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Santautė VENSLAVIENĖ

ASSESSMENT OF BLOCKCHAIN'S IMPACT ON CROWDFUNDING

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Supervisor

Prof. Dr Jelena STANKEVIČIENĖ (Vilnius Gediminas Technical University, Economics – S 004).

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Address: Saulėtekio al. 11, LT-10223 Vilnius, Lithuania.
Tel.: +370 5 274 4956; fax +370 5 270 0112; e-mail: doktor@vilniustech.lt

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Vadovas

prof. dr. Jelena STANKEVIČIENĖ (Vilniaus Gedimino technikos universitetas, Ekonomika – S 004).

Vilniaus Gedimino technikos universiteto Ekonomikos mokslo krypties disertacijos gynimo taryba:

Pirmininkas

prof. dr. Rima TAMOŠIŪNIENĖ (Vilniaus Gedimino technikos universitetas, Ekonomika – S 004).

Nariai:

doc. dr. Indrė LAPINSKAITĖ (Vilniaus Gedimino technikos universitetas, Ekonomika – S 004),

prof. dr. Javier Oliver MUNCHARAZ (Valensijos politechnikos universitetas, Ispanija, Ekonomika – S 004),

prof. dr. Laima OKUNEVIČIŪTĖ NEVERAUSKIENĖ (Vilniaus Gedimino technikos universitetas, Ekonomika – S 004),

prof. dr. Vaida PILINKIENĖ (Kauno technologijos universitetas, Ekonomika – S 004).

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Adresas: Saulėtekio al. 11, LT-10223 Vilnius, Lietuva.
Tel.: (8 5) 274 4956; faksas (8 5) 270 0112; el. paštas doktor@vilniustech.lt

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Abstract

During the Global Financial Crisis (2008), many large banks in the most advanced economies of the world failed. This boosted distrust in these massive financial institutions. Repeated computer hacking attacks demolished trust even further. Therefore, decentralized systems, such as blockchain technology, became very attractive.

Recent crowdfunding and blockchain technology, while being critical applications of the FinTech industry, might disrupt traditional financial intermediation and serve as alternatives for financing new businesses. Blockchain-based crowdfunding has become a significant economic phenomenon and an essential approach to financing businesses. Blockchain can help crowdfunds eliminate financial intermediaries and reduce costs and transaction documentation.

The main goal of this research is to develop and empirically test an integrated model for assessing the impact of blockchain on crowdfunding, the application of which would allow rational economic and investment decisions. Hence, the theoretical framework for evaluating blockchain's impact on crowdfunding was proposed. The framework recommends the assessment of the blockchain's impact from the perspective of investors and crowdfunding platforms. Additionally, the proposed new model for assessing the blockchain's impact on crowdfunding involves modeling tools like ARIMA for forecasting crowdfunding revenues, the use of VASMA and modified VASMA-L criteria weighting methods that consider both WASPAS-SVNS (subjective) and information entropy (objective) weights. The modified VASMA-L weighting methodology is a novelty to scientific literature as it was developed while formulating this research. According to this methodology, modified VASMA-L criteria weighting methodology can be applied to extensive criteria sets by separating them into smaller subsets and later comparing overall results to get the most significant factors of the entire criteria set.

This research implemented and tested the evaluation model's practical suitability to assess blockchain's impact on crowdfunding and empirical research methodology. The results show that blockchain technology impacts crowdfunding platforms and their technical structure, while investors see little difference in its impact when investing in crowdfunding campaigns. Finally, this research proves that blockchain technology can support crowdfunding platforms.

Reziumė

Per 2008 m. pasaulinę finansų krizę bankrutavo daug didelių bankų pažangiausiose pasaulio ekonomikose, todėl didžiausios finansinės institucijos tapo nebepatikimos. Be to, pasitikėjimą sugriovė ir pasikartojantys įsilaužimo į kompiuterių sistemas atvejai. Todėl decentralizuotos sistemos, tokios kaip blokų grandinės technologija, tapo labai patrauklios.

Pastaruoju metu sutelktinis finansavimas ir blokų grandinės technologija, būdami labai svarbūs finansinių technologijų (angl. *fintech*) pramonės segmentai, gali sutrikdyti tradicinį finansinį tarpininkavimą ir tapti alternatyvomis naujoms įmonėms finansuoti. Neseniai blokų grandinės technologija pagrįstas sutelktinis finansavimas tapo reikšmingu ekonominiu reiškiniu ir svarbiu verslo finansavimo metodu. Blokų grandinė gali padėti sutelktiniam finansavimui visiškai eliminuoti finansinius tarpininkus, sumažinti išlaidas ir sandorių dokumentaciją.

Pagrindinis šio darbo tikslas – sukurti ir empiriškai patikrinti integruotą modelį, skirtą įvertinti, kokį poveikį blokų grandinė daro sutelktiniam finansavimui, ir kurio taikymas leistų priimti racionalius ekonominius ir investicinius sprendimus. Taigi buvo pasiūlyta teorinė blokų grandinės poveikio sutelktiniam finansavimui vertinimo sistema. Sistemoje rekomenduojama įvertinti blokų grandinės poveikį investuotojų ir sutelktinio finansavimo platformų požiūriu. Be to, pasiūlytas naujas blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelis apima tokias modeliavimo priemones kaip ARIMA – sutelktinio finansavimo pajamoms prognozuoti, VASMA ir modifikuoto VASMA-L kriterijų svorių metodų, kuriuose atsižvelgiama į WASPAS-SVNS (subjektyvųjį) ir informacijos entropijos (objektyvųjį) svorius, taikymą. Modifikuota VASMA-L kriterijų svorių nustatymo metodika yra naujovė mokslinėje literatūroje, nes ji buvo sukurta formuluojant šį tyrimą. Pagal šią metodiką, modifikuotą VASMA-L kriterijų svėrimo metodiką galima taikyti didelėms kriterijų aibėms, išskaidant jas į mažesnius poaibius, o vėliau lyginant rezultatus visus kartu, kad būtų gauti svarbiausi visos kriterijų aibės veiksniai.

Šiame tyrime buvo įgyvendintas ir išbandytas praktinis vertinimo modelio tinkamumas blokų grandinės poveikiui sutelktiniam finansavimui vertinti ir empirinio tyrimo metodika. Rezultatai rodo, kad blokų grandinės technologija daro įtaką sutelktinio finansavimo platformoms ir jų techninei struktūrai, o investuotojai, investuodami į sutelktinio finansavimo kampanijas, nemato didelio blokų grandinės technologijos poveikio skirtumo. Galiausiai šis tyrimas įrodo, kad blokų grandinės technologija gali padėti sutelktinio finansavimo platformoms.

Notations

Abbreviations

ARIMA – autoregressive integrated moving average model (liet. *autoregresinis integ ruotas slenkančio vidurkio modelis*);
BC – blockchain (liet. *blokų grandinė*);
CCPs – central counterparties (liet. *centrinės sandorio šalys*);
CF – crowdfunding (liet. *sutelktinis finansavimas*);
CFP – crowdfunding platform (liet. *sutelktinio finansavimo platforma*);
DApp – decentralized applications (liet. *decentralizuotos programos*);
FinTech – financial technology (liet. *finansinės technologijos*);
ICOs – initial crypto-asset offerings (liet. *pirminiai kriptovaliutų siūlymai*);
KYC – know your customer (liet. *pažink savo klientą*);
MCDM – multiple-criteria decision-making methods (liet. *daugiakriteriniai sprendimų priėmimo metodai*);
VAS – visual analogue scales (liet. *vizualinės analoginės skalės*);
VASMA – VAS Matrix (liet. *VAS matrica*);
WASPAS – weighted aggregated sum product assessment (liet. *svertinis agreguotos sumos sandaugos vertinimas*);
WASPAS-SVNS – weighted aggregated sum product assessment with a single-valued neutrosophic sets (liet. *svertinis agreguotos sumos sandaugos vertinimas su vienareikšmėmis neutrosofinėmis aibėmis*);.

Contents

Introduction

Problem Formulation

The main research problem in this dissertation is how to assess blockchain's impact on crowdfunding. Financial technologies, or FinTech, are a priority of the European Commission and Lithuania's economic policy, as they can play an essential role in achieving the targets of the banking union, the single market, retail financial services, and the capital markets union. Blockchain technology, while a critical part of financial technologies, can solve the problems of financing new businesses and can be one of the alternatives for financing new businesses.

Crowdfunding is another essential part of FinTech. Currently, several crowdfunding platforms have been deployed on the blockchain, rewarding people's financial contributions to a project with specific project shares. Recently, blockchain-based crowdfunding grew into a significant economic phenomenon, especially in 2017/18, and became a substantial approach to finance businesses. Nevertheless, blockchain-based crowdfunding is highly similar to traditional crowdfunding yet possesses distinct characteristics. Hence, the criteria that determine the success of investments in conventional financial crowdfunding may not have the same impact on blockchain-based crowdfunding. Understanding success characteristics is crucial for comprehending the key similarities and variations

across different crowdfunding models, creating effective blockchain-based fundraising campaigns, and for investors to consider specific evaluation criteria.

This dissertation analyzes the impact of blockchain on crowdfunding. Specifically, the importance of blockchain is investigated from different angles, such as from investors, crowdfunding platforms, and crowdfunding campaigns. The proposed evaluation methodology suggests multi-criteria evaluation from different criteria sets where the best factors are selected and compared.

Relevance of the Dissertation

Crowdfunding is a nascent and evolving phenomenon that has garnered significant public interest. Crowdfunding platforms have become especially prevalent for publishing campaign ideas and collecting backing. Blockchain technology can help crowdfunding reduce risks, remove financial intermediaries, ease required international legislation, and increase the value of investing in crowdfunding campaigns. It is important to suggest a complex assessment model that shows the impact of blockchain on crowdfunding.

Moreover, this dissertation is critical to academic literature as it proposed a new modification to the multi-criteria weighting methodology that simultaneously allows evaluating and comparing criteria from different criteria group sets. This evaluation allows for the selection of the most appropriate and best factors from all possible criteria sets.

Research Object

The object of the present research is blockchain's impact on crowdfunding.

Aim of the Dissertation

The dissertation aims to develop and empirically test an integrated model for assessing the impact of blockchain on crowdfunding, the application of which would allow rational investment decisions.

Tasks of the Dissertation

To achieve the goal of the dissertation, the following tasks should be solved:

1. To prepare a scientific literature analysis regarding the concept of financial technologies and the evolution and characteristics of crowdfunding and blockchain technology.
2. To investigate the existing possible success factors of the valuation of crowdfunding platforms and crowdfunding campaigns, as well as to analyze the risks of crowdfunding as a form of investment.
3. To develop a model for assessing the blockchain's impact on crowdfunding that involves quantitative and qualitative methods.
4. To propose the new modification of the criteria weighting methodology to the existing criteria weighting method.
5. To implement and test the practical suitability of the evaluation model and empirical research methodology.

Research Methodology

The following *research methods* are chosen to analyze the *object*: complex, multi-criteria decision-making evaluations, comparative analysis, quantitative and qualitative analysis methods, statistical data analysis, modeling, and others.

The empirical part of the dissertation is designed to create and verify a model for evaluating, using a combination of quantitative and qualitative methods for forecasting (ARIMA) and multi-criteria decision-making methods (VASMA, VASMA-L) that involve both subjective and objective weighting parts of criteria and expert evaluation to approbate the results.

Scientific Novelty of the Dissertation

While developing this doctoral dissertation, the following significant results for the science of economics were accomplished:

1. Success factor categories for criteria weighting methods were taken from crowdfunding, Venture Capital and Business Angels, and E-commerce theories. Additionally, the comparison of E-commerce and crowdfunding is crucial and unique. It adds several risk categories as possible success factors that were not considered before in academic literature for crowdfunding.
2. The new proposed model to assess the blockchain's impact on crowdfunding is oriented to the goals of investors, crowdfunding platforms, and crowdfunding campaign owners. The model employs modeling tools like ARIMA to forecast crowdfunding revenue. Using VASMA and

VASMA-L criteria weighting methods helps systematically assess the influence of blockchain on crowdfunding by selecting the most relevant success factors.

3. The proposed modification of the existing VASMA criteria weighting methodology is unique and a novelty to scientific and academic literature as it was created specifically for this research. This modified VASMA-L criteria weighting method can be applied to large multiple criteria sets by separating them into smaller subsets and later comparing results to get the most significant factors of the entire criteria set.

Practical Value of the Research Findings

The proposed model for assessing blockchain's impact on crowdfunding suggests success factor criteria weighting for investors, crowdfunding platforms, and crowdfunding campaign owners. The findings of this research indicate that blockchain technology does not influence individual investment decisions regarding blockchain-based or financial crowdfunding campaigns.

Alternatively, this research demonstrates that blockchain technology impacts crowdfunding platforms in several ways. First, blockchain technologies provide a different base for crowdfunding platforms. Second, blockchain applications can help develop crowdfunding and improve the trustworthiness and transparency of crowdfunding platforms. Third, blockchain can help crowdfunding platforms reduce or even eliminate intermediary costs and help expand campaign availability worldwide with simplified legal contracts and regulations.

Defended Statements

The following statements are derived from the findings of the current investigation:

1. Assessing the blockchain's impact on crowdfunding from the perspectives of investors and crowdfunding platforms and based on a complex combination of factors gives a more inclusive understanding of each part's contribution to crowdfunding success.
2. The proposed model for assessing the blockchain's impact on crowdfunding involves modeling tools, such as ARIMA (to forecast crowdfunding revenues), VASMA, and VASMA-L criteria weighting methods (to select the most suitable success factors), which allows for systematic evaluation of the blockchain's impact on crowdfunding.

3. The proposed unique modified VASMA-L criteria weighting method might be applied to large multiple criteria sets to find and select the most significant factors of the entire criteria group.

Approval of the Research Findings

The topic of this dissertation was addressed in four scientific publications in *Scopus* and *Clarivate Analytics Web of Science* databases (Venslaviene & Stankeviciene, 2021; Venslaviene et al., 2021; Venslaviene et al., 2023a; Venslaviene et al., 2023b). The results of the research were presented at three presentations at scientific conferences and seminars:

- International scientific conference "Contemporary issues in business, management and economics engineering 2021", Vilnius, Lithuania.
- International Colloquium "New Scientific–Didactic Challenges in Time of Turbulence", 2021, Bialystok, Poland.
- International Conference on Applied Business and Economics 2022, 18th Edition: A Hybrid Conference, University of Malta, 2022, Valletta, Malta.

Structure of the Dissertation

The dissertation is structured around three main chapters: an introduction, three chapters with general conclusions with recommendations for further research, an extensive references list, and annexes. The summarized logic structure of the dissertation is shown in Annex A.

The dissertation is 125 pages long, including the summary, but without annexes. It contains 13 formulas, 12 figures, and 36 tables. In total, 198 literature references were used when preparing the dissertation.

1

Theoretical Assumptions of the Blockchain's Impact on Crowdfunding

This chapter provides an overview of financial technologies, also known as FinTech, and their development and significance in the current economic system. Moreover, the evolution of crowdfunding and blockchain will be discussed as they are essential to the financial technology sector. The literature review should examine the definition, factors of crowdfunding growth, and the forms of crowdfunding. Moreover, price structure, the importance of crowdfunding platforms' social networks, and the success of funded campaigns should be discovered. Finally, investors' investment risks and values should be defined, and the main success factors of investing in crowdfunding campaigns should be identified.

The second part of this chapter reviews the definition and characteristics of blockchain technology. Furthermore, this part discusses blockchain-based crowdfunding and its important success factors for investors and crowdfunding platforms.

The chapter ends with the proposed theoretical framework for assessing the blockchain's impact on crowdfunding. Essentially, the framework suggests eval-

uating the blockchain's impact from the perspectives of investors and crowdfunding platforms. Three scientific publications were published on the topic of this chapter (Venslaviene & Stankeviciene, 2021).

1.1. Concept of Financial Technologies and Evolution of Crowdfunding

The current financial system heavily depends on numerous centralized and trusted intermediaries. Central securities depositories (CSDs) handle securities settlements, central counterparties (CCPs) ensure trades on exchanges, CLS Bank facilitates foreign exchange transactions, the Society for Worldwide Interbank Financial Telecommunication (SWIFT) facilitates global money transfers, several banks have significant control over correspondent banking, and a minimal number of banks offer custody services to large investment institutions (Kumar et al., 2024; Varma, 2019). A decade ago, it was often believed that the solid financial position and effective management of these central hubs made it exceedingly improbable for them to experience failure. Furthermore, there was a prevailing assumption that these entities were deemed too large to experience failure and that the government could intervene and provide financial assistance in the event of their failure.

The Global Financial Crisis in 2008 and the Eurozone Crisis from 2010 to 2012 shattered these assumptions as numerous significant banks in the world's most developed economies collapsed or required government assistance, and wealthy nations could not meet their financial obligations. This provoked fear that these massive financial institutions could not be trusted anymore (Pandey et al., 2024). Another factor that has ruined trust is large financial institutions' repeated hacking attacks. When trust in centralized financial hubs is exceptionally questioned, decentralized systems like blockchain technology become very attractive (Baliker et al., 2024).

FinTech, or the financial technology sector, is technology-driven innovation in financial services that leads to the creation of new business models, applications, products, or processes that have a substantial influence on financial institutions and markets and the financial services establishment (Jalal et al., 2024; Ministry of Finance of the Republic of Lithuania, 2023). According to Recommendations on the 2023–2028 guidelines for the development of the FinTech sector in Lithuania (Ministry of Finance of the Republic of Lithuania, 2023), 263 FinTech companies operated in Lithuania at the end of 2022. This number is more than three times higher compared to the year 2016, with 82 FinTech companies. Around 34 percent of FinTech companies in Lithuania are electronic money and payment institutions. Crowdfunding and blockchain are the

primary applications of FinTech, representing two breakthroughs that have the potential to disrupt traditional financial intermediation, albeit distinctly (Cai, 2018; Wan et al., 2023). Crowdfunding can be seen as an existing FinTech application that can cut out financial intermediaries. Intermediation is a crucial element of the financial sector. Recently, regulation reforms and new technologies have changed the financial industry. Today, more and more individuals seek to avoid traditional financial markets to get fewer restrictions, lower costs, and more efficiency. Led by new regulatory initiatives and technological expansions, customers in many financial service sectors have changed their attitudes toward those with the legitimacy and resources to provide financial services, challenging the role of financial intermediaries in favor of FinTech inventions. (Cai, 2018; Jalal et al., 2024).

Thus, crowdfunding platforms are observed as less regulated new intermediaries but do not eliminate the need for them. Crowdfunding offers several key benefits, including fewer regulatory obligations and lower transaction expenses than traditional banking institutions (Wan et al., 2023). Crowdfunding platforms serve as a modern mediator, supplanting conventional financial intermediaries. On the other hand, Blockchain disrupts the old model where a trusted and centralized third party is required to determine the validity of a transaction (Cai, 2018). Blockchain might challenge banks by presenting trust in a decentralized way. Blockchain has the potential to remove the need for intermediation in some sectors, bringing new forms of intermediation while reducing the layers of traditional intermediation (Wan et al., 2023).

Crowdfunding is part of the broader world of financial innovation enabled by technological advances, also known as FinTech (European Commission, 2016; Kumar et al., 2024; Wati & Winarno, 2018). Since crowdfunding is a very new phenomenon, several definitions describe it. Table 1.1 summarizes crowdfunding definitions.

Table 1.1. Crowdfunding definition (source: created by the author)

Author	Year	Definition
Gierczak et al., 2014	2014	"An innovative form of financing that links those who can invest money with others who require funding for a particular project."
Thies et al., 2014	2014	
Mora-Cruz & Palos-Sanchez, 2023	2023	
Bento et al., 2019	2019	"An Internet-based way for a company or other organization to raise money, either in the form of a donation or an investment, from a large number of individuals."
Hussain et al., 2023	2023	
The World Bank, 2013	2013	

End of Table 1.1

Author	Year	Definition
Schwienbacher & Larralde, 2010	2010	"Pooling money from a group of persons rather than professional parties is the basic principle of crowdfunding."
Zvilichovsky et al., 2015	2015	
Agrawal et al., 2013	2013	"The practice of entrepreneurial individuals and groups raising funds for their ventures by collecting relatively modest amounts of money from a large number of people using the Internet, bypassing the need for traditional financial middlemen."
Mollick, 2013	2013	

The idea of crowdfunding is not new, but the way it is enabled by technology is new. One of the core features of crowdfunding is its effort to interrupt typical financial intermediation. Explanations of crowdfunding might change, but they usually contain the following core components: (i) increasing funds in small amounts, (ii) from many to many, and (iii) using digital technology (Hussain et al., 2023; Jenik et al., 2017; Mora-Cruz & Palos-Sanchez, 2023).

The crowdfunding industry experienced a significant surge in the wake of the global financial crisis in 2008. This crisis eroded trust in the financial system, specifically the banking sector. Subsequently, crowdfunding experienced a significant increase in popularity on a global scale. Technological, macroeconomic, regulatory, social, and cultural factors are driving the rapid growth of crowdfunding (Table 1.2).

Table 1.2. Factors of Crowdfunding growth (source: adapted from Jenik et al., 2017; the World Bank, 2013)

Technological factors	The reduced cost of operation, brought about by improved Internet access through smartphones and other devices, user-generated web content, the proliferation of online applications, the growing popularity of social networks, the utilization of big data analytics, and the emergence of the FinTech revolution, has made crowdfunding a feasible option.
Macroeconomic environment	Due to the financial crisis and the credit crunch, major financial intermediaries have restricted access to credit, particularly for smaller loans. This created a new demand for capital fundraisers.
Regulatory factors	Crowdfunding platforms have benefited from post-crisis regulatory alterations. The strict regulatory requirements increased banking costs. Due to the nascent nature of crowdfunding law globally, numerous nations currently need more stringent regulations regarding

End of Table 1.2

	crowdfunding. This method confers an advantage to the crowdfunding business over its competitors, particularly financial service providers.
Social factors	Individuals must actively participate in online social networks, which is the most critical driver of crowdfunding activity. To support entrepreneurs and build trust, communities should influence start-up events and community-backed finance.
Cultural factors	The private sector should be involved in creating channels for worthwhile business ventures that can be potential investment opportunities. The private sector may significantly contribute to fostering an entrepreneurial culture by offering tangible facilities, guidance from experienced individuals, opportunities for collaborative learning, and structured experimentation to determine the viability of products in the market. Additionally, they can provide resources such as crowdfunding, company incubation, and other support services.

Crowdfunding can revolutionize capital distribution by shifting it away from traditional channels, such as foundations, funds, and banks, and toward a more personalized and direct investment framework. However, it remains uncertain whether crowdfunding is a more effective technique for supplying cash to local firms. Governments should provide policy and strategic advice to promote the development of the crowdfunding ecosystem. These recommendations should address the economic, social, technological, and cultural difficulties that the ecosystem faces.

1.1.1. Main Forms of Crowdfunding

Crowdfunding can revolutionize retail financial services by leveraging technology. Enhanced connectivity via mobile phones and other devices, legal and regulatory frameworks, and dynamic economic conditions enable new and inventive firms to rival established market players (Gera & Kaur, 2018; Hussain et al., 2023; Mora-Cruz & Palos-Sanchez, 2023; Polishchuk et al., 2019). This competition may allow entrepreneurship and economic growth, particularly in countries with less advanced financial systems.

Formally, a crowdfunding platform features five qualities (Dushnitsky & Fitza, 2018; Mora-Cruz & Palos-Sanchez, 2023; Siering et al., 2016): (a) it is a digital platform, (b) gathering funds from multiple individuals, where (c) each individual typically backs a small portion of the requested amount, (d) based on a set of goals and objectives, and (e) their evaluation of the principal project.

There are five primary forms of crowdfunding platforms. These forms are described in the literature (Behl et al., 2023; Belleflamme et al., 2015; Borello

et al., 2015; Gebert, 2017; Griffin, 2013; Hussain et al., 2023; Kim & Viswanathan, 2019; Kirby & Worner, 2014; Mora-Cruz & Palos-Sanchez, 2023):

1) Donation-based, e.g., without any reward besides goodwill;
2) Reward-based, which is with non-financial rewards, such as products;
3) Lending-based or debt, e.g., with financial returns, such as interest;
4) Equity-based, with financial returns, such as equity or dividends;
5) Royalty-based, where a fraction of revenues or profits is offered.

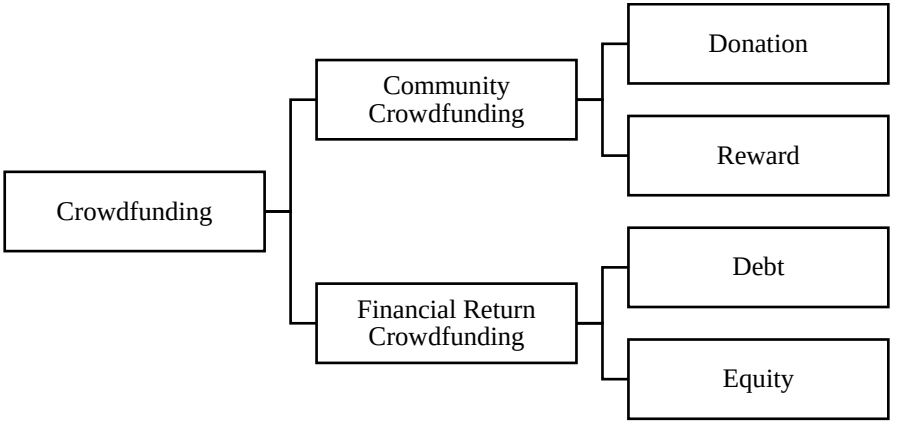

Fig. 1.1. Crowdfunding forms (source: created by the author)

These groups are based on what funders expect to get for their money (and what motivates them to invest first). Donation – and reward-based forms of crowdfunding – are for charitable causes. These two forms of crowdfunding may be called "community crowdfunding" (Fig. 1.1). The key features of Community crowdfunding are that it does not provide any financial return and is not typically regulated. These two forms have been essential to the whole development and emergence of the industry. In certain instances, they may also serve as a gateway for financiers or fundraisers to engage in more intricate variations of crowdfunding, which are often not seen as financial activities and hold little significance (Jenik et al., 2017; Kumar et al., 2024). On the contrary, debt and equity-based crowdfunding can be stated together as "financial return crowdfunding". Due to technological improvements, financial return crowdfunding is solely an Internet-based market. It is also accessible to many potential investors and borrowers, as many investors can invest small amounts of an overall funding request (Behl et al., 2023; Kirby & Worner, 2014). All forms of crowdfunding are explained separately in Annex B, giving the most importance to equity crowdfunding as it is the most complex legally (Behl et al., 2023).

Initially, most crowdfunding platforms were donation-based, followed by lending-based and reward-based platforms. Since that time, the amount of reward-based crowdfunding platforms has grown powerfully. In 2022, it financed projects for the value of EUR 161 million via crowdfunding platforms. Compared with the 2021 year, the funded sum increased by EUR 46.3 million (Ministry of Finance of the Republic of Lithuania, 2023). The sharp growth in the amount of funding, the number of transactions, and the number of investors requires paying more attention to the maintenance of crowdfunding platforms. In November 2021, the European Union's crowdfunding regulation entered into force, according to which platforms with new licenses can provide services throughout the European Union (Valiante, 2022). This is expected to accelerate the growth of the sector.

Crowdfunding campaigns serve as a valuable means of market research, offering insights into the project and forecasting the prospective demand for a particular product or service. Crowdfunding has been shown to "democratize" finance by mitigating geographical and gender prejudices commonly associated with conventional venture capital fundraising (Agrawal et al., 2011; Valiante, 2022; Zhu et al., 2023).

1.1.2. Investment Risks and Values of Crowdfunding

Perceived value can be defined as a consumer's overall assessment of the utility of a product (or service) based on perceptions of what is received and what is given (Zeithaml, 1988). Consumer choice is a function of multiple consumption values (Harms, 2007).

Furthermore, the perceived risks from the perspective of the funding object, project initiator, and intermediary (Appio et al., 2023; Chen et al., 2023; D'Arcangelo et al., 2023; Senney & Lhost, 2023; Shrestha et al., 2023) were discussed. Also, these risks were compared between e-commerce and crowdfunding. In addition, ten motivational values were discovered and categorized into five value dimensions: functional, financial, epistemic, social, and emotional.

Annex C summarizes all the value dimensions and risks from the perspective of the funding object, project initiator, and intermediary.

1.1.3. Financing Crowdfunding Campaigns and Success Factors

The crowdfunding ecosystem might be very complex and different in each model. A crowdfunding ecosystem relies on a platform, which is a technology-driven solution that connects those seeking funds with those willing to provide them. The demand side comprises individuals and diverse organizations seeking financial

support. Depending on the particular model, they can function as borrowers, issuers, or beneficiaries. The supply side includes lenders, backers, contributors, and investors (Jenik et al., 2017; Kumar et al., 2024). The crowdfunding ecosystem contains three main groups: the crowdfunding platform, campaign owners looking for funds, and investors who invest.

Crowdfunding has become a new and popular financing channel worldwide (Huang et al., 2023; Vroomen & Desa, 2018). Yet, crowdfunding campaign success rates still need to be below 50% on most platforms (Lukkarinen et al., 2016; Zhao et al., 2017). Hence, it is vital for project supporters not only to strive to attract a more significant number of visitors but also to comprehend their financial motivations. This is especially important to increase the success of crowdfunding as an alternative funding tool (Gierczak et al., 2014). To gain a deeper comprehension of the mechanics of crowdfunding and enhance the likelihood of successful campaigns, it is imperative to comprehend the elements that contribute to the achievement of crowdfunding (Fan-Osuala et al., 2018). It is essential to understand what motivates people to create or fund these projects as the number of crowdfunded projects increases (Gerber & Hui, 2013). The success of crowdfunding campaigns is influenced by various factors, including social capital theory (Butticè et al., 2017; Colombo et al., 2015; Skirnevskiy et al., 2017), signal theory (Ahlers et al., 2015; Courtney et al., 2017), the herding effect (Mohammadi & Shafi, 2018), and local bias (Mendes-Da-Silva et al., 2016).

Nevertheless, there needs to be more knowledge regarding the evaluation of crowdfunding aims. Furthermore, there is a scarcity of studies examining the aspects that contribute to the success of crowdfunding campaigns and the criteria that investors use when investing in crowdfunding. Agrawal et al. (2013) and Kuppuswamy and Bayus (2013) analyzed revenue allocation data from a crowdfunding site situated in the Netherlands. Furthermore, Ahlers et al. (2015) conducted research using an Australian equity crowdfunding platform to evaluate the influence of several start-up attributes on the success of crowdfunding campaigns. Cholakova and Clarysse (2015) examined the factors influencing individuals' investing choices in equity crowdfunding. In addition, the research by Kim and Viswanathan (2019) investigated the impact of early investors on the overall success of crowdfunding campaigns. The experiment by Bern-stein et al. (2017) examined the significance of obtaining various forms of information for accredited early-stage investors.

Lukkarinen et al. (2016) filled the gap of the limited amount and scope of research to explain the variation in the success of equity crowdfunding campaigns. They utilized research from the two financing methods most similar to equity crowdfunding in the funding cycle. With non-equity-based crowdfunding, they combined both business angels and venture capitalists. As they all reflect the funding needs of growing businesses, venture capital, angel investing, and equity crowdfunding are

often assessed and compared together (de Buysere et al., 2012; Hornuf & Schwienbacher, 2016; Wilson & Testoni, 2014). Kgoroeadira et al. (2023) and Lukkarinen et al. (2016) postulated that the conventional investment criteria employed by venture capitalists and angel investors could serve as indicators for forecasting the efficacy of equity crowdfunding campaigns. Additionally, they selected different company and campaign features to predict the crowdfunding campaign's success. Ultimately, Dushnitsky and Fitza (2018), Huang et al. (2023), and Salomon (2016) deliberated on the overall operation of crowdfunding as a means of financing and contrasted the decision-making procedure of equity crowdfunding with that of conventional venture capital financing (Hagedorn & Pinkwart, 2016; Löher, 2017; Salomon, 2016). Similarly to the mentioned literature, this research will combine criteria from traditional funding, business angels, and venture capital with criteria from crowdfunding theory. In addition, reward-based crowdfunding is a form of pre-selling (Ahlers et al., 2015) and, therefore, can be compared to e-commerce transactions, such as the buying process on marketplaces. This similarity allowed the application of theoretical insights on risk from the e-commerce literature. As a result, a risk criteria group is added to this research.

To identify potential success criteria for equity crowdfunding campaigns, a comprehensive search was conducted to gather information from many sources, including studies on different types of crowdfunding, venture capital, business angels' theory, and e-commerce literature. In addition, the group of risks identified in e-commerce literature was included as a crucial concern for investors. To the best of the author's knowledge, it could not be found in the literature that risk might affect the decision to invest in crowdfunding campaigns. Still, it looks critically vital for crowdfunding campaigns, as there is a lot of ambiguity. After analyzing the literature on e-commerce and crowdfunding, three risk categories were identified: project-related risk, initiator-related risk, and intermediary-related risk. The complete compilation of 24 success factors documented in the literature may be found in Table 1.3.

Table 1.3. Success factors for crowdfunding campaigns found in the literature (source: created by the author)

Success factor category		Success factor	Description	Author
Crowd-funding theory	Campaign character-istics	Campaign duration	duration of the project cam-paign	Lukkarinen et al., 2016; Drabløs, 2015; Burtch et al., 2013; Frydrych et al., 2014; Mollick, 2014; Ferreira & Pereira, 2018; Kuppuswamy and Bayus, 2013; Cumming et al., 2020

Continued Table 1.3

Success factor category		Success factor	Description	Author
Crowd-funding theory	Campaign characteristics	Funding target	minimum sum needed to launch the project	Lukkarinen et al., 2016; Block et al., 2017; Drabløs, 2015; Frydrych et al., 2014; Ferreira & Pereira, 2018; Kuppuswamy and Bayus, 2013; Cumming et al., 2020; Ahlers et al., 2015; Hakenes and Schlegel, 2014; Mollick, 2013; Belleflamme, 2014
		Min. Investment	minimum amount to invest to participate in the project campaign	Lukkarinen et al., 2016; Kuppuswamy and Bayus, 2013; Cumming et al., 2020; Ahlers et al., 2015; Ordanini et al., 2011
		Provision of financials	financial forecasts/projections, early financial statements	Lukkarinen et al., 2016; Block et al., 2017
		Number of early backers	number of investors who invest before the campaign is launched	Lukkarinen et al., 2016; Block et al., 2017; Drabløs, 2015; Colombo et al., 2015; Kuppuswamy and Bayus, 2013; Cumming et al., 2020
		Capital raised	total capital raised for one project	Lukkarinen et al., 2016; Drabløs, 2015; Frydrych et al., 2014; Colombo et al., 2015; Kuppuswamy and Bayus, 2013; Cumming et al., 2020
		Number of investors	actual number of investors investing in the same project	Lukkarinen et al., 2016; Block et al., 2017; Kuppuswamy and Bayus, 2013; Cumming et al., 2020
	Networks	Social media networks	the followers' social network of the project owner	Lukkarinen et al., 2016; Block et al., 2017; Drabløs, 2015; Colombo et al., 2015; Ahlers et al., 2013; Mollick,

Continued Table 1.3

Success factor category		Success factor	Description	Author
Crowdfunding theory	Networks	Private networks	family and friends who support the project	2014; Ferreira & Pereira, 2018
	Understandability	Understandability	is it oriented to business (B2B) or customer (B2C)	Lukkarinen et al., 2016; Drabløs, 2015; Ahlers et al., 2013
		Information about risk	if the crowdfunding campaign is giving information about the risk	
		Environment commitments	if the crowdfunding campaign is committed to the environment	
	Quality signals	Updates	how often updates are sent to audience	Block et al., 2017; Drabløs, 2015; Frydrych et al., 2014; Mollick, 2014; Ferreira & Pereira, 2018
		Spelling mistakes	are there any spelling errors in the campaign text	
		Video	is there a descriptive video about the campaign/product industry expertise	

Continued Table 1.3

Success factor category		Success factor	Description	Author
Venture Capital and Business Angels	Company ratings	Team rating	educational background	Lukkarinen et al., 2016; Block et al., 2017; Drabløs, 2015; Frydrych et al., 2014; Macmillan et al., 1985; Sudek, 2007; Streletzki and Schulte, 2013; Prowse, 1998; Anthony, 2011; EBAN, 2014
			Experience	
			the balance between team members' skill sets	
			perceived motivation, drive, passion, commitment, honesty	
		Markets rating	attainable market that determines the company's growth potential.	Lukkarinen et al., 2016; Drabløs, 2015; Burtch et al., 2013; Macmillan et al., 1985; Sudek, 2007; Streletzki and Schulte, 2013; Prowse, 1998; Anthony, 2011; EBAN, 2014; Zhu et al., 2023; Huang et al., 2023
		Concept rating	how well the product fits the target market	Lukkarinen et al., 2016; Block et al., 2017; Macmillan et al., 1985; Sudek, 2007; Streletzki and Schulte, 2013; Prowse, 1998; Anthony, 2011; EBAN, 2014; Zhu et al., 2023; Huang et al., 2023
			relevance of the end customer's problem	
			how well the company addresses the problem compared to other alternatives	
			value of the solution to the customer	

Continued Table 1.3

Success factor category		Success factor	Description	Author
Venture Capital and Business Angels	Company ratings	Scalability rating	it is easy to scale up the solution to the entire target market.	Lukkarinen et al., 2016; Sudek, 2007; Prowse, 1998; Anthony, 2011; EBAN, 2014; Zhu et al., 2023; Huang et al., 2023
		Terms rating	valuation	Lukkarinen et al., 2016; Sudek, 2007; Prowse, 1998; Anthony, 2011; EBAN, 2014
			whether the targeted funding amount is sufficient to lift the company to the next level	
		Stage rating	progress of the company on its development path	Lukkarinen et al., 2016; Sudek, 2007; Prowse, 1998; Anthony, 2011; EBAN, 2014; Huang et al., 2023
			remaining gap to the target state	
			status of the product	
			status of market validation	
			existence of paying customers	
E-commerce theory	Risk	Risks associated with the project	product risk/funding object risk	Cunningham et al. (2005); Stone and Grønhaug (2006); Zhang et al. (2012); Gierczak et al. (2014); Hong and Cha (2013); Shrestha et al., 2023; F. Chen et al., 2023; Senney & Lhost, 2023; Appio et al., 2023; D'Arcangelo et al., 2023; Zhu et al., 2023
			Social risk	
			psychological risk	
			post-funding risk/ repayment risk	

End of Table 1.3

Success factor category		Success factor	Description	Author
E-commerce theory	Risk	Risks associated with the project initiator	project initiator risk/owner risk/seller risk	Verhagen et al. (2006); Gierczak et al. (2014); Bente et al. (2012); Al Kailani and Kumar (2011); Shrestha et al., 2023; F. Chen et al., 2023; Senney & Lhost, 2023
			time risk/convenience risk	
			delivery risk	
		Risks associated with the intermediary	intermediary risk/privacy risk	Verhagen et al. (2006); Gierczak et al. (2014); Featherman and Pavlou (2003); Forsythe et al. (2006); Diallo (2012); Delis et al., (2014); Lepetit et al., (2008); Panjer (2002); Oxera (2015); Wati and Winarno (2018); Shrestha et al., 2023; Appio et al., 2023
			financial risk	
			performance risk/operating risk	

Table 1.3 summarizes the success factors for crowdfunding campaigns found in the literature. The success factors are collected from crowdfunding theory and venture capitalists' and business angels' theories. Moreover, risk factors from e-commerce theory were added.

1.2. Definition and Characteristics of Blockchain

Blockchain is the spine and the leading technology behind bitcoins and the cryptographic system (Sahani et al., 2020). Satoshi Nakamoto developed it in 2008. It is believed that Satoshi Nakamoto was a Japanese man born in 1974. Others think that this name is just a mysterious pseudonym for an unknown group of developers (Faustino et al., 2022). While it remains a secret, of who Satoshi Nakamoto is, he not only invented such a complex system but also provided a remedy to all the problems in the current monetary system (Sahani et al., 2020). As an evolving technology, blockchain plays a promising part in today's software-defined networking (SDN)-)-enabled Internet of Things (IoT) applications (Rahman et al., 2023). Several definitions of blockchain are given in Table 1.4.

Table 1.4. Blockchain definition (source: created by the author)

Author	Year	Definition
Varma, 2019	2019	The blockchain is a distributed, duplicated, tamper-proof (immutable), sequential record of transactions.
Raddatz et al., 2023	2023	The blockchain is a secure and decentralized database that prioritizes data privacy protection and ensures the accuracy and reliability of transactions.
Singh et al., 2023	2023	Blockchain is a decentralized information technology network that tracks digital asset transactions using distributed ledgers. These ledgers are maintained by intermediaries such as banks, credit agencies, accountants, and governments.
Cai, 2018; Raddatz et al., 2023; Zheng et al., 2023	2018, 2023	The blockchain enables users to authenticate and monitor their Bitcoin transactions, while the data recorded within each block serves as the foundation of trust.
Gurnani et al., 2023	2023	Blockchain technology is a sophisticated system with a robust database that enables clear and widespread information sharing inside a business model or network. The data is kept in interconnected blocks, forming chains.
Ghosh et al., 2023	2023	Blockchain is a network that operates without a central authority. Its database is distributed among multiple participants, and transactions are recorded in a digital ledger. The blockchain may establish connections between several computers through nodes and does not necessitate transactions to construct a new block, facilitating the secure transmission of information between individuals.
Guggenberger et al., 2023	2023	Blockchain is a decentralized network that uses a distributed ledger to record and secure transactions.

Blockchain enables all stakeholders to possess their version of the ledger, resulting in a decentralized and duplicated system that ensures the integrity of the official record. The trust element, crucial to blockchain, is the primary factor that enables blockchain technology to potentially eliminate the necessity for financial intermediaries in some industries (Raddatz et al., 2023). Blockchain encompasses

several key elements, including the use of distributed ledgers, decentralized data management, robust data security, transparency and integrity, protection against tampering and forgery, high operational efficiency, cheap costs, and the absence of risks associated with centralized database failures (Singh et al., 2023). Additionally, the programmable nature of blockchain increases reliability and flexibility in different application scenarios. (Raddatz et al., 2023; Rahman et al., 2023; Zheng et al., 2023; Zhu & Zhou, 2016).

Blockchain-based decentralized applications (DApp) are gaining more attention as blockchain technologies are increasingly developed and widely applied. (Rikken et al., 2023; Zheng et al., 2023). Many funds are invested in crowdfunding numerous types of blockchain-based decentralized applications. As reported in August 2022, more than 5,000 decentralized applications have more than 1.67 million daily Unique Active Wallets (users) (Rikken et al., 2023; Zheng et al., 2023). In addition, a research report from the World Economic Forum suggests that 10% of the world's gross domestic product will be stored on blockchain by 2027 (Singh et al., 2023).

Blockchain technology proposes a solution to most crowdfunding problems, so its practice is growing with relative confidence among investors and passive approval from governments (De Filippi, 2016; Rikken et al., 2023). Blockchain technology offers a high level of security, instilling trust in the information contained within the blocks regarding entrepreneurs. Consequently, individuals can make informed investment decisions by considering project descriptions, progress, funder response, and completion timelines. The security of the blockchain is ensured by its time-stamped nature, connection to the preceding block, and immutable configuration, which prevents retroactive alteration of block data (Gebert, 2017; Singh et al., 2023). Blockchain's efficiency lies in its unparalleled ability to connect investors and fundraisers without the need for paperwork or additional accreditation from a certifying body. Blockchain offers a solid basis for smart contracts, which are contracts integrated into computer code instead of using legal language (Gurnani et al., 2023). Smart contracts streamline the process of negotiating and enforcing contracts, resulting in lower transaction costs and enabling economically feasible low-value transactions.

Blockchain technology facilitates crowdfunding in several ways as a secure, efficient, and affordable platform. First, the system eliminates the threats of money laundering, fraud, and information asymmetry (Behl et al., 2023; Polishchuk et al., 2019; Siering et al., 2016). This also increases the efficiency of the crowdfunding process, as investors can more quickly assess the projects they are interested in funding. The transaction and fund simplicity through blockchain technology is an encouragement for backers and crowdfunding platforms (Wan et al., 2023). Thus, investors can obtain rewards from funded projects. This fea-

ture of the blockchain eliminates several challenges that would hinder crowdfunding. In addition, the technology avoids the duplication of spending that can occur when similar orders arrive at the same time and multiple funders sign up at the same time (Gebert, 2017; Wan et al., 2023; Zhu & Zhou, 2016). Furthermore, blockchain technology decreases operating expenses that may accrue on conventional platforms, such as service costs. Investors can use blockchain technology to securely direct funds toward the appropriate project. These kinds of transactions are called peer-to-peer transactions, where transfers occur through the electronic network, with the blockchain serving as a middleman. The primary benefit of this transmission technique is enhanced security. The peer-to-peer functionality of blockchain technology is highly beneficial for crowdfunding, as it allows for bypassing regulatory procedures imposed by financial management authorities while ensuring the uninterrupted flow of funds.

1.3. Blockchain-based Crowdfunding and Success Factors

Blockchain-based crowdfunding campaign models closely resemble traditional crowdfunding. Nevertheless, the legislative framework for this innovation is still inadequate in most nations and lacks worldwide standardization (Hartmann et al., 2019; Wan et al., 2023; Xu et al., 2023). This can be explained by at least three different types of tokens that reflect their features: payment type, utility type, and investment type (Hacker & Thomale, 2018; Zkik et al., 2023). Most of the time, those tokens are reflected in hybrid form in cryptoassets. Utility tokens are essential to a protocol, platform, or network because someone must hold them to participate in or access the products offered by the protocol, platform, or network. Hence, utility token offerings can be seen as a reward-based crowdfunding model. On the contrary, security and currency tokens are in the context of blockchain-based crowdfunding, and they can be related to financial crowdfunding models, e.g., equity crowdfunding (Guggenberger et al., 2023; Zkik et al., 2023) – payment tokens, just as Bitcoin, closely resemble fiat money in terms of their practicality and functionality. Although bitcoin is widely used, its exchange is impractical due to the exorbitant transaction fees. Because of this, bitcoin is more often represented as an asset. Instead, security tokens can represent a wide range of financial instruments. Furthermore, security tokens can be categorized into two primary groups: fully on-chain security tokens and a hybrid version that combines off-chain and on-chain characteristics. Fully on-chain security tokens are digital tokens that exclusively exist in a distributed ledger. Due to their lack of well-defined borders with the real world, regulating them is highly challenging (Zkik

et al., 2023). Without these restrictions in many countries, certain start-up companies in the blockchain industry strive to establish hybrid security token issuance models that connect on-chain tokens to off-chain contracts (Xu et al., 2023).

1.3.1. Blockchain-based Crowdfunding Success Factors

To analyze the key characteristics contributing to the success of blockchain-based crowdfunding, a comprehensive assessment of relevant literature on financial crowdsourcing and blockchain-based crowdfunding was conducted, employing a snowball sampling method. Upon comparing two forms of crowdsourcing and their determinants of success, it was seen that not all criteria were examined in both groups, and specific characteristics appeared to be unique and significant to only one crowdfunding group. Both financial and blockchain-based crowdfunding recognized six critical success factors: the industry, team size, location, early funding, social network presence, and the share of retained ownership or tokens (Zkik et al., 2023). The industry affects the success of financial crowdfunding, as campaigns may attract attention from investors depending on the industry. This aligns with other research where games, technology, and design were the most frequently selected by investors (Venslavienė & Stankevičienė, 2021). In contrast, blockchain-based crowdfunding ICO valuations do not differ across industries (Fisch, 2019). The location factor influences both crowdfunding groups, as campaigns with better locations may interest early investors quickly, and those investors have wider social networks (Zkik et al., 2023). In addition, several studies have shown the importance of location in a favorable regulatory environment for blockchain-based crowdfunding (Adhami et al., 2018; Fenu et al., 2018). However, the location of the business does not affect the ICO rating according to (Fisch, 2019). Although team size appears to be significant for financial crowdfunding, there is little or no evidence that team size is positively correlated with ICO success (Amsden & Schweizer, 2018; Cerchiello et al., 2019; Fenu et al., 2018; Fisch, 2019). Moreover, some studies related to social networks impact the success of both equity crowdfunding and blockchain-based crowdfunding (Cerchiello et al., 2019; Colombo et al., 2015; Mollick, 2013; Vismara, 2016; Zheng et al., 2017). Early investments, which is the fifth component contributing to success, have been extensively examined in research and have been found to have a positive relationship with success in both traditional and blockchain-based crowdfunding (Lee et al., 2019; Lukkarinen et al., 2016; Vulkan et al., 2016). The final success factor for both crowdfunding categories is the share of retained equity or token. Some researchers add the importance of equity retention in financial crowdfunding (Ahlers et al., 2015; Ralcheva & Roosenboom, 2016; Vismara, 2016) in the blockchain-based crowdfunding campaigns, which have just started

to sell equity as security tokens. Nevertheless, almost no reliable analysis is available on this type of token offering. In contrast, it has been found that token retention can have a positive impact on ICO success (Amsden & Schweizer, 2018; Lee et al., 2019).

Finally, 15 success factors that are exceptional only to blockchain-based crowdfunding were discovered in the literature: tokens allow contributors to access a specific service (or to share profits), number of tokens issued, using Ethereum, KYC/pre-registration, ICOBonus/discounts, presale, accepting multiple currencies (digital and Fiat), loyal CEO, well-connected CEO, and presence on GitHub. The final six factors are not specifically applicable to blockchain-based crowdfunding, although they can be relevant to various crowdfunding models. The final list of 21 success factors is given in Table 1.5.

Table 1.5. Blockchain-based Crowdfunding Success Factors (Source: created by the author)

Success factor	Crowdfunding type		Author
	Financial	Blockchain-based	
Industry	X	X	Davies & Giovannetti, 2018; Fisch, 2019; Mamonov & Malaga, 2018
Location	X	X	Adhami et al., 2018; Agrawal et al., 2015; Choo et al., 2015; Fenu et al., 2018; Mamonov & Malaga, 2018; Ralcheva & Roosenboom, 2016
Team size	X	X	Ahlers et al., 2015; Amsden & Schweizer, 2018; Cerchiello et al., 2019; Fenu et al., 2018; Fisch, 2019; Frydrych et al., 2014; Mamonov & Malaga, 2018; Ralcheva & Roosenboom, 2016; Stam & Schutjens, 2005
Social network	X	X	Amsden & Schweizer, 2018; Cerchiello et al., 2019; Davies & Giovannetti, 2018; Mollick, 2013; Vismara, 2016; Zheng et al., 2017
Early investments	X	X	Agrawal et al., 2015; Colombo et al., 2015; Davies & Giovannetti, 2018; Kuppuswamy & Bayus, 2013; Lee et al., 2019; Lukkarinen et al., 2016; Polzin et al., 2018; Vulkan et al., 2016

End of Table 1.5

Success factor	Crowdfunding type		Author
	Financial	Blockchain-based	
Share of retained equity/ token	X	X	Ahlers et al., 2015; Amsden & Schweizer, 2018; Lee et al., 2019; Ralcheva & Roosenboom, 2019; Vismara, 2016
Tokens allow contributors to access a specific service (or to share profits)		X	Adhami et al., 2018
Using Ethereum		X	Amsden & Schweizer, 2018; Fenu et al., 2018; Fisch, 2019
Number of tokens issued		X	Amsden & Schweizer, 2018; Fisch, 2019
ICO Bonus/discounts		X	Adhami et al., 2018; Lee et al., 2019; Mamonov & Malaga, 2018
KYC/Pre-registration		X	Lee et al., 2019
Presale		X	Adhami et al., 2018; Amsden & Schweizer, 2018; Lee et al., 2019
Accepting multiple currencies (digital and Fiat)		X	Amsden & Schweizer, 2018; Lee et al., 2019
Well-connected CEO		X	Amsden & Schweizer, 2018
Loyal CEO		X	Kuppuswamy & Bayus, 2013
Presence on Github		X	Amsden & Schweizer, 2018; Fisch, 2019
Average analyst rating		X	Fenu et al., 2018; Lee et al., 2019
White paper availability		X	Adhami et al., 2018; Cerchiello et al., 2019
White paper content		X	Amsden & Schweizer, 2018; Cerchiello et al., 2019; Fisch, 2019
Multi-language white paper		X	Lee et al., 2019
The code source is available.		X	Adhami et al., 2018; Fisch, 2019

Table 1.5 summarizes the success factors for different types of crowdfunding. Regular (or financial) crowdfunding is compared with blockchain-based crowdfunding. All the factors found in the literature were collected and reviewed. To sum up, out of 21 success factors, only six are the same for financial and blockchain-based crowdfunding.

1.4. Framework for Assessing the Blockchain's Impact on Crowdfunding

Decisions by investors, crowdfunding platforms, and project owners should be evaluated to set the framework for assessing blockchain technology's impact on crowdfunding. The evaluation of the blockchain's impact is based on several aspects.

First, the impact of blockchain on crowdfunding should be analyzed from the investors' side. The critical factors that impact investors' decisions to invest in one or another crowdfunding campaign should be found and analyzed. This aspect is twofold: (a) general factors are discovered, and (b) factors related to blockchain-based crowdfunding should be evaluated.

Second, the impact of blockchain on crowdfunding should be analyzed from the crowdfunding platform's side. This aspect is twofold: (a) the crowdfunding platform revenues will be analyzed, and (b) the most important factors that influence the performance of the blockchain-based crowdfunding platforms. The schematic framework is shown in Fig. 1.2.

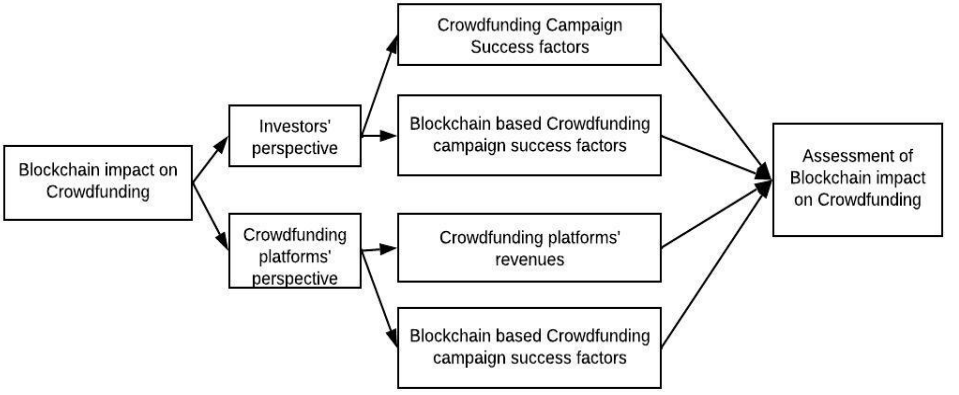

Fig. 1.2. Framework for assessing the blockchain's impact on crowdfunding (source: created by the author)

Finally, the evaluation of project owners' decisions based on blockchain-based crowdfunding platforms should be left for future research and should not appear in this research.

1.5. Conclusions of the First Chapter and Formulation of the Dissertation Objectives

1. While the first chapter mainly discussed the literature on the concept of financial technologies as well as the evolution and characteristics of crowdfunding and blockchain technology, the existing success factors in evaluating crowdfunding campaigns were investigated. Also, the risks of crowdfunding as an investment form were analyzed.
2. The first chapter concluded with a theoretical framework to assess the blockchain's impact on crowdfunding. The theoretical framework proposed evaluating the blockchain's impact from the perspectives of crowdfunding platforms and investors (backers). From this framework, the model for assessing the blockchain's impact on crowdfunding, which involves quantitative and qualitative methods, was developed in other chapters.

In the light of the conclusions, the following dissertation objectives should be formulated:

1. To prepare a scientific literature analysis regarding the concept of financial technologies and the evolution and characteristics of crowdfunding and blockchain technology.
2. To investigate the existing possible success factors of the valuation of crowdfunding platforms and crowdfunding campaigns, as well as to analyze the risks of crowdfunding as a form of investment.
3. To develop a model for assessing the blockchain's impact on crowdfunding that involves quantitative and qualitative methods.
4. To propose the new modification of the criteria weighting methodology to the existing criteria weighting method.
5. To implement and test the practical suitability of the evaluation model and empirical research methodology.

2

Methodology for Evaluating the Blockchain's Impact on Crowdfunding

This chapter investigates the methodology for evaluating the blockchain's impact on crowdfunding. The literature proposes a framework to assess the impact of blockchain. It is composed of several parts. Every crowdfunding campaign consists of a project, investors, and a goal. Usually, investors, project owners, and crowdfunding platforms have different goals for crowdfunding campaigns. This research analyzed other goals from the perspective of investors or backers and crowdfunding platforms while leaving the goals of project owners for future research. Four scientific publications were published on the topic of this chapter (Venslaviene et al., 2021; Venslaviene et al., 2023a;).

2.1. Developing the Model to Assess the Impact of Blockchain on Crowdfunding

To find the best methodology to assess the impact of blockchain on crowdfunding, a literature review of possible methods was conducted, and later, the best one was

chosen. Fig. 2.1 below summarizes schematically the whole research of this dissertation on developing the Model for the Assessment of Blockchain Impact on Crowdfunding.

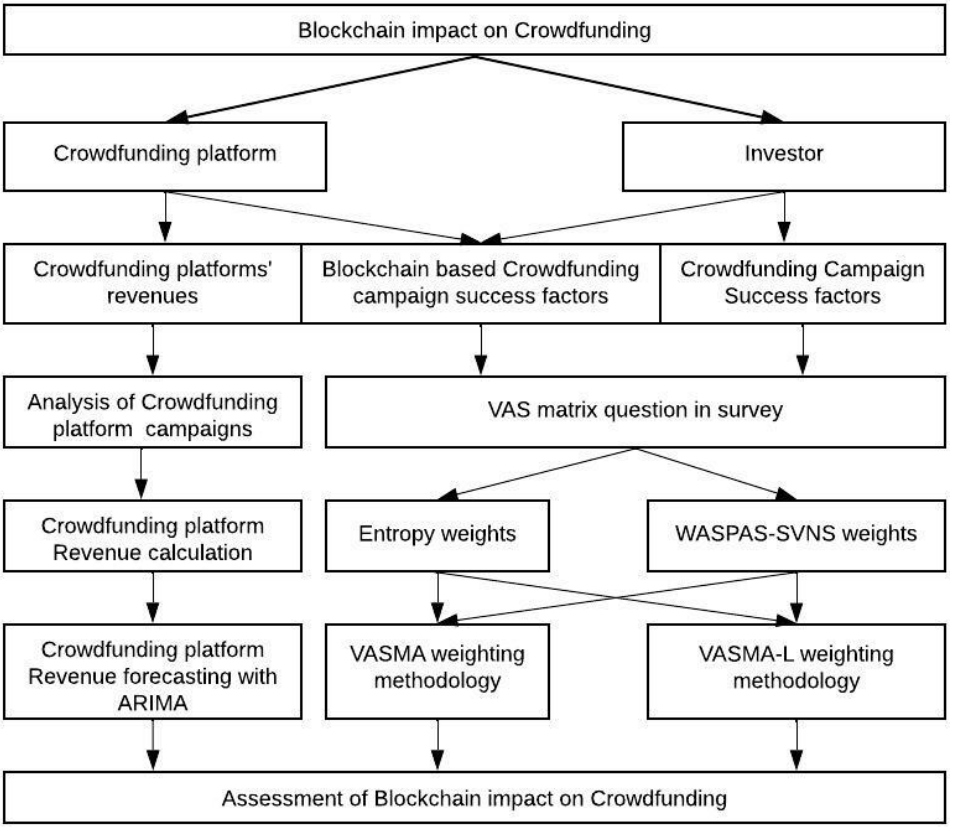

Fig. 2.1. Model for the Assessment of Blockchain Impact on Crowdfunding (source: created by the author)

From the investors' perspective, VAS matrix questions will be chosen in the target expert questionnaire. The VASMA weighting methodology will be applied to determine the most significant criteria for investors when selecting crowdfunding campaigns. Moreover, a modified VASMA-L criteria weighting methodology will be applied to determine the most significant criteria for investors when selecting blockchain-based crowdfunding platforms and campaigns.

From the crowdfunding platform's perspective, it will be chosen to analyze their most important goal: revenues. Revenues will be calculated from the three

most successful and most profitable crowdfunding campaign categories. Revenues will be forecasted using the ARIMA model. In addition to this, the VASMA criteria weighting methodology will be chosen to identify the most important factors for crowdfunding platforms when the crowdfunding platform is blockchain-based.

The following parts of this dissertation should follow this schematic procedure (Fig. 2.1), considering crowdfunding platforms' and investors' (backers) decisions, leaving aside the decisions of project owners for future research.

2.2. Research Data Collection and Processing

This dissertation consists of four studies. The studies were conducted to determine the blockchain's impact on crowdfunding from the perspectives of investors and crowdfunding platforms.

The first research analyzed crowdfunding platform revenues. To analyze the most effective and lucrative campaign segments on crowdfunding platforms, researchers collected daily data from Kickstarter, one of the largest crowdfunding sites in the world. The data was collected from 21 November 2020 to 20 February 2021 (Kickstarter Stats, 2022) for a total of 14 weeks. This data was collected to perform crowdfunding platform revenues and later forecast them with the ARIMA model.

Ten successfully funded technological campaigns specified in robots from the Kickstarter crowdfunding platform were taken for the second research. The campaigns underwent analysis, and comprehensive data was acquired from them. Only the information derived from the theory of crowdfunding was deemed pertinent as a determinant of success. Experts were requested to assess the variables and risk by reading the campaign stories to put all factor groups into operation. Subsequently, the correlations between all variables and the pairwise correlations between each independent and dependent variable were examined, considering the appropriate parameters. The dependent variables chosen were the amount raised and the number of investors (Lukkarinen et al., 2016). Furthermore, to diminish the skewness of variables, logarithmic transformations were made as well. The variables with the strongest pairwise correlations were subsequently selected to form the final criteria list for investing in crowdfunding campaigns. Thus, the total criteria list of 24 success factors (Table 3) was reduced to 14 final criteria lists that were applied in the VAS matrix questionnaire of the target group of experts. The list of final criteria is presented in Table 2.1.

Table 2.1. List of final success factors for crowdfunding (source: created by the author)

	Success factor category	Success factor
Crowdfunding theory	Campaign characteristics	Campaign duration
		Funding target
		Min. investment
	Networks	Social media and private networks
	Understandability	Environment commitments
	Quality signals	Updates
		Spelling mistakes
		Video
Venture Capital & Business Angels Theory	Company ratings	Team rating
		Markets rating
		Concept rating
E-commerce theory	Risk	Risks associated with the project
		Risks associated with the project initiator
		Risks associated with the intermediary

The third research analyzed investor choices when investing in a particular campaign using a blockchain-based crowdfunding platform. The data was mainly acquired from scientific sources to obtain all relevant success elements for blockchain-based crowdfunding. The identified elements contributing to success were consolidated and shown in Table 1.5 (Sub-chapter 1.3). Due to the similarity, several success factors were combined. The final list of 18 key success factors was used in the VAS matrix questionnaire for the target group of experts. Furthermore, the success factors were categorized into two groups based on their pertinence to the particular form of crowdfunding. The split is necessary due to the difficulty for respondents in rating all 18 success elements simultaneously and the requirement for all criteria items to be displayed on one screen without the need for scrolling (Lescauskiene et al., 2020; Toepoel et al., 2009). Due to respondents' inability to evaluate complex and extensive questionnaires, the results might be poor quality. All the respondent psychological aspects of long and complex surveys and their impact on survey results are covered in detail by Venslavienė et al. (2023a) and will not be analyzed in this dissertation. The final success factor groups are detailed in Table 2.2 and Table 2.3. The two success element lists will be incorporated into the expert questionnaire matrix questions and will fit seamlessly on a single screen, whether a computer desktop or a mobile device. The modified VASMA-L criterion weighting methodology will

be used to aggregate findings from both groups and determine the value of specific success factors for the entire group of success factors.

Table 2.2. Adjusted list of success factors for financial and blockchain-based crowdfunding (source: created by the author)

Success factor	Financial and blockchain-based crowdfunding
Industry	X
Location	X
Team size	X
Social network	X
Early investments	X
Share of retained equity/token	X

Table 2.3. Adjusted list of success factors for blockchain-based crowdfunding (source: created by the author)

Success factor	Blockchain-based crowdfunding
Tokens allow contributors to access a specific service (or to share profits)	X
Using Ethereum	X
Number of tokens issued	X
ICO bonus/discounts	X
KYC/pre-registration	X
Presale	X
Accepting multiple currencies (digital and Fiat)	X
well-connected and loyal CEO	X
presence on GitHub	X
Average analyst rating	X
White paper availability, content, and multi-language	X
The code source is available	X

For the last research, data was taken from literature regarding crowdfunding platforms and their perspective on blockchain technology. Parameters pertinent to blockchain technology and its influence on crowdfunding platforms were sought. The expert questionnaire included a final list of 11 success factors, which may be found in Table 2.4.

Table 2.4. Success factors impacting crowdfunding platforms (source: created by the author)

No.	Success factors impacting crowdfunding platforms
1	Operational costs
2	Marketing costs
3	Development costs
4	Potential losses due to the volatility of cryptocurrency
5	Potential losses due to the exchange rate
6	Market size
7	Investment success (trading activity, portfolio diversification, investments in lottery-type tokens)
8	Complex regulations associated with cryptocurrencies in different countries result in huge costs.
9	No law that can force CF users to respect all terms of funding
10	Storage of required documents using blockchain technology
11	Cybersecurity risks

Four studies will use all the data. The methodology is given in the following sub-chapters, along with the justification of the chosen methodology.

2.3. Methods for Developing the Assessment Model

This sub-chapter discusses the methods applied in this dissertation and the theoretical justification for the most appropriate methods. Three methods are applied: (1) the ARIMA model to forecast the crowdfunding platform's revenues, (2) the VASMA criterion weighting technique to evaluate the best success factors for investments, and (3) the modified VASMA-L criteria weighting method for investments into blockchain-based crowdfunding campaigns.

2.3.1. Forecasting Crowdfunding Platform Revenues with Autoregressive Integrated Moving Average Model

Time series forecasting is a significant field of forecasting that involves gathering and analyzing past data of a variable to create a model that accurately captures the underlying relationship (Zhang, 2003). The Box-Jenkins (BJ) method, technically referred to as the ARIMA method, focuses on analyzing economic time series' probabilistic or stochastic properties. It does not prioritize constructing single-equation or simultaneous equation models (Gujarati, 2004; Shim, 2000). The ARIMA model is widely

recognized as a highly effective tool for financial forecasting, particularly for generating accurate short-term projections. An autoregressive integrated moving average model (ARIMA) assumes that the future value of a variable may be predicted by a linear combination of previous observations and random errors (Python | ARIMA Model for Time Series Forecasting – GeeksforGeeks, 2022; Zhang, 2003). The model can be represented using the mathematical formula:

$$Yt = \varphi 0 + \varphi 1 Yt{-}1 + \varphi 2 Yt{-}2 + \ldots + \varphi p Yt{-}p + \varepsilon t{-}\theta 1 \varepsilon t{-}1{-}\theta 2 \varepsilon t{-}2{-} \ldots {-}\theta q \varepsilon t{-}q, \quad (1)$$

where: Y_t represents the actual value at period t, ε_t – random error at period t, φ_i and θ_j – coefficients, p and q – are integers commonly referred to as the orders of the model. Typically, they reflect autoregressive and moving average models.

When examining time series data, it can be challenging to determine if it adheres to a strictly autoregressive (AR) process, a strictly moving average (MA) process, an autoregressive moving average (ARMA) process, or an autoregressive integrated moving average (ARIMA) process. The Box-Jenkins approach can be utilized to determine the nature of a given process. The procedure comprises four sequential steps, as seen in Fig. 2.2.

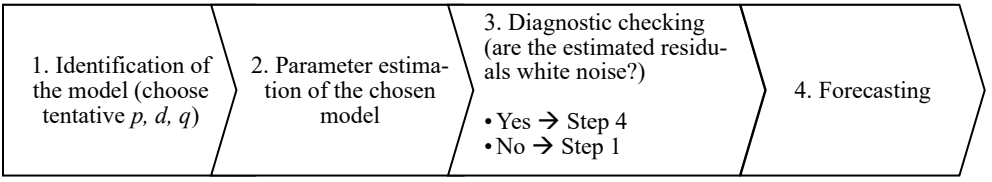

Fig. 2.2. Box-Jenkins methodology for selecting the ARIMA model (source: adapted from Gujarati, 2004)

After the data was gathered, a comprehensive analysis was conducted to compare and analyze the statistical data of crowdfunding platform projects. Subsequently, the categories of projects that yielded the highest profits and had the most tremendous success were identified and subjected to both collective and individual analysis.

The project groups were compared, and the data was organized. Ultimately, the crowdfunding platform's profits were determined by analyzing the projects that received successful investments. More precisely, the revenues were calculated based on the most successful and profitable groupings of crowdfunding campaigns.

Ultimately, it is necessary to forecast the income of the crowdfunding site. To accomplish this, it is necessary to identify and construct the ARIMA model. Projections for the future income of the crowdfunding platform should be calculated using the established ARIMA model. The complete process is provided in Fig. 2.3.

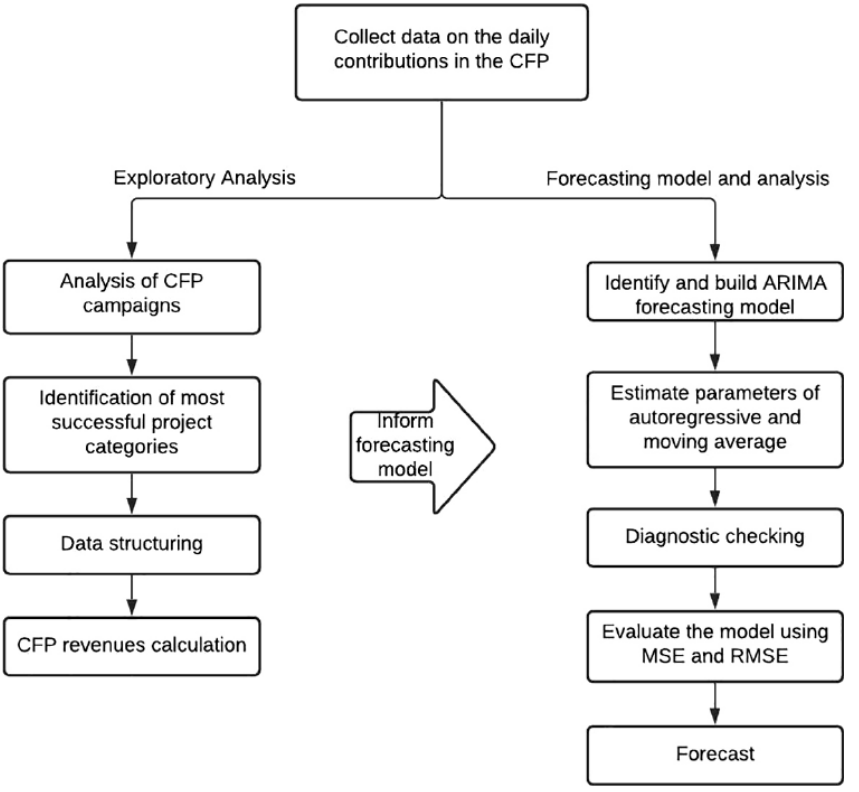

Fig. 2.3. Methodology used for forecasting crowdfunding platform revenues (source: created by the author)

Fig. 2.3 shows the methodology applied in crowdfunding platform forecasting. Initially, a thorough analysis was conducted on several crowdfunding site campaigns to identify the most successful ones. Subsequently, the profits of the crowdfunding platform were computed based on the categories of the most successful crowdfunding campaigns. Ultimately, the crowdfunding platform determined and predicted its income. The ARIMA model was recognized and developed for this purpose.

2.3.2. Theoretical Justification for Multiple-criteria Decision-Making Methods for Assessing the Blockchain's Impact on Crowdfunding

The literature analysis found that the blockchain's impact on crowdfunding might be best assessed by using multiple-criteria decision-making methods (MCDM).

Multi-criteria decision-making is a prominent concern in decision-making that seeks to determine the optimal alternative by considering multiple criteria during the selection process (Barretta et al., 2023). Multi-criteria decision-making (MCDM) methods are frequently employed due to their capacity to handle unclear data, enabling specialists to consider a broader spectrum of scenarios (Więckowski et al., 2023). When considering the significance and potential of blockchain concerning crowdfunding, it is difficult to determine the most appropriate MCDM technique for addressing the dissertation topic due to the many available options.

The decision-making process is a highly intricate process that can be categorized as either rational or illogical. It is susceptible to several influences, including physiological, biological, cultural, and social elements. Additionally, decisions can be made based on both qualitative and quantitative criteria (Barretta et al., 2023; Hashemi et al., 2022; Więckowski et al., 2023; Zavadskas et al., 2022). Every decision-making process in the MCDM approach consists of three main steps: (1) identify and select criteria, (2) determine the weights of criteria, and (3) rank the criteria by using a suitable MCDM method. The final values of criteria weights can be affected by different preferences of methodologies, opinion diversity, evaluation process transparency, or the competence of decision-makers (Lescauskiene et al., 2020). Moreover, when the public is involved in decision-making, it is found that its opinion differs from expert evaluation, and this might cause inaccuracy in the preference elicitation results.

In general, when participants are requested to provide ratings about many aspects of a single subject, it is recommended that all questionnaire items be given together and formatted as matrix questions. Matrix-style questions can be used to gather comments on satisfaction, quality, and the significance of the things being studied (Lescauskiene et al., 2020). Furthermore, the ease of comparing items in a matrix query may enhance the precision of direct weighting techniques.

Matrix questions are assessed using the chosen measurement scale. Due to easy usage, Likert-type scales are the most popular (Lescauskiene et al., 2020; Likert, 1932). However, it should not be assumed that the intervals between Likert-type values are identical. Additionally, the biases caused by the ordinal data points may have contrasting impacts on the calculations of statistical measures (Chang & Little, 2018; Venslavienė et al., 2021). Continuous scales or visual analogue scales (VAS) are employed to mitigate these issues with Likert-type measures. VAS is typically presented as a straight line, with two verbal descriptions placed at opposite ends. Meanwhile, VAS employs a linear scale to assess primary behaviors and get data measurements, such as weighting outcomes, without being constrained by the limited number of response categories (Kuhlmann et al., 2017; Musangu & Kekwaletswe, 2012). Furthermore, VAS scales are more suitable for statistical and mathematical algorithms due to their interval-level measurements (Reips & Funke, 2008). Finally, a set of VAS scales combined in

a single question is called a VAS matrix. The high degree of detail in the VAS scales can be extremely valuable when minor modifications might be detected between the evaluated criteria. Due to this, VAS scales are vastly sensitive to respondents' opinions. As a result of the high sensitivity to respondents' views, the new preference technique that takes the VAS Matrix for the expert survey-based data collection will be used to assess the blockchain's impact on crowdfunding.

Determining criteria weights is a crucial phase in the decision-making process, so it is necessary to categorize methods for weighting criteria. However, there is no single classification; preference elicitation can be divided into several criteria weighting techniques: direct and indirect, objective and subjective, statistical and algebraic, etc. Criteria weighting techniques are summarized in Fig. 2.4.

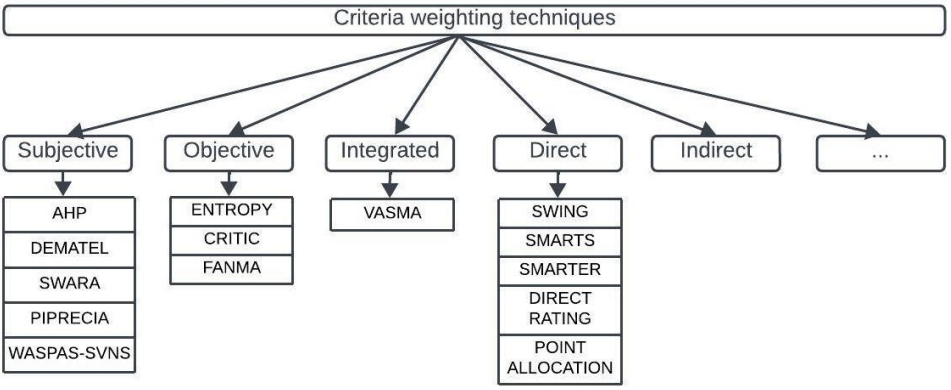

Fig. 2.4. Classification of criteria weighting techniques (source: created by the author)

Subjective weights are described merely by the preferences of the decision-makers. Usually, the subjective judgments are mainly based on pairwise comparison methods such as AHP (Analytic Hierarchy Process) (Van Nguyen et al., 2023; Tavana et al., 2023), DEMATEL (Decision-making Trial and Evaluation Laboratory) (Bali et al., 2023; Šmidovnik & Grošelj, 2023), SWARA (Step-Wise Weight Assessment Ratio Analysis) (Alrasheedi et al., 2023; Deveci et al., 2023), PIPRECIA (Pivot Pairwise Relative Criteria Importance Assessment) (Janovac et al., 2023; Qaddoori & Breesam, 2023), or WASPAS (weighted aggregated sum product assessment) (Alrasheedi et al., 2023; Barbara et al., 2023; Zavadskas et al., 2012). Recently, WASPAS and its different modifications have been broadly employed for several multi-criteria decision-making tasks (Pandurang, 2021; Petrovas & Bausys, 2022; Semenas & Bausys, 2022; Vaid et al., 2022).

Typically, when objective weights are employed, the influence of separate decision-makers is diminished. The most recognized objective weighting approaches are the information entropy method (Sun et al., 2023; Vaid et al., 2022;

Wu et al., 2023; Wu et al., 2022), CRITIC (Criteria Importance Through Intercriteria Correlation) (Mishra et al., 2023; Zhong et al., 2023), and FANMA methods (Chatterjee & Chakraborty, 2023; Wu et al., 2022).

Since subjective evaluations are affected by experts' experience and knowledge, most often, subjective weights ignore objective information. Therefore, integrated weighting methods are used to get more precise results of criteria weights. Integrated techniques typically combine subjective weights derived from expert opinions with mathematical data representations. The VASMA approach, which integrates both objective and subjective weights from the same questionnaire data, will be used in this dissertation. VASMA criteria weighting and its modifications (VASMA-L, VASMA-C) are widely used in social, economic or environmental studies (Venslavienė et al., 2023a, 2023b; Zavadskas et al., 2022).

2.3.3. Visual Analogue Scale Matrix for Criteria Weighting Methodology

VASMA weighting, also known as VAS Matrix for criterion weighting, is a technique used to provide weights to criteria based on expert surveys. The combination comprises weights derived from WASPAS-SVNS (weighted aggregated sum product assessment with single-valued neutrosophic sets) and information entropy. The WASPAS-SVNS method determines the subjective weights, while the information entropy method determines the objective weights. Zavadskas et al. (2012) initially presented WASPAS and later prolonged it with single-valued neutrosophic sets (WASPAS-SVNS). WASPAS and its variations are broadly used for several multi-criteria decision-making tasks (Bausys et al., 2020; Bausys et al., 2020; Mardani et al., 2020; Zavadskas et al., 2019). On the contrary, information entropy is extensively debated by Friesner et al. (2016). The VASMA weighting system is designed to minimize the uncertainty inherent in evaluating criteria based on surveys. The comprehensive VASMA weighting algorithm is outlined in Fig. 2.5.

The selected criteria were incorporated into a matrix question and included in an online questionnaire for the target group of experts, following the methodological technique shown in Fig. 8. Subsequently, the replies were retrieved from the questionnaire database and inputted into the data matrix R. This matrix comprises the number of criteria and experts. The scores are transformed from VAS scales to whole numbers. The number at the negative extreme, labeled as "absolutely unimportant", is initialized to 1, while the value at the positive extreme, labeled as "extremely important", is initialized to 100. The remaining values are computed as the subtraction of these two numbers. If the respondent deviated from the default middle position of the VAS scale, it is inferred that the respondent does not have a particular view on the given criterion.

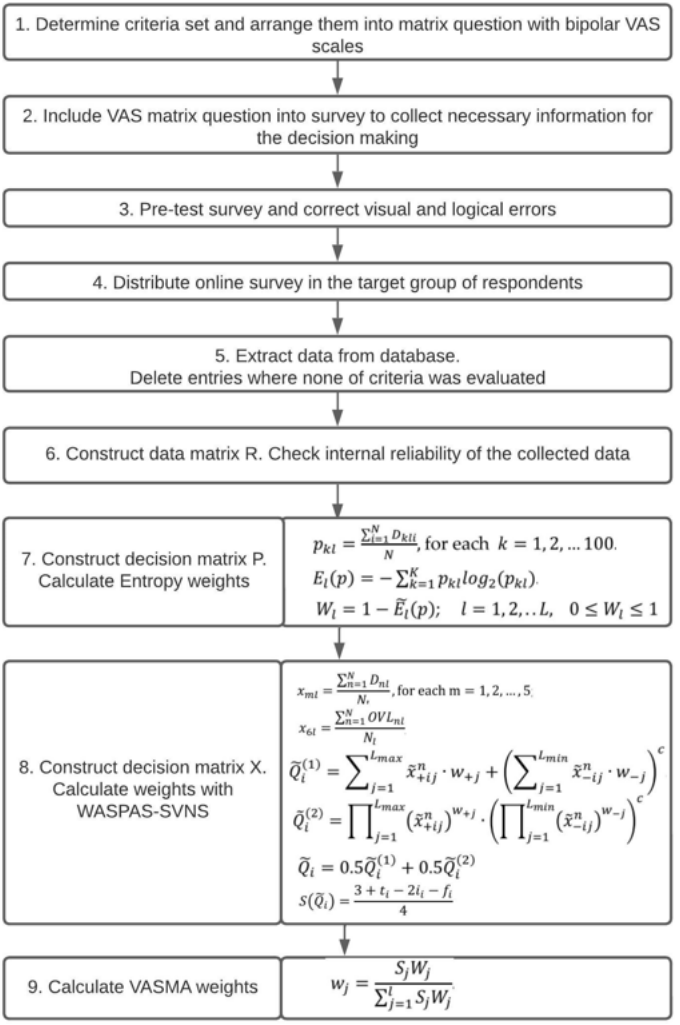

Fig. 2.5. VASMA weighting methodology (source: adapted from Lescauskiene et al., 2020)

Furthermore, suppose a participant consistently selects the options of "Absolutely unimportant" or "Extremely important" for all their responses. In that case, it can be inferred that they did not properly consider the evaluation issue and highlighted outliers. Hence, the straightforward data-clearing technique is deleting the entries where the respondent either did not assess any of the criteria or evaluated all the criteria to the extreme. The matrix *R*, including all the data, is used to construct two more matrices, *P* and *X*. The objective entropy weights are calculated

using decision matrix *P*, while the subjective WASPAS-SVNS weights are computed using decision matrix *X*. The VASMA weighting approach involves the use of matrices *P* and *X*, with application of several mathematical operations which are covered in detail by Lescauskiene et al. (2020), and it was not added in this research as it is not the first importance of this research.

Once the information entropy weights and the WASPAS-SVNS weights have been estimated, the final VASMA weights can be obtained. The VASMA weights *wj* are formulated by combining the entropy weights *Wj* with the WASPAS-SVNS weights *Sj*.

2.3.4. Visual Analogue Scale Matrix for Criteria Weighting Methodology's Modification Visual Analogue Scale Matrix for Criteria Weighting Methodology-L

VASMA-L is a modified approach that utilizes weights derived from a comprehensive collection of criteria. This set is divided into smaller subsets, which are then combined to assess the relative relevance of each criterion. The following text comprehensively explains the entire process for this altered technique.

- Step 1. Divide the original set of criteria C^0 into subsets of criteria $C^1, C^2, .. C^g$. Let $C^0 = \{c_1;\ c_2 .. c_N\}$, and $C^0 = \mathrm{C}^1 + \mathrm{C}^2 + .. + C^g$. For example, if g=3 and N represents the total number of criteria being analyzed, then $C^1 = \{c_1;\ c_2 .. c_d\}, C^2 = \{c_{d+1}; c_{d+2} .. c_f\}$, $C^3 = \{c_{f+1};\ c_{f+2} .. c_N\}$. Due to the potential cognitive overload of the human memory, it is advised that each subset contains approximately 10±4 elements.
- Step 2. Calculate the significance $q^1, q^2, .. q^g$ for each subset $C^1, C^2, .. C^g$. The weights must adhere to the rules: $q^1 + q^2 + .. + q^g = 1$. For this aim, one can utilize expert-based methodologies like SWING, DR, or even AHP.
- Step 3. Generate a distinct VAS matrix question for each subset $C^1, C^2, .. C^g$ and incorporate all of them into a single questionnaire. Each matrix question should be sequentially provided with a distinct title to differentiate them.
- Step 4. Disseminate the questionnaire to the participants belonging to the specific target group and gather the data obtained from each matrix question into distinct decision matrices $R^1, R^2, .. R^g$
- Step 5. For each of the $R^1, R^2, .. R^g$ calculated non-normalized VASMA weights M1, M2, … M^g :
    - Perform data cleansing and update the decision matrix R. Although questionnaire experts are not obligated to evaluate all

the criteria in the analyzed VAS matrix question, it is important not to eliminate replies with non-response levels without further evaluation.

- Assess the internal dependability of the data entered into decision matrix R. If it is suitable, proceed with the calculations.
- Determine the objective weights W_l for each criterion l, in the analyzed dataset using the information entropy theory:

$$E_l(p) = \frac{\sum_{k=1}^{100} p_{kl} log_2(p_{kl})}{log_2\left(\frac{1}{100}\right)}; l = 1,2,..L, 0 \leq E_l(p) \leq 1.$$

$$W_l = 1 - E_l(p); l = 1,2,..L, 0 \leq W_l \leq 1.$$

- The subjective weights S_l for each criterion l in the analyzed dataset will be calculated using the WASPAS-SVNS multi-criteria decision-making technique and the psychometric properties of the VAS scales. Lescauskiene et al. (2020) explain the mathematics of subjective weights.
- Determine the non-normalized VASMA weights M_l for each criterion l within the analyzed subset of criteria, and then multiply these weights by the importance q of this subset.

$$M_l = q\, S_l W_l$$

- Step 6. Compute the global VASMA weights. Aggregate the individual VASMA weights computed from each decision matrix $R^1, R^2, .. R^g$ into a unified set of VASMA weights M^0 which includes N elements. In the aforementioned example, when g=3 and $C^1 = \{c_1;\ c_2..c_d\}, C^2 = \{c_{d+1}; c_{d+2}..c_f\},\ C^3 = \{c_{f+1};\ c_{f+2}..c_N\}$, the set M^0can be defined as:

$$M^0 = M^1 \cup M^2 \cup$$
$$M^3 = \{M_1;\ M_2..M_d;\ M_{d+1}; M_{d+2}..M_f; M_{f+1};\ M_{f+2}..M_N\}$$

- Step 7. Normalize global VASMA weights M'_n

$$M'_n = \frac{M_n}{\sum_{n=1}^{N} M_n}, n = 1,2,..N.$$

Fig. 2.6 comprehensively describes the data collection and processing procedures necessary for using the VASMA-L approach in the expert survey preference elicitation process.

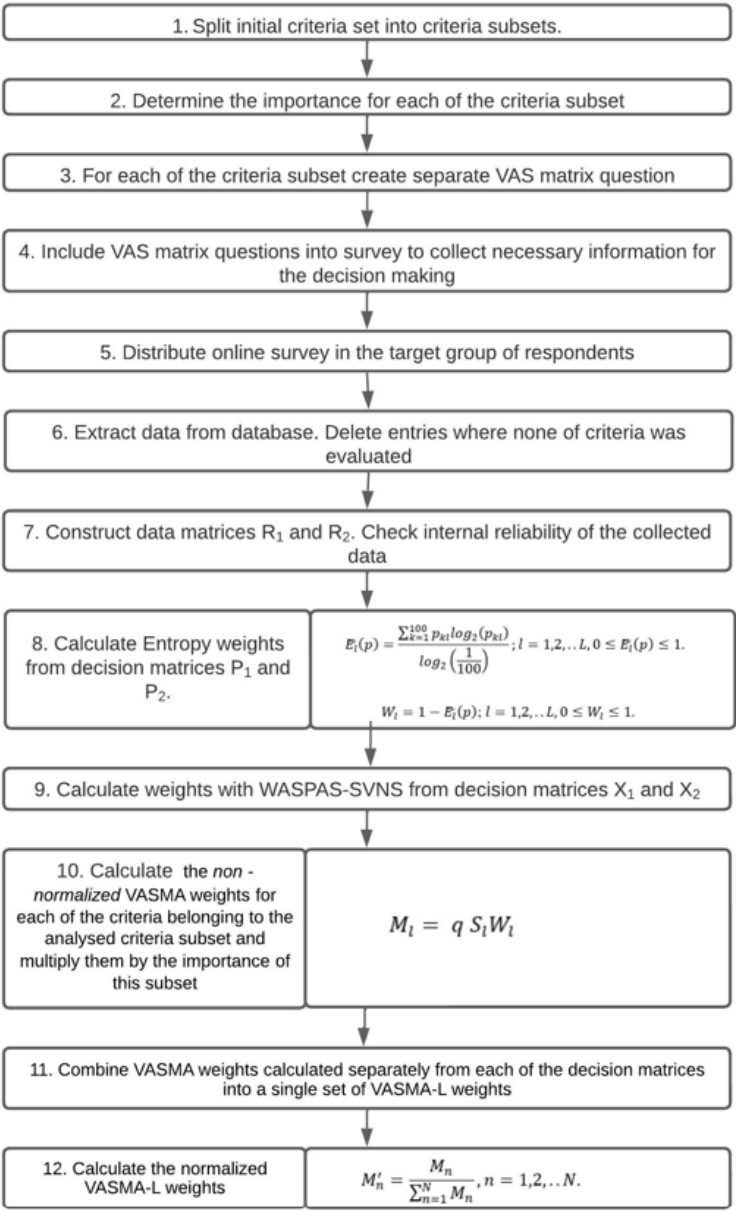

Fig. 2.6. Modified VASMA-L methodology for assessing the extensive criteria sets (source: created by the author)

The methodology described should be taken practically in the four studies of this dissertation.

2.4. Conclusions of the Second Chapter

1. This chapter discusses the data found in the literature, expert opinion, questionnaires, and the crowdfunding platform Kickstarter. All the data was used in four main pieces of research for this dissertation. For the first research of this dissertation, the data was collected from the crowdfunding platform Kickstarter to calculate and later forecast the revenues from successful campaigns. The data of the second research consisted of success factors coming from crowdfunding, venture capital and business angels' theories. Similarly, e-commerce theory was analyzed to determine all risk factors added to the research. Additionally, the literature for the third research checked the possible success factors of blockchain-based crowdfunding. Specifically, in this research, the data was split into two groups: (1) the factors that fit both financial and blockchain-based crowdfunding, and (2) factors that fit only blockchain-based crowdfunding. The split was made due to the reason that it is difficult for respondents to evaluate a big group of criteria at once. The last research's data was taken from literature relevant to blockchain technology, which explicitly impacts crowdfunding platforms.
2. Additionally, this chapter discussed all the methods applied in this dissertation and the theoretical justification for the most appropriate method. Three methods were applied. The first method was the ARIMA model, which helped forecast the revenues of a crowdfunding platform. This model was selected based on its reputation as one of the most renowned techniques for financial forecasting and its proven ability to deliver accurate short-term predictions.
3. The second method employed the VASMA criterion weighting technique. VASMA weighting, also known as VAS Matrix for criterion weighting, is a technique used to provide weights to criteria based on expert surveys. This approach utilizes a combination of both WASPAS-SVNS (weighted aggregated sum product assessment with single-valued neutrosophic sets) weights and information entropy weights. The WASPAS-SVNS method calculates the subjective weights, whereas information entropy calculates the objective weights. This strategy is designed to reduce the uncertainty encountered in evaluating criteria based on expert surveys.
4. The third method was the modified VASMA-L criteria weighting methodology. This methodology is a modification of the VASMA criteria weighting methodology, and it can be applied to large criteria groups by dividing them into subgroups and later summarizing results to see the most important factors of the whole criteria group. This modification of the VASMA weighting methodology is a novelty to scientific literature as it was created specifically for this research.

3

Implementation and Testing of the Blockchain's Impact on Crowdfunding Evaluation Model

This chapter discusses and summarizes the results of four studies regarding blockchain's impact on crowdfunding. The studies were analyzed from the perspectives of investors, crowdfunding campaign goals, and crowdfunding platform goals. As will be seen from research results, blockchain technology mainly impacts crowdfunding platforms and their structure. In contrast, investors do not see much difference in the impact of blockchain technology when investing in a specific crowdfunding campaign. They are more interested in more general criteria related to the crowdfunding campaign itself but not in the crowdfunding platform's technical structure. Four scientific publications were published on the topic of this chapter (Venslaviene et al., 2021; Venslaviene et al., 2023a; Venslaviene et al., 2023b).

3.1. Forecasting Crowdfunding Platform Revenues

Kickstarter's crowdfunding platform specializes mostly in creative projects and offers 15 different project categories in which to invest. A total of USD 7.11 billion has been invested in various project categories to date. Technology, Games, and Design categories receive the most investment support and earn the most profitable campaigns. The following analysis for this dissertation is conducted exclusively on the three most popular investment categories.

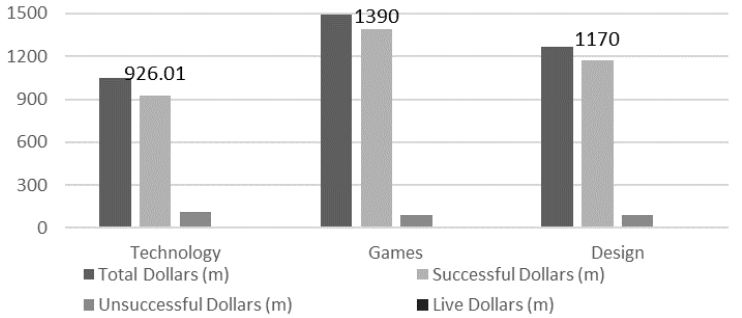

Fig. 3.1. Successful crowdfunding platform project categories (source: found by the author)

According to Fig. 3.1, successful technology initiatives received a total funding of USD 926 million, game projects received USD 1.39 billion, and successful design projects received USD 1.17 billion. Comparing the total number of successfully funded projects on the Kickstarter crowdfunding platform to those in the top three categories, it was found that this top three group of projects received 69% of the total successful funding.

Crowdfunding platforms make most of their money from fees charged to projects. The Kickstarter crowdfunding platform operates on an all-or-nothing basis, meaning it only collects fees from successfully funded projects. Kickstarter charges a 5% commission on each successfully financed project, which is deducted from the project owners' earnings. Fig. 3.2 displays the revenues generated from the three most prominent project categories: technology, games, and design. For clarity, certain fees received are regarded as Kickstarter's main revenues for the specified period.

The ARIMA time series model is executed using the statistical software *Python* to forecast income on crowdfunding platforms.

First, it is crucial to identify the specific ARIMA model accurately. Next, the parameters of the autoregressive and moving averages need to be computed. Furthermore, it is imperative to do a diagnostic check to determine the extent to which the chosen model accurately aligns with the provided data.

Also, it is imperative to execute the forecast. The program imports both the data set and the necessary statistical packages. The dataset used for analysis consisted of the Kickstarter crowdfunding platform earnings of the three most successful project groups (technology, games, and design), as shown in Fig. 3.2.

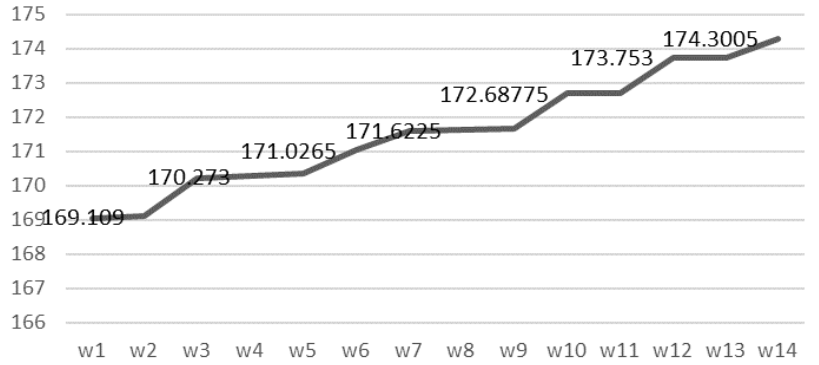

Fig. 3.2. Crowdfunding platform Kickstarter revenues in a million dollars (source: found by the author)

Subsequently, it is necessary to verify the stationarity of the data set. To do this, the mean and standard deviation of the time series must be calculated. One way to accomplish this is by utilizing the *data.rolling.mean* or *data.rolling.std* methods. Consequently, it was determined that the initial three values of the time series should be utilized to calculate the average and variability. Fig. 3.3 summarizes these findings, indicating that the mean and standard deviation exhibit non-stationary behavior.

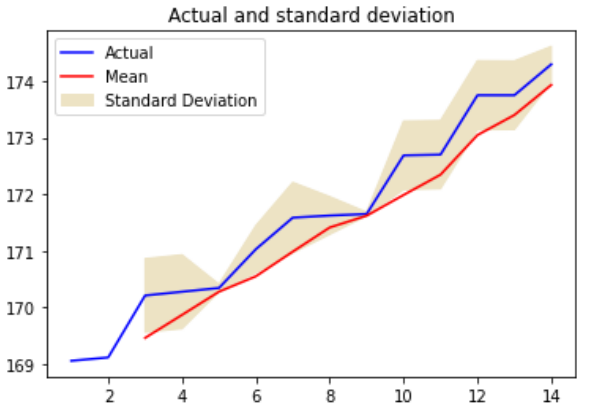

Fig. 3.3. Stationarity checking by the mean and standard deviation (source: created by the author)

The Dickey-Fuller test was employed to verify that the time series exhibited non-stationarity. This test is employed to ascertain the presence of a unit root in the time series. This is accomplished by executing the *adfuller* function from the *statsmodels.tsa.stattools* function in Python. The Dickey-Fuller test employs the AIC information criterion to assess the efficacy of the generated model. The results of the Dickey-Fuller test are displayed in Table 3.1. The test findings indicate that the p-value exceeds 0.5. The test statistics do not meet the threshold values, indicating that the studied time series is not stationary.

Table 3.1. Dickey-Fuller test results (source: found by the author)

Dickey-Fuller test results	Value
Test Statistic	–0.364637
p-value	0.915838
#Lags Used	1.000000
Number of Observations Used	12.000000
Critical value (1%)	–4.137829
Critical value (5%)	–3.154972
Critical value (10%)	–2.714477
dtype: float64	

The time series data was transformed into logarithmic form using the *log* function. The mean and standard deviation were re-estimated using logarithmic values. Subsequently, a seasonal decomposition was performed to transform the time series into a stationary form.

When performing ARIMA modeling, it is essential to determine the appropriate values of *p, d,* and *q* for the forecast. The optimal parameter values are $p = 1$, $d = 0$, $q = 1$. In Python, the ARIMA model was implemented using the *auto_arima* function from the *pmdarima* module. Ultimately, the model was evaluated to determine its compatibility with the data set. Finally, the prediction function was employed to determine the projection for the examined time series. The forecast is provided in Fig. 3.4.

Fig. 3.4 illustrates the projection that earnings from crowdfunding platforms will persistently increase based on the most prosperous and well-liked project types. The forecast indicates that there will be multiple high points during week 13, week 17, and week 21. Hence, crowdfunding platforms must carefully choose campaigns from prosperous categories, while investors should allocate their investments to these campaigns at their most prosperous periods. Nevertheless, it is essential to acknowledge that the precision of the forecast diminishes when additional forecast periods are included. Future research

should aim to verify the forecast's accuracy using a reduced number of forecasting periods.

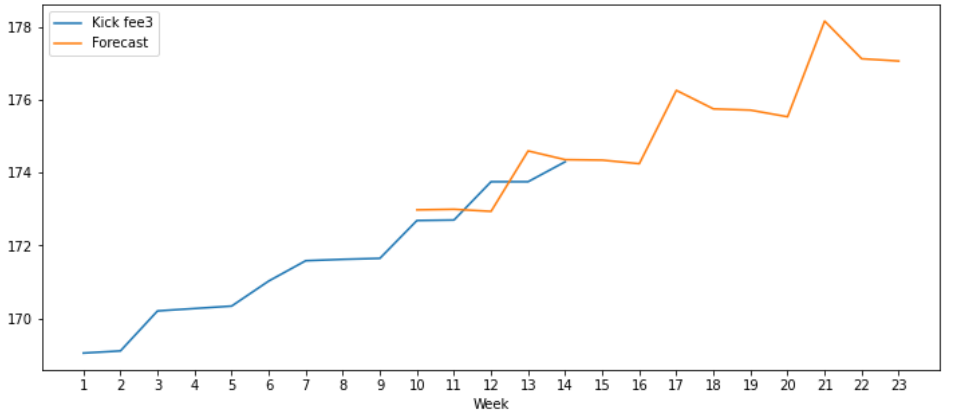

Fig. 3.4. Crowdfunding platform revenues forecast (source: created by the author)

The ARIMA model was selected and constructed in this research to predict the revenues of crowdfunding platforms. The primary source of revenue for crowdfunding platforms was the fees generated from successful campaigns. The investigation demonstrated that the optimal parameters for the values were $p = 1$, $d = 0$, $q = 1$. Thus, the ultimate ARIMA model was formulated as an ARIMA (1,0,1) model. The prediction results indicate that the ARIMA model is suitable for forecasting the revenues of crowdfunding platforms. The ARIMA (1,0,1) model is highly appropriate. Furthermore, crowdfunding platforms should prioritize selecting crowdfunding campaigns from prosperous industries like technology, games, or design. As far as the authors know, no other publications have explored revenue forecasting using the ARIMA model. Moreover, it is challenging to locate forecasts of crowdfunding platform earnings. Various authors have made predictions on revenues in general. Queenan et al. (2009) introduced Holt's double exponential smoothing (DES) technique. Pimentel et al. (2018) conducted a comparative analysis of the revenue production capacities of the bid price allocation technique and the nested network approach in the context of hotel revenue management. Kryvovyazyuk et al. (2020) employed various financial models, including the Discounted Cash Flow Model (DCFM), Capital Asset Pricing Model (CAPM), Terminal Growth Rate Model (TGRM), Gordon Growth Model (GGM), and Exit Multiple (EM), to forecast revenue for enterprises operating in the IT sector.

The primary constraint of this research is the dataset. Data was collected daily from the Kickstarter platform over 14 weeks. An extended period should be used

for more accurate calculations and predictions. Another constraint may arise from the ARIMA model itself. A different ARIMA model could be chosen with a different data set and interpretations. The third limitation is that the forecast accuracy decreases as the number of forecast periods increases. Therefore, the right number of forecast periods should be considered very carefully.

3.2. Crowdfunding Campaigns Criteria Evaluation

Increasingly, crowdfunding initiatives are garnering the attention of diverse investors. Nevertheless, investors face significant challenges when identifying lucrative crowdfunding campaigns to allocate their investments. Hence, it is imperative to establish precise criteria for assessing individual crowdfunding projects. To ascertain the most effective approach, one can inquire with investors about the key factors they consider significant while making investments. Hence, a web-based survey consisting of seven inquiries was explicitly developed for the group of expert specialists. The Visual Analogue Scale (VAS) matrix was presented as the fourth question, in which the experts were required to assess the significance of the studied variables in selecting a crowdfunding campaign to invest in. The VAS matrix provides a set of fourteen criteria derived from the literature analysis.

Overall, 64 expert individuals completed the online questionnaire. Since the subjective evaluations are affected by the experience and knowledge of experts, experts were chosen with investment, financial markets, and crowdfunding knowledge, considering their education (completed degree in related study programs) and investment into crowdfunding campaign experience, at least two years of investment experience. Nevertheless, one response was disregarded for further examination due to being positioned at the extreme ends of each VAS matrix question. This means that the expert did not care about the analyzed topic and just tried to escape the questionnaire very quickly. Hence, the ultimate count of experts amounts to 63. The demographic characteristics of experts are outlined in Table 3.2.

Table 3.2. Crowdfunding Expert Demographic Profile (source: found by the author)

Variable	Category	%
Gender	Male	76%
	Female	22%
Age	<24	14%
	25–30	22%
	31–35	22%

End of Table 3.2

Variable	Category	%
	36–40	25%
	41–50	14%
	>51	2%
Education	Secondary	5%
	Professional	10%
	Bachelor	40%
	Masters	38%
	Doctor	8%
	Other	0%

The demographic profile of crowdfunding campaign investors, as indicated by the expert analysis in Table 3.2, reveals that the majority (76%) are males between the ages of 25 and 40. Typically, they possess a high level of education, holding either a bachelor's or master's degree. Crowdfunding knowledge results show that experts are qualified enough to evaluate the given criteria for investments in crowdfunding campaigns.

The data obtained from the VAS matrix was automatically converted into a data matrix *R*. In this matrix, the columns (A1–A14) reflect the evaluation criteria, and the rows indicate the expert's ID (Table 3.3). Cases with $r_{nl} = 0$ were classified as non-response cases.

Table 3.3. Criteria evaluation converted from the VAS matrix to the data matrix R (source: found by the author)

ID	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
1	16	74	64	78	27	39	42	81	87	93	79	64	39	22
2	17	84	69	64	36	70	77	82	90	91	91	88	68	75
3	11	68	14	97	55	100	76	22	68	42	66	79	61	33
4	68	70	57	32	13	43	29	24	96	97	91	78	82	12
5	56	26	20	59	22	63	83	36	100	100	100	100	100	56
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
58	19	72	83	82	15	70	86	66	89	80	95	96	72	86
59	96	93	8	7	62	84	4	8	84	80	89	99	99	95
60	92	45	63	60	29	39	73	8	77	100	67	99	99	98
61	76	38	21	27	36	20	81	16	63	37	44	100	74	38
62	72	53	40	52	97	59	81	45	68	72	90	92	55	74
63	64	80	64	16	31	65	82	32	86	87	90	92	90	92

Table 3.4 displays the descriptive statistics of the data obtained from the VAS matrix. As can be seen, all 63 experts analyzed in this research scored all criteria.

Table 3.4. Descriptive statistics of selected criteria from the expert questionnaire (source: found by the author)

No	Criteria	Mean	Median	SD	Count
A1	Campaign duration	54.98	64	28.27	63
A2	Funding target	68.84	72	23.75	63
A3	Min. investment	53.79	62	27.89	63
A4	Social media and private networks	43.29	37	29.79	63
A5	Environment commitments	34.10	28	28.32	63
A6	Updates	55.92	63	29.06	63
A7	Grammar mistakes	67.81	76	28.18	63
A8	Campaign video	31.22	27	25.06	63
A9	Team rating	72.19	74	23.15	63
A10	Markets rating	74.70	80	22.96	63
A11	Concept rating	76.30	80	23.32	63
A12	Risks associated with the project	88.37	92	12.20	63
A13	Risks associated with the project initiator	84.60	88	15.84	63
A14	Risks associated with the intermediary	81.94	90	21.53	63

Although all the experts evaluated all the criteria, it is good to check if the collected data in the expert questionnaire can be trusted. Cronbach's alpha was employed to assess the internal consistency of the collected data. The overall Cronbach's alpha reliability coefficient was 0.7571. This indicates that the overall internal dependability of the gathered data is substantial. When a Cronbach's alpha of 0.70 and above, it is generally regarded as satisfactory.

The VASMA weighting process should be used to estimate the weights, as described in Sub-chapter 2.3.3. The weights to be estimated include Entropy, WASPAS-SVNS, and VASMA. Using entropy weights in the VASMA weights methodology may overshadow the objective component. A decision matrix, *P*, was constructed using the data matrix *R*, taken explicitly from Table 12. The matrix *P* represents a set of criteria in its columns and the possible values of VAS scales in its rows. The values $p_{kl,}$ which are shown in Table 14, represent the proportion of responses k for the studied criterion l ($0 \leq p_{kl} \leq 1$ and $\sum_{k=1}^{100} p_{kl} = 1$).

Table 3.5. Matrix P found from Matrix R for Entropy weighting (source: found by the author)

k	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
1	0.00	0.00	0.02	0.05	0.08	0.06	0.02	0.08	0.00	0.00	0.02	0.00	0.00	0.00
2	0.02	0.00	0.02	0.02	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.03	0.05	0.00	0.00	0.06	0.02	0.00	0.02	0.00	0.00	0.00
4	0.00	0.00	0.00	0.02	0.02	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.02	0.00	0.02	0.05	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
96	0.02	0.03	0.03	0.00	0.00	0.02	0.03	0.00	0.05	0.03	0.02	0.05	0.03	0.05
97	0.00	0.00	0.02	0.02	0.02	0.00	0.02	0.00	0.00	0.02	0.00	0.05	0.11	0.03
98	0.02	0.06	0.00	0.00	0.00	0.02	0.08	0.02	0.05	0.06	0.03	0.08	0.05	0.13
99	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.03	0.06	0.03
100	0.03	0.03	0.02	0.00	0.02	0.06	0.05	0.00	0.08	0.10	0.11	0.17	0.10	0.13

Table 3.6 displays the ultimate values of entropy weights and their corresponding rankings. The data for this calculation was taken from matrix *P* (Table 3.5). The more precise description of the calculation of these weights was mentioned in Sub-chapter 2.3.3.

Table 3.6. Entropy weights calculated from expert questionnaire data for selected criteria (source: found by the author)

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
El(p)	0.81	0.77	0.81	0.82	0.78	0.78	0.77	0.76	0.76	0.75	0.75	0.66	0.69	0.70
Wl	0.19	0.23	0.19	0.18	0.22	0.22	0.23	0.24	0.24	0.25	0.25	0.34	0.31	0.30
Rank	13	9	12	14	10	11	8	7	6	4	5	1	2	3

The WASPAS-SVNS weights approach is a component of the multi-criteria decision-making process that addresses the subjective aspect of VASMA weights. Matrix *X* in Table 3.7 was derived from matrix *R*. The columns in matrix *X* represent variables V1–V6, while the rows represent the examined alternatives. The precise process of constructing matrix *X* and determining variables *V1–V6* is detailed in Sub-chapter 2.3.3.

The weights of WASPAS-SVNS are specifically developed to serve as the score function for the generalized criterion, as outlined in Table 3.8. Additionally, the weight rankings are displayed. These calculations are made using matrix *X* (Table 3.7).

Table 3.7. Matrix X found from Matrix R for WASPAS-SVNS criteria weighting (source: found by the author)

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
V1	0.03	0.03	0.06	0.19	0.27	0.10	0.06	0.25	0.03	0.03	0.05	0.00	0.00	0.00
V2	0.37	0.16	0.35	0.35	0.43	0.30	0.16	0.49	0.11	0.11	0.06	0.02	0.05	0.08
V3	0.29	0.40	0.30	0.25	0.21	0.32	0.21	0.17	0.37	0.24	0.25	0.10	0.19	0.22
V4	0.24	0.27	0.21	0.19	0.06	0.19	0.38	0.06	0.30	0.38	0.43	0.49	0.40	0.29
V5	0.08	0.14	0.08	0.02	0.03	0.10	0.19	0.02	0.19	0.24	0.21	0.40	0.37	0.41
V6	4.95	6.56	4.54	3.29	2.65	5.03	6.83	2.13	6.81	7.21	7.86	9.79	9.00	9.10

Table 3.8. WASPAS-SVNS weights calculated from expert questionnaire data for selected criteria (source: found by the author)

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
S(Qi)	0.79	0.84	0.76	0.61	0.47	0.75	0.81	0.48	0.85	0.85	0.84	0.97	0.95	0.94
Rank	9	6	10	12	14	11	8	13	5	4	7	1	2	3

The VASMA weights were derived by multiplying the weights obtained from Entropy and WASPAS-SVNS weights and dividing the result by the sum of the multiplications. The complete equation is displayed in Sub-chapter 2.3.3. Table 3.9 shows the ultimate VASMA weights and their corresponding ranks.

Table 3.9. Final VASMA weights and ranks for selected criteria of crowdfunding campaigns (source: found by the author)

No	Criteria	VASMA	Rank
A1	Campaign duration	0.0539	10
A2	Funding target	0.0705	7
A3	Min. investment	0.0529	11
A4	Social media and private networks	0.0408	13
A5	Environment commitments	0.0381	14
A6	Updates	0.0605	9
A7	Grammar mistakes	0.0690	8
A8	Campaign video	0.0418	12
A9	Team rating	0.0754	6
A10	Markets rating	0.0798	4
A11	Concept rating	0.0785	5
A12	Risks associated with the project	0.1231	1
A13	Risks associated with the project initiator	0.1106	2
A14	Risks associated with the intermediary	0.1052	3

Table 3.9 shows that the top three rankings and VASMA weights of 0.1231, 0.1106, and 0.1052 are assigned to all forms of risk, including risks related to the project (A12), the project initiator (A13), and the intermediary (A14). The aforementioned characteristics are deemed to be the fundamental factors for investors in selecting crowdfunding projects. Investors, when investing in crowdfunding campaigns, first consider all risk factors and later assess the other factors. On the other hand, the characteristics that are considered least significant by investors are environmental commitment (A5) with a VASMA weight of 0.0381, social media and private networks (A4) with a VASMA weight of 0.0408, and campaign video (A8) with a VASMA weight of 0.0418. While investing in crowdfunding campaigns, investors consider these factors the least, as they are more interested in the campaign itself.

3.3. Blockchain-based Crowdfunding Campaign Criteria Evaluation

Blockchain-based crowdfunding, as well as cryptocurrencies, has become a novel and fascinating opportunity for investors worldwide. Investors have shown increasing interest in these specific forms of crowdfunding campaigns. However, the method for identifying the most optimal blockchain-based crowdfunding campaigns for investment remains unclear. Given the wide variety of criteria that influence investment decisions, it may be best to ask blockchain-based crowdfunding investors which criteria they consider most important. Hence, a web-based questionnaire consisting of eight questions was explicitly developed for the intended audience of experts. The questionnaire included two Visual Analogue Scales (VAS) matrices, placed as the third and fifth questions, which asked professionals to rate the significance of explicit variables in their decision-making process when choosing a blockchain-based crowdfunding campaign to invest in. Eighteen criteria derived from the literature investigation were presented in VAS matrices, consisting of six and twelve criteria, respectively. The split was made because it is difficult for individuals to evaluate all criteria in the group at once.

Thirty-four expert individuals with knowledge of blockchain technology and blockchain-based crowdfunding answered the online questionnaire, considering their education, completed study programs, and having at least one year of experience in blockchain technology or crowdfunding. Table 3.10 gives the demographic profile of experts.

The demographic profile of experts, as shown in Table 3.10, indicates that most blockchain-based crowdfunding investors are males (74%) between the ages of 25 and 30.

Table 3.10. Demographic profile of questionnaire experts (source: found by the author)

Variable	Category	%
Gender	Male	74%
	Female	24%
	I don't want to disclose it	3%
Age	<24	6%
	25–30	29%
	31–35	15%
	36–40	18%
	41–50	24%
	>51	9%
Education	Secondary	6%
	Professional	3%
	Bachelor's	38%
	Master's	41%
	Doctor	12%

Furthermore, these investors possess a high level of education, having obtained either a bachelor's or master's degree. Moreover, 91% of professionals have made at least one attempt to invest in crowdfunding projects based on blockchain technology. Ultimately, they were asked to specify certain crowdfunding platforms that operate on blockchain technology. The platform Tecra Space was cited the most frequently, with four mentions. Three other platforms, namely Bitfund, Coinlist, and Kickstarter, were each mentioned twice. Four further platforms, namely Revolut, Binance, Crypto.com, and Huobi, were each mentioned once. Since blockchain technology is new and still emerging, a concentrated group of experts was chosen to participate in the expert questionnaire. Also, to perform the VASMA criteria weighting methodology and its modifications, it is enough to have a low number of questionnaire participants, provided that they are experts in the analyzed field and have enough knowledge on the topic.

The data was obtained from two VAS matrices, one for each success factor subgroup. This data was then automatically translated into two data matrices, R_1 and R_2. In these matrices, the columns indicate the set of criteria for evaluation, and the rows reflect the expert's ID. The corresponding tables for these matrices are Table 3.11 and Table 3.12. Values with $r_{nl} = 0$ were considered cases with non-response values.

Table 3.11. Criteria evaluation converted from VAS matrix to data matrix R_1 (source: found by the author)

ID	B1	B2	B3	B4	B5	B6
1	82	60	33	74	86	57
2	68	25	40	79	70	61
3	62	31	18	13	45	75
4	77	40	36	37	70	83
5	82	39	32	41	64	41
...	...	...	...	...	...	...
30	71	28	30	30	38	71
31	71	34	30	28	31	63
32	67	29	28	31	29	72
33	67	31	29	29	28	62
34	90	39	68	85	57	19

The first criteria sub-set consisted of six criteria *(B1–B6)*, refer to Table 3.11, while the second criteria sub-set was constructed of twelve criteria (*BA1–BA12)*, refer to Table 3.12.

Table 3.12. Criteria evaluation converted from VAS matrix to data matrix R_2 (source: found by the author)

ID	BA1	BA2	BA3	BA4	BA5	BA6	BA7	BA8	BA9	BA10	BA11	BA12
1	77	66	29	40	88	68	94	23	62	77	88	69
2	50	60	52	50	40	50	89	83	54	50	70	50
3	59	27	69	63	73	28	15	70	43	59	40	60
4	66	57	81	68	20	52	21	69	33	40	21	69
5	84	63	79	68	64	72	68	63	34	33	38	64
...	...	...	...	...	...	...	...	...	...	...	...	...
30	68	36	71	30	34	77	25	75	26	30	32	66
31	70	32	66	74	32	72	35	72	36	71	41	73
32	68	25	66	34	30	72	35	78	32	71	28	70
33	71	36	69	31	24	78	33	67	37	30	27	72
34	85	71	21	58	33	13	94	84	68	77	58	37

The descriptive statistics for the VAS matrices were obtained using a statistical software application and are displayed in Table 3.13. All 34 experts included in this research examined all the factors from both criteria sub-sets.

Table 3.13. Descriptive statistics of selected factors from the expert questionnaire (source: found by the author)

No	Factor	Mean	Median	SD	Count
B1	Industry	68.71	68	7.93	34
B2	Location	35.44	35	7.68	34
B3	Team size	33.82	32	8.07	34
B4	Social network	38.18	33	15.61	34
B5	Early investments	47.12	36	18.96	34
B6	Share of retained equity/ token	67.65	72	15.20	34
BA1	Tokens allow contributors to access a specific service (or to share profits)	67.18	67.5	7.06	34
BA2	Using Ethereum	40.59	37	12.85	34
BA3	Number of tokens issued	65.56	67	11.63	34
BA4	ICO bonus/discounts	57.35	66	16.56	34
BA5	KYC/pre-registration	37.91	35	14.16	34
BA6	Presale	64.53	68	13.88	34
BA7	Accepting multiple currencies (digital and Fiat)	40.82	35	19.13	34
BA8	Well-connected and loyal CEO	65.47	68	11.81	34
BA9	Presence on Github	35.35	33.5	9.62	34
BA10	Average analyst rating	38.35	32.5	14.93	34
BA11	White paper availability, content, and multi-language	34.91	31.5	13.29	34
BA12	The code source is available	66.06	69	13.35	34

Furthermore, the accuracy of the data was verified. In this research, Cronbach's alpha was utilized to assess the internal consistency of the gathered data. The overall Cronbach's alpha reliability coefficient was 0.8071. This indicates that the overall internal dependability of the collected data is high. Typically, data is deemed credible when Cronbach's alpha is equal to or greater than 0.70.

Following the VASMA-L weighting methodology (Sub-chapter 2.3.4), Entropy, WASPAS-SVNS, and VASMA-L weights should be calculated. Entropy weights are a component of the VASMA-L weights methodology that concerns the objective aspect. Decision matrices *P1* and *P2* must be constructed based on data matrices *R1* and *R2* to determine entropy weights. Matrices *P1* and *P2* represent sets of criteria on the column side, while rows indicate possible values of VAS. The values from matrices *P1* and *P2* show the proportion of responses for the analyzed factor. The detailed description and example of the *P* matrix can be referred to in another research (Venslavienė et al., 2021).

Tables 3.14 and 3.15 display the ultimate calculations of entropy weights and rankings. The methodology of this research mentions how to estimate these weights (Sub-chapter 2.3.4). The entropy weights for both criteria groups are derived from matrices *P1* and *P2*.

Table 3.14. Entropy weights calculated from questionnaire data for selected criteria from the B criteria group (source: found by the author)

Entropy Weights	B1	B2	B3	B4	B5	B6
El (p)	0.5981	0.5897	0.5804	0.5975	0.6048	0.6705
W_l	0.4019	0.4103	0.4196	0.4025	0.3952	0.3295
Rank	4	2	1	3	5	6

Entropy or objective weights for criteria sub-group B1–B6 are given in Table 3.14, while entropy weights for criteria sub-group BA1–BA12 are found in Table 3.15.

Table 3.15. Entropy weights calculated from questionnaire data for selected criteria from the BA criteria group (source: found by the author)

Entropy Weights	BA1	BA2	BA3	BA4	BA5	BA6	BA7	BA8	BA9	BA10	BA11	BA12
El (p)	0.6085	0.6495	0.5625	0.6368	0.6406	0.6440	0.5765	0.6373	0.5908	0.5841	0.6103	0.5943
W_l	0.3915	0.3505	0.4375	0.3632	0.3594	0.3560	0.4235	0.3627	0.4092	0.4159	0.3897	0.4057
Rank	6	12	1	8	10	11	2	9	4	3	7	5

The subjective aspect of the VASMA weights methodology is addressed by the WASPAS-SVNS weights method, a component of the multi-criteria decision-making process. To calculate the weights for WASPAS-SVNS, decision matrices X_1 (Table 3.16) and X_2 (Table 3.17) need to be created using data matrices R_1 and R_2, respectively. A detailed explanation of the building of matrix *X* and the process of finding variables is provided in another paper (Venslavienė et al., 2021).

Table 3.16. Matrix X_1 found from Matrix R_1 for WASPAS-SVNS criteria weighting (source: found by the author)

	B1	B2	B3	B4	B5	B6
V1	0.000	0.000	0.000	0.000	0.000	0.000
V2	0.029	0.941	0.971	0.853	0.588	0.118
V3	0.824	0.059	0.029	0.088	0.353	0.559

End of Table 3.16

	B1	B2	B3	B4	B5	B6
V4	0.147	0.000	0.000	0.059	0.059	0.324
V5	0.000	0.000	0.000	0.000	0.000	0.000
V6	4.029	1.500	1.147	1.412	2.441	4.000

The columns in matrices X_1 and X_2 represent variables V1–V6, while the rows represent the examined alternatives. The precise process of constructing matrices X_1 and X_2 and determining variables V1–V6 is detailed in Sub-chapter 2.3.3.

Table 3.17. Matrix X_1 found from Matrix R_2 for WASPAS-SVNS criteria weighting (source: found by the author)

	BA1	BA2	BA3	BA4	BA5	BA6	BA7	BA8	BA9	BA10	BA11	BA12
V1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
V2	0.00	0.82	0.06	0.29	0.88	0.09	0.82	0.09	0.91	0.82	0.91	0.09
V3	0.88	0.18	0.85	0.68	0.09	0.76	0.09	0.76	0.09	0.12	0.06	0.76
V4	0.12	0.00	0.09	0.03	0.03	0.15	0.09	0.15	0.00	0.06	0.03	0.15
V5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
V6	7.71	4.00	7.85	6.68	2.97	7.62	3.76	8.00	2.79	2.53	2.12	8.18

The conclusive evaluations of WASPAS-SVNS weights and their rankings are presented in Tables 3.18 and 3.19.

Table 3.18. WASPAS-SVNS weights calculated from questionnaire data for selected criteria from the B criteria group (source: found by the author)

WASPAS-SVNS weights	B1	B2	B3	B4	B5	B6
S(Qi)	0.7822	0.596	0.5863	0.6353	0.6893	0.7881
Rank	2	5	6	4	3	1

WASPAS-SVNS or subjective weights for criteria sub-group *B1–B6* are given in Table 3.18, while WASPAS-SVNS weights for criteria sub-group *BA1–BA12* are found in Table 3.19.

Before calculating the global VASMA-L weights, the significance of each criterion set *B* and *BA* was established.

Table 3.19. WASPAS-SVNS weights calculated from questionnaire data for selected criteria from the BA criteria group (source: found by the author)

WASPAS-SVNS weights	BA1	BA2	BA3	BA4	BA5	BA6	BA7	BA8	BA9	BA10	BA11	BA12
S(Qi)	0.78	0.68	0.77	0.75	0.69	0.77	0.70	0.78	0.67	0.69	0.68	0.77
Rank	1	11	4	6	9	5	7	2	12	8	10	3

It is essential because professionals evaluate criteria set *B* and *BA* using the VAS matrices provided on a different webpage. Although local VASMA weights are derived from each matrix and enable comparison of criteria relevance, it is not easy to directly compare specific parameters within various criteria groups. To ensure accuracy and minimize errors in the expert questionnaire findings, it is necessary to determine the importance of the examined criterion sets. This will allow for the calculation of global VASMA weights and the evaluation of VAS criteria matrices individually. It is important not to evaluate or compare criteria from multiple VAS matrices together.

Three experts, representing decision-makers, investors, and blockchain professionals, remotely participated in assessing the significance of criteria sets *B* and *BA*. The assessments and the computed DR weights are displayed in Table 3.20.

Table 3.20. Importance of the criteria sets calculated by the Direct Rating (DR) methodology (source: found by the author)

Criteria set	Expert1	Expert2	Expert3	DR weight	Normalized DR weight
B	100	100	100	100	0.58
BA	80	60	75	72	0.42

Overall, the expert evaluation (Table 3.20) found that the first criteria set (B) with a normalized DR weight of 0.58 is more important than the second criteria set (BA) with a normalized DR weight of 0.42.

The global VASMA-L weights were determined by utilizing equations (3)–(5) of the VASMA-L approach. Table 3.21 displays the global VASMA-L weights and their corresponding ranks.

Table 3.21. Final VASMA-L weights and their ranks (source: found by the author)

No	Criteria	VASMA-L	Rank
B1	Industry	0.0779	1
B2	Location	0.0606	6

End of Table 3.21

No	Criteria	VASMA-L	Rank
B3	Team size	0.0609	5
B4	Social network	0.0633	4
B5	Early investments	0.0675	2
B6	Share of retained equity/ token	0.0643	3
BA1	Tokens allow contributors to access a specific service (or to share profits)	0.0542	9
BA2	Using Ethereum	0.0425	18
BA3	Number of tokens issued	0.0603	7
BA4	ICO bonus/discounts	0.0486	15
BA5	KYC/pre-registration	0.0442	17
BA6	Presale	0.0491	13
BA7	Accepting multiple currencies (digital and Fiat)	0.0530	10
BA8	Well-connected and loyal CEO	0.0501	12
BA9	Presence on Github	0.0487	14
BA10	Average analyst rating	0.0514	11
BA11	White paper availability, content, and multi-language	0.0474	16
BA12	The code source is available	0.0560	8

The findings indicate that the industry (B1), early investments (B5), and share of retained equity/token (B6) are the most significant factors. This conclusion is based on their highest ranks and highest VASMA-L weights (0.0779, 0.0675, and 0.0643). Furthermore, these three characteristics belong to the first group of criteria. In contrast, the criteria of using Ethereum (BA2), KYC/pre-registration (BA5), and white paper availability, content, and multi-language (BA11) are judged to be the least essential. These criteria have VASMA-L weights of 0.0425, 0.0442, and 0.0474, respectively.

3.4. Blockchain's Impact on Crowdfunding Platforms' Operational Efficiency

Transparency, reliability, purpose, and trustworthiness are crucial for crowdfunding systems (Kumar et al., 2019; Nguyen et al., 2021). Although there is growing interest in the possible impact of blockchain technology on crowdfunding platforms, few studies have investigated the connection between the specific features

of blockchain technology and the key factors of crowdfunding platforms (Cai, 2018; Chang et al., 2020). Hence, gaining a comprehensive understanding of the crucial elements of crowdfunding platforms, including blockchain technology, might offer valuable insights into the emerging uses of this technology. A web-based survey consisting of seven questions was developed and distributed to a specific set of experts. The fourth questionnaire question involved a VAS matrix question, in which experts were required to assess the level of importance of the particular parameters that affect blockchain-based crowdfunding platforms. Overall, responses to the online questionnaire were received from 19 experts who work at crowdfunding platforms directly with crowdfunding campaigns, support crowdfunding platforms, or own crowdfunding platforms. The demographic profile of experts is provided in Table 3.22.

Table 3.22. Demographic profile of expert individuals (source: found by the author)

Category		%
Gender	Male	52.6%
	Female	47.4%
Age	<24	47.4%
	25–30	10.5%
	31–35	15.8%
	36–40	5.3%
	41–50	15.7%
	>51	5.3%
Education	Bachelor's	68.4%
	Master's	21.1%
	Doctor	5.3%
	I don't want to disclose it	5.2%

The demographic profile of experts (Table 3.22) indicates that the majority of employees on the crowdfunding platform are men (52.6%) under the age of 24. In addition, these employees have a high education, with at least a bachelor's or master's degree. When evaluating a crowdfunding platform's status, all employees categorically disputed that their present platform is built on blockchain technology. Nevertheless, a significant proportion of specialists, 36.8%, concurred that they intend to integrate blockchain technology into their crowdfunding platform in the foreseeable future. Given the nascent and somewhat untested nature of blockchain technology, it is understandable that the market is not yet prepared for it. However, it is essential to acknowledge the potential for this transformative

shift. Again, as it was applied in previous research, due to a small market, having a low number of questionnaire participants is enough to perform the VASMA criteria weighting methodology and its modifications.

The data collected from the VAS matrix was automatically converted into a data matrix, with columns representing the set of criteria and rows indicating the ID of experts. The matrix labeled Table 3.23 was utilized for subsequent calculations and analysis.

Table 3.23. Collected data from VAS matrix question (source: found by the author)

ID	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
1	82	45	59	34	40	56	72	84	87	75	84
2	37	38	68	35	70	35	75	73	63	59	85
3	62	37	59	40	42	61	76	72	77	81	88
4	75	44	74	61	60	61	92	65	79	77	89
5	71	40	70	64	37	61	67	78	79	69	89
…	…	…	…	…	…	…	…	…	…	…	…
15	82	82	68	62	73	75	65	86	77	73	86
16	65	43	60	35	65	65	67	83	74	74	85
17	67	27	44	74	61	63	68	68	63	74	83
18	82	67	58	39	72	67	70	71	63	75	77
19	65	34	60	74	63	68	60	74	74	75	87

The descriptive statistics of the data obtained from the VAS matrix were computed using a statistical software tool and are provided in Table 3.24. All 19 experts who participated in the questionnaire assessed all the criteria.

Table 3.24. Descriptive statistics of selected criteria from the online expert questionnaire (source: found by the author)

ID	Criteria	Mean	Median	SD	Min	Max	Count
D1	Operational costs	71.74	72	11.79	37	87	19
D2	Marketing costs	46.89	41	15.72	27	82	19
D3	Development costs	60.79	63	11.91	31	76	19
D4	Potential losses due to the volatility of cryptocurrency	56.42	62	15.09	34	74	19
D5	Potential losses due to the exchange rate	55.68	61	13.76	34	73	19
D6	Bigger market size	58.95	61	13.91	33	80	19

End of Table 3.24

ID	Criteria	Mean	Median	SD	Min	Max	Count
D7	Investment success (trading activity, portfolio diversification, investments in lottery-type tokens)	68.26	70	13.60	35	92	19
D8	Complex regulations associated with cryptocurrencies in different countries	72.26	72	8.05	62	86	19
D9	No law that can force crowdfunding users to respect all terms of funding	70.11	69	7.29	59	87	19
D10	Storage of required documents using blockchain technology	73.00	74	6.30	59	83	19
D11	Cybersecurity risks	86.58	87	4.03	77	93	19

Entropy weights consistently encompass the objective component of the VASMA weighting algorithm. A decision matrix was created using the initial data matrix. The entropy matrix is organized so that each column represents a distinct set of criteria, while each row corresponds to the various possible values of VAS. The entropy weights and ranks were computed from the decision matrix and are presented in Table 3.25. The precise calculation of these weights was described in (Lescauskiene et al., 2020).

Table 3.25. Entropy weights calculated from expert questionnaire data for selected criteria (source: found by the author)

Entropy weights	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
El(p)	0.54	0.68	0.61	0.51	0.62	0.55	0.66	0.46	0.43	0.47	0.27
Wl	0.46	0.32	0.39	0.49	0.38	0.45	0.34	0.54	0.57	0.53	0.73
Rank	6	11	8	5	9	7	10	3	2	4	1

The WASPAS-SVNS weights approach is a component of the multi-criteria decision-making process, specifically addressing the subjective aspect of the VASMA weighting methodology. A secondary matrix is constructed based on the initial data matrix to compute the weights for WASPAS-SVNS. The complete process of constructing the matrix and calculating the weights can be found in (Lescauskiene et al., 2020). The weights of WASPAS-SVNS are specifically designed as the scoring function for generalized criteria and may be found in Table 3.26. The weights are also displayed in the rankings.

Table 3.26. WASPAS-SVNS weights calculated from expert questionnaire data for selected criteria (source: found by the author)

WASPAS-SVNS weights	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
S(Qi)	0.76	0.59	0.72	0.68	0.68	0.72	0.75	0.76	0.76	0.77	0.80
Rank	5	11	7	9	10	8	6	3	4	2	1

The VASMA weights were derived by multiplying the weights obtained using the Entropy and the WASPAS-SVNS methods and dividing the result by the sum of the multiplications. The whole equation and complete calculation of VASMA weights can be found in the research conducted by Lescauskiene et al. in 2020. The weights and ranks of the VASMA are provided in Table 3.27.

Table 3.27. Final VASMA weights and ranks for selected criteria of blockchain technology (source: found by the author)

ID	Criteria	VASMA	Rank
D1	Operational costs	0.092	5
D2	Marketing costs	0.049	11
D3	Development costs	0.073	8
D4	Potential losses due to the volatility of cryptocurrency	0.088	6
D5	Potential losses due to the exchange rate	0.068	9
D6	Bigger market size	0.085	7
D7	Investment success (trading activity, portfolio diversification, investments in lottery-type tokens)	0.067	10
D8	Complex regulations associated with cryptocurrencies in different countries	0.108	3
D9	No law that can force crowdfunding users to respect all terms of funding	0.113	2
D10	Storage of required documents using blockchain technology	0.106	4
D11	Cybersecurity risks	0.152	1

The data in Table 3.27 indicate that the primary factors of significance for employees of crowdfunding platforms are Cybersecurity risks (D11) with a weight of 0.152, the absence of laws that can compel crowdfunding users to adhere to all funding terms (D9) with a weight of 0.113, and the intricate regulations linked to cryptocurrencies in various countries (D8) with a weight of 0.108. These

factors hold the top three positions in terms of rankings across all the criteria. Conversely, the criteria with the most minor significance are Marketing costs (D2), Investment success (D7), and Potential losses owing to the exchange rate (D5). Their ranks are the lowest, with weights of 0.049, 0.067, and 0.068, respectively.

3.5. Conclusions of the Third Chapter

1. The third chapter summarized the results of four studies that were conducted in this dissertation. All the studies were made from the viewpoint of either an investor in crowdfunding campaigns or a crowdfunding platform. As it was found, blockchain technology impacts crowdfunding platforms and their structure but does not affect investors' decisions. Investors are more interested in criteria related to the crowdfunding campaign but not how the crowdfunding platform is built technically.
2. The first research analyzed the revenues of crowdfunding platforms. Initially, an assessment was conducted on the Kickstarter crowdfunding platform to determine the overall number of established projects. The results revealed that only 38% of these initiatives could secure funding from investors. Kickstarter crowdfunding platform proposes fifteen different investment categories; only three are the most successful and popular: technology (USD 1.05 billion), Games (USD 1.49 billion), and Design (USD 1.27 billion). The analysis disclosed that these three most important categories together gain 69% of successful funding. After identifying the most valuable investment categories, it was decided to calculate fees from successfully financed campaigns. These fees were regarded as the crowdfunding platform's primary income source. An ARIMA model was explicitly developed to forecast the income of a crowdfunding website. The investigation revealed that the optimal values for the parameters were $p = 1$, $d = 0$, and $q = 1$. As a result, the final ARIMA model was determined to be ARIMA (1,0,1). The ARIMA model was constructed using the Python statistical program. The forecast illustrates that the revenues of crowdfunding platforms will continue to grow in the most valuable investment categories. Therefore, investors should support technology, games, and design categories the most, while crowdfunding platforms should pay more attention to them when selecting new projects to launch in the crowdfunding platform.
3. The second research discovered success criteria and their evaluation for crowdfunding campaigns from the perspective of investors. Success criteria were identified in different forms of crowdfunding, venture capital or business angels' theory, and e-commerce literature. Overall, 15 success criteria

were found from crowdfunding theory, six from venture capital and business angel theory, and three risk groups were added as possible success criteria for investors. To complete, the whole list of 24 success criteria was described in this research. Later, the list of success criteria was shortened to 14 success criteria and applied to the expert questionnaire for further evaluation. The VASMA weighting algorithm was utilized to evaluate the criteria that impact investors' investment decisions the most. The VASMA weighting system combines entropy weights and the WASPAS-SVNS multi-criteria decision-making method. This methodology can encompass both the objective and subjective aspects of criteria weighting. The research findings indicated that the three criteria of risk (risks associated with the project (A12), project initiator risk (A13), and intermediary risk (A14)) were the most important to investors. These criteria received the highest rankings and VASMA weights of 0.1231, 0.1106, and 0.1052, respectively. These results were highly anticipated as they align with investment theory. Conversely, environment commitments (A5) with a VASMA weight of 0.0381, social media (A4) with a VASMA weight of 0.0408, or campaign video (A8) with a VASMA weight of 0.0418 were the least crucial for investors.

4. The third research concentrated on the main success factors impacting investors' decision to invest in blockchain-based crowdfunding platform campaigns. The online expert questionnaire was distributed to a specific demographic of investors participating in blockchain-based crowdfunding campaigns. In addition, a thorough expert assessment was conducted before distributing the questionnaire. This was done to analyze the division of factor groups and determine the significance of each sub-group's success factors in blockchain-based crowdfunding campaigns. This evaluation revealed that the first criteria subgroup valid for financial and blockchain-based crowdfunding (normalized DR weight 0.58) is more vital than the second sub-criteria group with a normalized DR weight of 0.42. It is typically a case when one criteria group is more important than the other. Thus, by assigning distinct weights to each data set, two independently evaluated sets of criteria can be meticulously combined and compared. The modified VASMA-L weighting methodology helped to do this. The research revealed that the primary determinant for successful investment in a blockchain-based crowdfunding campaign is the industry in which it operates, as shown by the VASMA-L weight of 0.0779. Investor interest levels in crowdfunding campaigns can vary depending on the sector. This aligns with another survey in which specific campaign industry sectors were selected as the most favored by investors (Venslavienė & Stankevičienė, 2021). According to the results, the two most important success factors are early investments (B5) and share of retained equity/token (B6), as they have the highest ranks and highest VASMA-L weights (0.0675

and 0.0643, respectively). Interestingly, all three of the most important success factors fall into the first criteria set. The criteria for success, as determined by the VASMA-L methodology rankings, might be highly valuable for picking financial and blockchain-based crowd-funding projects to invest in. In contrast, the criteria of Using Ethereum (BA2), KYC/Pre-registration (BA5), and White paper availability, content, and multi-language (BA11) are considered to be the least important, with VASMA-L weights of 0.0425, 0.0442, and 0.0474, respectively. The results of this research also contributed to academic literature, as the main strength of this research was its unique VASMA-L methodology for choosing success factors from multiple criteria sets for investment in crowdfunding campaigns.

5. The fourth research of this dissertation discovered critical criteria that impact the decisions of crowdfunding platforms. On this occasion, the interview focused exclusively on employees working on crowdfunding platforms. Once again, the VASMA weighting mechanism was utilized. The results indicate that the key factors for implementing blockchain technology are primarily related to cybersecurity risks (D11) with a VASMA weight of 0.152, the absence of specific laws to comply with all funding terms (D9) with a VASMA weight of 0.113, and complex cryptocurrency regulations in various countries (D8) with a VASMA weight of 0.108. These results may be anticipated based on the architecture of the crowdfunding site. Conversely, the criteria with the most minor significance are Marketing costs (D2), Investment success (D7), and Potential losses resulting from the exchange rate (D5). Their ranks are the lowest, with VASMA weights of 0.049, 0.067, and 0.068, respectively. This research demonstrates blockchain technology's capacity to support crowdfunding platforms through several means. First, this research illustrates that blockchain technologies offer an alternate foundation for crowdfunding sites. Furthermore, the results of this research provide evidence that implementing blockchain technology in crowdfunding can facilitate its growth and enhance the integrity and reliability of crowdfunding platforms (Ahluwalia et al., 2020; Zhao et al., 2017). However, additional endeavors are necessary to ascertain the full potential of blockchain technology and its practical implementation (Chang et al., 2020; Hartmann et al., 2019).
6. Several research limitations were found in this research. Different ARIMA models could be built with different data interpretations and with more extended data periods. Moreover, this research considered only the views of investors and crowdfunding platforms, while project owners' views were not investigated. As blockchain-based crowdfunding is a narrow and specific form of investment, a limited number of experts is available. Finally, the modified VASMA-L criteria weighting method can examine more criteria groups

simultaneously, but only two criteria subgroups were applied for expert evaluation. In the future, it would be valuable to check campaign owners' and investors' choices in different contexts, such as developing countries, legal support for blockchain-based technology crowdfunding platforms with or without regulations, and whether blockchain technology might impact their decisions. Furthermore, it would be worth repeating this research after several years when blockchain-based crowdfunding will be more widespread in the market with more investors.

General Conclusions

1. The present research discussed the impact of blockchain on crowdfunding and how to assess it. It proposed a theoretical framework for evaluating the blockchain's impact on crowdfunding. The framework suggested assessing the blockchain's impact from the perspectives of investors and crowdfunding platforms, leaving crowdfunding campaign owners' perspectives aside for future research. Blockchain technology and crowdfunding are essential segments of financial technology. Financial technologies, or FinTech, have recently become significant in the financial sector. This research looked deeper into crowdfunding evolution, definitions, growth, different forms of crowdfunding, investment risks in crowdfunding campaigns, and the main success factors. Moreover, this research analyzed another critical segment of FinTech – blockchain technology, its definitions and characteristics. Overall, blockchain-enabled entrepreneurs create and distribute tokens for fundraising. While deliberating on blockchain technology, it focused more deeply on blockchain-based crowdfunding and its importance for crowdfunding platforms and investors. Possible success factors for investing in blockchain-based crowdfunding were identified and analyzed.
2. The second part of this dissertation discussed the data and the methodology used in four central studies. The data was taken from various literature sources, surveys, expert opinions, and the crowdfunding platform Kickstarter.

The first research analyzed the revenues of the crowdfunding platform Kickstarter; thus, the data was mainly collected from this platform. Moreover, the second research analyzed success factors in investing in crowdfunding campaigns. Hence, the data was found in the literature considering venture capital, business angels' theory, and crowdfunding theory. In addition, the risk factors considered were based on the e-commerce theory. The third research discovered the possible success factors of investing in blockchain-based crowdfunding campaigns. To be precise, the found factors were split into two groups. These groups were evaluated separately and ultimately compared to determine the most critical factors. The last research examined the blockchain-specific factors that impact crowdfunding platforms.

3. Moreover, the developed model for assessing the blockchain's impact on crowdfunding involves three methods applied in this dissertation. The first method was the ARIMA model, which helped forecast possible revenues for the crowdfunding platform in the first research. The second method was the VASMA (VAS Matrix for criteria weighting) methodology. This methodology is a matrix question technique that helps to weight chosen criteria. VASMA syndicates both WASPAS-SVNS (subjective) weights and information entropy (objective) weights. The VASMA method was developed to decrease the uncertainties found in expert survey-based criteria evaluation. The VASMA methodology was used in the second and fourth studies of this dissertation. The third method was the modified VASMA-L criteria weighting technique. This method is a modification of the original VASMA criteria weighting methodology and is thus very similar. The main difference is that the VASMA-L criteria weighting methodology can be applied to extensive criteria sets by separating them into smaller subsets and comparing results to get the most significant factors of the entire criteria set. This modification of the VASMA weighting methodology is a novelty to scientific literature as it was created specifically for this research.
4. The third part of this dissertation reviewed the results of all four explored studies. The research was made from the perspective of investors on crowdfunding campaigns and crowdfunding platforms. The results concluded that blockchain affects crowdfunding platforms and their technical structure but does not impact investor decisions. The results from the first research revealed that only three out of fifteen are the most successful crowdfunding campaign categories on the Kickstarter platform. Those three categories (technology, games, and design) earn the highest funding, and the crowdfunding platform gets the highest revenues from them. The ARIMA (1,0,1) model was built and used in future revenue forecasts. The forecast results showed that the most successful crowdfunding campaign categories will remain successful, and revenues will continue to increase.

5. The results from the second research of this dissertation showed that of the fourteen success criteria for investing in crowdfunding campaigns, only related risk factors were the most important. To find this out, the VASMA criteria weighting methodology was selected for evaluation. This methodology is relatively new in scientific literature, and it is a combination of entropy (objective) weights and WASPAS-SVNS (subjective) multi-criteria decision-making method. Therefore, the evaluation revealed that all three criteria related to risk (risks associated with the project, project initiator risk, and intermediary risk) played the most significant role for investors as these criteria had the highest rankings and VASMA weights. These results were expected according to investment theory. On the other hand, environmental commitments, social media, and campaign videos were the least vital for investors.
6. The proposed modification of the VASMA criteria weighting methodology allows for evaluating success factors that impact investing decisions in blockchain-based crowdfunding platform campaigns. Therefore, the third research focused on this. Due to the extensive criteria set, it was split into two criteria sub-sets for better evaluation. Additionally, three experts assessed the importance of each criteria sub-set of blockchain-based crowdfunding campaigns. After the assessment, one criterion sub-set was more crucial than the other. Two separately evaluated criteria sets can be related by giving the appropriate weights for separate data sets. The modified VASMA-L weighting methodology was applied. Results revealed that the most critical success factors for investments in blockchain-based crowdfunding campaigns were industry, early investments, and share of retained equity/token with the highest ranks and VASMA-L weights. Interestingly, all three critical success factors fall into the first criteria set. On the other hand, the least essential criteria were using Ethereum, KYC/pre-registration, white paper availability, content, and multi-language. The results of this research also contributed to academic literature, as the main strength of this research was its unique VASMA-L methodology for choosing success factors from multiple criteria sets for investment in blockchain-based crowdfunding campaigns.
7. The results of the fourth research analyzed the blockchain-based criteria that impact the decisions of crowdfunding platforms. Again, the VASMA weighting technique was selected. The results specified that the most critical factors in implementing blockchain technology were related to cybersecurity risks, no specific laws to respect all terms of funding and complex cryptocurrency regulations in different countries. Considering the technical structure of the crowdfunding platform, these results could be expected. On the contrary, the least important criteria for crowdfunding platforms were marketing costs, investment success, and potential losses due to the exchange rate, which has the lowest ranks and VASMA weights.

8. The practical suitability of the evaluation model to assess the blockchain's impact on crowdfunding and empirical research methodology were implemented and tested in four studies of this research. The results show that blockchain technology impacts crowdfunding platforms and their technical structure. At the same time, investors do not see much difference in the impact of blockchain technology while investing in crowdfunding campaigns. This research proves that blockchain technology can support crowdfunding platforms in several ways. First, this research demonstrates that blockchain technologies provide an alternative base for crowdfunding platforms. Second, the findings of this research support the argument that blockchain applications can help the development of crowdfunding and improve the transparency and trustworthiness of crowdfunding platforms. Third, blockchain can help crowdfunding platforms reduce or eliminate intermediary costs and help expand the campaign's availability worldwide with simplified legal contracts and regulations.

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List of Scientific Publications by the Author on the Topic of the Dissertation

Papers in the Reviewed Scientific Journals

Venslavienė, Santautė; Stankevičienė, Jelena; Vaiciukevičiūtė, Agnė. Assessment of successful drivers of crowdfunding projects based on visual analogue scale matrix for criteria weighting method // Mathematics: Special Issue Multiple Criteria Decision Making. Basel: MDPI. ISSN 2227-7390. 2021, vol. 9, iss. 14, art. no. 1590, p. 1-18. DOI: 10.3390/math9141590.

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Summary in Lithuanian

Įvadas

Problemos formulavimas

Pagrindinė šios disertacijos tyrimo problema – kaip įvertinti blokų grandinės poveikį sutelktiniam finansavimui.

Blokų grandinės technologijos (angl. *blockchain technology*), kuriose saugomi tinkle paskirstyti informacijos blokai, yra vienos pažangiausių, užtikrinančių aukštą internetinių ekonominių sandorių atsekamumo ir saugumo lygį. Neabejotina, kad jos turės įtakos skaitmeninėms paslaugoms ir pakeis verslo modelius tokiose srityse kaip sveikatos priežiūra, draudimas, finansai, energetika, logistika, intelektinės nuosavybės teisių valdymas ar vyriausybinės paslaugos.

Finansinės technologijos (angl. *fintech*) yra Europos Komisijos, taip pat ir Lietuvos ekonominės politikos prioritetas (Ministry of Finance of the Republic of Lithuania, 2023), nes jos gali atlikti svarbų vaidmenį siekiant bendrosios rinkos, bankų sąjungos, kapitalo rinkų sąjungos ir mažmeninių finansinių paslaugų tikslų. Blokų grandinės technologija, būdama svarbi finansinių technologijų dalis, gali išspręsti naujų verslų finansavimo problemas ir gali būti viena iš naujų verslų finansavimo alternatyvų.

Kita svarbi finansinių technologijų dalis – sutelktinis finansavimas. Sutelktinis finansavimas (angl. *crowdfunding*) remiasi didelio skaičiaus asmenų įnašais, siekiant finansuoti konkretų projektą ar naują įmonę (Hussain et al., 2023; Mora-Cruz & Palos-Sanches,

2023). Jau kelios sutelktinio finansavimo platformos yra įdiegtos blokų grandinės pagrindu, jose už žmonių finansinius įnašus į projektą atlyginama realiomis projekto akcijomis.

Pastaruoju metu blokų grandine grindžiamas sutelktinis finansavimas tapo reikšmingu ekonominiu reiškiniu, o ypač 2017–2018 m. – svarbia įmonių finansavimo strategija (Ministry of Finance of the Republic of Lithuania, 2023). Blokų grandine grindžiamas sutelktinis finansavimas, kuriam atstovauja pirminių kriptovaliutų siūlymų, o pastaruoju metu – saugumo žetonų siūlymų srautas, tampa nauja sutelktinio finansavimo forma (Hartmann et al., 2019). Nors blokų grandine grindžiamas sutelktinis finansavimas labai panašus į tradicinį sutelktinį finansavimą, jis turi savų unikalių savybių. Todėl sėkmės veiksniai, turintys įtakos investicijoms į tradicinį sutelktinį finansavimą, gali netikti blokų grandine grindžiamam sutelktiniam finansavimui. Žinios apie sėkmės veiksnius yra svarbios norint suprasti pagrindinius įvairių sutelktinio finansavimo modelių skirtumus ir panašumus, parengti sėkmingas blokų grandine grindžiamas lėšų rinkimo kampanijas ir investuotojams atsižvelgti į konkrečius vertinimo veiksnius.

Šioje disertacijoje yra analizuojamas blokų grandinės poveikis sutelktiniam finansavimui. Konkrečiai, blokų grandinės svarba tiriama įvairiais aspektais, pavyzdžiui, investuotojų, sutelktinio finansavimo platformų ir sutelktinio finansavimo kampanijų požiūriu. Taikant minėtą vertinimo metodologiją siūlomas daugiakriteris vertinimas iš skirtingų kriterijų rinkinių, kai atrenkami ir palyginami geriausi veiksniai. Pagal šią svertinio vertinimo metodiką blokų grandinės technologija labiausiai veikia sutelktinio finansavimo platformas dėl mažesnių tarpininkavimo sąnaudų ir paprastesnio reglamentavimo.

Darbo aktualumas

Sutelktinis finansavimas yra neseniai atsiradęs ir vis dar besivystantis reiškinys, sulaukęs visuomenės susidomėjimo. Ypač išpopuliarėjo sutelktinio finansavimo platformos, kuriose skelbiamos projektų idėjos ir renkamos lėšos. Kadangi sutelktinio finansavimo populiarumas vis didėja, reikia rasti ir sumažinti visas investuotojams kylančias rizikas, kurios gali neigiamai paveikti ketinimą investuoti į vieną ar kitą sutelktinio finansavimo kampaniją. Vadovaujantis ta pačia logika, taip pat reikėtų surasti motyvuojančias vertybes, skatinančias investuoti į sutelktinio finansavimo projektą. Blokų grandinės technologija gali padėti sutelktiniam finansavimui sumažinti kai kurias rizikas, pašalinti finansinius tarpininkus, sušvelninti reikiamus tarptautinius teisės aktus ir padidinti vertę investuoti į sutelktinio finansavimo kampanijas. Svarbu pasiūlyti kompleksinį vertinimo modelį, kuris parodytų blokų grandinės poveikį sutelktiniam finansavimui. Vertinimo modelis gali padėti finansuotojams investuoti į konkrečias sutelktinio finansavimo kampanijas, o lėšų rinkėjams – lengviau gauti finansavimą.

Be to, ši disertacija yra labai svarbi mokslinei literatūrai, nes buvo pasiūlyta nauja daugiakriterio svėrimo metodikos modifikacija, leidžianti vienu metu vertinti ir lyginti kriterijus iš skirtingų kriterijų grupių rinkinių. Toks vertinimas leidžia iš visų galimų kriterijų grupių atrinkti tinkamiausius ir geriausius veiksnius.

Tyrimo objektas

Disertacijos tyrimų objektas yra blokų grandinės poveikis sutelktiniam finansavimui.

Darbo tikslas

Pagrindinis šios disertacijos darbo tikslas – sukurti ir empiriškai patikrinti integruotą blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelį, kurio taikymas leistų priimti racionalius investicinius sprendimus.

Darbo uždaviniai

Norint pasiekti disertacijos tikslą, buvo sprendžiami šie uždaviniai:

1. Parengti mokslinės literatūros analizę apie finansinių technologijų sampratą, sutelktinio finansavimo ir blokų grandinės technologijų raidą ir ypatumus.
2. Ištirti esamus galimus sutelktinio finansavimo platformų ir sutelktinio finansavimo kampanijų vertinimo sėkmės veiksnius, taip pat išanalizuoti sutelktinio finansavimo, kaip investavimo formos, riziką.
3. Sukurti blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelį, apimantį kiekybinius ir kokybinius metodus.
4. Pasiūlyti naują kriterijų svorių metodologijos modifikaciją esamam kriterijų svorių metodui.
5. Įgyvendinti ir patikrinti vertinimo modelio ir empirinio tyrimo metodikos praktinį tinkamumą.

Tyrimų metodika

Objektui tirti pasirenkami šie tyrimo metodai: kompleksinis, daugiakriteris sprendimų priėmimo vertinimas, lyginamoji analizė, kiekybiniai ir kokybiniai analizės metodai, modeliavimas, statistinių duomenų analizė ir kiti.

Teorinėje disertacijos dalyje, kurioje analizuojama mokslinė problema ir mokslinė literatūra, taikyti lyginamasis, apibendrinimo ir sisteminis metodai.

Antrojoje disertacijos dalyje, kurioje analizuojami blokų grandinės vertinimo metodai ir šaltiniai, taikyti moksliniai ir analitiniai metodai, taip pat kokybiniai ir kiekybiniai metodai.

Trečiojoje, empirinėje, disertacijos dalyje privalu sukurti ir patikrinti vertinimo modelį, taikant kiekybinio ir kokybinio vertinimo metodų derinį, prognozavimo (ARIMA), taip pat daugiakriterius sprendimų priėmimo metodus (VASMA, VASMA-L), kurie apima tiek subjektyvias, tiek objektyvias kriterijų svorio dalis ir ekspertinį vertinimą rezultatams aprobuoti.

Darbo mokslinis naujumas

Rengiant šią daktaro disertaciją buvo pasiekti šie ekonomikos mokslui reikšmingi rezultatai:

1. Sėkmės veiksnių kategorijos kriterijų vertinimo metodams buvo paimtos iš sutelktinio finansavimo teorijos, rizikos kapitalo ir verslo angelų teorijos bei elektroninės komercijos teorijos. Be to, e. komercijos ir sutelktinio finansavimo palyginimas yra labai svarbus ir unikalus, o kaip galimi sėkmės veiksniai pridėtos

kelios rizikos kategorijos, kurios anksčiau mokslinėje literatūroje rašant apie sutelktinį finansavimą nebuvo nagrinėtos: su projektu susijusi rizika, su projekto iniciatoriumi susijusi rizika ir su tarpininku susijusi rizika.

2. Naujasis siūlomas blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelis yra orientuotas į investuotojų, sutelktinio finansavimo platformų ir sutelktinio finansavimo kampanijų savininkų tikslus. Modelyje taikomos tokios modeliavimo priemonės kaip ARIMA – sutelktinio finansavimo pajamoms prognozuoti, o VASMA ir VASMA-L kriterijų svorių metodų taikymas padeda sistemingai įvertinti blokų grandinės įtaką sutelktiniam finansavimui, atrenkant aktualiausius sėkmės veiksnius.
3. Siūloma nauja esamos VASMA kriterijų svorių metodikos modifikacija yra unikali ir yra naujovė mokslinėje akademinėje literatūroje, nes buvo sukurta specialiai šiam tyrimui. Šio modifikuoto VASMA-L kriterijų svorių nustatymo metodo unikalumas yra tas, kad jis gali būti taikomas didelėms daugialypėms kriterijų aibėms, išskiriant jas į mažesnius poaibius, o vėliau lyginant rezultatus visus kartu, kad būtų gauti reikšmingiausi visos kriterijų aibės veiksniai.

Praktinė tyrimo rezultatų vertė

Siūlomas blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelis siūlo investuotojams, sutelktinio finansavimo platformoms ir sutelktinio finansavimo kampanijų savininkams nustatyti sėkmės veiksnių kriterijų svorį.

Šio tyrimo išvados rodo, kad blokų grandinės technologija neturi poveikio individualiems investiciniams sprendimams dėl blokų grandine pagrįsto ar finansinio sutelktinio finansavimo kampanijų. Jiems svarbiausi yra rizikos veiksniai ir kiti su sutelktinio finansavimo kampanijomis susiję veiksniai, bet ne techninės sutelktinio finansavimo platformų specifikacijos.

Kita vertus, šis tyrimas rodo, kad blokų grandinės technologija daro poveikį sutelktinio finansavimo platformoms keliais būdais. Pirma, blokų grandinės technologijos sutelktinio finansavimo platformoms suteikia kitokį pagrindą. Antra, blokų grandinės programos gali padėti plėtoti sutelktinį finansavimą ir padidinti sutelktinio finansavimo platformų patikimumą ir skaidrumą. Trečia, blokų grandinės gali padėti sutelktinio finansavimo platformoms sumažinti ar net panaikinti tarpininkavimo išlaidas ir padėti išplėsti kampanijų prieinamumą visame pasaulyje, supaprastinus teisines sutartis ir taisykles.

Ginamieji teiginiai

Šio tyrimo rezultatais pagrįsti teiginiai:

1. Blokų grandinės poveikio sutelktiniam finansavimui vertinimas iš investuotojų ir sutelktinio finansavimo platformų perspektyvų, remiantis veiksnių kompleksu, kartu leidžia geriau suprasti kiekvienos dalies indėlį į sutelktinio finansavimo sėkmę.
2. Siūlomas blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelis, apimantis tokias modeliavimo priemones kaip ARIMA (sutelktinio finansavimo pajamoms prognozuoti) ir VASMA, VASMA-L kriterijų svėrimo metodus

(tinkamiausiems sėkmės veiksniams atrinkti), leidžia sistemiškai įvertinti blokų grandinės poveikį sutelktiniam finansavimui.

3. Siūlomas unikalus modifikuotas VASMA-L kriterijų svorių nustatymo metodas gali būti taikomas didelėms daugialypėms kriterijų grupėms, siekiant rasti ir atrinkti reikšmingiausius visos kriterijų grupės veiksnius.

Darbo rezultatų aprobavimas

Disertacijos tema buvo nagrinėjama keturiose mokslinėse publikacijose *Scopus* ir *Clarivate Analytics Web of Science* duomenų bazėse (Venslavienė ir Stankevičienė, 2021; Venslavienė ir kt., 2021; Venslavienė ir kt., 2023a; Venslavienė ir kt., 2023b). Tyrimų rezultatai buvo pristatyti trijuose pranešimuose mokslinėse konferencijose ir seminaruose:

- Tarptautinėje mokslinėje konferencijoje „Šiuolaikiniai verslo, vadybos ir ekonomikos inžinerijos klausimai 2021“, Vilnius, Lietuva.
- Tarptautinis kolokviumas „Nauji moksliniai-didaktiniai iššūkiai turbulencijos laikotarpiu“, 2021 m., Bialystok, Lenkija.
- Tarptautinė taikomojo verslo ir ekonomikos konferencija 2022 m., 18-oji laida: Mišri konferencija, Maltos universitetas, 2022 m., Valeta, Malta.

Disertacijos struktūra

Disertaciją sudaro trys pagrindiniai skyriai: įvadas, trys skyriai su bendromis išvadomis ir rekomendacijomis dėl tolesnių tyrimų, išsamus literatūros sąrašas ir priedai. Apibendrinta disertacijos loginė struktūra pateikta D priede (Annex D).

Disertacijos apimtis yra 125 puslapiai, įskaitant santrauką, tačiau be priedų. Joje pateikta 13 formulių, 12 paveikslų ir 36 lentelės. Rengiant disertaciją iš viso naudotasi 198 literatūros šaltiniais.

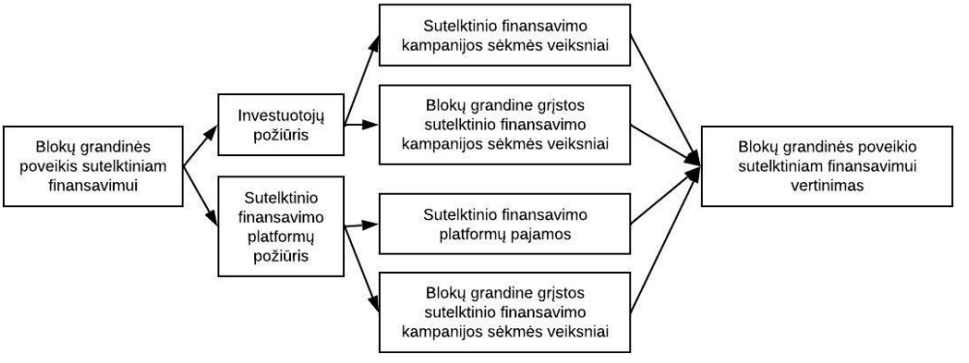
1. Literatūros šaltinių disertacijos tematika apžvalga

Nors pirmajame skyriuje daugiausia aptarta literatūra apie sutelktinį finansavimą, svarbu paminėti, kad sutelktinis finansavimas kartu su blokų grandinės technologija yra finansinių technologijų dalis. Finansinės technologijos, arba *fintech*, yra labai svarbios šiuolaikinėje finansų sistemoje. Kadangi sutelktinis finansavimas ir blokų grandinė yra vienos svarbiausių finansinių technologijų sektoriaus dalių, buvo nuodugniai apžvelgta sutelktinio finansavimo sąvoka, augimo veiksniai ir formos (European Commission, 2016; Kumar et al., 2024; Wati & Winarno, 2018). Literatūroje yra minimos keturios pagrindinės sutelktinio finansavimo formos, iš kurių daugiausiai dėmesio buvo skiriama finansiniam sutelktiniam finansavimui. Be to, buvo atrasti pagrindiniai sėkmės veiksniai, skatinantys investuoti į sutelktinio finansavimo kampanijas.

Vėliau rasta ir išanalizuota blokų grandinės technologijos sąvoka ir ypatybės. Satoshi Nakamoto sukūrė blokų grandinę 2008 m. Manoma, kad Satoshi Nakamoto buvo 1974 m. gimęs japonas. Kiti mano, kad šis vardas tėra mįslingas nežinomos kūrėjų grupės pseudonimas (Faustino et al., 2022). Nors ir lieka paslaptimi, kas yra Satoshi Nakamoto, jis ne

tik sugalvojo tokią sudėtingą sistemą, bet ir pateikė visų dabartinės pinigų sistemos problemų sprendimo būdą (Sahani et al., 2020). Apskritai blokų grandinė suteikė verslininkams galimybę kurti ir platinti lėšų rinkimo žetonus. Blokų grandinės technologija siūlo daugumos sutelktinio finansavimo problemų sprendimą, todėl jos taikymo praktika auga su santykiniu investuotojų pasitikėjimu ir pasyviu vyriausybių pritarimu. Blokų grandinės technologija keliais būdais palengvina sutelktinį finansavimą kaip saugi, veiksminga ir įperkama platforma (De Filippi, 2016; Rikken et al., 2023). Pirma, sistema pašalina pinigų plovimo, sukčiavimo ir informacijos asimetrijos grėsmes. Tai taip pat padidina sutelktinio finansavimo proceso efektyvumą, nes investuotojai gali greičiau įvertinti juos dominančius finansuoti projektus (Wan et al., 2023). Sandorių ir lėšų paprastumas naudojant blokų grandinės technologiją yra paskata rėmėjams ir sutelktinio finansavimo platformoms. Todėl blokų grandine grindžiamas sutelktinis finansavimas ir jo investicijų sėkmės veiksniai buvo tiriami nuodugniau.

Pirmojo skyriaus pabaigoje buvo pateikta teorinė koncepcija, skirta blokų grandinės poveikiui sutelktiniam finansavimui įvertinti. Teorinėje koncepcijoje pasiūlyta įvertinti blokų grandinės poveikį sutelktinio finansavimo platformų ir investuotojų (rėmėjų) požiūriu. Blokų grandinės poveikio vertinimas grindžiamas keliais aspektais. Pirma, blokų grandinės poveikis sutelktiniam finansavimui turėtų būti analizuojamas iš investuotojų pusės. Reikėtų surasti ir išanalizuoti kritinius veiksnius, kurie daro įtaką investuotojų sprendimams investuoti į vieną ar kitą sutelktinio finansavimo kampaniją. Šis aspektas yra dvejopas: a) atrandami bendrieji veiksniai ir b) turėtų būti įvertinti veiksniai, susiję su blokų grandine grindžiamu sutelktiniu finansavimu. Vėliau reikėtų išanalizuoti blokų grandinės poveikį sutelktiniam finansavimui iš sutelktinio finansavimo platformos pusės. Šis aspektas yra taip pat dvejopas: a) bus analizuojamos sutelktinio finansavimo platformos pajamos ir b) svarbiausi veiksniai, darantys įtaką blokų grandine pagrįstų sutelktinio finansavimo platformų veiklos rezultatams. Schematinė sistema pateikta S1.1 pav.



S1.1 pav. Blokų grandinės poveikio sutelktiniam finansavimui vertinimo sistema

2. Blokų grandinės poveikio sutelktiniam finansavimui vertinimo metodika

Antrajame skyriuje nagrinėjama blokų grandinės poveikio sutelktiniam finansavimui vertinimo metodika. Aptartoje literatūroje siūloma blokų grandinės poveikio vertinimo koncepcija. Ją sudaro kelios dalys. Kiekvieną sutelktinio finansavimo kampaniją sudaro projektas, investuotojai ir tikslas. Paprastai investuotojai, projekto savininkai ir sutelktinio finansavimo platformos turi skirtingus sutelktinio finansavimo kampanijos tikslus. Šiame tyrime skirtingi tikslai bus analizuojami iš investuotojų arba rėmėjų ir sutelktinio finansavimo platformų perspektyvos, o projektų savininkų tikslus paliksime ateities tyrimams.

Atlikus literatūros analizę nustatyta, kad blokų grandinės poveikį sutelktiniam finansavimui geriausia būtų vertinti taikant daugiakriterinius sprendimų priėmimo metodus (MCDM). Daugiakriterinis sprendimų priėmimas yra svarbi sprendimų priėmimo problema, kuria siekiama nustatyti optimalią alternatyvą, atrankos proceso metu atsižvelgiant į daugelį kriterijų (Barretta et al., 2023). Daugiakriteriniai sprendimų priėmimo (MCDM) metodai dažnai taikomi dėl jų gebėjimo tvarkyti neaiškius duomenis, todėl specialistai gali svarstyti platesnį scenarijų spektrą (Więckowski et al., 2023).. Nagrinėjant blokų grandinės reikšmę ir potencialą, susijusį su sutelktiniu finansavimu, sunku nustatyti tinkamiausią MCDM metodą disertacijos temai spręsti dėl daugybės galimų variantų.

Sprendimų priėmimo procesas yra labai sudėtingas procesas, kurį galima suskirstyti į racionalius ir nelogiškus. Jį veikia keletas veiksnių, įskaitant fiziologinius, biologinius, kultūrinius ir socialinius elementus. Be to, sprendimai gali būti priimami remiantis ir kokybiniais, ir kiekybiniais kriterijais (Barretta et al., 2023; Hashemi et al., 2022; Więckowski et al., 2023; Zavadskas et al., 2022). Kiekvieną sprendimų priėmimo procesą pagal MCDM metodą sudaro trys pagrindiniai etapai: (1) kriterijų nustatymas ir atranka, (2) kriterijų svorių nustatymas ir (3) kriterijų reitingavimas taikant tinkamą MCDM metodą. Galutinėms kriterijų svorių reikšmėms įtakos gali turėti skirtingi metodikų pasirinkimai, nuomonių įvairovė, vertinimo proceso skaidrumas arba sprendimus priimančių asmenų kompetencija (Leskauskienė et al., 2020). Be to, kai į sprendimų priėmimą įtraukiama visuomenė, nustatoma, kad jos nuomonė skiriasi nuo ekspertų vertinimo, ir tai gali lemti preferencijų nustatymo rezultatų netikslumą.

Apskritai, kai dalyvių prašoma pateikti vertinimus apie daugelį vieno dalyko aspektų, rekomenduojama visus klausimyno punktus pateikti kartu ir suformuoti kaip matricinius klausimus. Matricos tipo klausimai gali būti naudojami norint surinkti pastabas apie pasitenkinimą, kokybę ir tiriamų dalykų svarbą (Leskauskienė et al., 2020). Be to, dėl lengvo matricinio klausimo elementų palyginimo gali padidėti tiesioginio svėrimo metodų tikslumas. Matricos klausimai vertinami naudojant pasirinktą matavimo skalę. Šioje disertacijoje matricos klausimai bus vertinami tęstinių skalių arba vizualinių analoginių skalių (VAS) pagalba.

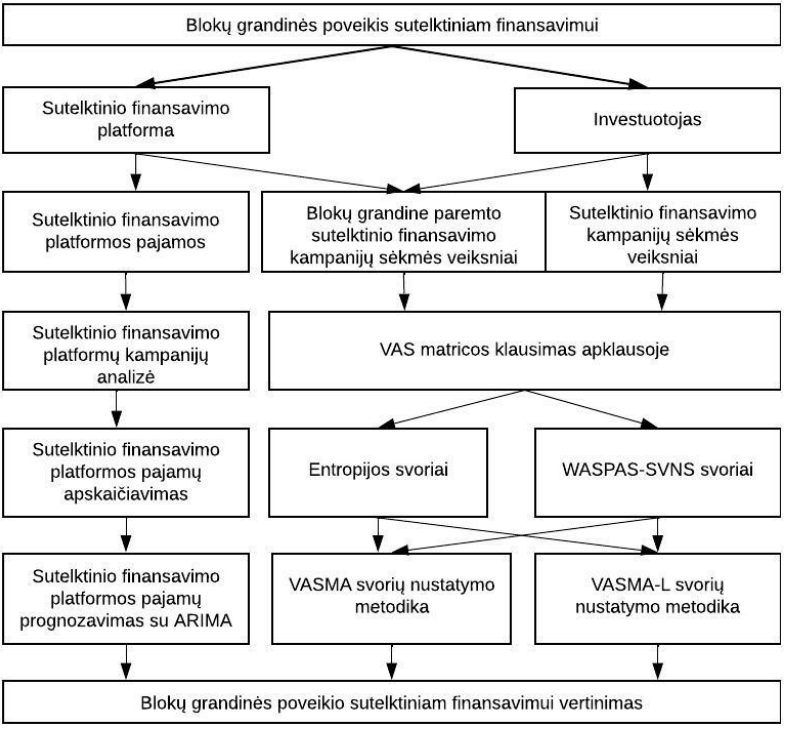
Kadangi subjektyviems vertinimams įtakos turi ekspertų patirtis ir žinios, dažniausiai nustatant subjektyvius svorius neatsižvelgiama į objektyvią informaciją. Todėl, siekiant gauti tikslesnius kriterijus atitinkančių svorių rezultatus, taikomi integruoti svorių nustatymo metodai. Integruotieji metodai paprastai sujungia subjektyvius svorius, gautus iš ekspertų nuomonių, su matematiniais duomenų atvaizdais (objektyviais svoriais). Šioje

disertacijoje bus naudojamas VASMA metodas, kuris integruoja ir objektyvius, ir subjektyvius svorius iš to paties klausimyno duomenų. VASMA kriterijų svorių nustatymas ir jo modifikacijos (VASMA-L, VASMA-C) plačiai taikomi socialiniuose, ekonominiuose ar aplinkosaugos tyrimuose (Zavadskas et al., 2022).

Investuotojų požiūriu bus pasirinkti VAS matricos klausimai tikslinių respondentų apklausoje, klausimai bus pritaikyti VASMA svorių nustatymo metodikoje. VASMA svorių nustatymo metodika bus taikoma siekiant išsiaiškinti investuotojams svarbiausius kriterijus, renkantis sutelktinio finansavimo kampanijas. Dar daugiau – modifikuota VASMA-L svorių nustatymo metodika bus taikoma siekiant patikrinti, kokie kriterijai investuotojams yra svarbiausi renkantis blokų grandine grindžiamą sutelktinio finansavimo platformą ir kampanijas.

Žvelgiant iš sutelktinio finansavimo platformų perspektyvos, bus pasirinkta analizuoti svarbiausią jų tikslą – pajamas. Pajamos bus skaičiuojamos iš trijų sėkmingiausių ir pelningiausių sutelktinio finansavimo kampanijų kategorijų. Pajamos bus prognozuojamos taikant ARIMA modelį. Be to, siekiant nustatyti svarbiausius sutelktinio finansavimo platformų veiksnius, kai sutelktinio finansavimo platforma yra pagrįsta blokų grandine, bus pasirinkta VASMA kriterijų svorio nustatymo metodika.

Toliau pateiktame S2.1 pav. schematiškai apibendrinami visi šios disertacijos tyrimai.



S2.1 pav. Blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelis

Tolesnėse šios disertacijos dalyse turėtų būti laikomasi šio scheminio modelio (S2.1 pav.), atsižvelgiant į sutelktinio finansavimo platformų sprendimus ir investuotojų (rėmėjų) sprendimus, o projektų savininkų sprendimus paliekant būsimiems tyrimams.

3. Blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelio įgyvendinimas ir testavimas

Trečiajame skyriuje buvo įgyvendintas ir išbandytas praktinis vertinimo modelio tinkamumas blokų grandinės poveikiui sutelktiniam finansavimui vertinti keturių tyrimų pagrindu. Tyrimai buvo analizuojami iš investuotojų į sutelktinio finansavimo kampanijas perspektyvos ir iš sutelktinio finansavimo platformų perspektyvos.

Pirmajame disertacijos tyrime buvo analizuojamos sutelktinio finansavimo platformų pajamos. Pirmiausia buvo įvertintas bendras pradėtų kampanijų skaičius sutelktinio finansavimo platformoje *Kickstarter* ir nustatyta, kad investuotojai sėkmingai finansuoja tik 38 % kampanijų. *Kickstarter* sutelktinio finansavimo platformoje iš penkiolikos kampanijų kategorijų tik trys yra sėkmingiausios – technologijos (1,05 mlrd. dolerių), žaidimai (1,49 mlrd. dolerių) ir dizainas (1,27 mlrd. dolerių). Analizė atskleidė, kad šios trys svarbiausios kategorijos kartu sudaro 69 % sėkmingo finansavimo. Nustačius vertingiausias investicijų kategorijas, nuspręsta apskaičiuoti mokesčius, kurie imami iš sėkmingai finansuotų kampanijų. Šie mokesčiai buvo laikomi pagrindinėmis sutelktinio finansavimo platformos pajamomis. Siekiant prognozuoti sutelktinio finansavimo platformos pajamas, buvo nustatytas ir sudarytas ARIMA modelis. Tyrimo metu nustatyta, kad geriausiai tinka $p = 1$, $d = 0$, $q = 1$; taigi galutinis ARIMA modelis buvo ARIMA (1,0,1). ARIMA modelis buvo sudarytas naudojant *Python* statistinę programinę įrangą.

Antrajame tyrime nustatyti sutelktinio finansavimo kampanijų sėkmės veiksniai ir jų vertinimas iš investuotojų perspektyvos. Sėkmės veiksniai buvo nustatyti įvairių formų sutelktinio finansavimo, rizikos kapitalo ar verslo angelų teorijoje, taip pat elektroninės prekybos literatūroje. Iš viso nustatyta 15 sėkmės veiksnių iš sutelktinio finansavimo teorijos, 6 sėkmės veiksniai iš rizikos kapitalo ir verslo angelų teorijos ir galiausiai pridėtos 3 rizikos grupės kaip galimi investuotojų sėkmės veiksniai iš elektroninės prekybos teorijos. Pabaigoje iš aprašyto 24 sėkmės veiksnių sąrašo buvo pasirinkta 14 sėkmės veiksnių, kurie ir buvo pritaikyti ekspertų klausimyne tolesniam vertinimui (Cai, 2018; Chang et al., 2020). Šiam vertinimui buvo taikyta VASMA svorių nustatymo metodika. VASMA svorių nustatymo metodika sudaryta iš informacijos entropijos (objektyvi dalis) svorių ir daugiakriterio sprendimų priėmimo metodo WASPAS-SVNS (subjektyvi dalis) svorių (Lescauskiene et al., 2020). Tyrimo rezultatai atskleidė, kad visi trys su rizika susiję veiksniai (su projektu susijusi rizika (A12), projekto iniciatoriaus rizika (A13) ir tarpininko rizika (A14) investuotojams buvo svarbiausi, nes šie kriterijai buvo įvertinti aukščiausiais balais ir VASMA svoriais.

Trečiajame tyrime daugiausia dėmesio skirta pagrindiniams sėkmės veiksniams, darantiems įtaką investuotojų sprendimui investuoti į blokų grandine paremtas sutelktinio finansavimo platformos kampanijas. Internetinis ekspertų klausimynas buvo išsiųstas konkrečiai tikslinei blokų grandine paremtų sutelktinio finansavimo kampanijų investuotojų grupei. Be to, prieš klausimyną buvo taikomas ekspertinis vertinimas dėl veiksnių

grupės suskirstymo ir kiekvieno blokų grandine pagrįstų sutelktinio finansavimo kampanijų sėkmės veiksnių pogrupio svarbos. Šis vertinimas atskleidė, kad pirmasis kriterijų pogrupis, kuris galioja tiek finansiniam, tiek blokų grandine paremtam sutelktiniam finansavimui (normalizuotas DR svoris 0,58), yra svarbesnis už antrąją veiksnių grupę, kurios normalizuotas DR svoris 0,42. Paprastai tai dažnas atvejis, kai viena kriterijų grupė yra svarbesnė už kitą. Todėl, taikant konkrečius svorius atskiroms duomenų grupėms, dvi atskirai įvertintas kriterijų grupes galima kruopščiai sujungti ir palyginti kartu. Tai padaryti padėjo modifikuota VASMA-L svorių nustatymo metodika. Įdomu pastebėti, kad trys svarbiausi sėkmės veiksniai patenka į pirmąjį kriterijų rinkinį. Sėkmės veiksniai, turintys aukščiausius VASMA-L metodikos reitingus, gali būti labai naudingi praktiškai renkantis tiek finansines, tiek blokų grandine paremtas sutelktinio finansavimo kampanijas, į kurias būtų galima investuoti. Šio tyrimo rezultatai taip pat prisidėjo prie mokslinės literatūros, nes pagrindinė šio tyrimo stiprybė buvo unikali VASMA-L metodika, skirta investavimo į sutelktinio finansavimo kampanijas sėkmės veiksniams iš kelių kriterijų rinkinių parinkti.

Ketvirtajame šios disertacijos tyrime nustatyti svarbūs veiksniai, kurie daro įtaką sutelktinio finansavimo platformų sprendimams (Kumar ir kt., 2019; Nguyen ir kt., 2021). Šį kartą buvo apklausta konkreti tikslinė grupė – sutelktinio finansavimo platformų darbuotojai ar savininkai. Vėlgi taikyta VASMA svorių nustatymo metodika. Rezultatai rodo, kad svarbiausi veiksniai, susiję su blokų grandinės technologija, yra susiję su kibernetinio saugumo rizika (D11), nėra konkrečių įstatymų, kad būtų laikomasi visų finansavimo sąlygų (D9), ir sudėtingas kriptovaliutų reguliavimas skirtingose šalyse (D8). Šis tyrimas įrodo, kad blokų grandinės technologija gali keliais būdais padėti sutelktinio finansavimo platformoms.

Kaip matyti iš tyrimų rezultatų, blokų grandinės technologija daugiausia veikia sutelktinio finansavimo platformas ir jų struktūrą, o investuotojai nemato didelio blokų grandinės technologijos poveikio skirtumo investuojant į konkrečią sutelktinio finansavimo kampaniją.

Šis disertacijos tyrimas turi keletą apribojimų. Kitoks ARIMA modelis galėtų būti sudarytas interpretuojant skirtingus duomenis ir naudojant ilgesnį duomenų laikotarpį. Be to, šiame tyrime atsižvelgta tik į investuotojų ir sutelktinio finansavimo platformų nuomonę, o projektų savininkų nuomonė nebuvo tiriama. Kadangi blokų grandine grindžiamas sutelktinis finansavimas yra labai siaura ir specifinė investavimo forma, ekspertų skaičius yra ribotas (Ahluwalia et al., 2020; Zhao et al., 2017). Galiausiai modifikuotu VASMA-L kriterijų svorių nustatymo metodu vienu metu galima nagrinėti daugiau kriterijų grupių, tačiau ekspertiniam vertinimui buvo taikomi tik du kriterijų pogrupiai. Ateityje būtų vertinga patikrinti kampanijų savininkų ir investuotojų pasirinkimą įvairiomis aplinkybėmis – pavyzdžiui, išsivysčiusiose šalyse, esant teisinei paramai blokų grandinės technologijomis grindžiamoms sutelktinio finansavimo platformoms ir esant reguliavimui ar jo nesant – ir ar jų sprendimams gali turėti įtakos blokų grandinės technologija. Be to, šį tyrimą vertėtų pakartoti po kelerių metų, kai blokų grandine grindžiamas sutelktinis finansavimas bus labiau paplitęs rinkoje ir turės daugiau investuotojų.

Bendrosios išvados

1. Blokų grandinės technologija ir sutelktinis finansavimas yra svarbūs finansų technologijų segmentai. Rengiant mokslinės literatūros analizę buvo gilinamasi į sutelktinio finansavimo raidą, apibrėžimus, augimą, įvairias sutelktinio finansavimo formas ir investavimo į sutelktinio finansavimo kampanijas riziką bei pagrindinius sėkmės veiksnius. Taip pat buvo analizuojamas dar vienas svarbus *fintech* segmentas – blokų grandinės technologija, jos apibrėžimai ir ypatybės. Svarstant blokų grandinės technologiją, buvo giliau susitelkta į blokų grandine grindžiamą sutelktinį finansavimą ir jo svarbą sutelktinio finansavimo platformoms bei investuotojams. Buvo nustatyti ir išanalizuoti galimi sėkmės veiksniai investuojant į blokų grandine grindžiamą sutelktinį finansavimą. Atlikus mokslinę literatūros analizę, buvo pasiūlyta teorinė blokų grandinės poveikio sutelktiniam finansavimui vertinimo sistema, pagal kurią siūloma vertinti blokų grandinės poveikį sutelktiniam finansavimui iš investuotojų ir sutelktinio finansavimo platformų perspektyvų.
2. Antroje disertacijos dalyje buvo suformuotas disertacijoje atliekamų keturių tyrimų metodologinis pagrindimas bei naudojami duomenys. Pirmam tyrimui atlikti, siekiant išanalizuoti sutelktinio finansavimo platformos pajamas, duomenys buvo surinkti iš *Kickstarter* platformos. Antrajam tyrimui atlikti, remiantis rizikos fondų ir verslo angelų bei sutelktinio finansavimo mokslinės literatūros analize, buvo nustatyti sėkmės veiksniai, darantys įtaką investuotojų sprendimams, bei įvertinti rizikos veiksniai, remiantis elektroninės prekybos teorija. Trečiajam tyrimui atlikti buvo identifikuoti galimi sėkmės veiksniai investuoti į blokų grandine paremtas sutelktinio finansavimo kampanijas. Veiksniai buvo suskirstyti į dvi grupes: a) finansinį bei blokų grandine paremtą sutelktinį finansavimą ir b) blokų grandine paremtą sutelktinį finansavimą. Šios grupės buvo vertinamos atskirai ir vėliau palygintos, siekiant išsiaiškinti svarbiausius veiksnius. Ketvirtam tyrimui atlikti buvo nustatyti blokų grandinei būdingi veiksniai, darantys įtaką sutelktinio finansavimo platformoms.
3. Disertacijoje sukurtas blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelis integruoja tris metodus – ARIMA, VASMA ir VASMA-L. Pirmasis metodas – ARIMA modelis, leido prognozuoti galimas sutelktinio finansavimo platformos pajamas pirmajame tyrime. Antrasis metodas VASMA (VAS matrica kriterijų svoriams nustatyti), matricinių klausimų metodas, padeda nustatyti pasirinktų kriterijų svorius. VASMA metodas apima WASPAS-SVNS (subjektyvius) svorius ir informacijos entropijos (objektyvius) svorius. VASMA metodas leidžia sumažinti neapibrėžtumus, vykdant ekspertinį vertinimą. VASMA metodas taikytas antrajame ir ketvirtajame šios disertacijos tyrimuose. Disertacijoje pasiūlyta originali VASMA metodo modifikacija – VASMA-L kriterijų svorių nustatymo metodas. Įveikiant VASMA metodo ribotumus, VASMA-L kriterijų svorių nustatymo metodas gali būti taikomas dideliems kriterijų rinkiniams, juos išskaidant į mažesnius poaibius, o vėliau lyginant rezultatus visus kartu, siekiant nustatyti svarbiausius viso kriterijų rinkinio veiksnius. VASMA-L kriterijų svorių nustatymo metodas vertinamas kaip šios disertacijos mokslinis naujumas.
4. Trečiojoje disertacijos dalyje buvo įgyvendinamas ir testuojamas blokų grandinės poveikio sutelktiniam finansavimui vertinimo modelis. Pirmojo tyrimo rezultatai atskleidė, kad *Kickstarter* sutelktinio finansavimo platformoje sėkmingiausios yra tik trys

iš penkiolikos sutelktinio finansavimo kampanijų kategorijų. Šios trys kategorijos (technologijos, žaidimai ir dizainas) kartu generuoja daugiausia lėšų, o sutelktinio finansavimo platforma iš jų gauna didžiausias pajamas. Sudarytas ARIMA (1,0,1) modelis, kuris buvo taikomas sutelktinio finansavimo platformos pajamoms prognozuoti. Prognozės rezultatai parodė, kad investuojant į sėkmingiausias sutelktinio finansavimo kampanijų kategorijas, jos išliks sėkmingos ir sutelktinio finansavimo pajamos toliau augs.

5. Antrojo disertacijos tyrimo rezultatai parodė, kad iš keturiolikos sėkmės veiksnių investuoti į sutelktinio finansavimo kampanijas svarbiausi buvo tik su rizikos veiksniu susiję kriterijai. Siekiant tai išsiaiškinti, vertinimui buvo pasitelktas VASMA kriterijų svorio nustatymo metodas. Šis metodas yra gana naujas mokslinėje literatūroje ir yra entropijos (objektyvių) svorių ir WASPAS-SVNS (subjektyvių) daugiakriterių sprendimų priėmimo metodų derinys. Atliktas vertinimas parodė, kad visi trys su rizika susiję kriterijai (su projektu susijusi rizika, projekto iniciatoriaus rizika ir tarpininko rizika) investuotojams buvo svarbiausi, nes šie kriterijai buvo įvertinti aukščiausiais balais ir turėjo didžiausius VASMA svorius. Kita vertus, įsipareigojimai aplinkosaugos srityje, socialinė žiniasklaida ar kampanijos vaizdo įrašas investuotojams buvo mažiausiai svarbūs.
6. Disertacijoje pasiūlyta nauja VASMA kriterijų svorio metodo modifikacija, VASMA-L, trečiajame tyrime leido įvertinti sėkmės veiksnius, darančius įtaką sprendimams investuoti į blokų grandine paremtas sutelktinio finansavimo platformos kampanijas. Mokslinės literatūros analizės pagrindu atrinktų kriterijų padalinimas į du kriterijų poaibius leido ekspertams nustatyti kriterijų svorius, palyginti gautus rezultatus poaibiuose, taip pat įvertinti kriterijų visumą. Atskirai ekspertai vertino kiekvieno kriterijų poaibio svarbą blokų grandine grindžiamoms sutelktinio finansavimo kampanijoms. Atlikus vertinimą nustatyta, kad vienas kriterijų poaibis yra svarbesnis už kitą. Suteikus atskiriems duomenų rinkiniams atitinkamus svorius, du atskirai įvertinti kriterijų rinkiniai gali būti susieti kartu, taikant disertacijoje pasiūlytą VASMA-L svorių nustatymo metodiką. Rezultatai atskleidė, kad svarbiausi sėkmės veiksniai, lemiantys investicijas į blokų grandine grindžiamas sutelktinio finansavimo kampanijas, yra pramonė, ankstyvosios investicijos ir išlaikomo kapitalo / žetonų dalis, turintys aukščiausius rangus ir VASMA-L svorius. Įdomu tai, kad visi trys svarbiausi sėkmės veiksniai patenka į pirmąją kriterijų grupę. Kita vertus, mažiausiai svarbiais kriterijais buvo laikomi *Ethereum* naudojimas, KYC / išankstinė registracija ir baltosios knygos prieinamumas, turinys ir daugiakalbystė. Šio tyrimo rezultatai patvirtino pasiūlyto originalaus VASMA-L metodo taikymo galimybes, nustatant svarbiausius veiksnius iš kelių kriterijų rinkinių, taip pat ir investuojant į blokų grandine grindžiamas sutelktinio finansavimo kampanijas.
7. Ketvirtojo tyrimo rezultatai atskleidė blokų grandine pagrįstų sutelktinio finansavimo platformų kriterijus, turinčius įtakos sutelktinio finansavimo platformų sprendimams. Tyrimui atlikti buvo pasirinktas VASMA svorių nustatymo metodas. Rezultatai parodė, kad svarbiausi veiksniai, lemiantys blokų grandinės technologijos diegimą, buvo susiję su: 1) kibernetinio saugumo rizika, 2) konkrečių teisės aktų, pagal kuriuos būtų laikomasi visų finansavimo sąlygų bei 3) sudėtingų kriptovaliutų reguliavimų skirtingose šalyse. Priešingai, mažiausiai svarbūs kriterijai sutelktinio finansavimo

platformoms buvo rinkodaros išlaidos, investicijų sėkmė ir galimi nuostoliai dėl valiutos kurso, turintys mažiausius rangus ir VASMA svorius. Apibendrinant rezultatus daroma išvada, kad blokų grandinė daro poveikį sutelktinio finansavimo platformoms ir jų techninei struktūrai, tačiau neturi įtakos investuotojų sprendimams.

8. Vertinimo modelio praktinis tinkamumas blokų grandinės poveikiui sutelktiniam finansavimui vertinti ir empirinio tyrimo metodika buvo įgyvendinti ir išbandyti keturiuose šio tyrimo tyrimuose. Rezultatai rodo, kad blokų grandinės technologija daro poveikį sutelktinio finansavimo platformoms ir jų techninei struktūrai, o investuotojai, investuodami į sutelktinio finansavimo kampanijas, nemato didelio blokų grandinės technologijos poveikio skirtumo. Disertacijos rezultatai rodo, kad blokų grandinės technologija gali padėti sutelktinio finansavimo platformoms keliais būdais. Pirma, kad blokų grandinės technologijos suteikia alternatyvų pagrindą sutelktinio finansavimo platformoms. Antra, disertacijos rezultatai patvirtina, kad blokų grandinės taikomosios technologijos gali padėti plėtoti sutelktinį finansavimą ir padidinti sutelktinio finansavimo platformų skaidrumą ir patikimumą. Ir, trečia, blokų grandinės technologija gali padėti sutelktinio finansavimo platformoms iš naujo sumažinti ar net panaikinti tarpininkavimo išlaidas ir padėti išplėsti kampanijų prieinamumą visame pasaulyje, supaprastinus teisines sutartis ir įstatymus.

Annexes

Annex A. Logical structure of dissertation

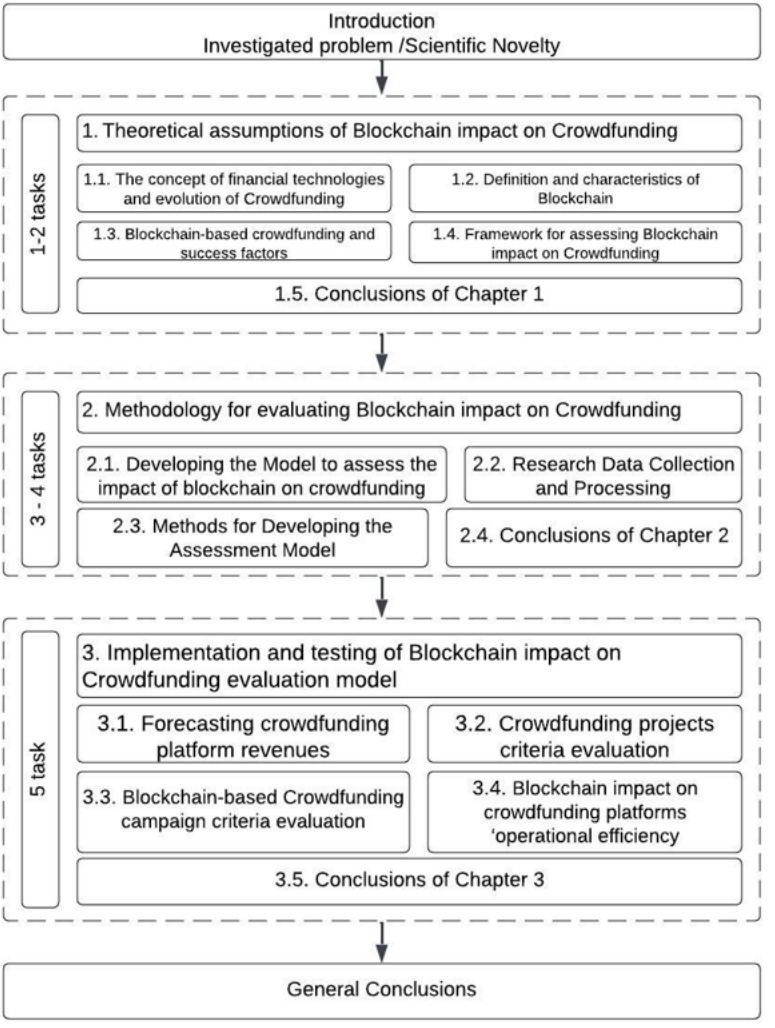


Fig. A1. Logical structure of dissertation (source: created by the author)

Annex B. Crowdfunding Forms

Crowdfunding can be Community or Financial return. These crowdfunding models are divided into four primary forms: donation-based, Reward-based, Equity-based, and Lending-based. Each form is described by its features, benefits, pros, and cons. Equity-based crowdfunding is described in more detail and will be analyzed in this dissertation.

Table B. Crowdfunding forms (Source: created by the author)

Crowdfunding model	Business form	Features	Benefits	Pros	Cons	Authors
Community	Donation-based	• Philanthropic: funders donate without expecting monetary compensation. • two standard subsections: personal campaigns and charity fundraising	• nonmonetary values such as participation in the community and staying closely with the projects • ability to voice their views • formalization of support for tax purposes • formalization of donations, basic accounting, advice, education and training, marketing	No risk.	Donors do not acquire security interest. Entrepreneurs have difficulty raising substantial capital.	Ahlers et al., 2015; Belleflamme et al., 2012, 2015; Borello et al., 2015; Gebert, 2017; Griffin, 2013; Hussain et al., 2023; Jenik et al., 2017; Kim & Viswanathan, 2019; Kirby & Worner, 2014; Mora-Cruz & Palos-Sanchez, 2023
	Reward-based	Funders receive a token gift of appreciation or pre-purchase of a service or product. This model is evolving into its marketplace, with firms raising considerable sums through presales.	• Nonfinancial reward: the form of appreciation gestures or the pre-purchasing of a product or service • • Used to fund art and develop new products or innovations, which assist marketing purposes.	Low risk (primarily fulfilment and fraud risk) – no real potential for financial return.	The potential return is small. No security is acquired, and there is no accountability mechanism. Most entrepreneurs may have difficulty raising substantial capital without a product with mass appeal to sell.	Agrawal et al., 2011, 2014; Ahlers et al., 2015; Belleflamme et al., 2015; Borello et al., 2015; Chen, 2023; Gebert, 2017; Gerber et al., 2012; Griffin, 2013; Hussain et al., 2023; Jenik et al., 2017; Kim & Viswanathan, 2019; Kirby & Worner, 2014; Kuppuswamy & Bayus, 2013; Mora-Cruz & Palos-Sanchez, 2023

Crowd-funding model	Busi-ness form	Features	Benefits	Pros	Cons	Authors
Finan-cial re-turn	Eq-uity-based	• Funders receive equity in-struments or profit-sharing arrange-ments. • If an in-vestment target is reached, the deal is closed be-tween the pool of funders, the issuer, and the platform. • The plat-form charges a commis-sion based on the amount raised and sometimes on future profit.	• proficient and effective inter-mediation of funds • access to in-vestment op-portunities, un-limited potential for fi-nancial gain, and aligned in-centives be-tween funders and fundrais-ers. • limited liability in case of de-fault, global reach, and im-proved invest-ment attrac-tiveness.	Potential to share in the venture's profitabil-ity. Unlim-ited poten-tial for financial gain. It may attract rela-tively large numbers of investors.	Potential loss of invest-ment. Equity holders are subordinate to creditors in the event of bank-ruptcy. Secu-rities laws re-lated to crowdfund-ing investing may be com-plex.	Ahlers et al., 2015; Behl et al., 2023; Belleflamme et al., 2015; Borello et al., 2015; Chen, 2023; Gabison, 2015; Gebert, 2017; Griffin, 2013; Hussain et al., 2023; Jenik et al., 2017; Kim & Viswanathan, 2019; Kirby & Worner, 2014; Mora-Cruz & Pa-los-Sanchez, 2023; Skare et al., 2023; Wan et al., 2023
	Lend-ing-based	• Funders receive a debt in-strument that pays a fixed in-terest rate and re-turns the principal on a spec-ified schedule. • three types: non-profit lending, socially oriented lending	• convenience, efficiencies, and potential to improve access to credit • The short time to apply for a loan can be from a distant location, and credit history is not required	Pre-deter-mined rate of return agreed upon be-tween lender and borrower. Debt hold-ers are sen-ior to eq-uity holders in case of bankruptcy. Secured status may make it easier for entrepre-neurs to raise capi-tal.	It may be subordinate to senior creditors. Start-ups' high failure rate presents a similar risk of loss as an equity invest-ment but with capped potential re-turns. This option re-quires a busi-ness that is already gen-erating cash flow. Exist-ing/estab-lished, cash	Ahlers et al., 2015; Aveni, 2015; Behl et al., 2023; Belle-flamme et al., 2015; Borello et al., 2015; Chen, 2023; Gebert, 2017; Griffin, 2013; Hussain et al., 2023; Kim & Viswanathan, 2019; Kirby & Worner, 2014; Mora-Cruz & Pa-los-Sanchez, 2023; Skare et al., 2023

Crowd-funding model	Busi-ness form	Features	Benefits	Pros	Cons	Authors
		and com-mercial lending			flow-positive businesses may consider this option because it can offer a more struc-tured exit op-portunity than typical equity offer-ings.	

Annex C. Investment value dimensions and risks

C.1. Investment value dimensions

There are five investment value dimensions: financial, Functional, Social, Epistemic, and Emotional. Every dimension has its values. The definitions and indicators of each dimension are summarized in Table C.1.

Table C.1. Investment value dimensions (source: created by the author)

Value dimension	Value	Definition	Indicators	Authors
Financial	Economic value	customer value as a trade-off between 'give' and 'get' components.	The tradeoff between what you pay and what you get	(Barberis & Thaler, 2003; Civardi et al., 2023; Harms, 2007; Kedas & Sarkar, 2023; Liu et al., 2023; Zeithaml, 1988; Zhang et al., 2022)
	Lottery effect	allows generating extreme revenues with a small investment	chance of a surprising financial gain	(Barberis & Thaler, 2003; Civardi et al., 2023; Harms, 2007; Sawhney & Eliashberg, 1996; Zhang et al., 2022)
	Certainty Effect	people put much more weight on outcomes that are certain than on merely probable outcomes	guaranteed tangible return	(Barberis & Thaler, 2003; Civardi et al., 2023; Harms, 2007; Kahneman & Tversky, 1979; Kivetz, 2003; Liu et al., 2023; Zhang et al., 2022)
Functional	Personal Utility	the degree to which the functional advantages of the project outcome assist a functional need of the individual consumer	High functional product meaning	(Civardi et al., 2023; Fournier, 1998; Harms, 2007; Kedas & Sarkar, 2023; Zhang et al., 2022)
Social	Self – Expressiveness	A product or service can help the consumer in the development of a visible, unique and personal representation of himself	online-identity, self-expression	(Civardi et al., 2023; Harms, 2007; Kedas & Sarkar, 2023; Ligas, 2000; Liu et al., 2023; Schau & Gilly, 2003; Zhang et al., 2022)

Value dimension	Value	Definition	Indicators	Authors
	Investor Community	The most critical component of crowdfunding is that projects are financed by the crowd, not by single investors.	The Expectation that others participate, too	(Civardi et al., 2023; Harms, 2007; Kedas & Sarkar, 2023; Ligas, 2000; Liu et al., 2023; Schau & Gilly, 2003; Zhang et al., 2022)
Epistemic	Epistemic	The utility acquired from an alternative's capacity to arouse curiosity, provide novelty, and satisfy a desire for knowledge	New experience: desire for novelty-seeking	(Civardi et al., 2023; Harms, 2007; Liu et al., 2023; Zhang et al., 2022)
Emotional	Enjoyment	The utility develops from the feelings that a product or service generates.	Positive emotions	(Bagozzi et al., 1999; Civardi et al., 2023; Harms, 2007; Kedas & Sarkar, 2023; Koufaris et al., 2001; Mainardes & Freitas, 2023; Nysveen et al., 2005; Zhang et al., 2022)
	Involvement		chance of voting on decisions	(Bagozzi et al., 1999; Civardi et al., 2023; Harms, 2007; Kedas & Sarkar, 2023; Mainardes & Freitas, 2023; Zhang et al., 2022)
	Supportiveness		helping behavior	(Bagozzi et al., 1999; Civardi et al., 2023; Harms, 2007; Kedas & Sarkar, 2023; Liu et al., 2023; Mainardes & Freitas, 2023; Zhang et al., 2022)

C.2. Comparison of Investment risks

There are three associations of risks: the product or project, the project initiator and the intermediary. All risk associations were compared among e-commerce and crowdfunding theories. Additionally, the primary factors and indicators are recapped.

Table C.2. Comparison of Investment Risks (Source: created by the author)

Risks associated with	Risk	Factors	Indicators	E-Commerce	Crowdfunding
The product/ project	Product risk / Funding object risk	lack of information	Can't examine the actual product; Size may be a problem with clothes; Can't try on clothing online; Inability to touch and feel the item; Must pay for shipping and handling; Must wait for merchandise to be delivered.	Cunningham et al., 2005; Forsythe et al., 2006; Forsythe & Shi, 2003; Kim et al., 2008; Lopez-Nicolas & Molina-Castillo, 2008; D. Zhang et al., 2018	Cunningham et al., 2005; Gierczak et al., 2014; D. Zhang et al., 2018; Shrestha et al., 2023; Chen et al., 2023; Senney & Lhost, 2023; Appio et al., 2023; D'Arcangelo et al., 2023; Zhu et al., 2023
	Social risk	buying reputation	There is a chance that using the website will negatively affect the way others think of you, leading to social loss.	Crespo et al., 2009; Featherman & Pavlou, 2003; Hong & Cha, 2013; Lu et al., 2018; Pires et al., 2004	Gierczak et al., 2014; Senney & Lhost, 2023;
	Psychological risk	inconsistency with self-image	The website will not fit in well with my self-image; the usage of the website will lead to psychological loss.	Crespo et al., 2009; Featherman & Pavlou, 2003; Hong & Cha, 2013; Pires et al., 2004	Gierczak et al., 2014; Hong & Cha, 2013; Chen et al., 2023

Risks associated with	Risk	Factors	Indicators	E-Commerce	Crowdfunding
	Post-funding risk/ Repayment risk	missing guarantees; problems with the funding object, the service guarantee and commercial disputes; product might not work;	product might not perform well; impossible to change product; possible non-delivery	Crespo et al., 2009; D. Zhang et al., 2018	Gierczak et al., 2014; Zhang et al., 2018; Shrestha et al., 2023; Chen et al., 2023; Senney & Lhost, 2023; Appio et al., 2023; D'Arcangelo et al., 2023; Zhu et al., 2023
The project initiator	Project initiator risk / Owner risk / Seller risk	unknown reputation; no online brand; no recommendations; owner experience	sellers will commit fraud; sellers will swindle; products will not perform as expected; sellers will behave opportunistically	Pavlou & Gefen, 2004; Verhagen et al., 2006	Bente et al., 2012; Gierczak et al., 2014; Verhagen et al., 2006; Shrestha et al., 2023; Chen et al., 2023; Senney & Lhost, 2023
	Delivery risk / Time risk	delivery time; damaged or lost goods; possible shortcomings and legal requirements	chances to lose time switching different payment methods; using a website would lead to a loss of convenience; Too complicated to place an order; Difficulty in finding appropriate websites or products; Pictures take too long to come up with infor-	Aghekyan-Simonian et al., 2012; Crespo et al., 2009; Featherman & Pavlou, 2003; S. Forsythe et al., 2006; Hong & Cha, 2013; Pires et al., 2004	Gierczak et al., 2014; Kumar et al., 2019; Shrestha et al., 2023; Chen et al., 2023; Senney & Lhost, 2023

Risks associated with	Risk	Factors	Indicators	E-Commerce	Crowdfunding
			mation; waiting too long for delivery		
The intermediary	Intermediary risk / Privacy risk	fundamental tasks of the CF platform: monitoring, protecting from fraud, taking care of personal data, transaction security	taking care of transaction security; precluding theft of money; protecting me against fraudulent sellers; preventing fraudulent seller from doing business; tracing sellers in case of disputes; privacy of payment info; loss of privacy; receiving more spam emails; personal info might be used without my knowledge	Crespo et al., 2009; Featherman & Pavlou, 2003; Lopez-Nicolas & Molina-Castillo, 2008; Verhagen et al., 2006	Featherman & Pavlou, 2003; Gierczak et al., 2014; Verhagen et al., 2006; Shrestha et al., 2023; Appio et al., 2023
	Financial risk	loss of money or other resources; Internet's minimal security; foreign platform (data protection standards and legal remedies)	chances to lose money; Internet-bill-payment service subjects your checking account to potential fraud; Can't trust the online company; May not get the product; May purchase something by accident; My personal information may not be	Crespo et al., 2009; Dai & Zhang, 2019; Diallo, 2012; Featherman & Pavlou, 2003; Forsythe et al., 2006; W. Hong et al., 2013; Littler & Melanthiou, 2006; Pires et al., 2004	Delis et al., 2014; Diallo, 2012; Featherman & Pavlou, 2003; Forsythe et al., 2006; Gierczak et al., 2014; Lepetit et al., 2008; Panjer, 2002; Shrestha et al., 2023; Appio et al., 2023

Risks associated with	Risk	Factors	Indicators	E-Commerce	Crowdfunding
			kept; My credit card number may not be secure; I may not get what I want; Might be overcharged		
	Performance risk / Operating risk	poor website/platform performance	website might not perform well and create problems with my credit; security systems are not strong enough to protect my checking account; there is a likelihood that there will be something wrong with the performance; expected level of service performance; servers may not perform well and process payments incorrectly;	Aghekyan-Simonian et al., 2012; Crespo et al., 2009; Featherman & Pavlou, 2003; Forsythe et al., 2006; Hong & Cha, 2013; Kuisma et al., 2007; Lee, 2009; Littler & Melanthiou, 2006; Pires et al., 2004	Featherman & Pavlou, 2003; Forsythe et al., 2006; Gierczak et al., 2014; Oxera, 2015; Wati & Winarno, 2018; Shrestha et al., 2023; Appio et al., 2023

Annex D. Loginė disertacijos struktūra

Fig. D2. Loginė disertacijos struktūra (sukurta autorės)

Santautė VENSLAVIENĖ

ASSESSMENT OF BLOCKCHAIN IMPACT
ON CROWDFUNDING DOCTORAL DISSERTATION

Doctoral Dissertation

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Economics (S 004)

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FINANSAVIMUI VERTINIMAS

Daktaro disertacija

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Lietuvių kalbos redaktorė Dalia Markevičiūtė
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Vilniaus Gedimino technikos universitetas
Saulėtekio al. 11, 10223 Vilnius
Spausdino UAB „Ciklonas“,
Žirmūnų g. 68, 09124 Vilnius