batch and scoring them according to the criteria set presented before in Figure 4.3. Decision makers are required to assign a score between 1-9 for each criterion for all startups. Since there are 29 criteria to evaluate, it is more convenient to operate TOPSIS method on category level scores due to the complexity in the euclidean distance calculation with

29 different point. Therefore, in this step; the score vectors $[S_i]$ for each category will be formed for all startups in the batch.

Step 2: Calculation of category score values

After the scoring the startups, category score values $[S_i^t]$ for each startup will be calculated with following equation using the local weight vectors of the sub-criteria calculated in the section 4.4.2.

$$S_i^t = W_i \bullet S_i \quad (4.3)$$

where $i = 1, 2, \dots, m$ that is the number of categories in the model which is 5 in this model;

Step 3: Formation of decision matrix $[G_{ij}]$

After calculating the category scores for each startup, the general score vector G_{ij} will be formed as ;

$$G_{ij} = [S_{ij}^t] \quad (4.4)$$

where $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$ which is the number of startups in the batch

Step 4: Normalization

The decision matrix is normalized by replacing every G_{ij} by n_{ij} using the formula:

$$n_{ij} = \frac{G_{ij}}{\sqrt{\sum_{i=1}^m G_{ij}^2}} \quad (4.5)$$

where $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

Step 5: Weighted normalization

The weighted normalized values are calculated as

$$v_{ij} = w_i * n_{ij}, \quad (4.6)$$

where w_i corresponds to the weight of the i^{th} category.

Step 6: Calculations of ideal solutions The positive ideal solution (PIS), A^+ , and the negative ideal solution (NIS), A^- , are calculated as follows:

$$A^+ = \{v_1^+, v_2^+, \dots, v_i^+, \dots, v_m^+\} \quad (4.7)$$

$$A^- = \{v_1^-, v_2^-, \dots, v_i^-, \dots, v_m^-\} \quad (4.8)$$

where $v_j^+ = \max_j(v_{ij})$ and $v_j^- = \min_j(v_{ij})$

Step 7: Calculation of euclidean distances:

The distances from every alternative to the ideal solutions are calculated. d_j^+ is the distance to A^+ , and d_j^- is the distance to A^- :

$$d_j^+ = \sqrt{\sum_{i=1}^n (v_{ij} - v_i^+)^2} \quad (4.9)$$

$$d_j^- = \sqrt{\sum_{i=1}^n (v_{ij} - v_i^-)^2} \quad (4.10)$$

Step 8: Calculation of relative closeness values

The relative closeness to both ideal solutions is calculated as follows:

$$R_j = \frac{d_j^-}{d_j^+ + d_j^-} \quad (4.11)$$

If $R_j = 0$, then $d_j^- = 0$ means that it is the worst possible case. On the other hand, if $R_j = 1$, then $d_j^+ = 0$ means that it is the best possible case. In general, $0 \leq R_j \leq 1$.

Step 9: Final ranking

The startups are ranked according to R_j in descending order. The best startup is the one with the highest R_j .

4.5 Validation of the Model Using a Representative Case From a Corporate Incubator

As the fourth objective of this study was application and validation of the model in a real-world case, an application scheme is designed to provide validation for the model. For validation purposes, a corporate incubator was asked to evaluate 10 random applicants from their portfolio with the model designed in this study using their application form and past responses.

Step 1: Scoring the startups

They have selected 10 startups that applied a year ago within a month, and evaluated them using this model with their information provided in their application form and the information gathered during their first meeting. The scores assigned by the evaluators is presented in Table 4.18.

Table 4.18 : Evaluation results of startups.

Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
T1	2	7	2	8	9	5	3	4	8	3
T2	2	9	8	7	7	5	8	4	7	5
T3	1	7	4	7	8	6	5	6	6	1
T4	4	9	4	5	8	6	6	5	7	1
T5	1	7	2	8	5	3	6	4	7	2
T6	7	7	4	6	7	9	8	5	5	4
T7	3	8	2	4	8	4	3	4	8	2
M1	4	9	4	6	9	9	4	7	5	6
M2	7	9	8	9	9	9	5	8	9	4
M3	7	4	5	7	6	5	7	4	6	2
M4	4	4	8	8	3	4	7	4	6	2
M5	3	9	4	5	7	7	3	7	7	6
P1	6	9	9	6	6	3	6	2	8	7
P2	5	6	5	7	8	9	4	8	6	4
P3	8	8	6	8	7	6	8	7	9	4
P4	5	8	7	5	7	8	5	2	5	7
P5	3	5	5	6	4	6	6	3	6	5
P6	7	7	2	4	6	3	7	8	8	2
P7	2	7	2	8	4	5	6	6	9	2
F1	3	6	4	6	8	4	9	3	8	1
F2	1	7	3	5	6	4	6	2	6	1
F3	5	9	6	7	8	7	4	6	8	3
F4	2	8	9	4	8	7	8	6	9	7
S1	2	6	4	8	7	8	4	3	8	2
S2	1	8	7	8	9	5	7	4	8	2
S3	4	8	5	6	6	6	6	5	7	3
S4	4	4	4	3	3	3	6	8	9	7
S5	2	3	4	4	6	4	7	8	9	8
S6	5	8	7	9	8	9	8	4	5	2

Step 2: Calculation of category score values Using the Equation 4.3, category score vectors $[S_i^t]$ is calculated and presented in Table 4.19

Step 3: Formation of decision matrix

Table 4.19 : Category score vectors of startups.

	S_1^t	S_2^t	S_3^t	S_4^t	S_5^t
A1	2.5718	5.3448	5.3915	2.7741	2.7524
A2	7.6966	7.3865	7.2354	7.0416	5.7379
A3	3.7188	6.0047	5.7967	4.6435	4.835
A4	6.7979	7.3042	6.531	5.7336	5.9205
A5	7.7346	7.3963	6.382	7.4888	6.2346
A6	5.3812	7.376	6.0793	4.8883	5.4489
A7	5.2937	5.1842	5.8286	7.1619	6.0955
A8	4.5315	6.339	5.1569	3.6327	5.5885
A9	7.0342	6.7331	7.2044	7.5911	8.0464
A10	2.6278	4.095	4.7874	2.0014	4.4189

After calculating the category scores for each startup, the general score matrix G_{ij} will be formed using the Equation 4.4. The resulted decision matrix is as follows;

$$G_{ij} = \begin{bmatrix} 2.5718 & 5.3448 & 5.3915 & 2.7741 & 2.7524 \\ 7.6966 & 7.3865 & 7.2354 & 7.0416 & 5.7379 \\ 3.7188 & 6.0047 & 5.7967 & 4.6435 & 4.835 \\ 6.7979 & 7.3042 & 6.531 & 5.7336 & 5.9205 \\ 7.7346 & 7.3963 & 6.382 & 7.4888 & 6.2346 \\ 5.3812 & 7.376 & 6.0793 & 4.8883 & 5.4489 \\ 5.2937 & 5.1842 & 5.8286 & 7.1619 & 6.0955 \\ 4.5315 & 6.339 & 5.1569 & 3.6327 & 5.5885 \\ 7.0342 & 6.7331 & 7.2044 & 7.5911 & 8.0464 \\ 2.6278 & 4.095 & 4.7874 & 2.0014 & 4.4189 \end{bmatrix}$$

Step 4 and 5 : Weighted normalization

The weighted normalized decision matrix has been formed using Equations 4.5 and 4.6. The resulting matrix is as follows;

$$v_{ij} = \begin{bmatrix} 0.04461 & 0.06590 & 0.05908 & 0.01197 & 0.02340 \\ 0.13350 & 0.09107 & 0.07929 & 0.03037 & 0.04878 \\ 0.06450 & 0.07404 & 0.06352 & 0.02003 & 0.04110 \\ 0.11791 & 0.09006 & 0.07157 & 0.02473 & 0.05033 \\ 0.13416 & 0.09119 & 0.06994 & 0.03230 & 0.05300 \\ 0.09334 & 0.09094 & 0.06662 & 0.02109 & 0.04632 \\ 0.09182 & 0.06392 & 0.06387 & 0.03089 & 0.05182 \\ 0.07860 & 0.07816 & 0.05651 & 0.01567 & 0.04751 \\ 0.12201 & 0.08302 & 0.07895 & 0.03274 & 0.06840 \\ 0.04558 & 0.05049 & 0.05246 & 0.00863 & 0.03756 \end{bmatrix}$$

Step 6: Calculations of ideal solutions

The positive ideal solution (PIS), A^+ , and the negative ideal solution (NIS), A^- , are calculated as follows using the Equations 4.7 and 4.8:

$$A^+ = [0.13416, 0.09119, 0.07929, 0.03274, 0.06840]$$

$$A^- = [0.04461, 0.05049, 0.05246, 0.00863, 0.02340]$$

Step 7-9: Calculation of euclidean distances, relative closeness and ranking:

Using the Equations 4.9 - 4.11 The distances from every alternative to the ideal solutions are calculated. Relative closeness values are calculated and the startups are ranked according to their closeness values. Results are tabulated in the Table 4.20

Table 4.20 : Final rankings of startups.

Startup	d^+	d^-	R	Rank
A9	0.014648238	0.101770623	0.874176418	1
A5	0.018023823	0.106855388	0.855669946	2
A2	0.019777842	0.106701327	0.84362767	3
A4	0.02675142	0.091041783	0.772895047	4
A6	0.04950137	0.069943094	0.585569993	5
A7	0.055249894	0.061989617	0.528743393	6
A8	0.067109363	0.050676323	0.430241779	7
A3	0.079383986	0.038934003	0.329062412	8
A1	0.107352225	0.017099231	0.137396796	9
A10	0.108420766	0.014199668	0.115801812	10

To measure the effectiveness of the model in selecting promising startups, their rankings are compared with their current state. Their success is considered to be based on their reached milestones like sale contracts, new customer acquisition, export contracts or similar milestones that would indicate their level of current success. As presented in Table 4.21, model managed to rank promising startups in the higher places. All milestones listed in the table is achieved after the application to the corporate therefore it is reasonable to state that the model is effective in eliminating the risky applications and predicting the success of the applicant startups.

Table 4.21 : Current status of evaluated startups

Startup	Rank	Milestones achieved or current status
A9	1	Exported for the first time, signed several major sale contracts
A5	2	Validated and patented their solution, signed a major sale contract
A2	3	Received 500K \$ investment from abroad, increased customer base
A4	4	Validated and patented their solution, received an international award, no sale contract yet
A6	5	Received several national awards, no sale contract yet
A7	6	Still in the prototype phase
A8	7	Still in the prototype phase
A3	8	No prototype yet
A1	9	Out of business
A10	10	Out of business



5. FINDINGS AND DISCUSSION

As Doran (2018) suggests, startup finance serves as a vital component of the global economy, as it is effective in the development of new jobs and the expansion of the economy. In light of this, it is imperative that these resources be distributed in a manner that is both equitable and efficient, particularly in developed economies such as Turkey. The fact that new businesses in Turkey wield a substantial amount of influence over the economy of the country, according to the data provided by TOBB, makes the distribution of resources even more important. In his article, Erdogan (2019) highlights the disturbingly high failure rate of startups, which is above 90 percent. This highlights the importance for stakeholders to optimize resource allocation. Also, some of the experts that have been interviewed within the Turkish ecosystem appreciate the necessity of conducting research such as this in order to increase the success rate of incubators.

This thesis, which established four research objectives from the beginning, aims to fill this gap in both literature and practice. The initial objective was to design a set of criteria for evaluating startups that were specifically targeted at the needs of corporate incubators in Turkey. The existing body of literature provides a limited amount of research on the evaluation of startups that is specifically focused on corporate incubators. While there are studies such as Bai (2021) investigating the use of machine learning to investigate the investment decision-making process of venture capitalists, Beyhan (2021) analyzing startup selection processes in Turkish accelerators, and Ioana (2018) investigating evaluation criteria for Romanian accelerators, these studies primarily focus on different stakeholders (venture capitalists, business angels) or locations (the United States of America, Romania, and Russia). A literature study on startup selection criteria was carried out by Ferrati (2019); nevertheless, it is problematic that these criteria sets do not fully connect with the specific requirements and objectives of corporate incubators in Türkiye.

In light of this, it was a necessity to take a methodical approach. The foundation was established by conducting a thorough literature review, which resulted in the identification of hundreds of criteria across 28 papers on the evaluation of startups for a variety of stakeholders and areas. This list was narrowed down to be comprised of only 38 criteria after going through a process of thorough refinement and frequency analysis. These criteria, on the other hand, had a global focus and so needed to be customized in order to accommodate the particular setting of the Turkish ecosystem as well as the specific requirements of corporate incubators.

For the purpose of facilitating this localization, surveys were conducted with a wide variety of specialists from a variety of sectors within the Turkish environment. Important insights were gleaned from in-depth interviews with innovation specialists from a variety of organizations. These interviews made it possible to modify the criteria that were established in order to better correspond with the specific objectives of corporate incubator providers. The end result of this multi-pronged approach was a final set of 29 criteria that were categorized under five primary areas: the team, the market, the idea or product, the finances, and the strategy.

The difference between the survey results and the interview results revealed the differences in corporate perspective in startup evaluation. They focus more on strategic gain than financial return in startups, therefore, the strategic fit and harmony between startup and the company appeared to be one of the most important attributes. Also relative industry experience is considered highly important for the companies and they tend to prioritize the startups in their industry. The quality of the team is also found itself in the top of the list with the perspective of a great team can achieve the other milestones given the support from the corporate.

It is essential to emphasize that there were no completely new criteria that were implemented. During the process of refining, while certain criteria were removed because of their low occurrence in the existing literature, others were restored based on interviews with subject matter experts. For instance, the strategic compatibility with the corporate criterion, which was only mentioned in Erdogan's (2019) research, was

incorporated into the model anyway due to the fact that interviewees made a direct reference to it.

The financial criteria presented a unique challenge. There was a strong emphasis placed on financial criteria in the literature, which was primarily focused on private investors and venture capitalists. Despite this, the refining process—which included the insights given by corporate leaders during the interviews—led to the elimination of the majority of the financial criteria. This is in line with Majumdar's (2023) assertion that assessing the financial viability of early-stage firms is a difficult process by nature. Further, according to the data collected from interviews, the importance of strategic alignment appeared to be greater for corporations than the importance of financial gains. The management of the corporation placed a high priority on ensuring that the aims of the startup and the strategic objectives of the corporation were aligned, which indicates a change away from an exclusive concentration on financial measures. Therefore, in this study, a fresh set of startup evaluation criteria has been developed, with the intention of catering exclusively to corporate incubators operating inside the Turkish ecosystem.

The second aim of this research was to allocate weights to the criteria in the startup assessment model. The content of the criteria set is crucial, but the allocation of relative weight to each criterion also greatly influences the selection process. Due to the various strategic objectives of entities such as venture capitalists and corporate incubators, the significance of each criterion also differs. Thus, this study utilized the Fuzzy Analytic Hierarchy Process (FAHP) approach to assign weights to the criterion. The study especially focused on corporate innovation executives to obtain insights that are pertinent to the corporate viewpoint.

Various approaches for criteria weighing are used in the literature, such as the best-worst method by Shafiee (2022), the Simos method by Nikolopoulos (2017), and the Analytic Hierarchy Process (AHP) by Kim (2018) and Oliveira (2021). The Fuzzy Analytic Hierarchy Process (FAHP) is a commonly employed technique in this particular field. Dhochak (2019) and Kelemen (2019) have provided evidence of its efficacy in the process of assigning weights to criteria for evaluating startups.

Corporate entrepreneurship and innovation experts conducted paired comparisons to accurately reflect the specific requirements of business incubators in determining the weights.

The FAHP study results closely corresponded with the findings in the current literature. The category labeled "Team" was determined to be the most significant, accounting for 31% of the overall importance. This is in line with research by Pintado (2007), Bai (2021), and Franke (2008), all of which emphasize the critical value of a strong team. Expert interviews provided additional evidence, emphasizing that the team's competence was a crucial aspect in the decision-making process. Within the "Team" category, the most essential aspect recognized was relevant industry experience, which is consistent with the findings from expert interviews and literature. Munoz (2015) and Erdogan (2019) highlighted the significance of industry expertise and robust networks in achieving success for startups. In addition, the concept of talent diversity has been identified as an important characteristic, which aligns with the author's field experience and study conducted by Hoogendorn (2017), Franke (2006), and Majumdar (2023). These studies indicate that teams consisting of individuals with different backgrounds and skills tend to achieve superior long-term performance.

The "Market" category was assigned a weight of 25%, indicating the significant emphasis put on market circumstances. This is consistent with the perspectives of Salomon (2018) and Spender (2017), who highlight the market as a major determinant of startup success. The sub-criterion of "globalization potential" was determined to be the most significant within this category. According to expert interviews, the Turkish startup ecosystem may have a distinct characteristic where global expansion is required because of domestic economic difficulties.

The "Product" category was assigned a weight of around 21%, which aligns with both existing research and expert opinions. According to Scott (2015), the concept itself is less crucial because it can be improved and adjusted, unlike the characteristics of the market and the team. During the interviews, experts expressed the same opinion, indicating that the idea category presented greater potential for enhancement within incubators in comparison to other categories. The attribute of the importance of

the problem has been identified as the most crucial factor, emphasizing the need to comprehend the pain points of customers. This supports Finger's (2013) proposition that understanding consumer pain points is vital, as there are frequently numerous alternatives to a single issue.

The "Financial" category was assigned a weight of less than 8%, which is the lowest among all categories. This is consistent with the literature that indicates that financial factors are more important for businesses in the latter stages that are seeking investment. According to Skalicka (2023), the challenge of evaluating the financial aspects of early-stage startups increases the significance of other factors. The attribute of realistic financial forecasts was deemed to be the most crucial in light of the limited financial track record of startups. According to Sari (2022), evaluations primarily depend on future financial expectations because there is a lack of historical evidence. Hence, the rationality of financial planning becomes pivotal in the assessment process. Ultimately, the "Strategy" category was assigned a weight of about 15%. This aligns with Bai's (2021) contention that relying simply on the assessment of historical performance poses inherent issues. An innovative structure that takes into account future ambitions in addition to prior accomplishments is essential. The criteria of "vision" and "strategic compatibility" continued to be the most important within this category.

Ultimately, the derived weights exhibit congruity with the current body of research. The FAHP methodology successfully integrated the viewpoints of corporate experts, leading to a customized weighting system that caters to the specific requirements of corporate incubators in the Turkish ecosystem.

The third objective of this study was the design of the decision-making process for a corporate incubator from the beginning. The criteria set had been created and weighted with the previous steps; therefore, the next step was the scoring and aggregation phase. For this part, there are several methods to apply in the literature, such as Promethee II by Nikolodois (2017), Fuzzy TOPSIS by Taweasangrunroj (2022), ANP by Milkova (2018) or SAW by Mohammadi (2022), Sari (2022) and Simoes (2019). In this study, the TOPSIS method is employed to include the relative quality of the startup within a

batch. It is suitable for the operation because there are a limited number of vacancies in the incubator, which will be filled with the best startups from the current batch.

For the fourth objective, the model needed to be used and validated with real-life cases. 10 different startup applications from last year have been evaluated using this model and the resulting rankings are compared with the current status of the startups. As explained in the final section, the model has been proven to predict promising startups.



6. CONCLUSIONS

This thesis aims to design a comprehensive startup evaluation framework for corporate incubators that addresses a research gap in the literature. For this purpose, a multi-step and multi-method research design have been performed. The first step was the construction of the criteria set to be used in the evaluation model, which is done through a triple-source approach including systematic literature reviews, expert surveys, and expert interviews. In the second step, the established criteria set is weighted using the fuzzy AHP method. The final step of the thesis was the design of a selection and ranking scheme for startups and for this phase, the TOPSIS methodology is employed. TOPSIS method provides the relative comparison of the startups within the batch therefore enables the incubators to fill the capacity with the best startups within the current batch. Additionally, the model has been validated through a case study within a corporate incubator.

6.1 Theoretical Implications of This Study

The study likely explores how corporate incubators can make informed decisions to maximize their impact on startups' growth and success. Additionally, being the first study in the Turkish ecosystem and one of the earliest in the global literature, this research contributes significantly to the theoretical foundation of corporate incubation. Researchers can build upon this work, refining and expanding our understanding of startup evaluation and decision-making.

6.2 Practical Application of This Study

The study focuses on optimizing the decision-making process within corporate incubators. Corporate incubators play a pivotal role in nurturing startups, and their decision-making processes significantly impact the success of these incubators. It

provides valuable insights for practitioners managing corporate incubators, offering practical guidance on improving decision-making processes.

For incubator managers, this study provides valuable insights from experts in the ecosystem and literature from around the world. This might improve the selection processes of corporate incubators with refined criteria and ranking system.

For the startup founders, this study might serve as a business check list for the startups to self evaluate themselves to better fit the incubators, etc. Founders might use the insights from the criteria list and relative importance values.

For the other stakeholders that assess startups for different purposes, this study can serve as a base scheme that can be modified to their specific needs. Decision-makers can improve their decision-making processes with the outputs of this research.

6.3 Limitations and Future Research

The primary purpose of this study was to minimize the influence of personal opinions in the startup evaluation process. Although the developed model provides a more objective approach, it is not realistic to completely eliminate subjectivity from the selection process. The selection process heavily relies on the human judgments of decision makers, as it involves the formation of criteria by experts, the weighing of operations by experts, and the scoring by experts. According to the principle of "wisdom of the crowd," the greater the number of experts involved in the process, the more closely the findings align with objective values. Consequently, increasing the sample size can improve the study.

Identifying certain stages of startups is challenging due to the unique nature of each startup's journey. Each firm has its own set of milestones and processes to achieve, making it difficult to establish a universal framework. Furthermore, any corporation possesses different strategies regarding entrepreneurship, thus necessitating varying evaluations of startups with slight modifications. Hence, the model proposed in this study requires slight adjustments to cater to the specific requirements of organizations. Economic and technological trends have a significant impact on organizations'

strategies, making this model time-sensitive. It may require adjustments in the long run.

The model incorporates multiple calculations in the ranking process, which may lead to confusion among decision-makers. To address this, a prelude can be created to provide an explanation of the calculations performed behind the scenes, ensuring that everyone understands the process.

Artificial Intelligence can also be used in the process for trivial criteria assessment like market size, growth rate etc. that can be result in less work for the experts and evaluators.

Evaluating a company based on a certain set of criteria, such as a scale of 9 or any other numerical value, might be imprecise and ambiguous. There is a requirement for a standardized scoring system to ensure that evaluations made by decision makers are somewhat consistent both inside and across different startups. For example, it is important to establish a standardized scale for evaluating the level of innovation or market growth rate of companies. This could involve assigning a score of 7 out of 9 to a firm if specific criteria are met. While it may be challenging, it is essential to establish standardized criteria in order to make objective judgments across different startups.

Corporate incubators are relatively new to the Turkish entrepreneurship ecosystem, leading to limited practical experience. Consequently, this study may be repeated in the future with greater participation from experts and businesses once they have obtained results from their ongoing models.

TOPSIS methodology needs the all alternatives and rank them with respect to each other, therefore it is convenient for incubators that are using batch-wise application processes. However, if an incubator collects applications without a time-frame and evaluate them with single case approach, an alternative scoring scheme should be employed like simple weighted scoring with a global threshold.

Validation of the model have been done using old application forms with the new model, therefore, it is limited to assess startups with just application forms that are not

designed to meet the needs for this model. The application process should be designed to serve this evaluation model well; this would increase the efficiency of the model.

As mentioned in the interviews and the study done by Franke (2008), many stakeholders, like investors, accelerators, or even incubators, have certain knockout criteria that they eliminate according to specific attributes that the startups have or lack. Therefore, the model might have included threshold values for each criteria or some knockout criteria that terminates the process from the beginning without working on it further.

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APPENDICES

APPENDIX A : Expert Survey Questionnaire - Translated

APPENDIX B : Fuzzy comparison matrices

APPENDIX C : MATLAB Script

APPENDIX D : Fuzzy Synthetic Extent Values





APPENDIX A : Expert Survey Questionnaire - Translated

Dear Expert,

This study is being conducted by Yusuf MAZ, a graduate student at the Department of Management Engineering, Graduate School, Istanbul Technical University, under the supervision of Assoc. Prof. Nihan Yıldırım. The subject of the study is "Evaluation Model to be Used in the Admission Phase of Incubation Programs for Early Stage Technology Startups".

The aim of this study is to create an evaluation model to be used in the admission of early stage technology startups to incubation programs, which will reduce the impact of personal judgment and prevent incomplete and subjective evaluations, in order to ensure the correct and effective use of limited resources and the proper distribution of support to be provided to entrepreneurs.

In order to create the findings of this study, the opinions of valuable experts who are knowledgeable and experienced in this field are being consulted. The criterion sets collected from the literature before this survey were subjected to a preliminary screening using frequency analysis and presented to your opinion.

The survey takes approximately 10 minutes and does not contain any personal information. Your answers will never be shared with 3rd parties and will only be used by the researcher for academic purposes.

Thank you for your support to our study.

Sincerely,

Yusuf Maz

• General Information

- Your Role in the Entrepreneurial Ecosystem
- Institutions You Work In:
- Your Function Within These Institutions:
- Years of Experience in the Entrepreneurial Ecosystem:

• Team:

- Team Experience in the Relevant Industry:
- Team's Entrepreneurial Experience:
- Leader Entrepreneur's Personal Characteristics (Leadership, Dedication, Coaching, etc.):
- Diversity of Talent Within the Team:
- Team's Work Experience:

- Team’s Educational and Academic Background:
- Number of Team Members:
- Ages of the Team Members:
- Team’s Qualitative Characteristics (Creativity, Open-Mindedness, Flexibility, Motivation, Commitment, Honesty, etc.):
- **Market:**
 - Market and Target Market Size:
 - Market Risk / Ease of Entry into the Market:
 - Market Growth Rate:
 - Competitive Conditions in the Market:
 - Globalization Potential:
- **Idea/Product:**
 - Importance of the Problem Being Solved:
 - Scalability:
 - Difficulty of Imitation:
 - Intellectual Property Rights:
 - Validation of the Developed Solution:
 - Current Stage of the Product (Idea, Prototype, Final Product, etc.):
 - Sustainability of the Competitive Advantage:
 - Technology Readiness Level:
 - Technical Feasibility:
- **Financial:**
 - Key Financial Indicators (Internal Rate of Return (IRR), Net Present Value (NPV), Return on Investment (ROI)):
 - Regular Cash Flow:
 - Profitability:
 - Realism of Financial Projections:
- **Strategy:**
 - Vision:
 - Business Plan:
 - Realistic Risk Analysis:
 - Marketing Strategy:
 - Financial Strategy:
 - Operational Strategy:

- Existing and Planned Strategic Partnerships:
- Sensitivity to Political and Economic Fluctuations:
- Strategic Compatibility with the Investor:

- **Additional Comments:**





APPENDIX B : Fuzzy comparison matrices

Table B.1 : Fuzzy comparison matrices for team criteria.

	T1	T2	T3	T4	T5	T6	T7
T1	(1,1,1)	(2.99,3.45,3.93)	(2.61,3.04,3.47)	(1.69,2.02,2.38)	(1.86,2.29,2.72)	(2.51,2.93,3.35)	(2.89,3.27,3.64)
T2	(0.25,0.28,0.33)	(1,1,1)	(1.35,1.59,1.85)	(1.05,1.29,1.56)	(1.1,1.26,1.44)	(1.5,1.79,2.11)	(2.1,2.5,2.9)
T3	(0.28,0.32,0.38)	(0.53,0.62,0.73)	(1,1,1)	(1.08,1.26,1.45)	(1.24,1.56,1.9)	(1.55,1.91,2.3)	(1.74,2.12,2.51)
T4	(0.42,0.49,0.58)	(0.63,0.77,0.94)	(0.68,0.79,0.92)	(1,1,1)	(2.37,2.75,3.12)	(1.75,2.16,2.58)	(1.7,2.08,2.45)
T5	(0.36,0.43,0.53)	(0.69,0.78,0.9)	(0.52,0.63,0.8)	(0.32,0.36,0.42)	(1,1,1)	(1.2,1.44,1.7)	(1.4,1.75,2.11)
T6	(0.29,0.34,0.39)	(0.34,0.39,0.47)	(0.39,0.47,0.55)	(0.47,0.55,0.66)	(0.55,0.66,0.43)	(1,1,1)	(1.43,1.79,2.16)
T7	(0.27,0.3,0.34)	(0.3,0.34,0.34)	(0.34,0.34,0.4)	(0.34,0.4,0.47)	(0.4,0.47,0.39)	(0.46,0.55,0.69)	(1,1,1)

Table B.2 : Fuzzy comparison matrices for market criteria.

	M1	M2	M3	M4	M5
M1	(1,1,1)	(1.65,1.94,2.25)	(1.77,2.09,2.44)	(1.32,1.52,1.75)	(1.82,2.2,2.59)
M2	(0.44,0.51,0.6)	(1,1,1)	(2.5,2.91,3.33)	(2.33,2.75,3.16)	(2.05,2.48,2.92)
M3	(0.4,0.47,0.56)	(0.34,0.34,0.4)	(1,1,1)	(1.57,1.79,2.01)	(1.54,1.78,2.04)
M4	(0.56,0.65,0.75)	(0.31,0.36,0.42)	(0.49,0.55,0.63)	(1,1,1)	(1.86,2.17,2.48)
M5	(0.38,0.45,0.54)	(0.34,0.4,0.48)	(0.48,0.56,0.49)	(0.4,0.46,0.53)	(1,1,1)

Table B.3 : Fuzzy comparison matrices for idea/product criteria.

	P1	P2	P3	P4	P5	P6	P7
P1	(1,1,1)	(1.54,1.73,1.93)	(1.59,1.88,2.2)	(2.31,2.75,3.19)	(1.23,1.48,1.76)	(2.2,2.58,2.95)	(1.14,1.34,1.54)
P2	(0.51,0.57,0.64)	(1,1,1)	(2.04,2.5,2.95)	(3.04,3.5,3.95)	(2.15,2.62,3.09)	(2.25,2.58,2.91)	(2.2,3.3,2.66)
P3	(0.45,0.52,0.62)	(0.33,0.4,0.48)	(1,1,1)	(2.31,2.69,3.07)	(1.9,2.29,2.68)	(2.45,2.91,3.37)	(1.36,1.66,1.97)
P4	(0.31,0.36,0.43)	(0.25,0.28,0.32)	(0.32,0.37,0.43)	(1,1,1)	(1.23,1.42,1.62)	(2.2,4.1,2.83)	(1.29,1.53,1.79)
P5	(0.56,0.67,0.81)	(0.32,0.38,0.46)	(0.37,0.43,0.52)	(0.61,0.7,0.81)	(1,1,1)	(2.02,2.41,2.81)	(1.34,1.61,1.89)
P6	(0.33,0.38,0.45)	(0.38,0.45,0.54)	(0.45,0.54,0.68)	(0.34,0.38,0.44)	(0.38,0.44,0.29)	(1,1,1)	(0.74,0.86,0.98)
P7	(0.64,0.74,0.87)	(0.74,0.87,0.37)	(0.87,0.37,0.42)	(0.37,0.42,0.5)	(0.42,0.5,0.5)	(1.01,1.16,1.33)	(1,1,1)

Table B.4 : Fuzzy comparison matrices for financial criteria.

	F1	F2	F3	F4
F1	(1,1,1)	(2.69,3.08,3.48)	(2.29,2.69,3.1)	(2.48,2.91,3.36)
F2	(0.28,0.32,0.37)	(1,1,1)	(1.53,1.77,2.04)	(1.98,2.41,2.86)
F3	(0.32,0.37,0.43)	(0.48,0.56,0.65)	(1,1,1)	(1.85,2.25,2.65)
F4	(0.29,0.34,0.4)	(0.34,0.41,0.5)	(0.37,0.44,0.53)	(1,1,1)

Table B.5 : Fuzzy comparison matrices for strategy criteria.

	S1	S2	S3	S4	S5	S6
S1	(1,1,1)	(1.64,1.9,2.18)	(1.4,1.63,1.87)	(1.09,1.24,1.4)	(1.15,1.37,1.6)	(1.43,1.79,2.16)
S2	(0.45,0.52,0.6)	(1,1,1)	(1.29,1.54,1.8)	(0.8,0.95,1.12)	(0.5,0.58,0.68)	(1.86,2.2,2.55)
S3	(0.53,0.61,0.7)	(0.55,0.64,0.77)	(1,1,1)	(0.81,0.97,1.15)	(0.83,0.99,1.18)	(2.28,2.7,3.13)
S4	(0.7,0.8,0.91)	(0.88,1.04,1.24)	(0.86,1.02,1.23)	(1,1,1)	(0.86,0.92,0.98)	(3.16,3.58,4)
S5	(0.62,0.72,0.86)	(1.46,1.71,1.98)	(0.84,1.1,1.19)	(1.01,1.08,1.15)	(1,1,1)	(3.37,3.83,4.29)
S6	(0.46,0.55,0.69)	(0.55,0.69,0.39)	(0.69,0.39,0.45)	(0.39,0.45,0.53)	(0.45,0.53,0.31)	(1,1,1)



APPENDIX C : MATLAB script

This function is built in order to find the weights of the criteria according to Extent analysis method on fuzzy AHP (Chang's) ("Da-Yong Chang, Applications of the extent analysis method on fuzzy AHP, European Journal of Operational Research, Volume 95, Issue 3, 1996, Pages 649-655, ISSN 0377-2217, [https://doi.org/10.1016/0377-2217\(95\)00300-2](https://doi.org/10.1016/0377-2217(95)00300-2).")

INPUTS P: Pairwise Matrix

OUTPUTS

S: The value of fuzzy synthetic extent

W: Weights

AUTHORS Demet CILDEN Dogus GULER (gulerdo.dogus@gmail.com) LAST UPDATE March 30, 2018

```
function [S,W]=fuzzAHP1(P)
```

```
nn=size(P); n=nn(1);
```

```
B=zeros(n,3); C=B; t=0;
```

```
for i=1:n
```

```
    k=1;
```

```
    for j=1:n
```

```
        B(i,1)=B(i,1)+P(i,k);
```

```
        B(i,2)=B(i,2)+P(i,k+1);
```

```
        B(i,3)=B(i,3)+P(i,k+2);
```

```
        C(i,1)=C(i,1)+sum(P(:,k+2));
```

```
        C(i,2)=C(i,2)+sum(P(:,k+1));
```

```
        C(i,3)=C(i,3)+sum(P(:,k));
```

```
        k=k+3; t=t+1;
```

```
    end
```

```
end
```

```
C=1./C; S=B.*C;
```

```
k=1;
```

Weights

```
for i=1:n
```

```
    k=1;
```

```

for j=1:n
if j ==i
if S(i,2)>=S(j,2)
V(i,k)=1;
elseif S(j,1)>=S(i,3)
V(i,k)=0;
else
V(i,k)=(S(j,1)-S(i,3))/((S(i,2)-S(i,3))-(S(j,2)-S(j,1)));
end k=k+1;
end
end
W1(i)=min(V(i,:));
end
W=W1'./sum(W1);
end

```

This function is built in order to find the weights of the criteria according to "Tian-Shy Liou, Mao-Jiun J. Wang, Ranking fuzzy numbers with integral value, Fuzzy Sets and Systems, Volume 50, Issue 3, 1992, Pages 247-255, ISSN 0165-0114, [https://doi.org/10.1016/0165-0114\(92\)90223-Q](https://doi.org/10.1016/0165-0114(92)90223-Q)."

INPUTS

P: Pairwise Matrix

a: The index of optimism

OUTPUTS

S: The value of fuzzy synthetic extent

W: Weights

CR: Consistency Ratio

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LAST UPDATE

March 30, 2018

function [S,W,CR]=fuzzAHP2(P,a)

nn=size(P); n=nn(1);

B=zeros(n,3); C=B; t=0;

```

[m]=RI(n); Random Index
for i=1:n
k=1;
for j=1:n
B(i,1)=B(i,1)+P(i,k);
B(i,2)=B(i,2)+P(i,k+1);
B(i,3)=B(i,3)+P(i,k+2);
C(i,1)=C(i,1)+sum(P(:,k+2));
C(i,2)=C(i,2)+sum(P(:,k+1));
C(i,3)=C(i,3)+sum(P(:,k));
M(i,j)=(P(i,k)+4*P(i,k+1)+P(i,k+2))/6;
k=k+3; t=t+1;
end
end
C=1./C; S=B.*C;
k=1;
Weights
for i=1:n
W1(i)=0.5*(a*S(i,3)+S(i,2)+(1-a)*S(i,1));
end
W=W1'./sum(W1);
A1=M*W;
lambda=mean((A1./W));
CI=(lambda-n)/(n-1);
CR=CI/m;
if CR<0.1
fprintf('The consistency ratio is acceptable. (Wangs approach)') else warning('The
consistency ratio is not acceptable! (Wangs approach)') end end

```



APPENDIX D : Fuzzy Synthetic Extent Values

Table D.1 : Fuzzy synthetic extent values of team criteria.

Criteria	Fuzzy Synthetic Extent Value
T1	0.2171,0.2897,0.3836
T2	0.1167,0.1566,0.2098
T3	0.1037,0.1419,0.1927
T4	0.1195,0.1616,0.2175
T5	0.0767,0.1032,0.1398
T6	0.0642,0.0862,0.1174
T7	0.0468,0.0608,0.0821

Table D.2 : Fuzzy synthetic extent values of market criteria.

Criteria	Fuzzy Synthetic Extent Value
M1	0.2136,0.2790,0.3635
M2	0.2349,0.3072,0.3988
M3	0.1372,0.1715,0.2180
M4	0.1198,0.1510,0.1919
M5	0.0738,0.0914,0.1109

Table D.3 : Fuzzy synthetic extent values of idea/product criteria.

Criteria	Fuzzy Synthetic Extent Value
P1	0.1532,0.2028,0.2676
P2	0.1804,0.2398,0.3158
P3	0.1364,0.1824,0.2421
P4	0.0889,0.1173,0.1548
P5	0.0865,0.1146,0.1525
P6	0.0476,0.0604,0.0785
P7	0.0642,0.0826,0.1092

Table D.4 : Fuzzy synthetic extent values of financial criteria.

Criteria	Fuzzy Synthetic Extent Value
F1	0.3471,0.4489,0.5773
F2	0.1967,0.2555,0.3311
F3	0.1503,0.1937,0.2499
F4	0.0829,0.1019,0.1289

Table D.5 : Fuzzy synthetic extent values of strategy criteria.

Criteria	Fuzzy Synthetic Extent Value
S1	0.1576,0.2065,0.2685
S2	0.1206,0.1572,0.2038
S3	0.1224,0.1600,0.2086
S4	0.1526,0.1933,0.2458
S5	0.1693,0.2157,0.2750
S6	0.0540,0.0673,0.0860

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