


Accelerators and decelerators of the growth of NTBFs

Stefan Slavik

Management Department,
University of Economics in
Bratislava, Slovakia
stefan.slavik@euba.sk
 0000-0002-2890-8091

Veronika Bednarova

DNA ERA, s. r. o. Bratislava,
Slovakia
veronicka.bednarova@gmail.com
 0000-0003-2286-8962

Hanna Rydehell

School of Business, Innovation and
Sustainability at Halmstad
University, Sweden
hanna.rydehall@hh.se
 0000-0003-1208-7011

ABSTRACT

Research background: New technology-based firms (NTBFs) have novel but unfinished technologies and are exposed to an uncertain to indefinite business environment. Their growth is slow, although the growth expectations from founders and especially from investors are high. The factors that accelerate or slow down growth are not well understood.

Purpose of the article: The aim of the research is to identify external and internal factors that accelerate or slow down growth. Another aim of the research is to clarify the relationships between the factors of acceleration and deceleration of growth. The aim of the research is also to deepen and expand knowledge about the internal causes of the emergence and existence of these factors.

Methods: Field research was conducted to collect qualitative data that characterizes the technologies being developed, provides evidence of the originality of the technologies, and describes the internal and external factors that accelerate and slow down the growth of firms based on new technologies. The research sample includes 67 NTBFs. The source of knowledge about the growth of the studied firms is the personal experience from a guided interview with the founder, which is recorded in a questionnaire. The respondents' statements were analysed using critical discourse analysis (CDA) with the support of artificial intelligence.

Findings & Value added: The research results in external growth accelerators (offer of capital, regulatory and political environment, market and economic opportunities, technological progress and innovation), external growth decelerators (availability of capital, regulatory barriers, market competition, economic and political uncertainties), internal growth accelerators (innovative corporate culture and internal processes, qualified and motivated team, strong leadership and strategic vision, use of adopted technologies) and internal growth decelerators (insufficient resources and capacities, resistance to change, lack of innovation and creativity, inefficient processes and systems). The order of factors within each group corresponds to the weight of their positive or negative impact on growth. The knowledge gained can be used to identify growth factors and modify them according to the external and internal capabilities of a particular enterprise. Accelerating the growth of NTBFs is an important source of economic development, a driving force of economic growth and innovative entrepreneurship in most business sectors. Field empirical research has revealed a complex structure of factors that influence the growth of NTBFs and thus determine their viability and competitiveness.

RECEIVED: June 2 © **ACCEPTED:** July 19 © **PUBLISHED ONLINE:** December 31

KEYWORDS: NTBF, external growth accelerators, internal growth accelerators, external growth decelerators, internal growth decelerators

JEL CLASSIFICATION: L26, M13, O30, O32

CITATION: Slavik, S., Bednarova, V. & Rydehell, H. (2025). Accelerators and decelerators of the growth of NTBFs. *Journal of Business Sectors*, 3(2), 10–25. <https://doi.org/10.62222/FOCX2959>

INTRODUCTION

New technology-based firms (NTBFs) have a significant impact (Rydehell et al., 2019/a) on long-term economic development and are considered a driving force of economic growth and innovation. In particular, they contribute to exports, employment, taxes, research and development. NTBFs help (Zapata et al., 2017) convert inno-

vative ideas into business opportunities, stimulate competition, and increase productivity. Their contribution to the internationalization of business, even to the acceleration of business internationalization (Cahen et al., 2017) is not negligible. Although they also cause job losses (Rannikko et al., 2019), their overall contribution to job creation is positive. The research also found (Rannikko et al., 2019) a surprisingly high survival rate (72%). Ho-

wever, very few businesses experienced high growth during their first years of existence.

Extensive research endeavours have been dedicated to unravelling the multifaceted dynamics underpinning NTBFs' trajectories, with scholars striving to elucidate the myriad factors influencing their growth trajectories. Notably, much of this research has focused on quantitative measures, employing statistical analyses to identify and quantify the impact of various determinants on NTBFs' growth rates (Rydehell, 2018; Ranniko et al., 2022; Löfsten et al., 2023, 2024). From analyses of market conditions (Löfsten et al., 2024) and regulatory environments (Hemmer et al., 2023), (Frederiks et al., 2024) to explorations of organizational strategies (Giones, 2020) and managerial competencies (Tarillon, 2022), a rich tapestry of knowledge has been woven to illuminate the intricate interplay of variables shaping NTBFs' destinies.

Against this backdrop, our study endeavours to bridge this lacuna by adopting a qualitative approach that focuses on identifying accelerators and decelerators of NTBF growth. By delving into the rich narratives and lived experiences of NTBF founders (Thomson, 2022), executives (Tarillon, 2020), and key stakeholders (Badoiu et al., 2020), we aim to uncover the underlying mechanisms and contextual nuances (Ungerer et al., 2021) driving NTBFs' growth trajectories. Leveraging an interdisciplinary lens (Pisano, 2024), (Blase et Leinwand, 2024) that integrates insights from entrepreneurship, innovation management, and strategic management, we seek to elucidate the multifaceted interplay of internal and external factors shaping NTBFs' evolution from inception to maturity.

This study aims to report on the factors of different origin and quality that affect the growth of NTBFs, in an organized and transparent way, based on the results of qualitative research. Why the theme of growth? Business growth is proof of viability, confirmation of the ability to apply new technology to a useful product or service, and evidence of competitiveness. The research question is: "What factors, causes, and reasons influence, accelerate, and slow down the growth of a company based on new technologies?" In continuation of the above part 2 provides an overview of the characteristics of the NTBFs and the known external and internal factors of their growth, part 3 describes the research sample and research method, part 4 contains the results of critical discursive analysis (using artificial intelligence) of qualitative data, part 5 deals with the discussion of empirical findings and part 6 summarizes the conclusions from the research.

The research aim is to identify the accelerators and decelerators of the growth of NTBFs, which are located in the external and internal environment of the technological company. Faster company development and growth in the early stages of existence will result in more likely success in the long term (Mauer et al., 2024), while few NTBFs can be considered fast-growing companies (Ranniko et al., 2019).

THEORETICAL BACKGROUND

Characteristics of new technology-based firms (NTBFs)

According to Fudickar and Hottenrott (2019), new technology-based firms (NTBFs) are independently owned, have existed for less than twenty-five years, and operate in high-tech or knowledge-intensive industries. Paradoxically, they are very innovative despite having limited resources. Side effects of the business ecosystem contribute to their innovativeness. Arantes et al. (2019) created a typology of NTBFs, which is divided into dependent and independent enterprises. Dependents are supported by accelerator programs, incubators, technology parks, academic institutions, or companies and their development depends on these institutions.

In general, NTBFs (www.igi-global.com) are recently established companies by a group of entrepreneurs who want to develop and increase the value of an invention or technological innovation and employ a high proportion of qualified employees. Little (1977) defined NTBFs as independent enterprises that were founded on the use of invention or technological innovation, and play a decisive role in these processes and also in the remaining economic activities (Lutz, 2003). The consulting company Arthur D. Little Group similarly defined NTBF back in 1977: age under 25, business based on an invention, above average technological risk, practical use of the invention or technological innovation, and independence, meaning that the business is owned by individuals and is not a branch of an established company. Newer knowledge says (Cunha et al. 2013) that NTBFs are independent enterprises less than ten years old that base their business on the development, production, and commercialization of technology.

The founders of NTBFs focus on human capital, their know-how, experience, and talent when starting a business. Raising financial capital is not their focus at first. Later, they say that they should have paid more attention to generating revenue and looking for partners, including investors (Rydehell et Issakson 2016). International research that examined the impact of business models on the performance of enterprises based on new high-tech technologies found (Issakson et al., 2021) that sales growth is positively correlated with partners, resources, cost structure, and revenue streams. Baumol (2002) states that the implicit partnership between independent technology entrepreneurs and large corporations is critical to success in a market economy. A study by Lindelöf et Löfsten (2006) confirms that the external environment faced by NTBFs has an impact on the behavior of this type of company. A substantial part of the external environment is networking (Parida et al., 2016) so that NTBFs overcome their size and resource limitations, they seek a place and relationships in business networks (Choo et Yoon, 2021) to increase their business performance and develop a competitive advantage (Wang et Fang, 2022). From the short introductory overview, it is clear that the reasons for the slow and rapid growth of

NTBFs must be sought both inside the company and in its surroundings.

Internal factors influencing the growth of NTBFs

The central figure and key internal factor in a small and start-up technology enterprise is the entrepreneur (Zapata et al., 2017) with his personal (age, education, and others) and professional characteristics (skills, experience, and others). Entrepreneurial experience is complemented by growth orientation (Rydehell et al., 2019/a). It is expected (Camisón-Habaa et al., 2019) that the managerial capabilities of the entrepreneur (knowledge, experience, education, power, position) have an impact on the growth of the company. There are strong correlations between growth rates on the one hand and founder- and firm-specific factors (Almus et Nerlinger, 1999). The founder has technical and engineering skills and is surrounded by a founding team. The company has age, size, legal personality, and relations with external companies/partnerships. One of the most important reasons for the growth of the investigated companies (Farnoodi et al., 2020) was the competence of the founders and the active human power that works in them. This competence generally results from their professional background, experience, education, and work culture.

The role of the entrepreneurial team and the principles of team formation in technology start-ups are emphasized by Zellmer-Bruhn et al. (2021), the founding team's knowledge and access to external knowledge sources are considered by García-Cabreara et al. (2021) as an influential factor in the short-term and long-term performance of NTBFs. The quality of employees is the driving force behind the innovation performance of technology start-ups (Choi et al., 2020). The need to be autonomous and the pursuit of a higher level of competence are the main drivers for the founders and employees of NTBFs (Soñta-Drażczkowska, 2020). The ability to survive and grow also depends on the success of the NTBF in the first investment round (Passvanti et al., 2024), which is affected by five signals: education, work experience of the founders, ownership rights, partnerships/alliances, size of the founding team. Personal prerequisites for the growth of business performance are transformed into resilient organizational capabilities of NTBFs (Bueno Campos et al., 2019), strengthen the role of project management in product development in NTBFs (Soñta-Drażczkowska & Mrozewski, 2019) and the absorption and diffusion capacity of innovations (Pereira et Farias, 2023). The innovative capabilities of NTBFs are positively influenced by intellectual property rights (Acosta-Prado et al., 2020).

The business model is a strong and frequently researched factor in the existence and growth of NTBFs. Research by Rydehell & Isakson (2016) confirmed the important impact of the business model on the survival of a nascent NTBF. Further research by Issakson et al., (2021) used a canvas model described by sixteen variables that influenced early business performance and noted significant correlations with business performance. A

business model embedded in the broader context of external interest groups supports and accelerates the development of NTBFs (Rydehell, 2020). Commercialization of innovations affects the selection and alignment of two important components of the business model, namely customer value proposition and target market, to be consistent with the technological innovation (Mahdavi-mazdeh et al., 2020). The increased importance of some blocks of the business model is also confirmed by a study by Löfsten (2019), which shows how the value proposition and relationships with customers influence business performance at a very early stage of company development.

An important internal factor is also the interest in the internationalization of business. According to Baier-Fuentes et al. (2021) is early internationalization a path to the growth of NTBFs, Cahen et al. (2017) even recommend accelerating the internationalization of NTBFs. Research results from Löfsten (2019) show that early-stage firm performance is enhanced by product similarity (with other firms' products), internationalization, and maintaining very close customer relationships. Related to this is the knowledge (Renko et al., 2022) that NTBFs should invest in market orientation very early in their life cycle.

Internal growth factors usually act in aggregate. The combined use of R&D resources, internal financial resources, and scientifically skilled employees has a significant impact on the survival and growth of technology start-ups (Yang et al., 2017). The fit between the chosen technological strategy and the resources of the entrepreneur explains the performance of the company that it achieves in the foreign market (García-Cabrera et al., 2021). On the contrary, NTBFs fail due to several factors, namely technology, market, financing, and management competencies (Pinkwart et al., 2015).

A comprehensive view of internal factors is provided by research by Mauer et al. (2024). According to the causal logic, it identifies the accelerator of growth: enough investment already at the beginning of the business and growth decelerators: lengthy market research and lengthy planning; a lot of time and effort devoted to finding sources, customers, and partners; waiting for some specific events, conditions; a lot of time spent reworking original plans. According to the logic of action, it identifies growth accelerators: immediate action instead of planning, searching, and waiting; unexpected events are a source of opportunities; investment of effort in relationship building and growth decelerator: interest in growth arises late and is secondary for a long time.

External factors influencing the growth of NTBFs

External growth factors for NTBFs noted in the literature are institutions that support the establishment and maintenance of small starting technology companies. Public institutions support the innovative performance of NTBFs (Fudicar & Hotentott, 2019), providing specialized knowledge and resources (Baier-Fuentes et al., 2021), whose sources are government agencies, universities, and industry. It has a positive effect on the growth of NTBFs, if

stakeholders and R&D networks are located near them (Rydehell et al., 2019/a) and if the company is conveniently located in business networks (Rydehell et al., 2019/b). The novelty-oriented value proposition is affected (Rydehell et al., 2018) by business networks (external factor, informal networks) and growth orientation (internal factor, attitude towards growth). The beneficial effect of NTBFs' geographical proximity to external partners/cooperating companies, business and consulting networks is also confirmed by research by Löfsten et al., 2023. The leverage effect of partnerships is even identified (Combs et al., 2023). The supply chain and entry into the global market also have an effective influence (Al Natseh et al., 2013).

A relatively important role is played by incubators (Santisteban et al., 2021), which provide important means for NTBF development and growth acceleration, although they are negatively related to early performance (Rydehell et al., 2019/a). According to Ramírez-Alesón & Fernández-Olmos (2018), there is no evidence of a direct relationship between location in a science park and the innovation performance of NTBFs. The selection role of science parks that attract high-quality NTBFs is positive, an indirect effect is created. Being located in a science park can increase the innovation performance of NTBFs that cooperate and export together, and a moderating effect is created.

Commercialization of new technology is also supported by open innovation (OI), as companies combine external and internal ideas as a primary means of accelerating internal innovations or market access (Tchouwo et al., 2021). However, the relationship between OI and business performance was identified only indirectly (Lendowski et al., 2022).

The conclusion from the literature analysis. More, significantly more knowledge about the internal environment, probably also because the growth of a (technological) company is mainly an internal matter. A significant majority of research explicitly establishes potentially influential factors, which are then verified with correlations and regression models. Among the internal factors, the founder of the technological company, the team, the business model and the right decisions taken already in the early stages of the life cycle of the company dominate. Among the external factors, the influence of external partnerships and networks and supporting institutions (incubators and science parks) stands out. Research studies confirm that hypothetical factors either have a positive effect or their effect can not be confirmed. Research samples analysed by quantitative methods contain several tens to hundreds of enterprises, and research samples analysed by qualitative methods do not contain more than ten enterprises. There is a lack of research on larger samples of NTBFs analysed using qualitative methods that do not examine explicitly determined growth factors, i.e. the causes of growth are not predetermined. A research gap is a set of causes that are inside the company and in its surroundings and act positively as accelerators or negatively as decelerators without an

explicit characteristic, which can be the cause of cognitive distortions and limitations. It is assumed that filling this research gap will bring knowledge that can confirm the hitherto known determinants of growth, but may also bring hitherto unknown factors accelerating and decelerating growth in the summary structure.

RESEARCH OBJECTIVE, METHODOLOGY AND DATA

The research question will be answered and the research objective will be met based on a research design that includes data collection through field research of new technology-based enterprises that are actually doing business and data analysis using qualitative research methods. Field research provides the researcher with direct experience with the specific object of research, and qualitative analysis gives the respondent a reasonable degree of freedom in formulating answers, which may then bring unexpected new insights.

Research sample and field research. The research was conducted between February and November 2023 in 67 small and medium-sized enterprises in the territory of the Slovak Republic. The initial list contained approximately 120 NTBFs, the maximum number of enterprises of this kind in the country, but it was reduced due to the willingness to participate in the research and the innovativeness of the technology. The number of NTBFs is only a fraction of the total number of enterprises in the Slovak Republic, but with their innovativeness, which is based on the results of domestic basic and applied research and entrepreneurial potential, they are an exceptional and promising phenomenon in the economic life of the country. However, their growth problems are obvious and require academic research into the causes of slow growth. The conditions for selecting a company for the sample were independent research and development of a new, usually patented, technology, age three to ten years, and subsequent commercialization of products and services based on the new technology (e. g. Cunha et al. 2013). Formal industry affiliation was not a requirement, although it is recorded. The construction of the research sample is purposeful and therefore the selected enterprises must be based on a new and original technology that is expected to be a significant source of business performance and growth. The research was conducted in the form of a structured interview based on a questionnaire in direct contact between the respondent (usually the founder of the company) and the researcher. Additional insights were obtained from the company's website, publicly available databases, and professional journals that published interviews with founders and reports on technology companies. Industry incorporation of researched NTBFs according to SK NACE (Nomenclature statistique des économies économiques dans la Communauté européenne):

C - Industrial production: 10

E - Water supply; Sewerage, waste management, and remediation activities: 1

F - Other building completion and finishing work: 2

G - Wholesale and retail trade: 3

J - Information and communication: 19

L - Real estate activities: 1

M - Professional, scientific, and technical activities: 27

N - Administrative and support service activities: 2

P - Education: 1

Q - Human health and social work activities: 1

Data collection

The field research dealt with the collection of qualitative data that characterize the technologies being developed, provide evidence of the originality of the technologies and describe the internal and external factors that accelerate and decelerate the growth of enterprises based on new technologies. Respondents answered explicitly asked questions: Describe the new technology and its utility (offered value) for the customer. Present evidence of the originality of the new technology. What external and internal factors speed up and slow down business growth? Qualitative data take the form of verbal statements and text records about the attributes and quality of the phenomenon under investigation. Answers were handwritten on the spot during the interview, and then formally edited without changing the content. The interview lasted one and a half to two hours. During the interview, the researchers provided clarification on request if the questions were not completely clear. Qualitative research on the topic under study is scarce, perhaps the most inspired by suggestions from technological entrepreneurs and research by Mauer et al. (2024) on causal brakes and effectual pedals.

Data analysis

Qualitative statements were analysed using critical discourse analysis (CDA) with the aim of better understanding the accelerators and decelerators of the growth of new technology-based businesses. CDA (van Dijk, 2015; Qian et al., 2018; Liu & Guoo, 2016) provides unique tools for decomposing language and communication in a business context and enables a deeper insight into the essence of accelerators and decelerators. The choice of CDA as a methodological tool is motivated by its proven effectiveness in investigating the opaque relationships that underlie complex social phenomena (Fairclough, 1995; Wodak et Meyer, 2009). According to Fairclough (2003), CDA is understood as an interdisciplinary approach that uses spoken, written, and additionally visual language through images in an in-depth interpretation. Thematic analysis and the Gioia methodology were considered competing methods. In some cases, thematic analysis is suitable for finding meaningful patterns and connections between topics (Saunders, Thornhill et Lewis, 2019). The Gioia methodology is a qualitative approach to developing a grounded theory (Magnani & Gioia, 2023). The conducted research did not look for relationships between accelerators and decelerators of

growth, and the authors of the article did not consider the research sample large enough for the application of the Gioia methodology.

Critical discourse analysis can have a different number of steps, e.g. Mullet (2018) formulates seven steps, Luo (2023) four steps, and Cingerová & Motyková (2019) offer seven basic steps according to the Duisburg school. Qualitative data analysis software (Maxqda) offers CDA in four steps. The differences in the number of steps are not fundamental, some steps are just merged. CDA in this study consists of four main steps:

1. Reading and capturing first impressions: The initial reading of the texts results in recording first impressions, assumptions, and questions about the content and structure.
2. Text coding: Using open coding with manual labelling and subsequent recoding using the ChatGPT-4 artificial intelligence, the main concepts, themes, and ideas in the responses are identified and labelled.
3. Thematic analysis: Similar codes are merged into broader categories or themes. The subject of observation is how these themes intersect, recur, or are different or even contradictory in different texts or parts of a text.
4. Identifying patterns: The themes delineated in the previous step are analysed according to their distribution in the text, and then there are identified any recurring patterns or structures that indicate important evaluative positions of the discourse.

The identified patterns are A. the types of technologies on which the researched companies are based, B. evidence of the originality of the technologies that confirm their novelty, and C. accelerators and decelerators of the growth of the researched companies, which are identified in the internal and external environment of these companies. The order of the identified patterns expresses their importance/weight in the research sample.

The interpretive phase of critical discourse analysis (CDA) is a major part of the analysis process, as it is dedicated to a deeper understanding and interpretation of the discursive practices and patterns identified in the descriptive phase. This phase moves from the basic identification of discursive elements to an analysis of how these elements reflect and relate to the broader social, cultural, and historical contexts in which they are embedded. This process allows researchers to uncover the hidden meanings that shape and are shaped by discourse.

The ChatGPT-4 language model developed by OpenAI (<https://openai.com/chatgpt>) is an advanced text analysis tool that uses deep learning to understand and interpret human speech. In the described research, this model is used to identify patterns and validate the analysis results.

RESULTS & DISCUSSION

The formal industry incorporation of the investigated companies is not clear proof that they are based on new technologies. Discursive analysis therefore identified several groups of enterprises according to the type of technology developed and looked for evidence of the originality of this technology. The order of occurrence of technologies expresses their importance/weight in the research sample.

1. Ecological and sustainable materials. Companies carry out the development and production of products from renewable resources or materials that are degradable, recyclable, and do not burden the environment. Some materials are made from completely renewable resources and are completely biodegradable.
2. Medicine. Companies are engaged in the development of new or improved treatment technologies, therapeutic procedures, drugs, and diagnostic methods that improve healthcare and treatment outcomes for patients. Diagnostic methods are generally non-invasive and the display of test results is user-friendly.
3. Robotics and autonomous systems. Companies are developing autonomous and robotic systems designed to facilitate monotonous human work or completely replace humans in hazardous situations or performing routine tasks.
4. Data analysis and artificial intelligence (AI). Companies provide solutions for data analysis and artificial intelligence, thus enabling a better understanding of data, identifying paradigms in large data sets, improving decision-making, and refining arguments in the creation of business strategy.
5. Gaming industry. Companies offer services that maximize game performance and develop new game levels and new content for existing games to extend their lifespan and increase their economic efficiency.

The surveyed companies use different ways to prove the novelty of the new technology. Based on the discursive analysis of the answers, they can be classified into five categories, the order of which expresses the importance/weight of the evidence in the research sample.

1. Patents and protected designs. Applications filed and patents granted by domestic and foreign patent offices are the main proof of the novelty of the technology. Patents and protected designs serve as legal protection for innovations and at the same time confirm their uniqueness.
2. Awards and certificates. Less prestigious are awards and certificates of innovation and technology, which are also proof of originality and usefulness for the customer. Awards are given at exhibitions and contests, by expert associations, and professional and trade chambers. Certificates are awarded by testing

laboratories, specialized non-governmental agencies, and state authorities.

3. Scientific publications and research. Enterprises prove the originality of the technology by publishing research results in renowned scientific journals or at scientific conferences, which confirms the professional recognition of the excellence of the technology in the scientific community.
4. Unique technological solutions. Some companies emphasize the uniqueness of a technology that is not protected by a patent or confirmed by another public document for various reasons but is considered exclusive due to innovation, design, or specific usefulness. The uniqueness is given by the informal response of the professional public, professional associations and chambers, important customers, and respected competitors.
5. Marketing and sales success. Companies see market acceptance and commercial success as proof of the novelty and usefulness of a technology. It manifests itself as rapid growth of the customer base, expansion into new markets, positive feedback from customers, and, above all, significant growth in sales.

External growth accelerators are favourable external conditions that, as a rule, the company does not influence, but may or may not use. Their content includes factors listed in the order that expresses the importance of their impact.

1. Offer of capital. It is a key external accelerator of growth and is often the direct reason to continue growing the business. As a rule, the founders do not have their own capital or only a minimal amount, which is not enough for the growth of the company. Capital comes from private individuals, venture capitalists, state grants, and crowdfunding campaigns. The offer of capital determines the price of capital, the profitability of capital, the maturity period, the position of investors in the management of the company, and guarantees. Technology entrepreneurs actively seek funding schemes, in particular establishing and maintaining relationships with private investors/individuals, venture capital firms, and crowdfunding platforms. Illustrative statement from R&D of medicaments: "If investors offered us more cheap money, we could conduct clinical trials faster. Successful completion of clinical trials would attract additional investors and accelerate growth."
2. Regulatory and political environment. State support/non-investment and incentives/concessions are for entrepreneurs who establish a company on the development of new and unproven technologies with unclear commercialization, an important impetus, and insurance for the development of their business activities. Technology entrepreneurs expect the existence or creation of legislation that supports innovation and entrepreneurship and therefore creates a

favourable environment for the growth of companies. The second requirement is political and legislative stability, which are crucial for long-term planning and investment. The predictability of the regulatory environment reduces business risk and provides more certain opportunities. Technology entrepreneurs lobby to negotiate a more favourable legislative and regulatory environment, maintain an active dialogue with regulators, and adapt business models and strategies to the current and anticipated regulatory environment. Illustrative statement from R&D and battery production: "We would be helped by political decisions at the EU level favouring e-mobility in the automotive industry."

3. Market and economic opportunities. The opportunity to quickly enter new markets and take the position of a pioneer and market creator is a serious reason for accelerating the growth of the company. Social progress and changes in consumer behaviour are strong motivators for the development of business ideas and their use for business growth. However, these intentions are conditioned on the ability to identify developing markets and the ability to enter them. The second condition is a quick response to changes in consumer preferences and market trends. Entrepreneurs try to approach opportunities by regularly analysing market trends and consumer behaviour, flexibly modifying products and marketing strategies, and developing and differentiating the product range based on identified opportunities. Illustrative statement from the research, development, and production of ecological plastics: "Our business depends on the ecological awareness of the broad domestic civil and business public, but especially the European public and EU authorities."
4. Technological progress and innovation. Entrepreneurs realize that the use of new and original technologies with the support of partners is the way to competitive advantage and growth of their company. They develop new technologies, or seek access to them, and then use them innovatively to improve existing products and services. However, for the development or innovative use of technologies, small and medium-sized enterprises need to build partnerships with research institutions and technological leaders, because they have limited resources due to the difficulty of developing new or applying adopted technology. Entrepreneurs realize these intentions by investing in research and development, establishing relationships with other technological enterprises, and academic institutions, and integrating into innovation ecosystems and technology incubators. Illustrative statement from the development of the application of artificial intelligence in audio-visual recording: "The technology on which our business is based has improved significantly over the past six months. It happened very quickly, we didn't expect it to happen so quickly".

External growth decelerators are unfavourable external conditions that the company cannot change, but must respect or adapt to. Their content includes factors listed in the order that expresses the importance of their impact:

1. Availability of capital is considered the main obstacle to the growth of technology companies. Behind it is difficult to access capital, high interest rates for loan capital, depressing guarantees, or simply a lack of capital for unusual, highly novel, pioneering, and therefore high-risk projects. The unavailability of capital slows down or even stops expansion, research, development, and market entry. Technology entrepreneurs are actively reaching out to foreign investors because there is a lack of sufficient venture capital in their home country. Domestic sources of capital are not suitable for financing a business based on new technologies, and their eventual acquisition is associated with too demanding and complex bureaucracy. Illustrative statement from the development of genetic tests: "There is a lack of venture capital, domestic venture capitalists are small, foreign venture capitalists are hesitant."
2. Regulatory barriers, if strict or complex, cause significant obstacles to the growth of companies in highly regulated industries, e.g. in healthcare, financial services, and energy. These barriers represent costly and lengthy approval processes, high demands on quality, reliability, and safety of products and services, market restrictions, and regulatory uncertainties, which are caused by individual interpretations of unclear legislation and frequent changes in regulations. Technology entrepreneurs try to deal with these restrictions by actively communicating with regulators, consulting with authorities during research and development, and investing in qualified legal advice to better understand and comply with regulatory requirements. Illustrative statement from the development and production of bioplastics: "The EU legislation lags behind reality because it does not classify the composition of bioplastics. There are no relevant EU regulations on the composition of bioplastics, and therefore unfair competition is created."
3. Market competition, if it is intense, can be a big obstacle to the growth of companies, especially startups that enter the market for the first time. Mature markets with stabilized demand offer low margins and little opportunity for growth. A mature industry has many established companies that pursue aggressive pricing and marketing campaigns. In such a situation, technological entrepreneurs see a solution in innovation and differentiation. They develop unique products and services that stand out from the competition and thus can be competitive. Another solution consists in identifying and serving specific market segments (niches) with less competition, but also with less opportunity for scaling. Illustrative statement from the development and production of

microbial fertilizer: "The market is consolidated the big players influence the market significantly."

4. Economic and political uncertainties. Economic recessions, political changes, and geopolitical tensions have a negative impact on the growth of technology companies. The consequences of the fading COVID pandemic, and military conflicts, especially in Ukraine, which are manifested in deglobalization, disruption of supply chains, interruptions in the supply of goods, and threats to world shipping routes, introduce a significant amount of uncertainty in business and prospects. These factors lead to reduced demand, unstable market conditions, and limited access to foreign markets. Technological enterprises responded to the aforementioned uncertainties by applying agile business models that enable rapid adaptation to changes in the external environment. Other measures are minimization of business risk, creation of financial reserves, and diversification of markets. Illustrative statement from the development of 3D holograms in augmented reality: "We are troubled by the recession and the uncertain situation in which our innovations go sideways. The environment is conservative, neither education nor society is set up for innovation."

Internal growth accelerators are favourable internal conditions that stimulate the growth of the company from within, of its own volition, which can be expressed explicitly or implicitly. Specific internal factors are listed in the order that expresses the weight of their influence:

1. Innovative corporate culture and internal processes. A culture open to innovation and continuous improvement of internal processes is the main condition for the growth and adaptability of the company. An environment in which employees are encouraged to innovate, and in which internal processes are constantly improved to increase their efficiency, contributes significantly to faster growth. An innovative culture that appreciates creativity considers change as an opportunity and does not see it as a threat. Employees are engaged and therefore feel responsible for improving internal processes. Tech companies encourage creativity and innovative thinking, so they offer employees hackathons, workshops, and innovation freedom to a reasonable extent. Digitization plays a major role in increasing the efficiency of internal processes and reducing costs. Illustrative statement from data and software architects for profitable solar investments: "Refining internal processes, improving the division of labour, improving compensation so that people understand what they are getting paid for helps us grow. We show appreciation to people and they increase engagement, we make the work environment more pleasant in order to achieve satisfaction with the work performed and a sense of responsibility."
2. Qualified and motivated team. The creative team and the staff are almost identical employee entities

in the environment of a technological company. A creative team is the heart of such a company. The quality of the team depends on talent management, i.e. the ability to attract, develop, and retain talented employees. The second condition is motivated and committed employees who feel fairly evaluated, rewarded and celebrated. Technology companies strive to create an attractive work environment, offer opportunities for personal and professional development, and provide rewards and recognition that increase employee engagement and loyalty. Illustrative statement from a waste processing and soil regeneration company: "People are more important than technology itself. It could not develop without them. Quality people, a good team, trust, and commitment are an internal source of growth."

3. Strong leadership and vision. Top management sets a clear and attractive vision, inspires the team to achieve long-range goals, and formulates a convincing strategy to achieve those goals. Due to the long planning period, the ability to quickly and effectively make decisions and adapt to variable external and internal conditions comes to the fore. Founders of tech companies invest in workshops and training of executives to improve their skills in how to manage and motivate teams. Strategic plans are formulated explicitly and unambiguously but with the possibility of quick adaptation to changing market conditions. Illustrative statement from the development of diagnostic tests for cancer and covid: "We share a common vision, which is to save human lives."
4. Use of adopted technologies. Companies not only develop their own new technologies but also use adopted technologies to increase the productivity of researchers and developers and to develop new or improved products and services. The contribution of external technology to company growth depends on the ability of the company to adopt and effectively use the technology. Of the external technologies, digital technologies and their integration into all functions of the company are key. Growing companies are investing significantly in modernizing IT systems, including software, and implementing digital transformation across all functions and processes. Illustrative statement from the development and production of computer, electronic, and optical instruments: "We learn from foreign experiences to help employees improve their blockchain skills."

Internal growth decelerators are unfavourable circumstances that prevent the growth of the company from within. Specific internal constraints are listed in the order that expresses the weight of their influence:

1. Insufficient resources and capacities. Companies never have enough resources, they lack finance, people, and research, development, and production capacity. These restrictions prevent the rapid development of new products, expansion into new markets, and the increase of realization capacities. Tech

entrepreneurs are looking for funding sources across the spectrum of potential choices from angel investors to government subsidies. They solve the lack of experts by developing internal talents, external experts, and freelancers, and digitization/automation of internal processes. They increase insufficient operating capacity with process innovations. Illustrative statement from the design of a universal processor for electronic computers: "We only hire 10% to 20% of applicants, highly qualified specialists are in short supply. The work is highly demanding for unusual and rare knowledge that available universities do not provide."

2. Resistance to change. It prevents the introduction of new processes, technologies, and strategies. It is caused by fear of the unknown, lack of communication, and insufficient participation of employees in deciding the future of the company. Deeper reasons for resistance are conservative attitudes towards new work procedures and less flexibility and adaptability of existing processes. To overcome and eliminate resistance, tech entrepreneurs create an inclusive environment where innovative ideas and employee feedback are welcomed and valued. Employees receive offers for professional growth and skill development to adopt positive and adaptive attitudes toward change. The reasons for the changes and the benefits of adopting the changes are transparently announced and explained. Illustrative statement of a cigarette filter recycling company: "We are aware of the need to internationalize the business, but we are afraid of the international market."
3. Lack of innovation and creativity. Lack of innovativeness weakens the company's technological prestige, the market response of products and services, and competitive advantage. There is a lack of appropriate incentives for innovative and creative solutions to problems in conjunction with insufficient investments in research and development. Technology entrepreneurs are trying to overcome this unfavourable situation with initiatives that support innovation, e.g. internal grants, contests, and practice in a business incubator. They hold brainstorming discussions and

workshops to develop creativity and stimulate the emergence of new ideas. They also invite customers and cooperating partners into the innovation process, and thus use feedback and cooperation to identify customer needs and opportunities for innovation. Illustrative statement of the developers of space debris removal technology: "We are caught up in exhaustion, disillusionment with failure, consumption of equity capital, loss of enthusiasm and innovation, unclear employee motivations."

4. Inefficient processes and systems. Inefficient operational processes and systems waste resources, increase operating costs, and reduce overall company productivity. The consequence is lagging behind the competition. Operational processes are outdated, complicated, insufficiently technologized, and automated. Technological entrepreneurs revise, restructure, digitize, and automate inefficient processes. They provide employees with training on the efficient operation of new systems and technologies. Illustrative statement from communications software development: "A company that was once small and agile now has 250 employees. Managing a community of people that works across continents and time zones is more challenging than it used to be when people met, agreed on what they were going to do, and did it tomorrow. In the environment of a global company, it is much more difficult."

The result of the analysis of answers to open questions about accelerators and decelerators of NTBFs' growth is summarized in Table 1.

DISCUSSION

A. Knowledge contribution on accelerators and decelerators of growth of NTBFs. Previous research on the growth of NTBFs has focused to a greater extent on positive internal factors (Camisón-Habaa et al., 2019; Zellmer-Bruhn et al., 2021; Sońta-Drażkowska, 2020; Rydehell, 2020; Issakson et al., 2021) and to a lesser extent on positive external factors (Löfsten et al., 2023; Rydehell et al., 2019/b; Fudicar and Hotentott, 2019). The role of the founder and the team was confirmed and expanded, supplemented by an innovative culture and the use of adopted technologies. A positive external environment

Table 1: Summary overview of NTBFs' growth accelerators and decelerators

		↑ max Accelerators and their influence ↓ min	↑ max Decelerators and their influence ↓ min
External factors vs Internal factors	External factors	1. Offer of capital 2. Regulatory and political environment 3. Market and economic opportunities 4. Technological progress and innovation	1. Availability of capital 2. Regulatory barriers 3. Market competition 4. Economic and political uncertainties
	Internal factors	1. Innovative corporate culture and internal processes 2. Qualified and motivated team 3. Strong leadership and strategic vision 4. Use of adopted technologies	1. Insufficient resources and capacities 2. Resistance to change 3. Lack of innovation and creativity 4. Inefficient processes and systems

Source: own research

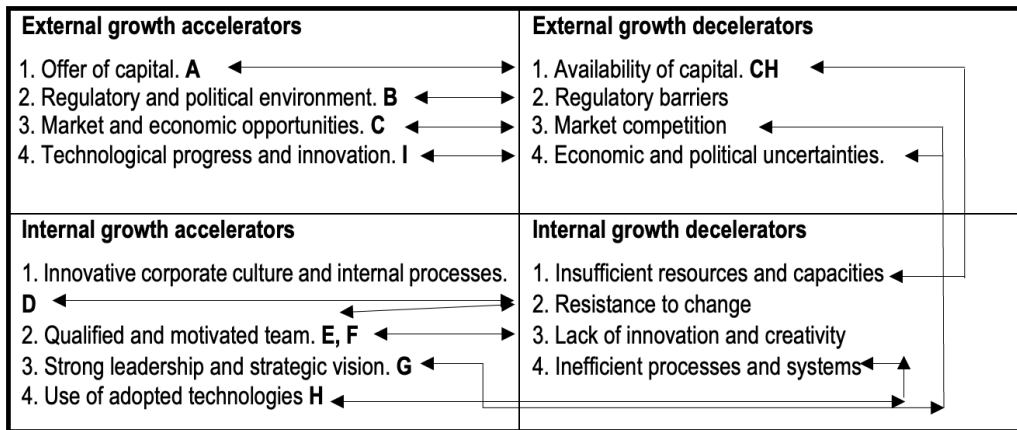
consists not only of the supply of capital, institutions, and partnerships, but also of a predictable regulatory environment, mature markets, and open innovation. Negative growth factors of NTBFs are usually on the edge of research interest. Negative external obstacles to growth are to some extent the opposite of external accelerators, except economic and political uncertainties, but the knowledge contribution is the explanation of the causes of their emergence. Internal growth obstacles bring perhaps the newest insights because they disrupt the idealized image of a flawless technology company.

B. Relationships between growth factors. From Table 2. it is obvious that some external and internal factors are related to each other, and other factors have a two-way or one-way influence, e.g. the offer of capital is limited by demanding conditions for its procurement (A), a similarly favourable business environment requires the fulfilment of demanding criteria (B), sufficient business opportunities are reduced by intense competition (C), an innovative culture and a developed team encounter resistance to change (D, E), a qualified team can be creatively exhausted (F), strong leadership can find solutions in a competitive and uncertain environment (G), adopted technologies can improve internal processes (H), unavail-

able capital causes a lack of resources and capacities (CH), the results of basic research applied in partnerships they can overcome competition and external uncertainties (I). The impact on growth caused by several, especially internal factors is also confirmed by studies by Yang et al. (2017), García-Cabrera et al. (2019), Pinkwart et al. (2015), and Mauer et al. (2024). Studies on the combined effect of internal and external factors are rare. With certain simplifications, they are studies with the impact of the business model, which includes partners and customers, e.g. Issakson et al. (2021). Passavanti et al. (2024) emphasize that between the number of financial resources raised during the first funding round from external investors and founders' education, the size of the company, property rights, and alliances exist a causal relationship. This supports the conclusion that influential factors act as a sum of causes of growth or stagnation of the enterprise, rather than isolated enablers.

C. The essence of growth factors. An explanation of the essence, or the background and internal structure of NTBFs' growth accelerators and decelerators is summarized in Table 3.

Table 2: Connections between the identified factors of acceleration and deceleration of the growth of NTBFs



Source: own research

Table 3: Summary overview of the background of NTBFs' growth accelerators and decelerators

<p>External growth accelerators - external versus internal background</p> <ol style="list-style-type: none"> 1. Sufficient risk capital, but also investment attractiveness of new technology. 2. Favourable conditions for business, but also knowledge of public rules. 3. Sufficient business opportunities, but also entrepreneurial skills of the founders. 4. Quality basic research with publicly available results, but also applied R&D technologies in cooperation with partners. 	<p>External growth decelerators - external versus internal background</p> <ol style="list-style-type: none"> 1. Little domestic/local risk capital, but also unattractive investment demand. 2. Very complicated legislative environment, but also ignorance of legislation. 3. Low barriers to entry into the industry, but also an uncompetitive product. 4. Too a complex and dynamic world, but also a weak vision of how to survive in it or escape from it.
<p>Internal growth accelerators - internal background</p> <ol style="list-style-type: none"> 1. Innovative and charismatic personality of the founder. 2. Talent management and engaged employees. 3. Visionary founder with strong horizontal leadership. 4. Technological ambidexterity. 	<p>Internal growth decelerators - internal background</p> <ol style="list-style-type: none"> 1. Small and start-up companies without complementary resources. 2. Too frequent and intense change that leads to frustration and fatigue. 3. The creation of complex and highly specialized knowledge is considerably limited in terms of personnel. 4. New technologies that also require new, untested internal processes.

Source: own research

External growth accelerators

1. Offer of capital means a sufficient supply of risk capital, which is attracted by the investment attractiveness of a new technology. The applicant for external capital provides investors with convincing arguments about the originality and perspective of the technology, which is transformed into a convincing business idea, i.e. a consumer application with a good product-market fit and growing sales. A condition for access to capital is the willingness of the founder to share ownership of the company and a functional and resilient team. A study by Mauer et al. (2024) also considers sufficient capital already at the beginning of a business to be an extremely important factor.
2. The regulatory and political environment creates favourable conditions for business, but their positive impact requires knowledge of public rules, compliance with new technology with relevant public policies, search for public professional support, finding allies, and upholders, and sufficient bargaining power to influence public rules. In this case, Löfsten et al. (2023) found that professional and consultative networks acquire business opportunities and thus contribute to NTBFs' growth.
3. Market and economic opportunities. However, sufficient business opportunities are conditioned by the entrepreneurial skills of the founders, thorough analysis of markets and industries, and skilful adaptation to opportunities. However, companies are usually founded by scientists, researchers, and top technical engineers. Adaptation to opportunities is helped by increasing participation in partnerships and business networks (Löfsten et al., 2023).
4. Technological progress and innovation. There is high-quality basic research with publicly available results that are transferred to applied research and technology development in cooperation with partners. The development and use of new technologies are carried out in cooperation with partners because new technologies are too complex to be developed and commercialized by a single company with very limited high-end human resources. Open innovation plays an important role in supplementing own knowledge (Tchouwo et al., 2021).

External growth decelerators

1. The availability of capital manifests itself as an insufficient supply of local (domestic) risk capital and difficult conditions for obtaining it, but also as an unattractive investment demand. Local venture capitalists have capital in the range of several hundred thousand euros, although several million euros would be needed in one investment round for one company for large, pioneering, and courageous scientific projects. There is a lot of risk capital abroad, but access to it is difficult or impossible for a young, small, and unknown company from a small

country. Public agencies provide more entrepreneurial know-how than investments (Fudicar & Hotentott, 2019), (Baier-Fuentes et al., 2021).

2. Regulatory barriers in this case are a very complicated legislative environment, but also ignorance of the legislation. Overcoming barriers requires highly specialized knowledge and practices, expensive legal advice, and an understanding of the changing and ambiguous interpretation of regulations. Marjovi & Zarei (2023) suggest that the public sector needs to be more active, act more intelligently, and be more agile in supporting NTBFs.
3. Market competition is a source of problems when it is intense. The reason is low barriers to entry into the industry, but also an uncompetitive product, which is a consequence of poor identification of an unsatisfied need, poor match between the product and the market, an undemanding imitation, weak legal protection, late entry into the market, selection of inappropriate markets. The leverage effect of partnerships also helps eliminate insufficient competitiveness (Combs et al., 2023).
4. Economic and political uncertainties weaken demand and deepen business uncertainty. The world is too complex and dynamic and lacks a strong vision of how to survive or escape it. The world is changing under the influence of so many factors that it is unpredictable, the changes are beyond the boundaries of the company's industry, they arise outside the market, outside the influence of market forces, and therefore observing them in their entirety is difficult, if not impossible, for a small company. Companies based on new technologies (NTBFs) show a high level of information asymmetry (Passavanti et al., 2024).

Internal growth accelerators

1. Innovative culture and internal processes. Favourable internal attitudes towards innovations are the result of the work of the founder's innovative and charismatic personality. Creativity, innovativeness, and engagement are considered the main values that are spread vertically and horizontally by innovative and resilient leadership. Creative and innovative team spirit is considered a key aspect of resilience (Campos et al., 2019). The main values are manifested not only in the quality of the results but also in the improvement of the methods (processes) of their achievement.
2. A qualified and motivated team is created based on talent management and committed employees. Top experts are purposefully selected, developed, and cultivated. Cultural values require a specific capable, committed, disciplined, and responsible personnel carrier, who is a cohesive team. Buenechea-Elberdin et al. (2017) considered highly qualified and motivated employees an important growth factor because

they can draw on a solid knowledge base and are willing to expand their knowledge frontier.

3. Strong leadership and vision. The founder is a visionary and cultivates strong horizontal leadership. It provides ideas, solutions, and ways out of uncertainty and gives strength/motivation for challenging adaptation. Internal accelerating factors 1, 2, and 3 are united in their background by the personality of the founder, whose influence is confirmed by research by Camisón-Habaa et al. (2019), Farnoodi et al., (2020) and (Rydehell et al., 2019).
4. Using technologies means working with two technologies, which can be called technological ambidexterity (Hughes, M. et al., 2020). One technology is developed (resulting, target) and the other technology is working (process). Work technologies speed up and make business functions and processes more efficient, thus contributing to the development of new technology and the rapid adaptation of the company to uncertainty. Technological enterprises should also focus on innovative ambidexterity, which consists of finding a balance between the creation and use of innovations (Wiratmadja et al., 2020).

Internal growth decelerators

1. Insufficient resources and capacities. Almost everything is missing, a small and starting company is without complementary resources. A small and initially unilaterally (research-oriented) built enterprise has only modest capital, the main asset is an idea and an unproven technology without traction. If the enterprise deals with elementary existence, then the interest in growth arises late and is secondary for a long time (Mauer et al., 2024).
2. Resistance to change. Too frequent and intense change leads to frustration and fatigue. Initial decisions about the type and application of new technology are a source of certainty in an uncertain world. Escalating heroism, pioneering in situations where the consequences of the first choice are unknown, deepens uncertainty and provokes resistance. Enthusiasm for new technologies has some limits, at least temporarily, especially if it is accompanied by lengthy internal processes that slow down growth (Mauer et al., 2024). Resistance is also caused by the limited scope for engagement of employees, or listening to them, limited access to decision-making, a barrier between managers and first-line employees (two worlds), loss of orientation, disgust, and apathy, especially if the expected results are not forthcoming.
3. Lack of innovation and creativity. The creation of complex and highly specialized knowledge is considerably limited in terms of personnel. High technologies require complex and highly specialized knowledge of a certain extent and quality, which is creatively applied so that innovations can arise. Acosta-Prado et al. (2014) state that the technological ca-

pability of NTBFs has a positive relationship with innovative and creative intellectual capital. Due to the size and creative capacity of the examined enterprises, this knowledge is limited, innovative capacity and creativity are not enough to meet the needs of the development of new technologies, i.e. to step up innovations to the limits of technological possibilities. The innovation capacity of small and start-up businesses is considerably limited.

4. Inefficient processes and systems. The development of new technologies also requires new, untested internal processes. Emphasis on new technologies, production of new knowledge, scientific research requires different processes, or processes performed differently (unpredictability of results, complex to impossible algorithmization, non-repeatability, randomness, dead ends, failures) than the commercialization of research results and routine operation of production and trade. It is a clash of two different worlds. Saemundsson & Candi (2017) suggested that for the successful growth of NTBFs, a balance is needed between adapting to changes in the market and changes in technologies.

Previous research has investigated the impact of mainly internal and, to a lesser extent, external factors on the business performance of technology companies, with few exceptions, using quantitative methods. The results of this research are achieved using qualitative methods and examine both external and internal influences on the growth of NTBFs in aggregate. This is where this research differs from other research. The research question was answered, as four groups of factors that accelerate and decelerate the growth of NTBFs

CONCLUSION

The purpose of the research study was to identify and explain the impact of external and internal factors that accelerate and decelerate the growth of NTBFs. Each factor is composed of four specific sub-factors, which are ranked according to the degree of their influence. External growth accelerators are the offer of capital, favourable business conditions, demand, and supply of new knowledge. External decelerators to growth are the availability of capital, formal obstacles to doing business, competition, and uncertainties. Internal growth accelerators are corporate culture, team, visionary leader, and absorption of external technologies. Internal decelerators to growth are insufficient resources, resistance to change, insufficient innovativeness, and inefficient operation. In each group of factors, the knowledge about the causes of the growth of NTBFs has been deepened and expanded, the largest volume of new knowledge is probably about internal decelerators of growth.

A challenge for further research is to clarify and potentially resolve the contradiction between the identified factors and characteristics of NTBF (a small to medium enterprise with a short history, founded by scientists without entrepreneurial experience with a high-risk business idea)

and the contradiction between limited resources of all kinds, including an exploratory but undeveloped idea (the only valuable asset) and the significant financial resources needed to complete the idea (permanent problem?).

The new findings can be used as a control chart for the founders of NTBFs, which, when applied to a specific technology enterprise, will show the external and internal incentives and obstacles to growth that the enterprise will be able to adjust in the future, given its external capabilities, internal resources, and growth ambitions, to enable it to meet growth targets, or signaled external and internal disturbances.

The research limits of the described research lie in the size of the sample, the scope of which cannot be increased too much, because the number of enterprises with a completely new technology in the country is relatively small. Field research carried out in a direct interview with the founder is demanding obtaining consent for a controlled interview and for the work schedule of the researcher and the respondent. This is also the reason for the limited research sample. The research limit is also the restricted time for an interview and the depth of insight into the researched topic, which, however, can be partially compensated by the analysis of publicly accessible documents about the relevant company.

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