

Critical success factors of innovative Lithuanian life sciences startups

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by

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### Abstract

The purpose of this thesis is to identify the critical success factors of innovative Lithuanian life sciences start-ups that drives them to commercial success. Literature review identified factors that are critical to the success of technology (or knowledge) intensive start-ups in various ecosystems throughout the World, although there was no specific research made on start-ups' critical success factors in the field of life sciences. Qualitative research was used to collect empirical data about innovative Lithuanian life sciences start-ups, which are developing new technologies, products or services, generating revenue, have more than one employee and are not experiencing any major financial difficulties. The findings of the research revealed that Lithuanian life sciences start-ups correspond to the global tendencies and same factors affect their operations as any other technology (or knowledge) intensive start-up, however start-ups are heavily dependent on the national and European Union funding opportunities.

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### INTRODUCTION

Life sciences are no longer being associated to fundamental research only as it grew into a huge industry which improves almost any aspect of global ecosystem, for example, the innovative research in agriculture resulted in improvement of harvests and sustainable food growth around the World; breakthroughs in biopharmaceuticals extended overall life expectancy of humankind; ground-breaking life sciences sector's achievements in biological research reduced the introduction of Ebola's vaccine to the market ten times and many more. Therefore, life sciences industries are considered to be the next fundamental milestone in the century of innovation and technology. It finally throws a challenge to an era of information technology which is still considered to be the main knowledge based instrument for global economic development which reflects in many reviews of the "Big Four", i.e. Price WaterhouseCoopers states that global total investment in various biotechnologies only is already in the second place (data of 2014). One of the preeminent advantages of life sciences is its adaptability and compatibility with other industries (i.e. information and communications technologies, engineering, ecology, agriculture, marine etc.).

While start-ups are the underlying power for economic, innovation and technology progress in almost any global industry without exception – in the field of life sciences. Era of startups hugely contributes to the development of this industry as they are not only coming up with innovative ideas, but they also improve the well-established products and services in the market in order to increase its effectiveness and/or come up with new unexpected applications, i.e. MyoKardia has used the developments of research in the heart muscle biochemistry and used to its own advantage combining it with the research made in cardiovascular genetics. And that resulted in affectedly improving the treatment of cardiomyopathies that will help millions of people who are affected by the heart diseases.

In order to keep the industry's growth on the right track it is imperative to identify the critical success factors of life sciences start-ups that might guarantee sustainable and long lasting growth of all fields in life sciences sector. For this reason, the aim of the thesis is to identify the critical success factors of Lithuanian life sciences start-ups that drive it to a commercial success. The goal of the thesis is to identify the main critical success factors of the industry, so that the startups could potentially take into consideration the researched factors in order to successfully grow. Such growth is being promoted differently country by country as diverse environment drives startups to commercial success, i.e. Israel is considered to be an example how an economy could be enhanced through various scientific achievements by creating a net of technology transfer offices (since 2004 "the U.S.-Israel Science and Technology Foundation (USISTF) formed an organization that would unite various technology transfer offices throughout Israel"), Switzerland attracts best LS start-ups because of its risk seeking venture capitalists etc.

Key objectives of this master thesis are the following:

1. While conducting the literature review: a) to analyze various critical success factors of companies, start-ups and use the identified factors for further research; b) to evaluate global and national outlook of life sciences industries; c) to write an overview of start-ups globally and locally; d) to identify innovativeness of start-ups and its categorization.
2. To prepare research methodology, build questionnaire and use qualitative research tools in order to conduct the research on critical success factors of Lithuanian life sciences start-ups and evaluate whether the literature review findings correspond with the Lithuanian life sciences industry.



3. Summarize the research results and compare it to the theoretical and literature review findings on critical success factors and check of differentiation or new findings in the industry.
4. Discuss the significant findings and propose the possible further research in the field.

Taking into consideration the importance of life sciences and its application to the humankind's every day being, this master thesis will base its research on innovative start-ups critical success factors and its potential impact to the future development of life sciences industry in Lithuania.

Literature review will discuss the topic of life sciences, consisting sciences in the field, global and domestic outlook of the industry, innovative start-ups, Lithuania's government and governmental agencies actions in order to foster the industry and start-ups, critical success factors of start-ups in the field will be identified throughout the literature review and the research design will be based on the identified factors and it will be conducted accordingly. The qualitative research design will be used in the thesis, based on life sciences startups based in two major Lithuanian cities: Vilnius and Kaunas, as the concentration of LS startups within the cities is the highest. The research itself will follow in order to collect the data from innovative Lithuanian life sciences start-ups. Discussion and conclusions will be provided upon the end of this thesis, which will enhance the validity of the arguments and position.

## LITERATURE REVIEW

### Innovative start-ups

Different authors define innovation differently and it could be categorized into various levels of innovativeness. Joseph Schumpeter (1912) defined innovation in the "Theorie der Wirtschaftlichen Entwicklung" and described five levels of it:

1. A completely new product that has not been introduced to the global market.
2. An improved way of manufacturing the product (that is discovered upon new scientific methods are introduced in the market).
3. Entering a new market with a new way of manufacturing goods that has not been entered before (either way if the market existed or was created).
4. Introducing new ways of supplying raw materials of pre-manufactured goods used in further manufacturing.
5. Creating a new, improved or better organization that can create a monopoly or break one (at any industry given).

The Innovation Union (created by European Commission for the strategy of Europe 2020) defines innovation as an overall concept that improves and/or speeds up introduction of new products, its development of production or manufacturing, as well as development of industrial processes and services. The end goal of innovation is to contribute to the improvement of human's lives, social environment and that the innovation itself would create more jobs. Most importantly, innovations should "provide real benefits for us as citizens, consumers, and workers".

A Nobel Prize Winner, an American biochemist, Robert Bruce Merrifield (1986), who contributed to the development of the life sciences industry in the US has stated that any innovation has to have "three stages in the process of innovation: invention, translation and

commercialization”. Similarly, that reflects the same stages as of any technological start-up (to translate a discovery into a business application).

Therefore, summarizing the definitions of J. Schumpeter (1912) and R. B. Merrifield (1986) and European Commission, an innovation of a start-up will be considered in this master thesis as a completely new product or an improved way of manufacturing or developing a product which contributes to the overall development of the industrial processes; while the purpose of the innovative product would be a potential commercialization.

### **Critical success factors**

The overall concept of critical success factors was first introduced by D. Ronald Daniel (1961). The general idea of the factors introduced was that the some certain factors might arise during any given type of the organizations operation that should be addressed properly. If the objectives to address the factors were not achieved, the specific factor could cause serious financial, organizational or managerial difficulties that might result in the worst case – organizations’ liquidation – scenario. Rockart (1979) has contributed to the development of the critical success factors and became the most cited author on the topic and stated that critical factors, if managed properly, guarantees successful competitive performance.

Esteves (2004) have discussed different dimensions of critical success factors. The author has identified 6 of them which are now most widely used. One the hierarchical dimension author suggests that CSFs should be grouped in two areas: either group of organizations that are operating in the same industry (so forth called “industrial CSF”) or group of managers that are responsible for specific duties at the organization (“occupational CSF”).

It is also crucial to state that various CSFs might not be regarded as equally important to various different organizations even though they fall to the same industrial category. Ellegard and Grunert (1993) study reveals that managers tend to mix the perceived and actual

critical success factors as every organization should follow their specific goals and mission. That is where the identified industrial CSF sometimes might fail in running a specific organization as it might have explicit various other factors that managers tend to ignore. Auruskeviciene, Salciuviene, Kazlauskaite, and Trifanovas (2006) suggests that managers should address this issue by having group meetings and analyze how managers identify and deals with various CSFs and whether the CSFs are not perceived subjectively and they are the actual critical factors (M. Amberg, F. Fischl, M. Wiener 2005).

This master thesis will address the industrial (life sciences) critical success factors of innovative start-ups in Lithuanian market. Based on the literature review industrial CSFs will be proposed for further research as well as during the qualitative research other CSFs will be identified during the interviews.

### **Identification of critical success factors**

#### **Unforeseeable uncertainty**

In Svenja C. Sommer, Christoph H. Loch, Jing Dong (2009) have identified that usually startups face not only with risk, but also with a unforeseeable uncertainty (UU). UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. The study was based on how a venture dealing with an unforeseeable uncertainty on high or low complexity (of the startup itself or the project it is carrying out) as well as its association on low or high trial-and-error learning (researching information on the issue and adjusting its activities accordingly to fit with the information found) and selectionism (trying different well considered actions in order to see which works better). Figure 1 below shows the summary of hypotheses Svenja C. Sommer, Christoph H. Loch, Jing Dong (2009) have defined.

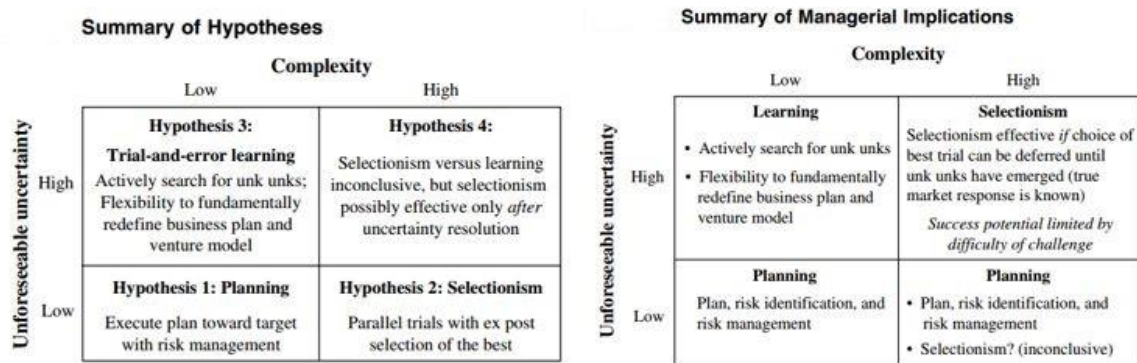


Figure 1. Summary of Hypotheses v Summary of Managerial Implications of unforeseeable uncertainty. From Svenja C. Sommer, Christoph H. Loch, Jing Dong, (2009) “Managing Complexity and Unforeseeable Uncertainty in Startup Companies: An Empirical Study”.

The figure “summary of hypotheses” summarizes that if the UU is high, the trial and error learning is being used in a case of the low complexity, however if the complexity is high, whether trial-and-error or selectionism should be used is not certain, while selectionism might be the more effective tool. With the low UU and low complexity, a traditional plan with risk management plan is used and with high complexity – selectionism. While the figure “summary of managerial implications” summarizes the managerial implications.

Christoph H. Loch, Michael E. Solt, and Elaine M. Bailey (2008) also addressed the challenge of unforeseeable uncertainty in new ventures as typically they do not assess the market opportunities correctly and do not take accurate steps to adapt their operations accordingly. Authors noted that new ventures in innovative technologies, products or services requires different managerial approaches than the classical ones that are used in traditional businesses. The findings of authors’ case study research in unforeseeable uncertainty identified that knowledge gaps are the key aspects of further unforeseeable uncertainty for a young organization. Trial-and-error (learning and experimentation) and selectionism (targets with deadlines) approaches were researched. The management and investors could address the unforeseeable uncertainty problem effectively by a designed approach that would help the

managers and venture capitalists to recognize the sub problems and identify the uncertainty that would eventually let the management to prepare an effective way to deal with the identified uncertainty.

An empirical study on Managing Complexity and Unforeseeable Uncertainty in Startup Companies (2009) conducted by the authors on 58 Shanghai based startups (out of which 12 were operating in the biotechnology or pharmaceuticals field), showed that if the startups are facing the unforeseeable uncertainty it is clear that no matter how high or low the complexity is, the execution of traditional risk management plan might not be enough and either selectionism or trial-and-error methods should be carried out as well. It is suggested by the paper when facing an UU and moderate complexity, the startup should concentrate on finding out the factors which are unclear as the success is impacted by the trial-and-error learning; even though more research is needed to be done when the complexity is high, it is suggested that thorough planning systems are the key factors to drive startup to success, results showed that selectionism is not supported by the results. The whole research unveiled that managers of startups should ask themselves two questions when implementing a new initiative: (1) whether the startup does not lack any knowledge gaps (referring to the unforeseeable uncertainty)? (2) How many different variables there are that can effect each another on various decisions (referring to the complexity)? The management which follows these questions and implements the required steps (risk management plan, trial-and-error learning, selectionism methods) to manage it are much more successful in creating value from the innovations and new technologies.

### **Financial constraints**

Financial constraints of the startups, according to Tobias Stucki (2014) who conducted a research on „success of start-up firms: the role of financial constraints“, are usually considered as having the most effect on the startups failure or success. As the first years of a

startup might be hectic as it does not generate the revenues needed and the initial investments owners as well known as the initial capital is usually limited in order to develop the startup on ideal conditions. For this reason, other sources of financial funds are needed such as business angels, venture capitalists or bank loans. The limited finances of almost any startup might be the reason of its failure. Tobias Stucki (2014) identifies that “main factor for these difficulties is the asymmetric information between the owners of the start-ups and external investors”.

The results of the empirical research carried out by Tobias Stucki (2014) states that financial constraints are negatively correlated with the young firms profit break point or even its survivability. The research revealed that in Switzerland strict financial constraints even discourage startups to enter the market leaving the idea unrealized in the real World. While the age of a startup does make a difference as the financial constraints disappear as the startup does get older each year, however the break-even profit point does not, states the results.

According to Nancy Huyghebaert and Linda M. Van de Gucht authors of “The Determinants of Financial Structure: New Insights from Business Start-ups” (2007) suggests that a start-up faces with a very troubling situation when it needs to get funding as it usually does not have history nor reputation which could be assessed by the bank. Although, authors concluded that “entrepreneurs who provide a credible quality signal through the amount of equity committed to their venture have a larger fraction of bank debt”. Such equity could be obtained as in traditional industries – through family, friends and by the entrepreneur himself (or herself).

Gardner J. on her online article “GO FOR A BOOST WITH BENEFITS” (2012) discussed that governmental funding is rather a competitive process, but it might be the key success factor for start-ups as it helps them to raise funding without reducing equity. Government’s goal is not to gain any returns with the provided grants (as it would be the

primary goal for any venture capitalist) it rather concentrates on other objectives, for example, the government expects that the industry itself or the region where the start-up operates will benefit. Author suggests that governmental funding might be the critical success factor which brings the innovative start-ups' technology, product or service to the marketplace for a commercialization.

### **Managing R&D and its costs**

Running a startup usually means racing with other similar establishments to introduce your product or service to the market first. There are many first-mover advantages according to the theory developer Melissa Schilling (2013), such as brand loyalty is built up by being the first one in the market, network advantages (i.e. licensing opportunities), generate bigger revenues and use that to cut prices when competition enters the market, the author also states that the originator could create costs of switching in order for customers to make difficulty in switching for the rivals product and lastly the first mover receives all the insights ahead of its rivals about the needs of customer, various distribution points etc. However, there are many disadvantages introducing your product and/or services to the market first, M. Schilling (2013) provides many insights on the topic, but the main conclusion of all disadvantages is the increased costs of almost any activities. The most important of them all – increased research and development costs.

One of the main problem for startups might be how to manage the research and development (R&D) costs in limited financial constraints. A variable of quality also appears in this part as only sufficient amount of funds can secure the quality of R&D products. There is a lot of research made and papers written on the cost reduction of R&D activities (i.e. J. Reinganum's (1985) cost reduction in order to increase its market share, M. Spence (1984) in his "Cost Reduction, Competition, and Industry Performance" paper suggested that the main cost reductions could be carried out on optimizing the R&D activities etc.). It is considered as



one of the most influential success factor of any young technological company/startup. U. B. Rao (2000) suggests the following guideline in order to optimize the R&D activities and costs:

- i. To define clear R&D goals. Setting a clear distinction between fundamental and industrial research and defining clear R&D goals is the most important part in order to conduct R&D successfully.
- ii. To break down the R&D project (product) and prioritize the different aspects of the project. As the R&D of the project consists many different aspects, it is crucial to break it down and prioritize which areas of the project needs the most human resources and financial investments.
- iii. To foresee the possible cost-reduction and quality effective options. Some of the activities might be outsourced for a cost reduction purposes or in other ways it is being outsourced in order to gain credibility as it could not be carried out in the industry's set quality standards, therefore a plan of possible outsourcing activities in order to keep the cost and quality effective ratio.

Case R. author of *MANAGING RISK IN PHARMACEUTICAL R&D* (2010) also underlines the risk of R&D projects, especially within pharmaceutical industry. As the studies of the sector shows that only 10% of the R&D projects within US pharma industry produces commercialized products. Author suggests two strategies: buckshot strategy and birdshot strategy. The buckshot strategy follows a pattern of investing bigger sums of funding into a smaller portfolio of projects which are better researched and more knowledge is gathered, while the birdshot strategy suggest dividing the funding into smaller sums of money and invest it into a broad, wide-array of projects where less data and knowledge is gathered. Both strategies have its risks and advantages, although two big pharmaceutical companies were compared in the article – Merck and SmithKline – where Merck is using the buckshot strategy and SmithKline is using the birdshot strategy. Interestingly, the evidence showed that Merck was having better

results in sales growth rate, return on equity, return on sales, return on assets and the overall R&D performance was higher. Although SmithKline ratios were better than the industry's average, but not as good as Merck's.

### **Managing human resources of a startup**

Management of human resources is also a crucial factor in order to lead a startup or pretty much any company to success. Especially startups which are developing rapidly usually change the duties for its employees rather often and new procedures take place, yet the managers of the startup fear of under or over staffing to keep the financial constraints in order. Therefore, one of the most important parts of a growing startup is to manage its staff as well as motivate and train their staff to achieve better results. There is no one right answer how to successfully manage employees of a startup. David Finegold & Stephen Frenkel (2006) highlight that it is very important to attract creative individuals into innovative life sciences/biotech companies as in these companies everything is based on innovations and its management. Specialists that are working in biotechnology/life sciences companies have their own specific fields and it is crucial to create conditions and system for them to satisfy their needs and also use their potential for the company. Fernando Muñoz-Bullon, Maria J. Sanchez-Bueno & Antonio Vos-Saz (2015) suggest, that in order to have successful management system in the company, the development of trust based relationships, open communication and sense of community is necessary.

Lindgren, M., & Packendorff, J. (2011) highlight the importance of the leadership and management in R&D companies – only competent leader can form and motivate the team, plan the project and ensure that the team will achieve results.

Jane Firth, a consultant working on organization's vision, leadership and communication guidance, does provide possible solutions for the matter. J. Firth (1991) have

identified four principles that helps organization's human resources grow more smoothly and avoid mistakes that could threaten the startup's future.

According to the author, the four principles are:

- Vision. It corresponds why the startup is in business and the purpose of it, it should provide the employees' sense of pride and a feeling that they are a part of something bigger and that their contribution to the company is important.
- Empowerment. J. Firth (1991) points out that managers of a startup usually are unwilling to give big responsibilities to their employees in order to keep a total control. However, trusting your own employees is the key to successful human resources management, therefore it is advisable to delegate responsibilities freely and let your own staff contribute with their own ideas to the tasks given. Also, it is crucial that the employees would learn about the organization's structure (even if the startup is small), its customers (or possible customer) and the overall features of the product or service.
- Open-system communication. It is usually taken for granted, but any conflicts risen between the employees should be solved openly, verbal (e-mails, letters, memos etc.) and non-verbal (actions) communications managers should be open with any type of communication and try to set the best example as possible, especially when they are looking for guidance. A big part of this principle is to be able give and receive feedback; managers should makes themselves approachable and accessible in order to assure themselves that they would be informed about any happenings in the organization, this way certain actions could be taken at the right time in order to fix it.
- On-going structure. Evaluating the startup's environment is also one of the founding principles in order to keep the HR intact. By doing so, managers could alter their goals, set new ones or reshape the existing ones and usually employees' complaints are one

of the best resource to do so. The ability to evaluate the environment and set new goals will keep the vision in place and will secure the growth of the HR's environment.

### **Managements' impact on the overall motivation of startup's human resources**

Tarek Miloud, Arild Aspelund and Mathieu Cabrol (2012) identified that management team is the most important aspect in the start-up and the success of startup depends on the performance of management team. Finegold and Mohrman (2001) stated that in the field of life sciences and other fields, that are science-based, the most important motivation is interesting and challenging work and it's strongly depends on the company itself – what kind of technology it is developing and what goals they want to achieve. Grupp, R. W., & Gaines-Ross, L. (2002) underline, that CEO's and the whole senior management team's ability to execute business strategy and business model as well as manage and motivate the team is critical to the company and the reputation of managers play very important role in all these processes.

Peter Bamberger, Samuel Bacharach, and Lee Dyer (1989) have researched the human resources management impact on a startup, which are operating with high technologies. Authors have discussed that young companies working in the field of high technological are different in four fundamental dimensions (environment, management, organization, workforce) and have a tendency to adopt different policies and strategies of human resources in order to manage it successfully. The main differences in the four dimensions are:

Environment is on a constant change as there are many unexpected alterations and changes (new technological variations, competition, shifts in market demand etc). The changing environment influences the management of a startup as it always has to adapt to the mentioned alterations, therefore it results in changes in the management itself; managers, according to the authors, are loners and they are experiencing difficulty in delegating responsibilities. Startup as an organization have a high mortality rate which means that failures

in some processes could be critical for the future of a startup and the main priority is set to the research and development activities. The workforce in high tech startups are more demanding as well as they do expect more freedom than working at a big corporate company, employees working on R&D activities on average are much more educated, but in startups the turnover of such employees is higher.

The results of the research have revealed two following factors are contributing to the successful management of a startup's human resources, these are: compensation level and the environment they work in. The bigger emphasis set by the startup on salary, research shows, contributes to two major areas of the startup development: the growth of sales (compared to the expectations) and employees are much more willing to find new innovations themselves in order to contribute to the product or service development of the startup rather than use/follow the established norms and processes that are in the industry. While the motivating environment (less bureaucratic compared to non-startups) contributes to the higher performance of the employees.

### **Knowledge management**

The establishment of a start-up company is based on special knowledge, how the problem that appears, might be solved by using innovative technology. This is the main reason, why knowledge management becomes a critical success factor for every start-up company. According to M. Alazmi and M. Zairi (1993) "Making knowledge available to the right people at the right time is crucial for building and sustaining an organization's competencies". There are a lot of different opinions about different knowledge management elements which lead it to critical success factor:

- Liebowitz (1999) states that every company should make special conditions for knowledge management such as a culture, determinate roles, how knowledge should be managed who should be responsible and motivate personnel to share their knowledge.

Only with clear system, tools and support from leaders, knowledge might lead company to the success.

- Farida Hasanali (2002) defines, that knowledge management might be divided in 5 categories: leadership (Manager of the company ensures the process of knowledge management, creates behavior model and promote It.), culture (Related to the leadership part, but culture of knowledge management creates the environment for sharing knowledge, builds broader understanding, why it is critical success factor for the company), structure (Setting of the rules, roles and responsibilities), IT infrastructure (tools for sharing knowledge) and measurement (case studies, measurement of the effectiveness, knowledge management influence to company's outcomes. All these parts are equal and compulsory in order to achieve results and run a successful company.
- Chong and Choi (2005) underline that nowadays there is a global transformation from product-based economy to knowledge-based economy this is why right knowledge management is considered as a critical success factor. Chong and Choi (2005) propose 11 steps for effective knowledge management which ensures successful company: training for employees (It helps to create the knowledge and shows the way how to use it); involvement of employees (It ensures effective contribution from employee to the company.), reliable team spirit (It encourages interactions between co-workers with different level and areas of knowledge and it might lead to successful solution or idea.), empowerment of employees (The reduction of the bureaucratic control might create an environment for revealing various talents and ideas from employees.), top management leadership and commitments (Strong leader and his commitments might inspire employees and increase productivity of knowledge sharing.) , information sharing system (the usage of ICT technologies), measurement of the performance (Information

about personal results and achievements.), knowledge friendly culture (The set of principles, beliefs which defines activities in organization on a daily basis, main purposes, motivation etc..) , benchmarking (Finding best practice.), structure of the knowledge (Timely and constructive knowledge sharing individually, in groups or with the whole organization.) and eliminate organizational constraints (Remove all possible boundaries which might negatively affect knowledge management.).

- Group of scientists from Stevens Institute of Technology in Hoboken, New Jersey, made a research on critical success factors in different sub-sectors (pharmaceuticals, medical devices and information and communications technology) and identified mutual critical success factors that are crucial for all subsectors. One of the factors was information dissemination internally and externally. Communication infrastructure for life sciences companies, according to Brown, E. S., Sawyer, K., Yeung, L., & National Research Council (2014), is a combination of resources (time and funding), incentives, skills and ability to train them, freedom, identification of target audience, support from academic institutions.

### **Infrastructure (environment) as an external success factor**

According to Critical Success factors analysis, which was made special for Biopharmaceutical companies by Tanja Rautiainen (2001), critical success factors might be divided in two groups: Internal Success Factors, such as circumstances and various factors that depend on company and might be easily changed in order to achieve better results (Internal success factors were described in previous paragraphs of this master thesis) and External Success factors - conditions, that are independent and company has no influence on it i.e. political background, geographic location and might be called as the general infrastructure.

- Clusters: It depends on company's geographic location – if company belongs to a hub of various life sciences companies, located in the same area, it is easier to build the

awareness of the company and attract clients and investor. The process of building clusters in specific area also encourages small companies to cooperate in order to get bigger orders or projects, it also leads to interdisciplinary cooperation which helps to achieve better and faster results, fosters the development of the industry itself. Tarek Miloud, Arild Aspelund and Mathieu Cabrol (2012) also stated that successful growth of new start-up is directly related to his network, possibilities to find new partners in their business and other external relationships (i.e. cluster, association, etc.). Meric S. Gertler & Tara Vinodrai (2009) mentioned that belonging to life sciences cluster leads to better learning dynamics and knowledge sharing processes and these activities are critical.

- General location, where the company is based – transportation and telecommunication issues, possibilities to attract qualified work force from local universities, general quality of life in the area.
- National policy. It depends on local government policy, priorities for funding sectors and areas, government support to start-ups, tax incentives, other national or regional support programs in order to strengthen country`s economy.

Practical view about critical success factors was submitted by the group of researchers: Jim Connell, Gary C. Edgar, Bill Olex, Robin Scholl, Todd Shulman and Russ Tietjen (2015) at AT&T, BOC Gases and Rhodia Inc. The main goal of this research was to exclude main critical success factors for the development of innovative and new products and services and then apply it to various development projects in different international companies. One of the critical success factors that were stated in their research was also considered as an infrastructure:

- Competitive environment.
- Regulatory affairs.



- Social and political environment.
- Tendencies in the global industry.

### **Global outlook of life sciences**

In this master thesis it is imperative to define what life sciences are, how they are being sub-categorized, what their current global position and perspectives are, influence on global economy.

According to the American Heritage Dictionary life sciences are being defined as “any of several branches of science, such as biology, medicine, or ecology that studies living organisms and their organization, life processes, and relationships to each other and their environment.” While there are many definition’s alterations in the major dictionaries (such as Cambridge University Press) or various scientists usually include into the definition “botany, zoology, biochemistry, and anthropology”.

Deloitte defines life sciences’ sector as “comprised of pharmaceutical, biotechnology and medical technology segments’, while very similarly Ernst & Young describes it as “biotechnology, pharmaceutical and medical technology”. This master thesis is not focused on basic scientific research, but on the transformational research which has a commercial success (practical application) in the market and could be considered as a business and/or startup. For this reason, the definition of life sciences will be based on sub-sectors which work on health treatment and/or improvement and it reflects the definitions used by Deloitte and Ernst & Young.

Biotechnology is “the use of living things, especially cells and bacteria, in industrial processes” (Cambridge University Press). This thesis will be referring to the “red” (or healthcare) biotechnology which are the medical or diagnostic products consisted of various living organisms. According to EuropaBio, it is based on creating new DNA sequences in the

living organisms that normally do not occur in the nature (also referred as “recombinant DNA”). It has a big input in the innovative medical and diagnostic areas - it provides innovative solutions in treating various diseases by using cell therapy, tissue engineering etc. as according to the EuropaBio “biotechnology aims to target the causes of diseases and not the symptoms”. Biotechnology also is considered as a supplement to the traditional (chemical) drug industry as using it via various synthesis new products could be developed or invented.

As the figure 2 below shows, European Union’s biotechnology’s industry is changing positively as its revenues, research and development’s (R&D) expenses, market capitalization and number of employees is increasing. While the net income represents the long lasting outcome of the global economic crisis which still had an effect in 2013, as reported in the Ernst & Young report.

	2013	2012	% change
<b>Public company data</b>			
Revenues	98.8	89.7	10%
R&D expense	29.1	25.4	14%
Net income	4.3	5.1	-15%
Market capitalization	791.8	478.7	65%
Number of employees	178,850	165,400	8%
<b>Number of companies</b>			
Public companies	616	602	2%

*Figure 2.* Growth in established biotechnology centers, 2012-13 (US\$b). From Ernst & Young. Biotechnology Industry Report 2014 biotechnology.

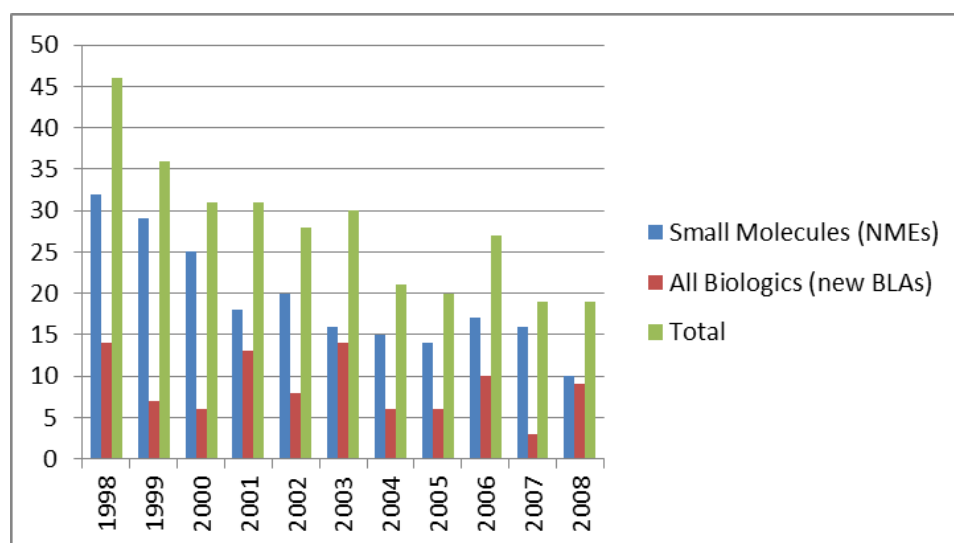
According to IBISWorld’s Global Biotechnology global market research report and Deloitte’s 2015 global life sciences outlook the industry of biotechnology keeps increasing and it is expected to have a five-year average growth of more than 10% with revenues of about 260 billion euros in 2014 only. It is also stated by Deloitte that a new trend of mergers and acquisitions is in place as the big pharmaceutical companies are not willing to develop new

innovations internally, but to buy smaller pharma companies and/or start-ups in order to take over their innovations in the field.

Other important part of the life sciences are pharmaceuticals and biopharmaceuticals. Various products, services and technologies are constantly being developed in order to improve the well-being of sick, advance the overall health or immune system in human's body or even extend the overall life expectancy. While various there are various ways to do that, pharmaceuticals were proven to be the most effective way. According to Oxford's dictionary pharmaceuticals are simply "compounds manufactured for use as a medicinal drug". While the more complex part is that there are hundreds of pharmaceutical compounds, classifications and categories yet they all are categorized into two main areas: small molecules, also referred as chemical molecules or just pharmaceuticals, "chemically manufactured active-substance molecules" according to Bayer HealthCare, always with small molecular weight and manufactured using various chemical reactions; and then there are big molecules, also referred as biological molecules or biopharmaceuticals, which are protein-based molecules with significantly bigger molecular weight and are always grounded on the essence of life sciences itself as it is based on living organisms (proteins themselves).

There is a clear distinction between the pharmaceuticals and biopharmaceuticals industries. As the small molecule drugs are the classical way to treat any type of diseases, big molecules are used for more life-threatening and serious diseases such as various cancers, arthritis, hepatitis or diseases which are extremely rare, also referred as orphan diseases. For this reason, even though big molecule pharmaceuticals require much more financial investments and it takes more time to develop while accepting bigger risk, many biotechnological and pharmaceutical companies are trying to enter the market. For this reason as the figure 3 below show small molecule approvals compared to big molecule approvals per

year in the US market show that the biological approvals are not steady and year by year they have ups and downs while chemical molecules are steadily declining.



*Figure 3.* Numbers of New Small Molecule Drug Approvals per Year (NMEs) Compared to New Biologic Drug Approvals, data of 1998 – 2008. From Samanen, J. (2014), Portfolio Management Solutions.

According to Damien Conover ff Morningstar: “biologics provided 22% of the big pharma companies’ sales in 2013, and he thinks this will rise to 32% by 2023”. While the Economist states that in America alone there are more than 900 big molecule drugs in development. It all shows that the medicinal drugs are shifting to the biological (biotechnological) side and big pharmaceutical companies are depending their future on it. While the only setback of biopharmaceuticals is that “biologics are hard to make and, at present, difficult to take. They must be injected, infused or inhaled, as they are destroyed in the stomach when swallowed” according to the Economist.

Last, but surely not the least part of the life sciences definition is the medical devices. The Federal Food, Drug and Cosmetic Act define a device as “an instrument, apparatus,

implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including any component, part or accessory.”

According to US Food and Drug administration (FDA), medical device must be approved and accepted by The National Formulary and USA Pharmacopeia (USP-NF – special publication of specific standards for various drug elements, dosages, medical or food supplements, medical equipment, etc. ) or any other related regulation body. Medical devices should be dedicated to the diagnosis or prevention of the disease in man or other animals as well as, it should have an effect on human or other animal body structure or function, which does not accomplish its most important purposes.

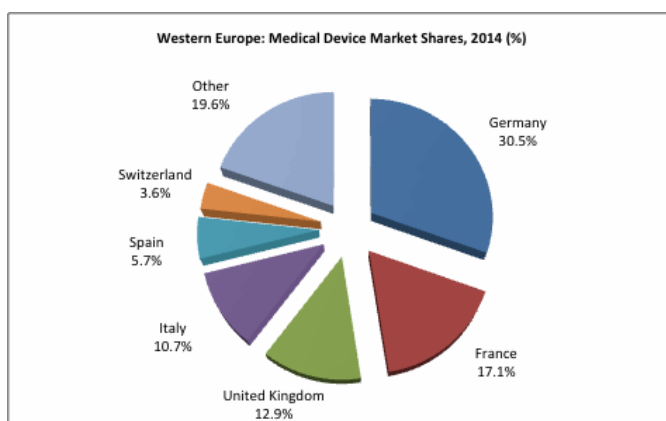
Committee on the Public Health Effectiveness of the FDA in Institute of Medicine of the National Academies defines that medical devices are used to diagnose, treat for and prevent diseases. They are used in hospitals, physician’s offices, nursing homes, clinics of rehabilitations and at home.

European Commission defines medical device as “any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for this proper application intended by the manufacturer to be used for human beings.” Core purposes of medical devices should be to investigate, diagnose, prevent, monitor and treat the diseases, injuries, various physiological processes.

In summary, medical devices definitions, according to USA and Europe regulation bodies, are very similar and it defines medical devices in a very broad range - from crutch for the broken leg, syringe to Curlin infusion products by Moog or non-invasive ICP meter, which was created by Lithuanian company Vittamed.

According to Kalorama Information published on PR Newswire, the role of medical devices industry in Europe is significant – more than 25000 companies are working in Europe

in the field of medical devices with more than 500 000 employees and annual sales for 95 billion in 2014. Global medical devices market reached 360 billion in 2014. It means that Europe is taking almost 1/3 of the global medical devices market and it leads to the second most important region after the USA (Figure 4). The strongest countries in medical devices industry are: Germany – more than 30% of the market, France – 17%, United Kingdom – almost 13%, Italy – nearly 11%. It is being reflected by IMD World Competitiveness rankings that list Germany, France and United Kingdom as the top 3 spenders on their R&D activities in Europe.



*Figure 4.* Medical Device Market Shares, 2014 (%). From BMI.

Medical devices industry is not only strong support for global economy but also has a crucial role on human healthcare and improvement on quality of life for those, who has disabilities and diseases.

### **Outlook of Lithuanian life sciences industry**

Lithuania's life sciences sector has been increasing rapidly for almost three decades and is currently considered to be the center of life sciences in Eastern and Central Europe. It is proven by the annual growth of the biotechnology, pharmaceutical and medical devices research and production sector which grows by more than 20 percent annually, according to the Statistics Department of Lithuania. According to Enterprise Lithuania, export promotion

and business entrepreneurship governmental agency, 90% of Lithuania's life sciences products and services are being exported all around the World.

The underlying success factor of Lithuania's life sciences' industry growth after gaining the independence is its well-developed and state of the art infrastructure. In order to support it, government of Lithuania with the financial and knowledge support of European Union created the whole system of integrated science, study and business valleys. The main purpose of the valleys is to boost the cooperation between science and business. There are 5 valleys in Lithuania, for this master thesis 3 of them are the imperative ones:

- Santara Valley, the main areas of expertise are biotechnology, innovative medicine, biopharmaceuticals, ecosystems and sustainable development. The valley is located in Vilnius.
- Santaka Valley, the main areas of expertise are sustainable chemistry, biopharmaceuticals, ICT. The valley is located in Kaunas.
- Sauletekis Valley, the main areas of expertise are lasers and medical devices, nano technology, various application of innovative engineering. The valley is located in Vilnius.

The valleys which related to life sciences are established in two major cities: Vilnius and Kaunas. The reason behind this is the higher education – according to the association of Lithuanian higher education for the general admissions there are more than 9000 life sciences students at universities and colleges which are primarily based in Vilnius and Kaunas, with more than 1200 students graduating each year. Based on Invest Lithuania, a governmental agency of foreign direct investments attraction, there are 22,000 researchers and specialists in Lithuanian life sciences industry. Lithuania is number 1 for science and technology graduates

in Central and Eastern Europe (data by Eurostat Erste Group Research). This provides a unique platform for future growth of life sciences in Lithuania.

Business friendly environment also plays a crucial role in the development of the sector, for example favorable tax incentives are set for research and development activities, such as triple deduction to expenses incurred by companies while carrying out R&D etc. Such incentives and governmental programs motivate both Lithuanian and foreign businesses to have their facilities in Lithuania, i.e. the company “Fermentas”, a famous Lithuanian company producing molecular biological products, was purchased by Thermo Fisher Scientific which is leader in serving science; one of the biggest pharmaceutical companies in the World Teva has started their manufacturing activities in Lithuania in 2003. The recognized potential of Lithuanian life sciences by such international companies boost the overall development of the sector and encourages smaller companies to start their business in Lithuania.

### **Lithuania’s strategy towards life sciences**

Lithuanian government has not yet set a clear strategy towards life sciences itself. Few governmental documents (decisions) where innovation and technology importance for sustainable Lithuanian economy development are issued. Based on Lithuanian strategy for development “Lithuania 2030” issued on 2012 includes vision and mission for the innovative industrial development, has three main parts in order to implement this strategy. These are:

- Smart Society (content society which strives for personal and economic development, equal income distribution within the society, higher environmental standards).
- Smart Economy (promotion of entrepreneurship, intellectual and innovative products and services, higher value added job positions, competitiveness growth).
- Smart Management (improvement of public sector that leads to progress).



The development of life sciences sector falls into the smart economy part, as this sector creates higher added value products and services and is always on a verge to promote innovative technologies and its application. The strategy “Lithuania 2030” was the first ever issued document which included the importance of innovation for sustainable Lithuanian development and this led to discussions and deliberations which industries and areas should be considered as the most promising. For this reason, Lithuanian “smart specialization” document which included six priority areas was issued next.

Smart specialization unravelled the key factors and strengths of Lithuanian research, potential of collaboration between fundamental science and business, development of innovation and technologies, and inter-institutional capacity to cooperate in order to increase the competitiveness of the region in EU and global markets. Therefore, the commission of experts have named six priority areas which were the most promising:

1. Energy and sustainable environment;
2. Health technologies and biotechnologies;
3. Agriculture innovation and food technologies;
4. New production processes materials and technologies;
5. Transport, logistic and information and communication technologies;
6. Inclusive and creative society.

Even two areas could be considered connected to the life sciences industry in Lithuania. That are health technologies and biotechnologies (various medicinal and biopharmaceutical technologies; advanced therapy for human health; advanced solutions for medical engineering, its treatment and diagnostic) as well as new product processes materials and technologies (nano technologies; laser technologies).

According to the Ministry of Economy, higher value-added products and high-tech sectors of the general Lithuanian export structure make only up to 3 percent of total exports. The rest of total exports are made of the traditional industries (food processing and agriculture, wood and furniture, minerals, textile, engineering, information and communication technologies etc.). Innovations management and increase of effectiveness, development of managerial skills, usage of Lithuanian scientific research potential as well as synergies between the science and business could make a positive influence on Lithuanian export and economy. This could potentially lead Lithuania to the list of innovative high-tech countries. Having considered this, Ministry of Economy has issued export guidelines in 2014 which identifies the main industries which should be fostered in order to grow export volumes and target markets (countries) which should be considered as the main export partners for Lithuanian companies. That is why the focus on industries, including life sciences, which create higher added value products and services has been set.

### **Lithuanian life sciences subsectors**

As the strategy of Lithuania does not clearly define what sectors are considered as life sciences, this master thesis will use the internationally accepted structure of life sciences sector, which consists of three sub-sectors – biotechnology, pharmaceuticals and medical devices.

Biotechnology field of Lithuania has started developing back in 1975 when the Institute of Applied Enzymology was established. The classical fermentation developed by this institution became quickly known not only in Lithuania but in all Soviet Union. Later on institute based its research primarily on gene engineering methods which put Lithuania's biotechnology industry on the map globally. It also laid the foundation for quick scientific development which resulted Lithuania becoming a leader in Central and Eastern European countries, according to Enterprise Lithuania, a governmental agency which promotes entrepreneurship and export in Lithuania. Lithuania's main expertise in biotechnology and the

main research activities were based on “reagents and enzymes for molecular biology and recombinant pharmaceutical proteins”. All this resulted some Lithuanian companies be nominated as best European Biotech SMEs.

Based on the Statistics of Lithuanian Statistic Department, total revenues exceeded 75 million euros of biotechnology’s industry with a skyrocketing annual growth of 23%, including growth of R&D expenditures by 14%.

Medical devices industry has started developing only after Lithuania gained its independence. Country has an immense strength in the field of engineering and its fusion with biotechnology and pharmaceutical sectors gave a good start for the development of medical devices. Various international manufacturers chose Lithuania as a perfect location situated in between West and East, according to Enterprise Lithuania. Also, talent pool of highly educated professionals, governmental goal to create an innovation driven economy contributed to the well-established environment. For this reason, medical devices industry for the past ten years has been booming. As an example, MOOG Medical Devices Group which is considered to be one of the leading international companies operating in medical devices sector, evaluated the Lithuanian environment and most importantly the potential it holds in the future. In 2009 MOOG has invested millions to open its manufacturing facilities in Vilnius, Lithuania and running its operations successfully since then.

Enterprise Lithuania states that “medical devices exports (including re-exports) more than doubled since 2008 and reached over 177 million euros in 2012” and according to Enterprise Lithuania the research areas are: “biomedical diagnostics and monitoring systems, deficiency research of electronic security systems, analysis and synthesis of electronic devices, quality of electronic systems”.

The Federal Food, Drug and Cosmetic Act define a device as “an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including any component, part or accessory.” For this reason, laser industry also has a big part in medical devices sector. Lasers technologies and its manufacturing capabilities outpaces anyone else in the World as Lithuania itself pioneered and created picosecond and femtosecond lasers which accounts for about 80% of the global market (according to Laser and Light Science and Technology association). Lithuanian lasers are considered to be of a highest quality and are used widely in the scientific research and medicinal science which is directly related to life sciences. At the moment, more than 80% of lasers manufactured in Lithuania are being exported to Europe and globally. The key drivers which keeps Lithuania in the lead are private companies which have state of the art technologies and invest widely into new innovations as well its inter-institutional collaboration with Vilnius University where world-class laser research is being done. Light sources that are made by Lithuanian scientists are used in various industrial applications to support the development of medical devices.

Pharmaceuticals industry in terms of research in Lithuania is not as developed as the biotechnology or medical devices field. Based on the Risk/Reward index, Lithuania ranks only 13<sup>th</sup> between the other Central and Eastern European countries in terms of attractiveness. Nevertheless, Lithuania has become a destination for international pharmaceutical companies (TEVA Pharmaceuticals, Thermo Fisher Scientific, Valeant) which bought or established their manufacturing facilities in Vilnius.

In collaboration with European Federation of Pharmaceutical Industries and Associations (EFPIA) and European Biopharmaceutical Enterprises (EBE) and the government of Lithuania, Innovative Pharmaceutical Industry Association (IFPA) was created in Vilnius. Association has 17 international pharmaceutical organizations which are working with Lithuania in terms of pharmaceutical sales and the development of the region, which includes

funding various public and private life sciences projects, initiates inter-institutional cooperation within the industry leaders and advocates the needs of Lithuanian pharmaceutical market at various European agencies.

Lithuanian pharmaceuticals industry's importance lies within the clinical trials in which Lithuania shows a great example to neighboring countries being a leader. According to the State Medicines Control Agency (SMCA) Lithuania's clinical trials ("any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes", by World Health Organization) industry is known as a trusted partner for clinical trials because of its appropriate population size, good infrastructure, experiences and motivated investigators. By the end of 2012, in Lithuania were: 12604 practicing physicians; 142 hospitals (excl. Nursing hospitals) with 22206 hospitals beds; 426 outpatient institutions under the Ministry of Health; 1946 private healthcare institution (excl. dental care). As the statistics shows (Table 1), the number of applications for clinical trials as well as number of applicants and ongoing clinical trials in the country has been growing since 2009. According to the State Medicines Control Agency of Lithuania, during the last decade (2004 -2013) the average of applications for clinical trials in Lithuania was 97, average number of applicants has reached 49 and the average of ongoing clinical trials conducted in the country was 318.

Table 1.

*Conducted clinical trials in Lithuania, 2004 – 2013.*

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of applications for clinical trials	84	85	109	110	123	86	87	96	93	97
Number of applicants	43	50	50	58	63	42	38	42	52	51

Number of ongoing clinical trials	297	315	375	354	361	280	278	278	301	342
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Note: From Statistics on consumption of medicinal products in three Baltic States, 2014.

According to European Commission, in the period from 2007 to 2011 the number of applications for clinical trials in Europe fell almost 25 percent's. While in Lithuania it was still growing in the period from 2007 to 2008 and after the crisis in 2009 the number of applications for clinical trials in Lithuania has stabilized.

According to Lithuanian Good Clinical and Regulatory Practice Association, the main therapeutic areas for clinical trials in Lithuania are: rheumatology, pulmonary, pediatrics, oncology, neurology/psychiatry, cardiovascular, hematology, gastroenterology, endocrine/metabolism, surgery. The wide range of therapeutic areas for clinical trials in the country might become of the most important factors in order to attract more international companies in Lithuania.

### **Summary of the literature review**

The identified critical success factors do not differ much from many micro or small businesses that are operating in the market in the first years, though some factors are targeted directly to start-ups. The gap is left in the literature review in especially specialized start-ups, as many authors do discuss the factors of various start-ups, but not much review is made in life sciences industry as fundamentally they differ from information and communications technologies startups for example. That is why the literature review made in this master thesis has identified specific success factors that determined by theory successful innovative life sciences start-ups and will be used in the research to determine how Lithuanian start-ups correspond to it and what effect it has for its success.

The list of the identified critical factors for companies and start-ups globally:

1. Unforeseeable uncertainty
2. Financial constraints
3. R&D management and its costs
4. Human resources management
5. Managements' impact on the overall motivation of startup's human resources
6. Knowledge management
7. Infrastructure

Global outlook of life sciences reveals the steady growth of the industry Worldwide with its five-year average growth of more than 10% (Deloitte, 2015). Pharmaceuticals, biopharmaceuticals and medical devices are on the rise, however biopharmaceuticals show the biggest growth both in investments and the market share. Lithuanian tendencies do reflect the global ones, but the growth is much more significant compares to other Northern/Eastern European countries. Developed infrastructure (valleys, open access R&D centers, business friendly environment) made Lithuania one of the most advanced life sciences hub in Lithuania, which more than 90% life sciences products or services are being exported Worldwide. The government also recognized the potential of the sector, therefore have introduced long term innovation strategies which mostly are associated to the IT, lasers and life sciences industries. It is expected for life sciences industry in Lithuania to triple its contribution to the GDP).

### **EMPIRICAL RESEARCH METHODOLOGY**

The research focus is on Lithuanian innovative start-ups operating within the life sciences industries, established mainly in Vilnius and Kaunas. The goal of the research is to identify the critical success factors of Lithuanian innovative life sciences start-ups. The research method – qualitative – will be used to collect data; through interviewing the founders and/or management team of the start-up as well as a scaling table. An analysis was made after the data were collected and critical success factors were identified; as it was the goal of this master thesis - to identify the main critical success factors of the industry, so that the startups could potentially take into consideration the researched factors in order to successfully grow.

The following steps were made in order to implement the research:

1. Tested the proposed (pre-defined) critical success factors that were identified during the literature review chapter on the Lithuanian life sciences start-ups. During the interview open questions were asked about each pre-identified critical success factor, also were asked to scale its importance (from 1 to 5) at the end of the interview.
2. Open ended questions introduced new critical success factors that were discussed by start-ups as critically successful to their operations.
3. Documented and listed all factors (both pre-defined and proposed by start-ups) which were mentioned during the interviewing process.
4. Analyzed the significance of specific critical success factors and short listed only those factors which are critical to the majority of the innovative life sciences start-ups in Lithuania.
5. Listed and discussed the most important critical success factors, which were identified during the interviewing process. Checked whether pre-defined factors criticalness correspond to innovative Lithuanian life sciences start-ups.



6. Discussed various critical success factors proposed by the start-ups itself and analyzed whether it is dependent factor on the operating area or it could be treated as a more general critical success factor which should be looked upon by many other Lithuanian innovative life sciences start-ups.

Qualitative research method was chosen because of the limited number of innovative life sciences start-ups in Lithuania in order to collect the primary data. In-depth interviews were conducted with innovative start-ups operating in the field of life sciences in Lithuania. Interviews were chosen (with both pre-determined questions and open questions) as it is the best tool to collect data on the critical success factors as it comes from the experience of the founder and/or the management team. Recordings of the interviews were made as well as the transcripts (see appendix no. 4).

The research method was chosen of its flexibility (compared to the quantitative method). Qualitative research method does give the flexibility during the interview to ask open ended questions, with possible clarifications and additional information on the question/topic. Also, the bond between the participants and the researcher is typically less formal which gives such advantage as receive more honest and thorough answers to questions.

During the interview the founder of the start-up and/or a representative from the management were introduced with the following (based on “Qualitative Research Methods: A Data Collector’s Field Guide”):

- The purpose of the research and how/where this research will be used, what outcomes are expected of the research.
- What is expected from the person that is being interviewed, in general what topics will be discussed and how much time approximately will be needed in order to conduct the interview.

- The participation might be ended at any point of the interview if the participant would like to.
- Confidentiality terms.
- List point of contact if any additional questions rises after the interview or the start-ups would like to exclude themselves from the research.

A qualitative research was based on interviewing Lithuanian innovative life sciences start-ups in order to identify critical success factors in the field. Vilnius University, Kaunas Technological University, Lithuanian University of Health Sciences and its various departments were contacted in order to provide information about life sciences start-ups that are working in their premises or the ones that have already spinned-off. Also, public and private institutions (Enterprise Lithuania, MITA, Nextury Ventures, INVEGA) were also asked to share lists or names of life sciences start-ups which they are or have worked with. After short listing the start-ups which would correspond to the innovative start-up definition, 19 start-ups were listed. 8 of them were known to Enterprise Lithuania, which gave an advantage to interview them first as they were known personally and they have not declined the interview. Out of 19 start-ups, 14 initially agreed for an interview, but two of them kept re-scheduling or did not find any time to meet the interviewer, therefore total of 12 start-ups were interviewed (out of 12, one start-up only filled the questionnaire in writing and insisted to be included in the empirical research). The interviews were conducted from November through December of 2015.

5 screening questions were asked at the beginning of the interview in order to secure the start-up's validity and suitability to participate in the research. Screening questions were followed up by 10 open questions that were used to identify critical success factors for the particular start-up. At the end a scaling table of pre-defined critical success factors from the literature review were shown in order to determine how the respondent evaluates them on a

scale from 1 (not important at all) to 5 (very important). Questionnaire is included in the appendix no. 1.

**EMPIRICAL STUDY**

Out of 12 start-ups which agreed to participate, 11 start-ups have successfully participated in the interview and one respondent sent the answers by e-mail (which will also be used in this research). All 12 start-ups are operating within life sciences industry and they are all generating revenue, are innovative with their technologies and/or products within their field.

Table 2.

*Summary of the screening questions.*

STARTUP	LEGALLY OPERATING (YEARS)	EMPLOYEES COUNT	GENERATING REVENUE	EXPERIENCING FINNANCIAL DIFFICULTIES
1	1,5	2	YES	NO
2	3	110	YES	NO
3	2	5	YES	NO
4	2,5	7	YES	NO
5	3,5	4	YES	NO
6	3,5	20	YES	NO
7	3,5	10	YES	NO
8	7	16	YES	YES
9	1	84	YES	NO
10	0,5	5	YES	NO
11	1,5	32	YES	NO
12	10	13	YES	NO

Note: From authors' collected empirical research data.

Youngest startup was operating legally for a half year, while the oldest one for 10 years (the oldest start-up had its breakthrough with their innovative technology 3 years ago). Median of legally operating startups sample is 2,75 years. Due to various reasons employees count vary which reasons will be discussed later in this thesis, the median of employees (both of full time and part time) is 11,5. The only start-up which is experiencing financial difficulties at moment

when was the interview taken, was experiencing only shortage of cash flows which did not have any negative influence on their successful operations. For this reason, all twelve start-ups which were shortlisted and interviewed are successful and innovative and the sample corresponded to the research.

Out of the sample more than half of the start-ups (7) were operating within biotechnology industry (biopharmaceuticals, services in biotechnology field, specific biotechnological products developers), 4 start-ups of the medical devices field and one in pharmaceuticals (developing small molecule drugs). It reflects the industry itself as the biotechnology industry is the strongest in Lithuania, followed by the medical devices. Only one successful start-up was identified within the pharmaceutical field in Lithuania.

Table 3.

*Sample distribution by industry.*

<b>DISTRIBUTION BY INDUSTRY</b>		
PHARMACEUTICALS	BIOTECHNOLOGY	MEDICAL DEVICES
1	7	4

Note: From authors' collected empirical research data.

### **Critical success factors of innovative Lithuanian life sciences start-ups**

#### **Critical success factors of the industry**

Start-ups were asked whether in their opinion all start-ups operating in their field are facing with the same critical success factors.

The majority of the start-ups (11) agree that there is a pattern in the field of critical success factors. Start-up no. 12 provided with an example of a life sciences start-up affiliated and funded by Google in life sciences – even though it had unlimited financial resources it still

had to follow the industry's path and face with the same challenges as any startup does. To deal with such challenges start-up has to implement same practices which evolve from the same critical success factors. Start-up no. 2 stated as well that the factors are the same and if the start-up is not facing with the same critical success factors, it means it is not following the right path and potentially might fail. Start-up no. 4 added that every start-up has to follow the same basic critical success factors, although it all sums up to the very basic and principle question - who will be faster or luckier.

Start-up no. 8 disagrees that there is a pattern in facing with CSFs and the reasons for it is that every start-up no matter of the industry is unique and it has to find its own critical success factors in order to disrupt the market. It also stated that it is impossible to implement same CSFs to another start-up as there are many different variables such as the team or board members.

All start-ups with one exception agreed that the same paths should be considered to take in order to be successful while developing their technologies, recruiting the team and trying to enter the market. It is safe to assume that start-ups might benchmark the successful ones in order to become one.

### **Critical success factors according to the start-ups**

The first question after the screening questions asked start-ups to identify critical success factors which are important for their overall activities, processes and the success itself. Start-ups were asked not only to identify the factors, but to explain why they are critical in their opinion. The table below sums up the overall mentioned critical success factors by each start-up.

Table 4.

*Critical success factors identified by the start-ups.*

## CSF OF INNOVATIVE LITHUANIAN LIFE SCIENCES STARTUPS

Start-up no.	Critical success factors
1	<ul style="list-style-type: none"> <li>• Products' high quality</li> <li>• Experienced team</li> </ul>
2	<ul style="list-style-type: none"> <li>• Being creative and innovative</li> <li>• Creating something new in the market</li> <li>• Managing human resources</li> </ul>
3	<ul style="list-style-type: none"> <li>• Innovative products</li> <li>• Ideas to improve it</li> </ul>
4	<ul style="list-style-type: none"> <li>• Motivation and dedication of the team</li> <li>• Employ highly distinguished people</li> <li>• Ability to find partners and effectively use it for joint technology development</li> <li>• Financing and access to finances</li> <li>• Staying focused on the current product(s)</li> </ul>
5	<ul style="list-style-type: none"> <li>• Competent team with different competences</li> <li>• Strong financial background</li> <li>• Governmental support</li> </ul>
6	<ul style="list-style-type: none"> <li>• Product and the concept of the product</li> <li>• Marketing of the product</li> <li>• Competent team</li> </ul>
7	<ul style="list-style-type: none"> <li>• Ability to find appropriate competence (team)</li> <li>• Access to the EU funds</li> <li>• The availability of financial resources</li> </ul>
8	<ul style="list-style-type: none"> <li>• Patenting of technologies and ideas.</li> </ul>
9	<ul style="list-style-type: none"> <li>• Knowledge management</li> <li>• Managing R&amp;D</li> <li>• Environment the startup is operating in</li> </ul>
10	<ul style="list-style-type: none"> <li>• Medical recognition</li> <li>• Product design</li> </ul>

	<ul style="list-style-type: none"> <li>• Legal aspects</li> </ul>
11	<ul style="list-style-type: none"> <li>• Enthusiasm.</li> <li>• Support from the government funding.</li> </ul>
12	<ul style="list-style-type: none"> <li>• Competent team</li> <li>• Technology / the product</li> <li>• Market research</li> </ul>

Note: From authors' collected empirical research data.

8 start-ups have identified critical success factors which are directly related to human resources (either managing it or finding the appropriate team for the operations). 6 start-ups also have identified critical success factors which are directly related to the product, services or technology. Access to financing and governmental/EU funding were recognized as critical by 5 start-ups. 3 start-ups stated that the external infrastructure (environment) was a critical factor for their success. Staying focused on the R&D and managing it was identified by three start-ups as a critical factor and two start-ups mentioned marketing of the product critical as well.

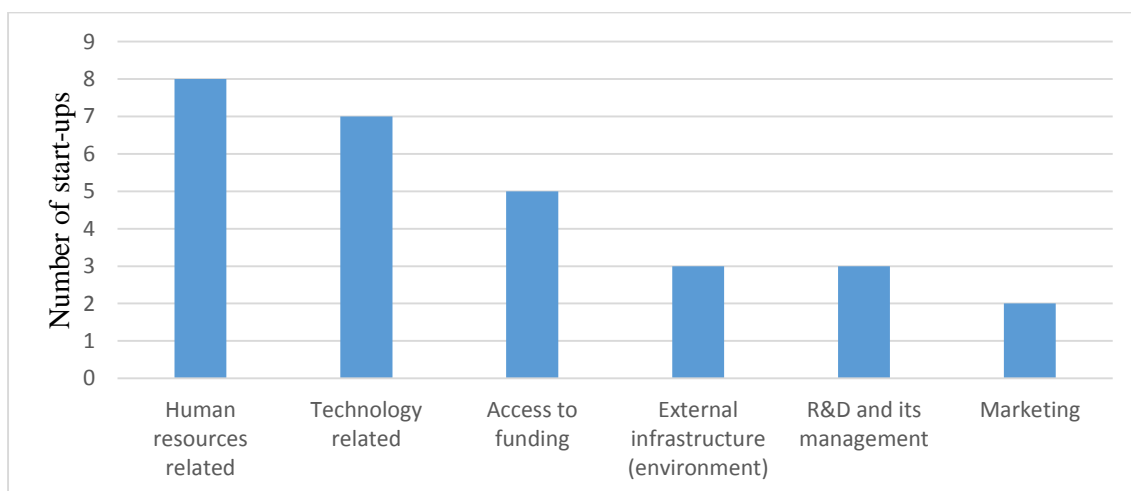


Figure 5. Critical success factors identified by innovative Lithuanian life sciences start-ups.

Note: From author's empirical data.



The overall reasons behind the human resources related critical factors were different. Start-up no. 1 stated that it is very important to recruit a team and keep it in-house in order the knowledge would not be accessed by anyone else and keep the highly qualified employees, start-up no. 2 said that only leaders in the field are able to create innovative products or services that might differentiate the company from competitors, for this reason it is a crucial aspect to build a well-rounded competent team which would complement one another. Start-up no. 4 added that the market lacks of middle level employees, i.e. technicians – for this reason, it is very hard to find appropriate people for highly distinguished scientists that would be able to follow their directions. Motivation was also distinguished as one of the factors for start-up no. 4 and 11. Start-up no. 5 said that a team should have different competences which cover both strong and deep scientific knowledge and business development part, for this reason it is crucial for a start-up to find a team with broad competences. Start-up no. 6 had an interesting aspect that a good employee at the very beginning could have not only months of development but financial resources as well, as on the later stages of the start-up a motivated team with good competences is a critical factor. Start-up no. 7 indicated that the Lithuanian education system is not able to teach the students the appropriate competences that would be valued by the business, especially in the biotechnology field. Students are taught only a broad and general background of biotechnological and chemical engineering, therefore the start-up had to hire very expensive people from the market, for this reason gathering a competent team is a critical factor, according to the start-up no. 7. Start-up no. 12 concluded that the first and most important aspect for a start-up is the team which is assembled by the management, owner or investors, and only a world class CEO and very competent team is able to attract funding.

The technology-related aspects for the start-ups was the second most mentioned factor. Start-up no. 1 stated that the quality is the number one aspect within the industry they are operating in, therefore it is the most critical factor. Start-up no. 2 and 3 mentioned that only

innovative product could be competitive globally, therefore the product itself is naturally the most important. Start-up no. 6 stated that not only the product, but the concept is not less critical. A start-up has to have a good concept first and only then the good implementation comes when the product is created as it is, therefore it is critical for any further developments. Start-up no. 12 stated that in order to survive the “death valley” is the developed technology and the gathered pilot data which would prove and show that the product (or device) is functionally working, while the start-up no. 8 added it is crucial to patent it and hold the full rights to it. As a hardware creator’s start-up no. 10 identified the design of the product as a critical success factor, which later they found out is a common denominator in the field, start-up no. 10 also added:

“A good product design is creating the uniqueness in the look and feel and it could be very important and valued for a lot of things. And what I was able to gather from people who are working in the sector - it is true, especially in the hardware section as it is very personal.”

The access to various funding was stated as critical by 5 companies: start-ups numbers 4, 5, 7, 11 and 12. Start-up no. 4 stated that the access to funding will either slow down or speed up the development of the technology you are creating, that is why in their opinion more than half of the start-ups’ success rate relies on this factor. Start-up no. 5, 7 and 11 added that the governmental support is equally critical as it helps start-ups to invest into the very needed equipment which is very costly as well as to fund the R&D activities. Start-up no. 12 summed up that basically start-ups success should be measured whether it is able to attract funding or not.

External infrastructure (environment) was mentioned as critical to three start-ups. Start-up no. 4 states that based on the environment it depends how many partners you may have in

order to develop your technologies – belonging to an association, cluster or hub helps to find such partners nationally and internationally. Start-up no. 10 had an opinion that the legal environment in Lithuania is very poor and that the legal processes are very archaic and should be reviewed or changed as it costs a lot of money and it is very difficult to manage for a young financially constrained company, because there is no way around it. Start-up no. 9 added the regulatory affairs in the field as a critical factor as it is correlates to the product very much and if some regulations change, it could mean that the product could not be sold not only in Lithuania, but in whole European Union.

Research and development and its management criticalness was recognized by the same three start-ups: 4, 9 and 10. Start-up no. 4 stated that during the R&D phase there are many interesting things happening in the meantime, therefore it is a critical aspect to stay focused on what the start-up started doing, as it would be the only way not to lose the direction and achieve tangible results. Medical recognition was identified by start-up no. 10 and 9 which could only be achieved by the extensive R&D activities, proven methodology and the data gathered as it creates a credible ground for the technology, product or service to be pitched to the clients.

The marketing aspect was stated as critical only by start-up no. 6. The marketing aspects gave the start-up access to the market at a very early stage which was used in order to transfer from technology push to a market pull in less than half a year which saved quite a significant amounts of R&D as they gathered a lot of feedback from the market.

### **Critical success factors in the early stage and later stages of the start-up**

The respondents were asked to identify whether the CSFs are the same in early stage (when the idea becomes a business plan) of the start-up from the later stages (clear system of operations and ready for expansion) of the start-up. Various opinions merged equally – 6 start-ups stated answered “yes” and 6 “no” which followed with diverse examples.

Start-up no. 3 detailed that knowledge and expertise with the help of mentors are always equally important which sums up their success. The respondent of start-up no. 9 said that he is working on various technological companies (start-ups) since 1989 and it is always the same challenges and factors.

On the other end Start-up no. 2 said that in the beginning it is all about proving the technology of the start-up, to differentiate, to recruit good people and to work with respectable companies in order to have a good track record, while on later stages it is more about execution when you face quite the opposite factors than the ones in the beginning. Start-up no. 10 noted that in the beginning start-up has to acquire an understanding what competences it needs and what steps will be made to achieve it, while in later stages it has to acquire those competences in the certain fields. Start-up no. 4 as well has a very similar opinion and stated that the beginning is about the development of the technology and the validation stage, when the start-ups has to differentiate to be interesting for investors, customers and various stake holders. After that, according to start-up no. 4, comes different challenges with “ability to scale, ability to get to the right people for execution, ability to get into interdisciplinary people, people with skills”. Start-up no. 6 also noted the importance of internationalization on later stages which are very critical, as well as growing distribution network, willingness to solve the problems and these come on a later stages when the product is ready for the market. Start-up no. 8 distinguished a good example that the board of the start-up becomes very important only on later stages of the company as in the beginning it is not critical. Start-up 12 sums all up as the beginning is for the development, for gathering the data about your technology, patenting and having intellectual property (IP) and the later stages is more about the money attraction, investments and bringing the product to the market. Obviously, in these two distinctive stages critical success factors vary.

The average operating time in the field of start-ups that stated the CSFs are the same in early and late stages of the start-ups is 2,25 years, the average of the ones which stated differently is 4,4 years. Therefore, a conclusion that the understanding and the stages of critical success factors correlates to the start-ups' operating time.

### **Findings of pre-identified critical success factors**

#### **Unforeseeable uncertainty**

Respondents were asked whether they take into consideration unforeseeable uncertainty as a factor which influence their processes and whether they try to manage it. Most of the start-ups agreed (9) that the unforeseeable uncertainty of course has influence on their start-ups as there are many uncertainties for any company which just started their operations in the field of developing innovative technologies or products. Although, some of the start-ups are not trying to manage it - not avoiding or minimizing the damage whether some uncertainties come true.

Start-up no. 12 describes the whole experience of working in a start-up as a journey which has many unexpected turns, a start-up which is usually undergoing through a rapid corporate development cycle is facing with many uncertainties which are usually unforeseen. Even though the start-up is trying to manage this uncertainty to some degree, but it states that this includes making very tough decisions, looking at the budgets, team and managing it accordingly, so it takes more time than the managers could afford to, therefore it is not managed in a more thorough extent. As an example, start-up 12 gave the matters that they had with the Ministry of Economy – it was agreed that a specific funding project will be available in 6 months for start-up which are planning to build a pilot plant, although 18 months later it was still not released and it was damaging the plans the start-up made for the future. After all, start-up has added that making sure of constant cash flow is more important than any uncertainties they could face in the future.

Start-up no. 1 and no. 5 emphasized the importance of making constant market researches in the field in order to minimize the uncertainties related to the IP rights, as sometimes a part of technologies that are used to develop other technologies could be patented and that would exponentially increase the costs of their developed products or services. Start-up no. 5 also added that this task is very much time consuming and though this factor is very important for the start-up, they can not find enough time to fully identify all possible risks and prepare plans to manage it. Start-up no. 3 deals with the unforeseeable uncertainty by preparing a project risk analysis. Start-up no. 6 agreed with its importance, but said they are successful to manage it only about 50%.

Start-up no. 2 highlighted this factor as a very critical not only for any start-up, but as well as for any company related to high-tech industry. Besides the time which is needed by the top management to prepare plans how to avoid or deal with the uncertainties, start-up also identifies the lobbyism as a key factor to deal with the political uncertainties.

Uncertainties of R&D, adaptation of the product's technology for the consumer, IP rights, extra financing and the market acceptance were stated by the start-up no. 7. According to them they are using a specific method called "stage-gate approach" to manage it (the only start-up using a specific literature method to deal with it). Start-up is assessing the possibilities of various product failures and try to minimize it until it is ready to be launched to the market.

Lastly, start-up no. 10 also recognizes the unforeseeable uncertainty as a big factor for their survivability, but instead of doing countless researches of the market, they have set some rules, that if they are not certain about something, they consider it by default as it could happen, according to the start-up, this way they can avoid some big mistakes.

On another hand, start-up no. 8 stated that they do not really deal or manage it in any way, as well as start-up no. 11 which calls the entire operation of a start-up as one big uncertainty and there is no reason to try managing it.

As an important or very important CSF unforeseeable uncertainty is recognized by 8 start-ups, importance of preparing a risk management plan is split among the start-ups – half of the startups seemed it as important or very important, 4 of them only as moderately important. Using a selectionism methods are more important than trial and error learning, as they were recognized as important or very important by 7 and 8 start-ups respectively.

### **Financial constraints**

The start-ups were asked with what kind of financial constraints they are or were facing with and whether managing them is one of the critical success factors of their start-up.

Start-up no. 1 highlighted the most important financial constraint the intensity of Lithuanian grants and European Union's financing projects which usually is 70% to 80%. Other 20-30% should be covered by the start-up itself and they found it as the biggest constraint as an inability to earn or raise such funds. The inability to hire the skills and manpower is identified as one of the financial constraints aspects by start-up no. 4. They also felt constrained by the lack of funds which are needed for scaling up the production, product development and marketing aspects.

Start-up no. 5 distinguished the costs of materials and equipment in the field which they could not access due to very limited funds, while the start-up no. 8 lacks of local Lithuanian partners who would have the funds and knowledge to finance their start-up. Start-up no. 7 stated that typically a start-up can not access to any loans or financing to the working capital, and the constraining is that capital must be financed through the equity which makes the cost

of equity very high (and higher than a debt), for this reason at such cases the owners have to give away a substantial part of the shares they hold in order to raise working capital.

Start-up no. 10 mentioned that it is hard in Lithuania to save some money that you could live of while the start-up has no investor or is not earning any revenue. Start-up lacks of well-structured incubators in Lithuania which would help them to spend as less as possible on team's living expenses. In addition, as the start-up is creating a hardware, the materials are very expensive especially for a start-up and it could be covered only through partnerships or various other agreements, although, the start-up stated that it is still possible to continue their work with all the constraints. Start-up no. 12 added that a start-ups faces with constraints raising money, constraints with cash as well as paying people top money in order to have the best possible team.

Start-up. No 2 did not face with any financial constraints as the owners funded the start-up itself which followed by easy access to the bank loan, even though it stresses that it would be critical to deal with constraints immediately if there are any. Start-up no. 3 did not face with financial constraining as well as start-up no. 6 which was funded at the beginning by the funds from relatives.

Generally, the respondents felt that there are many financial constraints in the market, but they did not agree whether they are critical for start-ups' success. 8 start-ups agreed that they are critical enough to survive, while 4 start-ups said it is possible to be successful without managing it.

7 start-ups scaled CSF financial constraints as very important, 4 agreed that it is important and only one stated it as moderately important. External financial funds (banks, venture capitalists) were very important or important to 11 start-ups, funds which come from the owners or relatives, friends were listed by 8 start-ups as important or very important and



external financial funds (governmental, EU projects) were recognized as important or very important by 10 start-ups. Overall, it shows that financial constraining is a factor which is needed to be managed in order to be successful and any type of funds are important during the development of a start-up.

### **Management of R&D and its costs**

Start-ups in the field of life sciences are heavily dependent on the development of their technologies, products and/or services, therefore start-ups were asked to comment more how the R&D activities and its costs are managed within their operations. All of the 12 start-ups have agreed that it is the critical success factor (the only factor which is agreed by every start-up that is or was critical on their success).

Start-up no. 12 noted that research and development is the difficult area even for big, well-funded companies. While any start-up has very short term objectives related to the R&D and in order to manage it two things are critical – motivating people and strictly managing the budget. Start-up also added that a revolutionary technology's R&D take about 2 to 3 years to finish, therefore any improvements that are not essential should not be done. Also at the certain point of the development every improvement should be tested with customers and patients in order to get the feedback. Start-up no. 2 agreed that financial of any R&D activities is the most critical part, so they always pitch new R&D project ideas to the management, scientists and other employees in order to get an approval. If a project is confirmed, it is always followed by strict budget planning and constant reviews in order to ensure that the project fits within its budget.

Start-up no. 3 identifies the major part as not having too many activities on R&D projects and focus on the core ones. Start-up no. 4 and 7 also excluded as being focused as a most important part of it and prioritizing specific parts of the R&D projects. Start-up no. 6 is

using a specific project planning tool in order to ensure the correct spending of human and financial resources on the project. Although, they were implementing a trial-and-error method before.

Interestingly, start-up no. 5, 8 and 11 are using universities as their R&D activities center. The research which start-up needs is done under the name of university and if it achieves any breakthroughs they just license it to the start-up which potentially can develop it further with external funding. The positive part for the university of such research activities is that it could hold the patents, publish articles and fund some of the vital research activities by the start-up's resources if the university does not allocate money for some specifics. Start-up no. 11 stated that the university is allocating around 290 thousand euros a year for the activities that start-up is operating in, for this reason start-up is successfully saving a lot of human and financial resources. But a conflict of interest is also named on this sensitive issue, as the state's money is used for private profit.

Start-up no. 8, 9 and 10 also added that it is a good strategy to manage the costs of R&D project by applying for national and international projects, where specific R&D activities could be funded through structural European Union's funds. Start-up no. 10 also looks for partners in the industry who would like to test their technologies with their product, this case they could get free testing in various fields, start-up is also using open access R&D centers in Lithuania which offers accessibility to expensive equipment only for a fraction of cost.

Management of R&D and its costs were named as important or very important by 10 start-ups (12 of them named it critical). Defining clear goals for R&D projects is the most important factor for start-ups (all start-ups rated it as important or very important), prioritizing different aspects of R&D projects – 9 start-ups stated it as important or very important. Start-ups did not entirely agree on the preparation of a possible cost-reduction and quality effective

options aspect – 4 companies rated it as somewhat or moderately important and 8 as important or very important.

R&D management factor was rated as the most important factor of the whole research and the only factor which was agreed as critical by all start-ups. It is proven that start-ups see the development aspect of their technologies, products and/or services as the most important part for their success.

### **Management of human resources**

Instead of asking to evaluate the importance of a qualified team's impact on the start-ups activities, it was asked to elaborate more on the management of human resources and its importance on the success. Only one start-up disagreed that it is critical factor for start-ups' success.

Only start-up no. 7 did not agree that managing HR is a critical factor, start-up stated that a start-up usually has to deal with a small team of people and has identified the importance of hiring the appropriate people to the team as the critical factor rather than managing them. Start-up no. 1 also agreed that the most important aspect in managing the HR is funding, as good employees have to be offered with good remuneration system, while the biggest obstacle while managing a team is making sure everyone understands one another functions in order to build up the synergy between people. Start-up no. 2 and 11 added that it is very hard to find appropriate people even if the funding is in order, simply because universities are not preparing specialists they need, therefore there is a shortage of specific skills in the market. For this reason, as lot of new employees have to be trained, helped with executing projects and finally keep them in the company once the skills are developed.

Start-up no. 3 also said that motivating people is one of the managerial challenges of a young organization.

Start-up no. 5 distinguished the big biotechnology companies in the market and that such companies offer good salaries and career opportunities, therefore it is hard to compete with them in order to attract some people. Also, the start-up has highlighted the shortage of mid-level employees who would understand the technological execution of processes, and the education system was named as a reason for that - academic institutions do not prepare specialists for technological implementation and there is a big gap at the moment in the market. This problem was stated by start-up no. 11 as well, but it was also noted that just recently universities have started to teach the much needed skills that lacks the market and it is only a matter of time when the situation will get better. Same start-up also noted that one of the key challenges for them is to manage different personalities in the laboratories, use the strengths of the employees and balance the competition within them and tone it down with the conflicts. Conflicts as a big part of the HR management was mentioned by start-up no. 12 as well, it has stated that there are always pre-determined conflict situations between the founders and the employees, the founders and investors and so on. Therefore, it takes a long time to manage it and making sure similar situations would not arise again.

Start-up no. 6 stated that it is hard to balance within giving employees enough freedom and micro-managing, but so far they did not have major problems with employees besides assisting staff like cleaning crew. Start-up no. 9 said that it is hard to manage the outsourced human resources in various markets, that is keeping them motivated and achieve better results.

10 start-ups stated that management of HR is important or very important, companies were not consistent how important is start-ups' vision, while empowerment of employees was rated as important or very important by 11 start-ups. An open-system communication is also not equally important to start-ups (9 start-ups scaled it as important or very important, 3 as moderately or somewhat important). Giving a feedback is a critical part for every start-ups as

all have agreed on its importance and re-evaluating start-ups environment in order to set new HR goals were distributed equally within moderately important, important and very important.

Generally, start-ups stated the under-funding problem as the main problem while managing human resources. Lack of funding prevents start-ups hiring the best possible team and even if the funding is in place, start-ups face with skills shortage in the market. This problem is associated to the academic environment in Lithuania as it is unable to prepare students who would be suitable to business needs. In order to keep the people within the team, conflict situations should be carefully managed as well.

### **Impact of management team on overall motivation of startup's human resources**

Start-ups were asked to share their thoughts about the impact of management on motivation of overall human resources. Whether the vision of owners or the management inspires people to achieve overall better results, make the team more motivated in order to keep them within the organization. 10 start-ups agreed that motivation coming from the management is critical in the success of start-ups.

Start-up no. 12 stated that vision of the start-up is the most important, because *“you have to believe in what you are doing and the employees have to understand that they are working for a bigger cause”*. Also, start-up added that it very important to give employees enough freedom at a startup as you want them to keep the “drive”, feel appreciated and focused. Start-up has a branch in the US and it stated that Lithuanian and USA has many crucial cultural differences within this area. As in the US people have clear timelines, budgets, they understand marketing and the way leading to the market, while in Lithuania people usually work for the purpose of working and just making the research whether it will give any tangible results or not. Therefore, it is very important for any start-up to be clear with goals, timelines, budgets in

order people could be motivated by the management to follow them and achieve specific results.

Start-up no. 1 and 2 stated that the management is responsible to make sure that the team is working functionally and it is one of the management's most important aspects of their jobs to achieve it through motivating people. No. 2 added that management should give the everyday boost of motivation in order to sparkle the energy in employees. Start-up no. 6 stated that motivation which usually comes in form of implementing employees offered changes (in technological processes or product's development) is very critical to start-up's success. The only issue with this that the management receives more proposals for improvements than they can physically review and implement.

Start-up no. 7 implements a strategy at their start-up to give away good employees some stocks in order not to pay big salaries that they can not afford and this way these employees are usually more motivated to achieve certain goals and even over-achieve at some cases. Start-up no. 9 also tries to apply methods from literature in order to create tools for management to motivate its people. Start-up no. 10 also tries to apply different management models with different people in their start-up in order to find the most effective one, but excluded the importance of the job itself that is more motivating than the management. Start-up gave an example that technological challenges for its engineers is the best motivation they need.

The overall general impact of management team on motivation of startup's HR was listed as important or very important by 9 start-ups, which highlights its importance. Only one company stated that giving freedom and space to start-up's employees, employees' salaries and creating less bureaucratic environment is not important at all (respectively 7, 8 and 9 scaled it as important or very important).

Summing up various opinions it is clear that management acts an important role as having an influence on start-ups motivation. Various tools and styles are applicable in order to make people more motivated (more efficient, happy etc.), but it is very important to pay attention that in such technologically heavy start-ups, the technology itself is very important and whether employees are able contribute to its development which is very motivating as well.

### **Knowledge management**

As start-ups are in the field of developing new products, services and technologies in the field of life sciences, a crucial aspect of the start-up also should be managed – the knowledge. Start-ups were asked to elaborate more whether this pre-identified factor was important in their opinion, assess its criticalness. Only one start-up stated that knowledge management is not critical for start-ups success.

Start-up no. 1, 4, and 8 are aware of the importance of sharing knowledge, but no official (formal) management tools are created at the start-up to manage knowledge itself.

Start-up no. 2 ensures there are no secrets within the various levels personnel. No. 2 and no. 5 also do trainings so that different specialists, from different fields would understand one another's needs and work. Even accountants are introduced to some specific information, because if people do not understand start-up's operations it means a member could not fully contribute to the overall development of the start-up.

Start-up no. 3 and 11 do regular meetings in order the knowledge should be shared and distributed among team members. While start-up no. 10 also states that it is a critical factor, but the challenge is to find an efficient tool to distribute that knowledge among team members and to discover a way how to sort which information should be shared and which should not.

Start-up no. 7 stated that knowledge management is the main tool not to repeat the mistakes you had prior. As the start-ups starts to grow it is important to stop the trial-and-error

implementation and make a transition to the more sophisticated tools. For this reason, start-up has implemented a formal tool to distribute knowledge among team members.

Lastly, start-up no. 12 stated that the bigger mistake than not sharing knowledge among team members is not making it confidential. Start-up added that it is a major mistake if the employees do not have confidentiality agreements as the knowledge they receive at a start-up is very valuable.

Even though most of the start-ups do not have any tools to manage knowledge, however they agreed that it is moderately important (rated by 4 start-ups) or important (rated by 6 start-ups) to create tools in order to motivate behavior of sharing the knowledge. Only one start-up stated it is not at all important to create a structure for knowledge management, and answers distributed differently whether tools should be created to measure the knowledge management's influence (4 start-ups scaled it as moderately important, other start-ups distributed evenly among other answers).

Generally, start-ups acknowledges the importance of sharing the knowledge among the personnel and managing it. But rarely a start-up has a system which would promote such behavior. Besides the weekly/monthly meetings or specific trainings, only one start-up has a formal tool to manage the knowledge within the start-up.

### **Infrastructure's (environment's) impact**

Start-ups were asked whether conditions, that are independent and the company has no influence on it i.e. political background, geographic location that are called as the general infrastructure or environment, have a negative or positive impact on their operations and whether it is critical.

Two start-ups (no. 6 and 7) that have not agreed about its criticalness had different reasons to state that this factor is significant to the start-ups operations, nevertheless, it is not



critical for the overall success. Start-up no. 7 gave a good example of how various regulations prevents them from generating bigger revenue:

*“We always wanted to put on the product an eco-label, because they are made of ecological, natural ingredients, but we couldn’t do so because there is some exception in eco-regulation both on EU and national regulation, which states that you can not be treated as eco-product if you have a micro-organism in the product.”*

Start-up no. 6 said this factor is not playing any important role in their activities, unless it is somehow concerned with the human resources (i.e. probably Klaipeda would not have enough talent pool to meet start-up’s HR needs).

Start-up no. 1 explained that external infrastructure (environment) is very important for start-ups which is developing hardware as Vilnius basically accommodates all their partners including consultants which are working in the field or they are conducting mutual R&D activities.

Geographical location and political system in the country were mentioned as the main factors of external infrastructure by start-up no. 2. Location is important that some foreign countries sees the start-up as the bridge between east and west with a given example that their start-up is usually seen as a gateway to Russia. Political behavior is important due to allocation of European Union’s funds and to manage this uncertainty, start-up is often considers a lobbyism as a part of managing this risk.

Start-up no. 4 differentiated the environment from the infrastructure which is the machinery and access to the equipment. It was noted that start-ups’ in other countries are better equipped with analytical equipment and they have much better access to resources, although according to the start-up Lithuanian start-ups have bigger motivation. Open access R&D centers are not as open as they should be, stated start-up, because the centers could always

refuse to let you in and usually it is the case if you do not have any people you know there. Therefore, technology dependent start-ups like no. 4 are suffering because they can not tap into using the million-dollar machines.

Start-up no. 4 also stated that infrastructure in general is a crucial factor in terms of using the equipment that the company would not need to buy. Start-up has added that it is a critical factor in terms of fast-changing scope of work that the company does, especially in its early steps, as in the biotechnology industry any company needs a lot of equipment, especially when you are changing your focus or trying to develop new technologies. While the environment itself is also very important – the regulations and the supporting system could have either negative or positive influence on the start-ups' activities.

Start-up no. 8 as a spin-off from a university also added that environment is a critical factor.

Start-up no. 9 identified the most important aspect as the regulations as it has the direct impact on their research and sales, while start-up no. 8 added that the environment is a critical factor as they would have never made a spin-off start-up from the university if different environment would have been in place.

Start-up no. 10 had a different take-on on the legal system of Lithuania, the company had problems with the name itself as it has to be Lithuanian or that every product created in Lithuania has to have a Lithuanian manual. “What if you are releasing this product globally, but not in Lithuania?” – start-up asked. Also the organization has named the problem with universities' technology transfer procedures which might take up to 10 times longer than the start-up could do it itself. Although start-up no. 11 said that it could never survive without the help of university and its laboratories which work full time for their start-up and also agreed that the general environment in Lithuania is a critical factor for them.

Lastly, start-up no. 12 stated that it could have not attracted ten millions of investments if they would have kept managing the start-up in Lithuania. Start-up has identified the importance of being in a cluster environment which supports your activities and attracts more attention to the region. An examples was given that start-ups in Chicago or France are having difficulties raising money so Lithuania does not stands a chance in the global arena. The suggestion was that every start-up which is considering a real expansion and are looking for investors should start their subsidiaries in Boston, San Francisco, New York or San Diego in the US, while in Europe good places could be Berlin, London, Zurich area and the Scandinavian corridor. Start-up has also added that investors are not comfortable in investing to non-US companies: *“Malaysian investors invest into US companies. Why? Because it will be developed in Boston, built in Boston and sold in Boston. Hopefully.”*

The general critical success factor of external infrastructure did not seem as very important to all of the start-ups, but 8 start-ups rated it as important or very important, generally belonging to a hub distributed unevenly within the importance scale (1 – not at all important, 4 – somewhat important, 2 – moderately important and 3 important or very important). The general location of the start-up was also rated as important or very important (by 9 start-ups), national policy towards the start-up’s activities and/or research as well as the regulatory affairs in the field were agreed by 10 and 9 start-ups respectively as important or very important.

All in all, start-ups identified different aspects of the external infrastructure (environment) for their operations and did not agree on the ones which would be more important than the others. This could be explained that start-ups within the life sciences work in different specific areas (medical devices, biotechnology, pharmaceuticals), therefore different national policies and regulatory affairs apply.

### **Summary of identified and pre-defined critical success factors**

#### **Factors identified by start-ups**

Most of the start-ups identified human-resources related factors as critical for their successful operations. Main reasons behind it included reasons of keeping competitive staff in-house in order the confidential data would not be leaked, professional teams could differentiate the products/services from the competitors and motivation to create something new and/or improved for the market. All mentioned HR aspects could lead the start-up to a successful fund raising rounds.

Second most-mentioned factor was technology related. Naturally, as the life sciences start-ups are heavily dependent on creating new or improved technologies, this aspect was identified by most of the start-ups as well. Founder and the management discussed that only innovative products or services could be competitive in the global arena which requires intense technology related R&D activities and a lot of testing.

Interestingly, access to funding is only third most-mentioned factor by innovative Lithuanian life sciences start-ups. Governmental and EU funding opportunities were identified as critical that helped start-ups operations to grow or conduct much needed R&D activities. Start-up have agreed that access to funding has a positive influence on speeding up the development of the technology, product or service.

#### **Pre-defined critical success factors**

The only pre-defined factor which was agreed as critical by all of the start-ups was the management of research & development activities and its costs. This factors includes not only the management of the technology development, but also related matters such as the human resources that work on it, as well as the financials which may become critical if the operations

are not managed properly. It proves that start-ups see the development aspect of their technologies, products and/or services as the most important part for their success.

Pre-defined human resources aspect conforms to the identified by the start-ups. It is rated second most important by the start-ups of the pre-defined critical success factors. Lastly, knowledge management is the third most important pre-defined CSF. Nevertheless, start-ups do not promote knowledge management behavior with specific systems or tools, they acknowledges the importance of sharing the knowledge among the personnel on less formal basis.

## DISCUSSION

### **Literature review synthesis to empirical research findings**

#### **Unforeseeable uncertainty**

None of the start-ups' operations correspond to the suggested management of unforeseeable uncertainty by the literature. Although, start-ups' do recognize its importance to the future development, but is not managed as it requires too much of financial and human resources. Start-ups in the best case scenario creates risk management plans, but Svenja C. Sommer, Christoph H. Loch, Jing Dong (2009) also suggests that usually it is not enough to manage the unforeseeable uncertainty. The importance of preparing a risk management plan is recognized by the most start-ups, but only few prepare it.

Interestingly, start-ups which are using trial-and-error strategies and the ones which are implementing selectionism methods do not try to change the strategy itself or mix it in different situations.

None of the start-ups correspond to the creation of a system to address the unforeseeable uncertainty effectively and recognizing the sub-problems in order to identify the uncertainties at first place as suggested in the literature review.

All in all, the general importance of unforeseeable uncertainty management is recognized by the start-ups, but none of them are taking any methods to manage it or address it effectively, it implies that the start-ups do not fully grasp the definition of unforeseeable uncertainty or they do not really recognize it as important if no actions are taken to manage it. Vanderbyl, S., & Kobelak, S. (2008) highlight that risk management plan must be constantly changing and it must correspond to the development and strategy of the company.

### **Financial constraints**

According to the T. Stucki (2014) it is very important for start-ups to have the initial equity raised from relatives, friends or the entrepreneur himself (or herself) in order to tap into broader funding opportunities, such as bank loans or venture capital. This implication has been confirmed as the majority of the start-ups agreed on its importance and only one third of the sample stated it is not somewhat important.

External funding opportunities were recognized important by all the start-ups and it correlates to the literature findings. Interestingly, none of the start-ups have complied with the implications that the start-up which got governmental funding should support the industry or the region start-up operates in; all start-ups stated that it is only important as an instrument to raise funding without reducing equity.

In general financial constraints as a critical factor has been confirmed by the empirical research as two thirds of the start-ups agreed on the importance of generating revenues needed which are usually constrained by lack of reputation, history or data.

### **Management of R&D and its costs**

A possible cost-reduction and quality effective options discussed in the literature review J. Reinganum (1985), M. Spence (1984), Charles W. L. Hill, Gareth R. Jones, Melissa A. Schilling (2013) correspond to the empirical data. Rather using the outsourcing opportunities, Lithuanian start-ups are effectively using public universities and its infrastructure which provides them cost reduction or even avoids any costs related to R&D. Empirical data also suggests that having an access to public infrastructure might provide a start-up with a competitive advantage compared to those which do not.

Start-ups also confirmed the importance of prioritizing different aspects of R&D project as suggested by the literature review. Interestingly, start-ups are prioritizing R&D activities by

its ability to conduct it either in-house or using the state's infrastructure, this helps to reduce the costs of human and financial resources.

A buckshot strategy that was discussed in the literature review is a strategy by R. Case (2010) used by innovative Lithuanian life sciences start-ups. This strategy suggests concentrating to specific projects by allocating bigger amounts of funding, it corresponds to the nature of life sciences start-ups which are created in order to develop the technology, product or service that they found as a breakthrough concentrating both human and financial resources to one direction.

Managing R&D activities and its costs is confirmed by all 12 start-ups as a critical success factor and it helps to introduce the technology, product or service to the market first which could result in earning bigger revenues and obtaining bigger return on the investment.

### **Management of human resources**

Creating vision and open system communication were the two factors which start-ups did not agree on its importance. As in the literature review vision (J. Firth (1991)) creates a sense of pride and the importance of employees' contribution to the company and its goals, while open system communication is important in order to avoid or solve efficiently conflict situations. Empirical data shows that some of the start-ups agree with its importance, while others state it is not as crucial, because the number of employees within teams are not big. Giving employees a feedback is also a part of open system communication (J. Firth (1991)) which was scaled as important or very important by all of the start-ups.

Theory highlights the importance of creating specific conditions or a clear system for scientists to satisfy the need of knowing how their work contributes to the technology, product or the service. While manager's trust in the scientist is a part of empowerment that is also recognized as an important factor by all 12 start-ups.



J. Firth (1991) and Fernando Muñoz-Bullon, Maria J. Sanchez-Bueno & Antonio Vos-Saz (2015) also suggest that the ability by the managers to evaluate the environment and set new human resources' goals would secure the successful further management of employees. Start-ups equally recognized it as moderately important, important and very important. It shows evidence that managers are aware of this issue and giving enough consideration.

Critical success factor of management of human resources is confirmed by innovative Lithuanian life sciences start-ups as different aspects of this factor were rated as mostly important and 11 start-ups confirmed its criticalness.

### **Management's impact on overall motivation of start-ups' human resources**

Bamberger, P., Bacharach, S., & Dyer, L. (1989) discuss that workforce in high tech start-ups are more demanding in terms of more freedom in their duties. 10 start-ups agreed with this statement as an important one and it confirms its importance in general.

Finegold and Mohrman (2001) also suggest that the most important motivation for employees in science based start-up is interesting and challenging work. Although, the empirical data of the research shows that the remuneration of employees is a very important factor for innovative Lithuanian life sciences start-ups.

Motivating environment contributes to the higher performance of employees which is recognized by the start-ups which listed the creation of less bureaucratic environment is important (only one start-up disagreed and stated that it is not important at all) according to Tarek Miloud, Arild Aspelund and Mathieu Cabrol (2012).

The critical success factor of management's impact on overall motivation of start-ups' human resources was confirmed as the majority of the start-ups agreed on its criticalness as well as importance of different aspects of the factor.

### **Knowledge management**

F. Hasanali (2002) stated that only with clear system tools and support from leaders knowledge might lead the company to the success. Majority of the start-ups agreed its moderate importance, but it was not recognized as the very important factor. It also applies to creation of set of rules, roles and responsibilities for knowledge management which also not a very important factor for innovative Lithuanian life sciences start-ups.

Chong Siong Choy, Choi Yong Suk (2005) define that knowledge management measurement tools are compulsory in order to achieve results and run a successful company. Empirical data shows that there is no clear understanding of such aspect as some of the start-ups do not recognize its importance and others do.

In general, critical success factor of knowledge management is confirmed as critical to innovative Lithuanian life sciences start-ups. It complies to M. Alazmi and M. Zairi (1993) statement that “making knowledge available to the right people at the right time is crucial for building and sustaining organizations competencies”.

### **Infrastructure (environment) as an external factor**

Tarek Miloud, Arild Aspelund and Mathieu Cabrol (2012) suggest general location's importance as it provides access to transportation and telecommunication issues, possibilities to attract qualified work force is recognized by the start-ups as well, all start-ups agreed on its importance. While the national policy towards the research and funding priorities and areas, government support to start-ups is even more important in accordance to the scale as it usually is the critical factor whether start-ups can conduct the research in the field and whether they could raise funding without sacrificing its equity. The answers' reflect the literature review's points.

It is stated by Tarek Miloud, Arild Aspelund and Mathieu Cabrol (2012) and Meric S. Gertler & Tara Vinodrai (2009) that building a network is crucial for successful growth of a new start-up and possibilities to find new partners increase. Literature also suggests that belonging to a life sciences cluster leads to better learning dynamics and knowledge sharing processes. Start-ups recognize the importance of this aspect, but it is not equally important to every start-up as the majority stated it is just somewhat important, some stated it is not important at all or very important.

Regulatory affairs aspect is also considered to be as an external success factor for a start-up by Jim Connell, Gary C. Edgar, Bill Olex, Robin Scholl, Todd Shulman, Russ Tietjen (2015), and it is critical for further development of new products and services. Start-ups recognized this aspect as the most important out of all external aspects that has a direct influence on their operations. Lithuania's regulatory affairs which correspond to EU standards are very strict, according to the start-ups, for this reason it is recognized as a very important aspect for future development.

### **Overview of significant findings**

The research revealed several significant findings which were discovered while gathering the empirical research data.

1. The Lithuanian educational institutions do not have a system of how technologies and products should be licensed or commercialized properly upon some breakthrough are achieved during the R&D projects. The empirical data shows evidence that start-ups are using not only universities' laboratories, but also employees and researchers of universities to conduct the R&D activities in a specific field which is needed by a start-up. Upon the public money is spent on the R&D projects, the findings are licensed for a fraction of costs to the start-ups so that they could look for further funding and

possibly commercialize the technology or product. Although, the respondents of the start-ups argue that public institutions do receive benefit in such cases: institutions hold the patents and they could publish articles in journals. The monetary aspect is crucial in this case, as the infrastructure of the university, laboratories or further research could be financed by the funds that it would get if the university would have a system for such cases and would receive the return on its breakthroughs. These type of agreements and collaborations also give a competitive advantage to selected start-ups and distorts the competition.

2. Most of the start-ups agreed on the criticalness of unforeseeable uncertainty on their operations, although the total majority of the start-ups do not do anything to manage it. This might suggest that start-ups in Lithuania are quite short sighted and do not plan anything long-term, instead of focusing on the presence and quick money. It might indicate that start-up owners are preparing their technologies, products or services to be sold upon some promising data is gathered and would not think of scaling up the start-up in the future.
3. Lithuanian life sciences industry is heavily dependent on the regulatory affairs of Lithuania and European Union. As this aspect was rated as important and very important by the start-ups. Examples given by the start-ups show evidence that every government's change brings new variations to the regulatory affairs of the industry to which start-ups have to adapt.
4. Lithuanian start-ups' employees' salaries is an important or very important aspect in order to attract employees to the team. It does not correlate to the literature which suggest that the most important motivation for employees in science based start-ups is interesting and challenging work. Instead, in Lithuania the salary is more important.

5. All pre-identified critical success factors were confirmed by the start-ups, although throughout the whole interviewing process some start-ups changed their opinions while answering different questions or filling the scaling table. That might suggest that start-ups were not honest and the managers interviewed tried to answer questions in a way that it should be done in their start-up instead of how it is truly done.

### CONCLUSIONS

The research concludes the critical success factors of innovative Lithuanian life sciences start-ups. As all pre-identified critical success factors were confirmed by the empirical data, it shows that Lithuanian life sciences start-ups are not much different from the rest of the World-renowned clusters which have the well-needed developed systems for start-ups to grow and develop. With a slight difference within the life sciences industry's sub-sectors (pharmaceuticals, biotechnology and medical devices) the same critical success factors were discovered as it was reviewed in the literature review.

In accordance to literature review chapter critical factors for companies and start-ups globally were identified and used on a later empirical research activities. Although, it has been discovered that a gap is left in the literature review especially in industry-specific start-ups, i.e. life sciences industry. Outlook of global and national life sciences industry made in the literature review revealed the growing importance of the life sciences industry in Lithuania and worldwide.

At the time when this master thesis was written, there were only 19 successfully operating start-ups in life sciences industry. However, the number of the start-ups generally is increasing and especially the number of start-ups in life sciences industry tend to grow faster than in any other industry, besides the information and communication technologies industry. For this reason, the achieved goal of this thesis to identify the main critical success factors of the industry, so that the startups could potentially take into consideration the researched factors in order to successfully grow, is very relevant. Three main critical success factors identified by the start-ups were: human resources related, technology related and access to funding; while pre-defined critical success factors were rated by importance: management of research & development activities and its costs (as most important), human resources related (second most important), knowledge management (third most important).

The empirical data shows that Lithuania's industry's aspects and factors are very much likely to follow the European and Worldwide tendencies in the field. For this reason, start-ups which are creating their technologies, products and services become competitive not only in Lithuania, but globally as well. Also, foreign investors appreciate that the national start-ups are following a global life sciences start-ups path, which would potentially help them to secure investments into their start-ups.

Having in mind the identified critical success factors importance on the national and EU funding opportunities, the future research could be made within the end of the EU structural funding (early 2020) as then the success factors should dramatically change, because the grants and funding structure for start-ups will adjust. Also, future research could be made by collecting data only from the ones which have attracted series A investments, as such start-ups have the biggest potential to be successful worldwide as their technology, product or service have promising data to scale up fast. Reasons for which start-ups have liquidated their operations or went bankrupt would also be a good sample to research in order to identify critical mistakes of the start-ups.

The Lithuanian educational institutions should improve the system of how technologies and products are licensed or commercialized properly upon some breakthrough are achieved during the R&D projects. As empirical data showed, public educational institutions are losing possible income from various licensing and commercializing activities.

One of the start-ups during the collection of empirical data stated that a start-up is like a functioning human's body - there are critical conditions that might kill the body instantly and there are the non-critical ones that will always become critical if not treated. Success factors are also a system of less important smaller aspects which all have to be taken into consideration in order to succeed in the competitive knowledge-based industry of life sciences.

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## APPENDICES

### Appendix no. 1 – The questionnaire of the interview

My name is Karolis Dumbrovas, I am a second-year student studying at ISM University of Management and Economics in Innovation and Technology management program. Currently, I am conducting qualitative research on innovative Lithuanian life sciences start-ups.

This research is currently being conducted in order to identify critical success factors of innovative Lithuanian life sciences startups. The following interview will have 15 questions, while the last part of this interview will contain a scaling form from zero to five to assess the importance of pre-identified critical success factors. The interview might take around 30 minutes to finish and the interview will be recorded. Please be noted that the confidentiality is guaranteed and the answers for the following questions will be kept undisclosed for any research-unrelated matters.

The 5 screening questions:

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?
2. How long is the start-up already operating legally?
3. How many employees work at the start-up?
4. Does your start-up generate revenue?
5. Does your start-up currently experience any financial difficulties?

10 questions that will be used to research CSFs:

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?
7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.
8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.
9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?  
*UU could be defined as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*
10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?
11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?
12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?
13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?
14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

15. Does the infrastructure (environment) has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?

*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

16. Using a scale from zero which is not important at all to 5 which is very important, please rate the following critical success factors and its related aspects for your start-up.

	0	1	2	3	4	5	No opinion
<b>CSF: Unforeseeable uncertainty</b>							
Preparing a risk management plan							
Implementing trial-and-error learning							
Using selectionism methods to manage UU							
<b>CSF: financial constraints</b>							
External financial funds (i. e. banks, VCs)							
Funds which come from the owner (or relatives, friends etc.)							
External financial funds (governmental, EU projects)							
<b>CSF: management of R&amp;D and its costs</b>							
Defining clear R&D goals							
Breaking down a R&D project and prioritize the different aspects of the project							
Preparing a possible cost-reduction and quality effective options (i.e. outsourcing)							
<b>CSF: management of human resources</b>							
Creating start-up's vision							
Empowerment of employees							
Creating a an open-system communication							
Giving employees a feedback							
Re-evaluating start-ups environment in order to set new HR goals							
<b>CSF: impact of management team on overall motivation of startup's human resources</b>							
Giving freedom and space to start-ups employees							
Delegating responsibilities with clear goals							
Salaries of start-ups employees							
Creating a less bureaucratic environment							
<b>CSF: knowledge management</b>							
Creating tools for leaders in order to create behavior model to share knowledge within personnel and promote it							
Creating structure (set of rules, roles and responsibilities) for knowledge management							
Creating measurement tools in order to measure knowledge management's influence on start-up's outcomes							
<b>CSF: infrastructure (environment) as an external factor</b>							
Belonging to a hub, cluster or association							
General location of the start-up							
National policy towards the start-up's activities and/or research							
Regulatory affairs in the field							

**Appendix no. 2 – Scaling (rating) summary of all start-ups**

CRITICAL SUCCESS FACTORS	1	2	3	4	5	TOTAL
<b>CSF: Unforeseeable uncertainty</b>	1	3	2	6	0	12
Preparing a risk management plan	1	1	4	3	3	12
Implementing trial-and-error learning	0	2	3	3	4	12
Using selectionism methods to manage UU	2	2	4	4	0	12
<b>CSF: financial constraints</b>	0	0	1	4	7	12
External financial funds (i. e. banks, VCs)	0	0	1	3	8	12
Funds which come from the owner (or relatives, friends etc.)	1	3	0	2	6	12
External financial funds (governmental, EU projects)	0	0	2	4	6	12
<b>CSF: management of R&amp;D and its costs</b>	0	0	2	5	5	12
Defining clear R&D goals	0	0	0	7	5	12
Breaking down a R&D project and prioritize the different aspects of the project	0	0	3	5	4	12
Preparing a possible cost-reduction and quality effective options (i.e. outsourcing)	0	1	3	5	3	12
<b>CSF: management of human resources</b>	0	0	2	6	4	12
Creating start-up's vision	0	2	3	3	4	12
Empowerment of employees	0	0	1	8	3	12
Creating a an open-system communication	0	2	1	5	4	12
Giving employees a feedback	0	0	0	7	5	12
Re-evaluating start-ups environment in order to set new HR goals	0	0	4	4	4	12
<b>CSF: impact of management team on overall motivation of startup's human resources</b>	0	0	3	7	2	12
Giving freedom and space to start-ups employees	1	1	3	5	2	12
Delegating responsibilities with clear goals	0	0	3	5	4	12
Salaries of start-ups employees	1	0	3	5	3	12
Creating a less bureaucratic environment	1	1	1	5	4	12
<b>CSF: knowledge management</b>	0	0	3	6	3	12
Creating tools for leaders in order to create behavior model to share knowledge within personnel and promote it	0	1	4	6	1	12
Creating structure (set of rules, roles and responsibilities) for knowledge management	1	1	2	6	2	12
Creating measurement tools in order to measure knowledge management's influence on start-up's outcomes	2	2	4	2	2	12
<b>CSF: infrastructure (environment) as an external factor</b>	0	2	2	4	4	12
Belonging to a hub, cluster or association	1	4	2	3	2	12
General location of the start-up	0	1	2	6	3	12
National policy towards the start-up's activities and/or research	0	1	1	4	6	12
Regulatory affairs in the field	0	2	1	2	7	12

### Appendix no. 3 – Summary of answers (of the research)

STARTUP	Q6 (What are the most important critical success factors for your start-up in your opinion)	Q7 (Are the same critical success factors are important both in early stage and later stages of the start-up?)	Q8 (Do same critical factors apply for all start-ups operating within the same field as your start-up?)
1	1. Products' high quality 2. Experienced team	Yes	Yes
2	1. Being creative and innovative 2. Creating something new in the market 3. Managing HR	No, as the company evolves, the CSFs evolve together.	Yes. If not, you are doing something wrong.
3	1. Innovative products 2. Ideas to improve it	Yes (expertise, knowledge in the field is important and support of Mentors all the time)	Yes
4	1. Motivation and dedication of the team 2. Employ highly distinguished people 3. Ability to find partners and effectively use it for joint technology development 4. Financing and access to finances 4. Staying focussed on the current product(s)	No, they change as you progress through the later stage.	Yes, same factors are universal.
5	1. Competent team with different competences 2. Strong financial background 3. Governmental support	Yes, developing a new product, a new idea that might become a product, it's the same as for established startup, very financially intensive, it needs a lot of knowledge, so it is more or less the same.	Yes, same factors within the industry.
6	1. Product and the concept of the product 2. Marketing of the product 3. Competent team	No, like international partnership, distribution network, problems solving abilities or willingness to solve the problems changes.	Yes.
7	1. Ability to find appropriate competence (team) 2. Access to the EU funds 3. The availability of financial resources	Yes.	Yes, the same.
8	1. Patenting of technologies and ideas.	No, growing startup calls for new CSF.	No, every startup is unique with different details and aspects that can become critical.
9	1. Knowledge management 2. Managing R&D 3. Environment the startup is operating in	Yes.	Yes, the same.
10	1. Medical recognition 2. Product design 3. Legal aspects	No, they are different. In later stages startup has to acquire those competences in certain fields and in early stage startup has to acquire that understanding what competences it needs and how it will be achieved.	Yes, most of them.
11	1. Enthusiasm. 2. Support from the government funding.	Yes.	Yes, more or less.
12	1. Competent team 2. Technology / the product 3. Market research	No, they differ investors, management, team change, therefore CSF change as well.	There is a pattern, but they differ. Sometimes even unlimited financial resources can't deal with some of the CSF the whole industry has.

## CSF OF INNOVATIVE LITHUANIAN LIFE SCIENCES STARTUPS

STARTUP	Q9 (Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up?)	Q10 (What type of financial constraints did your start-up face with?)	Q11 (How do you manage R&D activities and its costs?)
1	Yes (making research of the market and adapting to the news).	Difficulties with EU and national grants (because of intensity), still is not funded by VC. <b>It is a CSF.</b>	Funded or get funding from grants for R&D, agreement with outside partners for free outsourcing. <b>It is a CSF.</b>
2	Yes (taking into consideration lobbyism as the most important factor to manage it).	EU, government funding, bank loans. <b>It is a CSF.</b>	Tight system, everything is considered and everything is calculated. Investing in long term projects rather than short ones. <b>It is a CSF.</b>
3	Yes (project risk analysis is being done, identifying uncertainties and dealing with it).	None of the financial constraints. <b>It is not a CSF.</b>	To concentrate on the specific ones and not to make too many of them. <b>It is a CSF.</b>
4	Yes (prepared a risk management plan, financials are prepared to survive dry periods, plans prepared for scaling down the activities and the HR).	Yes, major financial constraints inability to hire skills and man power, can't afford sales team, marketing, manufacturing as they would wish to. <b>It is a CSF.</b>	Being concentrated on one thing at a time in R&D. <b>It is a CSF.</b>
5	Yes (market research, adapting to what's happening to avoid some big unforeseen mistakes like IP rights). As it is very labor and time intensive, it is not done 100%.	Mainly because of the cash flows, it's hard to manage the consumables and the payment for the services is received much later. <b>It is a CSF.</b>	Collaboration with Vilnius University (VU) - lot of things are done under the university name and then just licensed to the company. <b>It is a CSF.</b>
6	Yes (taking into account when making decisions, but not really successful), no experience in managing it.	No constraints, always had funding opportunities. <b>It is a CSF.</b>	Managing through project management tools, including all aspects of the R&D activities. <b>Is it a CSF.</b>
7	Yes, the uncertainty comes from many areas for a startup. Taking measures to manage it with stage-gate approach. Calculates possibilities and tries to minimize it.	Startups typically can not get any loans to finance the working capital, so not only the technology, not only the heart investments that are financed through the equity, but also the capital must be financed through the equity and this is constraining. As the cost of equity is high, shareholders have to give up some of their shares. <b>It is not a CSF.</b>	Prioritizing R&D activities and financing them. Trying to invest into the projects that would differentiate the products from the market. <b>It is a CSF.</b>
8	No.	Very important aspect as Lithuanian environment is very discouraging and lacking of financial partners. Most of the funding came from the owners. <b>It is not a CSF.</b>	Trying to find projects, local projects, even international projects that are funded and it is one of the possibilities to reduce the costs of R&Ds, working with local institutes and universities. <b>It is a CSF.</b>
9	As a part of the whole management of the startup, uncertainties are being managed, but it is not effective to put much work on it.	In Lithuania there are not enough funds and attracting the equity was a constraint. <b>It is a CSF.</b>	Besides using the internal resources, helps the governments' and EU's money to manage the costs of R&D. <b>It is a CSF.</b>
10	Instead of creating plans for possible risks or preparing internal risks, external risks tables a guideline rules were set which helps to manage the UU.	Very difficult to save money before setting up the startup, lack of well structured incubators, which results in facing other financial constraints. Inability to fund lack intensive processes at the startup. <b>It is not a CSF.</b>	Compensate costs by applying for different projects and enterin partnerships with other companies. Accessing open R&D centers of Lithuania, where you have to pay only a friction of what you would need to buy the whole equipment. <b>It is a CSF.</b>
11	Instead of managing uncertainty, a plan of actions is being done what has to be done for the next six months.	None at the time. <b>It is a CSF.</b>	Manage R&D and its costs through Vilnius University, which pays for everything. If a breakthrough happens, it is being licensed to the University. The startup itself could not afford to do it. <b>It is a CSF.</b>
12	It is only the secondary factor for a startup, if it includes managing uncertainty how the money will be raised, then this uncertainty must be dealt with. Specific managing styles are not being implemented.	Constraints to raise money, cash flow constraints, salaries constraints. <b>It is a CSF.</b>	Research and development should be implemented only where it is guaranteed to give results. Strict funding policy on every project should be implemented. People working should be completely concentrated on the product or technology and shouldn't think about anything else. <b>It is a CSF.</b>

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STARTUP	Q12 (With what challenges do you face with while managing start-ups' human resources?)	Q13 (Do you think management has an impact on overall motivation of startup's human resources?)	Q14 (Do you or anyone at your start-up manage "knowledge management"?)	Q15 (Does the infrastructure (environment) has an impact on your start-up? What are the most important aspects of it?)
1	Lack of funding prevents of hiring good specialists. No problem of managing HR. <b>It is a CSF.</b>	Management is the core factor of success startups and its motivation to people. <b>It is a CSF.</b>	Not managing, left for future. <b>It is a CSF.</b>	It has a major impact. Especially geographic aspect as all the partner institutions, consultants are in Vilnius. <b>It is a CSF.</b>
2	To find good people is the problem, then to train them and finally keep them in a company. <b>It is a CSF.</b>	Not only they have the impact, it is important that they do it to be on the same page. <b>It is a CSF.</b>	Managed, everyone shares everything, on top trainings are made. <b>It is a CSF.</b>	Political influence and geographic location is the major factor. Important to belong to an association, hub or cluster. <b>It is a CSF.</b>
3	To have good, motivated employees is critical. Challenge is to find them. <b>It is a CSF.</b>	Yes. <b>It is a CSF.</b>	Yes, at some extent the knowledge management is done, sharing and discussing at regular meeting knowledge we have and get during RnD. <b>It is a CSF.</b>	Yes. <b>It is a CSF.</b>
4	Not enough time to maintain the oversight of all activities that are going on, managing activities and directing activities or various employees. Unable to attract full time or near full time managers, managerial skills at the moment. <b>It is a CSF.</b>	Yes, giving the contents for the employees, on what they are doing, what are the successes, where we are going and why we are doing what we are doing is very motivating. <b>It is not a CSF.</b>	Yes, informal basis and to some degree formally. Two major aspects: IP knowledge and overall knowledge of what the startup is doing or its breakthroughs. <b>It is a CSF.</b>	Environment in Lithuania is extremely friendly for startups. Environment, political, investment environment, funding environment is very fibril. <b>It is a CSF.</b>
5	It is difficult to compete with big biotech firms in terms of HR. Lithuania and we lack of good middle level employees (technologists). <b>It is a CSF.</b>	Job is more important than the motivation from the management. <b>It is a CSF.</b>	Yes, people have to understand how things work. Also, sharing the knowledge with the environment is important in order to get some knowledge back. <b>It is a CSF.</b>	The regulations, the support and everything is very important, because it is a very sensitive industry (biotech) with quite a lot of regulations. <b>It is a CSF.</b>
6	Micro managing, problems with low level employees. <b>It is a CSF.</b>	Management is one of the most important motivators as their decisions are directly related to employees work and its improvement. <b>It is a CSF.</b>	Yes, through a formal tools and promoted by the management. It is important not to make same mistakes. <b>It is a CSF.</b>	Less relevant, not really important. <b>It is not a CSF.</b>
7	Managing itself is not critical. Only employing a team is. <b>It is not a CSF.</b>	Yes, instead of paying big salaries, management has to come up with other ways how to motivate people and this is very important factor for a startup. <b>It is a CSF.</b>	Yes, to some degree. Stage gate approach requires team to share knowledge. <b>It is not a CSF.</b>	Yes, it has, especially the regulatory aspects. <b>It is not a CSF.</b>
8	No problem with managing the human resources. The only problem is the manager who is managing it and/or its styles that are suitable to the team. <b>It is a CSF.</b>	The biggest impact the management has is setting the employees salary. <b>It is not a CSF.</b>	Managing KM, sharing ideas and information. <b>It is a CSF.</b>	Environment is very important as the startup rose from the spin off of University. <b>It is a CSF.</b>
9	Recruiting short term people, managing people who are working abroad (outsources HR). <b>It is a CSF.</b>	Applying managerial models to keep the people motivated and happy. <b>It is a CSF.</b>	Yes, it is managed. <b>It is a CSF.</b>	Yes, especially the regulatory part. <b>It is a CSF.</b>
10	Challenge is to find the right people at the beginning and to make sure they will be good enough on the later stages on the startup. People coming from specific industries are good only of handful of things, when a startup needs people who have knowledge on various aspects. Recognizing who is good and who is not also a challenge. <b>It is a CSF.</b>	Different management styles have different aspects on peoples motivation. Managers have the power to motivate people to be better at what they are doing. <b>It is a CSF.</b>	It is hard to do it, but it is being implemented. <b>It is a CSF.</b>	Lithuanian infrastructure, legal system of the country are the factors that have a huge impact on the startup. Universities are not working efficiently enough. <b>It is a CSF.</b>
11	Team is the biggest achievement of the startup. Hard to find competent people, usually you have to train themselves. Challenges include managing different personalities and the reduce the micro managing. <b>It is a CSF.</b>	The managed has the biggest impact. <b>It is a CSF.</b>	Sharing knowledge through meetings, weekly and monthly reports, making sure everyone understands everything. <b>It is a CSF.</b>	One of the most critical ones, as the startup is the spinoff of the University and University is paying for the research (governed by the state rules). <b>It is a CSF.</b>
12	Lack of time solving conflict situations, the challenge itself is the time to manage people. <b>It is a CSF.</b>	Yes, the management should keep the vision of the startup alive, motivate people by giving some freedom, making people feel appreciated and keep them focused. <b>It is a CSF.</b>	It is critical to manage the knowledge and its confidentiality, the IP confidentiality etc. <b>It is a CSF.</b>	Yes, in Lithuania it would have been impossible to find an investor. Important is the cluster environment to get the support, investors, R&D, institutions, hospitals. You need to be in a cluster. An Lithuania does not have one. <b>It is a CSF.</b>

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	SUMMARY OF THE ANSWERS	
	No	Yes
Q7 (Are the same critical success factors are important both in early stage and later stages of the start-up?)	6	6
Q8 (Do same critical factors apply for all start-ups operating within the same field as your start-up?)	1	11
Q9 (Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up?)	3	9
	SUMMARY OF THE ANSWERS	
	It is not a CSF	It is a CSF
Financial constraints	4	8
Managing R&D activities and its costs	0	12
Managing human resources	1	11
Management's impact on startup's human resources motivation	2	10
Managing knowledge	1	11
External infrastructure (environment)	2	10

## Appendix no. 4 – Transcripts of the qualitative research

### Start-up no. 1

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

Ok, first of all hello, thank you for the interview. I am a member of Lithuanian start-up (company name), (company name) is a manufacturer of (products description). Therefore, we are currently producing, creating our own (product), an end product, which will be used in food protection. Since March, 2015 I was appointed to lead the company as a CEO. So I am responsible of the company's fund raising, partnerships, agreements and etc. etc.

2. How long is the start-up already operating legally?

For about a half a year.

- So for six months?

No, sorry, for about one and a half years. Since March, 2014.

3. How many employees work at the start-up?

At the moment we are only two. But this question needs additional comments, because I think, in my opinion, number of employees in 21<sup>st</sup> century is not important. Because as I mentioned we are only two, but we have agreements with universities, institutions, we work with our partners equipment and we have projects with them. So we are only two, but if we would include our partnerships, we have a bigger team.

4. Does your start-up generate revenue?

Yes. We are selling to 14 countries. Revenues are not big yet, but they are getting there.

5. Does your start-up currently experience any financial difficulties?

No. There are no difficulties.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

Ok, first of all is to create a high quality version of end product. A reader. High quality is the most important challenge in our sector. Secondly, is to build an experienced team and of course to keep them in the company, because in this sector it is really important to collect know-how in house.

- Could you please elaborate a little bit more why in your opinion they are critical?

If you are a technological start-up, you have to create a high quality product, because your clients will buy it once and if you fail, they will never buy it again. Talking about team, there aren't many good specialists in Lithuania, in the field of technology. So, we need to create a team for long run period and to keep as I mentioned, the know-how in house.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

Yes, it is. Quality, good team and non-stop development are all the challenges that are always important.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

Majority of them, yes.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Yes, of course. Making researches of the market, inside laboratory, we need to make many tests, many experiments, so, yes.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

There are difficulties with EU and national grants, because the intensity aren't 100%, so in fact very less calls have the intensity of 100%, others are 70% to 80%, so we need to cover other 20-30% by ourselves. In life sciences sector, where amounts of product development is very high, buying necessary equipment and etc. is very high. So 20-30% is a big amount of startups. And yes, it is one of the critical factor to manage.

- Did you have any other financial constraints besides the EU and national grants? For example, venture capitalists, business angels, bank loans?

Yes. We still haven't funded by VCs or others, but we have plans to raise some money from VCs and etc.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?



Yes, it is one of the CSF. At this stage, where (*company name*) is we need to get funded or get funding from grants if we want to build our r&d team and at this moment we use outside know-how and equipment, and employees, as I mentioned before we have some agreements with partners. And because we have those agreements we can save money today.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Once again funding, because if we want to employ experienced specialists, we need to raise funding at this moment. But if we are talking about future, HR is also a critical factor for startups. It is very important to build, as I mentioned before a long term team, and we need to try to cover all know-how inside the company.

- Do you have any challenges at the moment while having two people?

With two people? One of them is still in the maternity leave.

- So, no?

No.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Definitely. I am sure that this factor is forgotten by majority of startups. I think, primary problem is that many people from technological field as inventors, constructors they think that only job that is done by them is important and management is not important at all. So in my opinion, management is the core factor of success startups, because there are at the beginning and at any stage there are a lot of processes that the company should control. So management is, as I mentioned, is core.

- And you would say that it is very important on the overall motivation of startup's human resources? Yes, of course.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.

*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Knowledge management as I understand are important at further steps that (*company name*) is. But it correlates with motivation of course. It is definitely very important to share the knowledge.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?

*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

So it depends on what kind of startup you are at, if you are creating hardware.

- In your startup particularly.

Yes, it is important for us. In Vilnius everything is constrained here, our partners, such as institute of physics, food safety and veterinary institute, all professors that consults us currently. So yes, it is important for us.

### Start-up no. 2

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

I am a BD manager at (*company name*), which is (*company description*).

2. How long is the start-up already operating legally?

Legally, it's operating for quite awhile. Operation started in 2013.

3. How many employees work at the start-up?

At the moment it is around 110.

4. Does your start-up generate revenue?

Of course.

5. Does your start-up currently experience any financial difficulties?

None to my knowledge.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

Well, I believe that there are not a lot of success factors critical to the operations and the company. But one of the most important one is to be creative and be innovative, to be best or do something different. So our company focusses on doing things different from others, it helps us to be leaders in the field. Other things that are important are people from the management to simple employees who are working to achieve our goals

- Would you say that management is more important on your activities or the scientists are the laboratories?

I wouldn't exclude any of these, I would say that the team itself. There would be no leaders without the small people and there would not be a company without leaders. So the team is important.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

Well, I would say that the success factors evolves together with the company. In the beginning the most important thing is, as I mentioned, to be different, to have people, to prove yourself in the field or in the market. Later, success depends on the execution. So if you prove yourself, you get the projects, the money, the funding then you need to do what you said. It is more like loyalty important, flexibility, everything that helps you to execute.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

Good question. I would say yes, critical factors in the same field are very similar. You need to be different, you need to have people, you need to be the best. You can't be doing something really different from others, meaning that success would not come if you would be doing something differently in this matter.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

I believe we are thinking about this everyday and UU also includes political background of the country that your startup operates in. Basically, we think about it every day, we even do lobbyism if it's needed, we are thinking ahead and then trying to eliminate the uncertainties as soon as possible.

- Do you think management of UU requires more time or financial resources?

I would say time resources and the top management's time resources are the most important here.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

We do have and I think we had financial constraints. Basically, the company was founded by the founders' money, but later EU and bank loans money were needed to build the manufacturing facility. But having all these loans or projects now does not influence the company.

- So would you say it is a CSF?

It is critical if you are not able to manage your financial constraints, you would go bankrupt.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

It is. If you would spend more than you get, especially in R&D, that's the problem. We always have people for that, team, managers, the scientists, they have to present budgets. It is being managed and it is critical not to overspend.

- Do you have any examples how is it being managed?

Sure, we do follow from the beginning the project. When someone want to starts something, it should be evaluated from the start. No one is doing anything without the evaluation or writing. If it is an innovative idea with the prospect of doing business with it, then we are going forward, we evaluate possible costs and possible revenue. This kind of step by step, if everything is going to be all right and it is going to be profitable we say "let's do it". And throughout the project every penny is counted and accounted for.

- From your experience, are there any R&D activities that were funded if they did not seem profitable but they seemed profitable at a later stage?

Sure, I don't believe that any of our projects are short term projects (short sighted). We always look ahead and if it will bring money in other forms, i.e. protein or molecule will help to develop another protein which would eventually bring profit, then we would also choose to develop it.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Oh, it is a CSF. It is a huge problem, it has to be managed. To find the right people is the first problem, Lithuania is not a huge country and we have universities but they are preparing different kind of specialists than we need. So first problem is to find them, then to train them and then to of course help them to execute the projects and keep them in the company.

- Would you say it is a CSF?

Yes, it is.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

So to begin with, it is a CSF as I mentioned before it is very important that the whole team would work as an entity. So managers, the leaders of the company have to motivate others and to explain what they are doing and give them a boost of energy everyday.

- What are the best motivating tools for the managers to motivate people?

This is a good question. People would like to say money, but I wouldn't say so, it's only third or forth in the queue of the motivators. I would say knowing that you are important, your company is important and knowing that you are doing something worthwhile is the most important.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Wow, that's a good question. I have never noticed this type of management on our company, maybe it is more natural and it is being distributed as we are open to each other, so there are no secrets between the team players, we are not doing any extra work for that.

- For example, maybe CSO would encourage sharing the knowledge, making some type of trainings?

In that way, yes, we are doing trainings, lecturers so that different specialists, from different fields would know other fields as well. That you would know the entire operations of the company.

- Would you say it is a CSF?

Yes, maybe it is not the top one, but it is.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?  
*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

It is a CSF, especially politicians and of course geographical location of the company, that I found out only working in this company. Being based somewhere specifically is very important, sometimes a German company would be already successful, on another hand if you are here in Lithuania means you are capable of working with the Eastern part of the World. So it is important and a critical part of the success.

## CSF OF INNOVATIVE LITHUANIAN LIFE SCIENCES STARTUPS

- Besides geographic location or political side, is there anything else? For example, belonging to a valley, cluster or association helps?

Sure, be a part of some system is very helpful, because you are increasing your visibility, you are offering more flexible products.

### Start-up no. 3

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

We are a start-up company developing innovative (products description). One of the fields we are working on – (company description). Our assays will enable physicians to diagnose cancer early and more precise, therefore patients will get necessary treatment on time.

We aim to translate achievements of genomics and our deep knowledge as well as experience in life science technologies such (products description) for medicine. Each single patient should benefit by getting precise diagnosis.

2. How long is the start-up already operating legally?

Since 2013.09.02

3. How many employees work at the start-up?

Five

4. Does your start-up generate revenue?

Yes, but very small.

5. Does your start-up currently experience any financial difficulties?

No

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

To have innovative ideas and great product/service which could be offered globally. No innovation – no success.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

In all stages expertise, knowledge in the field is important and support of Mentors.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

Yes

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?  
*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Yes we did and do. We did project risk analysis to overcome uncertainties, but still it happens. This is more about management how to avoid or overcome uncertainties and it is not easy.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

Did not have financial constrains as long as we follow approved plan and rules for getting finances.

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11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

It is important not to have too many activities

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

To have good, motivated employees is critical. Challenge is to find them.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Yes, I would agree.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Yes, we do at some extent the knowledge management, share and discuss at regular meeting knowledge we have and get during RnD

15. Does the infrastructure (environment) has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?

*Infrastructure (environment) is conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

Yes, it is.

16. Using a scale from zero which is not important at all to 5 which is very important, please rate the following critical success factors and its related aspects for your start-up.

### Start-up no. 4

The 5 screening questions:

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?  
Ok, so my name is (name) and I am the CEO and co-founder of (company name). The current role is CEO and main execution person, business development as well. The startup is involved in (company description).
2. How long is the start-up already operating legally?  
We were established in May, 2013. So over 2 years now.
3. How many employees work at the start-up?  
We have 7 employees, of which 2 work part time, I mean 2 work full time and other work part time and work at the university. So full time employees, basically 3 and a half.
4. Does your start-up generate revenue?  
Yes.
5. Does your start-up currently experience any financial difficulties?  
No.

10 questions that will be used to research CSFs:

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?  
For us CSF are first is the motivation and dedication of the team, it's particular challenge to have people who are highly distinguished scientists working in their respective institutions and are co-founders of the company, be involved at a critical enough level to be able to support the company's activities and its product and technology development. There is a high level of people at the co-founder level and there is a fairly level technical people at the employee level. So this middle ground is missing and the execution part, sales, business product development and that usually may come from mainly investment. So I think the fact that there is lack, not lack of motivation, but the set up is such

that motivation of top people and their ability to contribute to execution is one of the critical factors for us. I am not saying it's success for us, but if we would be able to manage it, it would be CSF.

One other factor is the ability to find partners and effectively use it for joint technology development. You know, there is a lot of trial and error, trying to find partners, start relationship with them and then find out that it is not working out. So being very focused and selective about it. Of course, at the same time partners are being selective about you.

Another one is really understanding the customer needs. Again, it sounds cliché and very simple. But very often scientists think they know what client needs and never ask, but when they ask they find out that it is not what they need or what they need is completely different. So it is important to be focused on it.

4<sup>th</sup> aspect that is very current for us, that in the field that we are operating in there are many, many directions you can go into and explore, find out and there are many interesting things going on, but you need to, you know, stay focused and that is another success factor, that if we can stay focus, we can succeed and if not we can lose the direction.

And of course financing and access to finances. We see companies in our field propelled by for example a company for the Netherlands, got investment of 5 million dollars in our field, you know, huge difference on what they are doing and how they are doing and the speed of the development of the development they are taking. We are having to sort of be in the back there and tread the waters by ourselves.

Would you say that access to the finances is the main factor for speeding the development itself.

It is probably 50-60% of any company of the stage we are at, yes.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

We are still in the early stage, we are at the technology development, validation stage. We are pre-investment stage, or pre-venture capital investment stage, the pre-seed investment stage. So they will be different. For now we have to show critical differentiation for our technologies to investors, customer, to our stakeholders, and once we, you know, get to that, prove it let's say, to a small group of interested parties, then very different challenges will come. Ability to scale, ability to get the right people for execution, ability to get into interdisciplinary people, people who and skills which might now be much readily in Lithuania, for example quality assurance, production management in life sciences, you know, these things are not existent here, there are very few people there in medical device. I don't know if I have answered the question.

- So in general they are quite different?

Yes, they change as you progress through the later stage.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

I think, yes. Generally, yes, probably the same factors are universal. I think where companies fail or anyone can fail are those basic organizational development, HR, lack of team cohesion, those kind of factors not that the technology does not work or whatever, because there are no new technologies, everything is more or less is worked on somewhere else, and it's just who is faster, more organized, more lucky and so on. It's all about those basic factors that end up being the critical success factors.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Yeah, I would say we do take it into consideration, we have a risk management plan. Not that we look at it every day, we have it as a part of our business plan. But some examples of risk management I would give you like this: we are trying to manage our, me personally trying to manage our finances in such a way, to make sure that we have a cushion of cash available for you know any unforeseeable let's say dry spells, where we are not getting revenue or we don't have project financing, we also have a back up plan how to scale down our activity. Now we have 7 people working, some part time, some full time. If something came up we could probably scale down to 2 or 3 people, of course activities would slow down. We try to as much as partners and share development with partners, so we do not have to buy much stuff ourselves on R&D part. So yes, in general, we do take into consideration, because there is so much uncertainty, you just never know. The whole thing is uncertainty.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

Yes, financial constraints, is the main success factor and the main risk factor. One of the financial constraints is the inability to hire skills and man power to be able to do many things that we have to do. And skills we need to attract, now we are being involved in scientific, technology development aspects mostly. We also need to look at production and scale up aspects, we also need to look at sales and product development aspects, marketing aspects and so on that we do not have these skills and we can not afford it. We can not buy good people out there, even though we know there are good people out there, we even have interview, trying to attract them. But that's one of the examples of financial constraints.

Otherwise, on the bright side, environment in Lithuania is extremely friendly for startups like us, you have a lot of assistance anything from patent fillings (MITA programme) to technology development (INTELEKTAS programme), to European level SME instrument – horizon2020, we were benefiting from EUROSTARS, we were benefiting from those programmes big time. When you have the right innovative product that is globally interested let's say, you can get those programmes and get funding. So in that sense, it could have been worse.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

That is probably 90% of what we do now. So yes, it is very critical. Because you can as I said be very focused and you also need to be able to change direction when something does not work and that is not easy at all. So yes.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes. With what challenges? One of my challenges, is that I, you know frankly, I am the CEO, I am the product manager, I am the let's say in some way financial manager and so on. There is not enough time to maintain the oversight of all activities that are going on. With our scientists being away, on their respective jobs, some of them outside, there is not enough oversight in terms of managing activities and directing activities of let's say technical level employees. And that is because we are unable to attract full time or near full time managers, managerial skills at the moment. So, it is as I said, one of the major challenges for the under-funded. Me being the CEO and the angel at the same time it helps for the human resources, but you know otherwise I can not see how the startup could go forward.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Yes, absolutely. You have always have to give the contents for the employees, on what they are doing, what are the successes, where we are going and why we are doing what we are doing.

- Would you say that management's impact on overall motivation of startup's human resources is one of the CSF?

I would not say it is that critical, probably not. It is important to have motivated employees, but I think in science it is a bit different. In science, some people like what they are doing and they don't really care what they are doing and why, they just like doing cell culture or chemical reactions, because they are chemists. Maybe in later stages, yes.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.

*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

We do it on an informal basis and to some degree formally. First, there is IP management, so you have to take certain precautions, first documenting your processes, protocols and so on. Of course filling them in forms of patents, but you know these talks about distributing knowledge among team members, it is more of a communication aspect of it. I feel its importance and we do need to do it, but we are not as good as we could be. So, for example this morning, I was thinking that a lot of new things happened, but a lot of staff don't know about it and you know we have to make a meeting and discuss them, bring them to speed, but another part of me is asking why to waste time as some of the people will not be changing their activities anyway because of this. But another part of me says again, they need to know because they have to feel important and understand of what's going on. So as always, in a startup there is not enough time to do it, but you have to do it and we try to do it.

15. Does the infrastructure (or the environment) has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?

*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

I guess it means the immediate environment. What we call infrastructure is our machinery, access to the equipment and it is critical. And before I go to environment stuff, I will talk about infrastructure as it is very important. We are competing with groups in the World, that have much better access to resource centers that are very well equipped with analytical equipment and so on. And it is more likely that those groups will advance ahead, everything else being equal. But do they have the same motivation, do they have the same people is another question. So if everyone had the same drive, same motivation, probably they would do gain more. And I guess on the criticism for Lithuania is that we also have heck a lot of equipment everywhere. In Kaunas medical university, physicist here, life sciences center here, but no one shares and there is no like real good informal or formal system to encourage that. And one of the ways to get this programme inocekiai going, you know, more frequent, probably in some way see what is not working and what is working do it a little but more frequently and maybe have other way to have those open access centers, which are not open access, when you turn to them, no one wants to do it, no one is motivated and so on. And you can not have a million dollar machine, you need to share it. And on infrastructure it is very important and access to it is very important to technology heavy startup like ours. Technology dependent.

- Would you say that this mentioned infrastructure is one of the CSF?

Yes. In that sense yes. Environment, political, investment environment, funding environment is very fibril. Sweden and other countries do not have such programs as we have.

### Start-up no. 5

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

Ok, so I am one of the three shareholders of the startup company working in industrial biotech. And at the beginning I was also the CEO of the company, but now I am more or less a consultant, just sharing my knowledge and helping with the contacts.

- Could you briefly introduce the activity of the startup?

Our startup is working in industrial biotech field, mainly with (products description).

2. How long is the start-up already operating legally?

Three and a half years.

3. How many employees work at the start-up?

Ok, now 4.

4. Does your start-up generate revenue?

Yes.

5. Does your start-up currently experience any financial difficulties?

For the biotech startup it's always let's say a financial difficulty. You always have to plan the investments to certain infrastructure. So the further you develop your business, the more infrastructure equipment you needs. So when you have more revenue, you plan to buy something new and then you still remain on the same level, you always have to calculate what you are spending your revenue on.

- But in terms of real financial difficulties, like bank is seizing your assets or anything like that, do you have any difficulties?

No, it's not such huge financial difficulties.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

First of all it's the very competent team with different competences which cover booth very strong and deep scientific knowledge then the knowledge how to apply more to the investor these scientific ideas and then business development part. So this is one part – team with very broad competences. The other thing would be strong financial background because everything in biotech field is very expensive – the material, equipment and so on. Strong financial basis and shareholders who could contribute investors who could contribute its very important. Then I would say the contacts that shareholders or team members have



because the competition in biotech is getting more intensive every day and the solutions are usually not the cheap ones and contacts help to find the clients. And I would say that some governmental support – not only financial one, but both in consultations, in finance, in some programs for biotech startups, investments into infrastructure that biotech startups could use that is also very important.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

I would say more or less, because maybe the sequence of them changes during the time, but still those factors are critical. If a biotech company is developing a new product, a new idea that might become a product, it's the same as for established startup, very financially intensive, it needs a lot of knowledge, so it is more or less the same.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

Yes I would say the same factors plus if we are looking into biotech sector more broadly – not only in industrial biotech sector that our startup is working in – let's say for medical biotech - for example developing of drugs – then the financial factor is getting even more important because it's even much more expensive to work in this field of biotech.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

I would say that uncertainty is always the case for biotech, because it is the field with a lot of IP, that is being patented. Of course, you try to keep your hand on the pulse what happens in the industry, but you never know if next day the patent will be issued and you will face in situation that you are infringing the IP. Or maybe someone does the same thing what you do and you may lose the advantage of being first in the market. So that is the big risk which happens every day for any biotech company.

- So do you manage it or just let it flow with UU?

No, of course, at least our startup is always looking what is happening in the market, what big players are doing, what researchers are doing. As you are working in the global market and anyone can start a startup and do what you do. So we try to do that, but the thing is that it is very labor intensive and time intensive, so you have to put so much time to it, but usually the case is that you can not so much time in that. But at least we try.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

I would say yes because of course you have to look what is happening in the market but also you have to see if you will be financial capable to continue your business and this is the case because to start to produce something you always need expensive materials and to balance those finances is very difficult. I believe what most startups do and we also try to do is to find other services or products that can be offered to the market and to balance the finances.

- What type of financial constrains did your startup face with – maybe some specifics if possible?

Let's say that you have to produce certain amount of products and you understand that you will get the payment after you will produce and sell them but you need to invest into material and sometimes it is the case – how to balance the amount of money that you have.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

I would say yes, it is a CSF. But in our case we collaborate a lot with Vilnius University (VU). So we see that a lot of things can be done under the university name and then just license to the company. It is a win-win situation, the university can have a project and external funding for certain activities, then have

scientific results for that, like patent or articles, and if the company sees potential in that can enter into licensing agreement and pay some money for university of course, but only if it could potentially commercialize it. So if I think that's the case how we can a little bit solve the problem of investments in R&D.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes it is quite difficult to compete with big biotech players – several big biotech players that we have in our biotech industry. People have to be motivated and to see bright future ahead. The biggest problem that we face and I know that other biotech companies face is that we have bright scientists, bright researchers, we have very good business people but we really leak – the people in the middle which are just simple technologists. In biotech you can develop something you want to apply into industry scale. There must be a person who understands how to make something that you did in a small scale – now in a very big scale and how to manage the process, how to work with companies that you would like to offer your product for. There is one more aspect – yes you can upscale your technology but when you come to the client - they all have some specific conditions, some specific equipment and once again you need to stand in their situation and once again you need good technologist and there is none of them in the market.

- Would you say that this is the problem of Lithuanian education system and universities that they do not prepare people good enough? Or they prepare people well enough but they just get a job instantly and can't find any labor in the market?

I would say that the problem of the universities because they are more focus on preparing biogeochemist or biotechnologist but not these with really technological approach. It's more like historical problem, because we had a lot of technologists and when the industry collapsed no one wanted to move to this direction and get the competences. So now the younger people already start to gain this experience but you really need to work some years to understand how to do that. The older generation – they are already going out of the market and really have a big gap now.

- And getting back to the question would you say that managing human resources is one of the critical success factors?

It is critical.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

I would say firstly job is the most important. People who work in the biotech they are obsessed with the ideas that they work on. So they work to see the result. Management is important, but the contents of the job is more motivating.

- Would you say that management' impact on overall motivation of startup's human resources is a CSF?

I would say it is critical, but it is not on the top of the list.

14. Do you or anyone at your start-up manage “knowledge management”? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Yes, we are working on that. Our understanding that everyone in the team has to understand how things are done and to be able to explain them and doesn't matter what you do, even if you work with the outsource or accounting, you try to explain to them quite in detail that everyone would be at a certain knowledge level and I think it is very important. And we try to get some knowledge from the surrounding environment, because in such case you never know when you can attract someone who is interested in that field and can give you new ideas.

- So would you say that managing knowledge is a CSF?

I would say yes, because if the people who are involved in the startup do not understand what the startup is doing, it is a “no-go” situation, because you can not work with something that you do not understand.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?  
*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

I would say that infrastructure first of all is extremely important, when you first work about the working environment and the equipment that the company has or has an access to. If you think about IT industry, it's easier. In biotech you really need a lot of different equipment and even if you slightly change your focus, you need another type of equipment, if you go upscale you need different type of equipment and so on and so forth. So this part is extremely important, because without it you can't do anything. But if looking more broad to the environment where we are working, the regulations, the support and everything are very important, because it is a very sensitive industry with quite a lot of regulations. So if you are supported in the positive way, it is quite helpful, but if the surrounding environment doesn't see biotech as an important industry, it might cause you some problems.

- So would you say that infrastructure as an external factor is one of the critical success factors?

Yes.

### Start-up no. 6

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

My name is (name). I'm a graduate masters of (academic field) and 3,5 years ago I was one of two founders of a startup called (company name). Which is a company producing extremely (product description).

2. How long is the start-up already operating legally?

Legally, 3 years and 5 months.

3. How many employees work at the start-up?

Currently it's 20.

4. Does your start-up generate revenue?

Yes we generate.

5. Does your start-up currently experience any financial difficulties?

No we are still having balance of investment left so in case we need additional funding we can always go to our investor and get additional funding that we need.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

I would say that the most important factor is the product and the concept of the product. I think the founders were creative enough from the beginning and later on the implementation was also quite successful. So we are more technology push company so we had this idea of the product and the concept and we just implemented it in a correct way. Also one of the success factors was that before finishing the product fully we started to promote it and this promotion gave us some access to the market and we heard the market need at very early stage. Another words we transferred from technology push to a market pool in just less than half a year which was saving enough r&d resources and we made another steps in accordance to the feedback from the market.

- Is there anything else?

I think, of course, the people we managed to gather. They are also very important for the success although sometimes I think that if from the very beginning we would be having one of the very experienced people in our company that might also save some months of the development and we would be launching earlier and generating some revenues and also profit earlier. But in the current situation and what we could do in Lithuania it was I think very good team that we collected and very good motivation from the beginning.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

I think they remain important but there are new success factor that come up. Like international partnership, distribution network, problems solving abilities or willingness to solve the problems. So these are key factors which come later let's say after the product is finished and launched to the market.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

Yes I think so.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?  
*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Yes I would say that we tried to take this into account but how successful we are with this prediction. I would say that we are successful only 50%.

- Would you say that it is critical success factor?

I would say it's critical but at the same time I would say that it really depends how good you can make it, it depends on your experience and how experienced you are at this risk assessments.

- Did you have any experience in the field before?

When I compare my previous experience to the experience I have now it's maybe 20 times different. I was a little bit experienced but now I am 20 times more experienced.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

In our case we always had a choice where to get funding from. At very early stage we decided to fund activities by ourselves. I took a loan from my uncle and only then we went to investors already having free money evaluation of 7000 euros. I think this was quite good strategy and there we used all the efforts and all possibilities that we had. I can not say like this, but we didn't want to look for funding outside Lithuania, for example. This saves us a lot of time and maybe expenses in legal issues, so I think we moved faster and got valuation with our strategy. So I think it was quite successful.

- So would you say that managing financial constraints is one of the CSF?

Yes, I would say.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

Yes, it's definitely one of the critical success factors and we are learning in managing. Now we have project management tool in our system and there we plan to plan ahead the projects including human resources and finance. But in the very beginning we were not very intensively planning. It was more like learning by doing. I think it was also quite a good strategy from the beginning. Now we are transferring into a planning type of project planning than just doing an experimenting right away.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes, I must agree, managing HR is a CSF as well.

- With what challenges do you face with?

So far we faced with challenges only with people who are low level employees, like cleaning lady, which initially we had a company for cleaning, then we switched to having our own, but she was not very reliable in terms of drinking. So that's one example, as for another ones, we always had a question how many things

as founders we have to manage and which to leave to other people to do. Some people are still complaining that we are doing micro managing, so this is still a question and I do not think there is an end to it.

- Who manages HR at your company?

My partner Jonas manages R&D and in part production resources, I manage partly production resources and the administration.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Yes, I think it is very critical. And yes, we always time to time to get some reminders from our employees, that we have to make attention to their proposals and we should take care that these proposals would be implemented.

- Do you think those proposals are directly related to their motivation to work?

Yes, it depends on the people, but it is very related if you take some time to implement their proposals. In most cases, these proposals are very correct and really helpful, the only thing is that you can not implement 100 proposals at once. So you have to pick some priorities and some people get demotivated that their proposal is not considered for half a year or a year. So this is the biggest issue we have in this case.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Yes, that would be me, always kicking everyone's ass to put something into our ERP system, project management tool that we have also experiment planning. Each experiment should be described carefully and comprehensively and it should appear on the ERP system.

- Do you think it is a CSF?

Yes, it is a CSF for not repeating the error for the best.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?  
*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

I would say this is less relevant, not so important. Much more depends on the internal system of the company, how people are handled. And what happens internally and only then what happens in the city, in the state.

- Would you say that your startup would have the same success if it would have been started in Klaipeda?

The only thing is only human resource availability in Klaipeda, but if compared to other similar size cities, like Helsinki, for example, I would say that we would be doing just fine in Helsinki.

### Start-up no. 7

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

Previous role CEO, previous and current role – investor and business angel.

2. How long is the start-up already operating legally?

Three and a half years.

3. How many employees work at the start-up?

At the moment 10 employees.

4. Does your start-up generate revenue?

Yes.

5. Does your start-up currently experience any financial difficulties?

No.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

Ability to find appropriate competence in the market, especially in biotech sector. There is at least 4 universities providing students with necessary background in biotech and chemical engineering, but they are not really ready for the market and they have to acquire additional competences, therefore a company has to invest into the people.

<the recording was interrupted, the following is extracted from the researchers' notes>

Other mentioned critical factors:

Access to the EU fund which is meant to co-finance R&D activities.

<the recording continued>

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

Yes, the same are important.

- There are no difference at all?

No difference, the other success factor is for a successful startup company is to have access to equity, so the business angels together with private equity funds could work together. The availability of these resources is another CSF for a startup.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

To the major extent, yes.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Absolutely, the uncertainty comes from many areas for a startup. The protection of the technology, the possibility to adapt the technology for the consumer (of the products), R&D uncertainty comes from uncertainty what kind of technology you will have at the end of the day. And investing into R&D does not mean that you will have a viable technology, so you may need to invest more to develop it or if you are successful you can develop the technology on the first phase of R&D. But the most cases you need to have extra financing to adopt technology and to commercialize it. So the other uncertainty is IP risks, rising from it. Because the technology you develop and you invest in may not have a patentability and it will not be protected and your products will not be protected, so this is quite important. Other uncertainty comes from the market, while you have not tested you technology, the products you have created with the technology, you are not sure if the market accepts the products, so you are risking to some degree that you will need to invest more into a product, in order to fit market needs.

- Do you take any actions to manage this unforeseeable uncertainty?

Well, we do take measures, because we use a stage-gate approach. It means that we do a thorough analysis not only on IP, but also on the market, on marketing, on regulation, on brand development and all the areas to reduce these risks, but still some possibility of failure of the product still exist, so we have to minimize it and we are always aware about the possibility that the product may fail. And we accept it, but of course if the possibility is high like 50 or 30 percent, then we do not pass the product through the gate, but if we are able to reduce the possibility to 5% or 10%, most probably we will pass it.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

It is. The constraint is that startups typically can not get any loans to finance the working capital, so not only the technology, not only the heart investments that are financed through the equity, but also the capital must be financed through the equity and this is constraining. It means that the cost of equity is very high, much higher than the debt, in these cases if the owners of the business have limited financial resources, they have to give away a substantial part of the share holding in order to obtain the financing for the working capital. And this is not attractive from the owners point of view.

- So just to be clear, you would say it is a CSF?

It's probably not critical, because you can still obtain financing through the equity, but I think it is important.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

Yes, because startups typically have limited financial resources, you have to decide or prioritize where you put your resources. In (company name) we had an option where to put the money, either to R&D or to marketing. So we couldn't do both, because of the limited financial resources and if you split them we would probably have not anything. So we decided to put it in the R&D, so the marketing suffered and that possibly reduced the revenues, on another hand decision was done in a way that R&D and technologically advanced products would differentiate us from the market and in the long run the product would become more attractive to the consumers. So it was a philosophy of a long term investment, but because of the limited financial resources, other areas like marketing suffered.

- So would you say it is a CSF?

Yes, it is.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes, it is probably to have a good team in place. The managing of a team in the startup phase is something different, because it is typically not big – up to 10 people or 20. So we do not need a big HR department to manage. So I would not say it is a critical factor managing HR, but the critical factor is to have a proper team. So I wouldn't say it is a critical factor.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

If management team is also the owners and it is typically so in the startup, so they do have an impact on motivation. Yes, I think so, especially if you have an outside investor like private equity fund or business angel investors. So business owners who also are the managers of the company, want to motivate people for the result by having stock options and this is important and it is a critical factors. Otherwise, you would need to pay high salaries for good people and for startups, so it's always a challenge not to make an overhead costs too high, so I think this kind of motivation through the stock options is very important and it is a critical success factor.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

To some degree yes, although it is not kind of a white or big system, because it is a small team, so everyone knows each other and what to expect from one another. We shouldn't probably implement big systems of KM, but again in some activities, like when we use the stage gate approach, it is naturally imbedded system of KM, because you involve knowledge from all team members to achieve the result, so to some degree yes, but I wouldn't say it is a critical success factor, because in small teams people know each other very well and communication is always very efficient.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?  
*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

It is absolutely important, especially in technology like in our area, like biotech, so the regulatory issues are very important, I could tell an example. We always wanted to put on the product an eco-label, because they are made of ecological, natural ingredients, but we couldn't do so because there is some exception in eco-regulation both on EU and national regulation, which states that you can not be treated as eco-product if you have a micro-organism in the product. So this was quite some limiting factor for our marketing activities, as we wanted to stress this for the consumer, but we couldn't because of this crazy regulation. I think it is important, but again it is not maybe vital, but it is important.

16. Using a scale from zero which is not important at all to 5 which is very important, please rate the following critical success factors and its related aspects for your start-up.

### Start-up no. 8

The 5 screening questions:

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?  
 Yes, I am one of the, let's say, partner of the company and the company is mainly working on the (company description). My role in this start up, it was, as a business development and now I am just one of the partner of this company.
2. How long is the start-up already operating legally?  
 Company is working seven years already. We are not very young startup.
3. How many employees work at the start-up?  
 Ok, good question. As I know, now it is working around 16 persons, most of them are working full time and there are, I think, two or three PhD students.
4. Does your start-up generate revenue?  
 Yes, of course, because on the startup now there is three different areas of interest and one of them is, let's say, the service, service for research and development of such kind of drugs, let's say, and making the regulatory part of the drug case, if you are trying to introduce a new drug to the new market, you need a case for regulatory point of view and (company name) has a department which is mainly working on that.
5. Does your start-up currently experience any financial difficulties?  
 Yes, of course, as always. We have few loans and the main problem is, not the problem, but let's say the main financial difficulties became when we start a project, let's say a national project, and because it's very hard to predict the flow of financials in a company. And of course with the project we start very serious researches. We start the toxicology studies in Italy and it was quite expensive research.

10 questions that will be used to research CSFs:

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?  
 Ok, important critical success factors. It could be a factor that when the ideas or let's say patents even. We have now 8 patents and I think the most of our success factors that we have our intellectual properties, because we start now, we have the contract with biggest Lithuanian company and we are working together and they are licensing our one patent from us. And other our activities are based on IP. I think, it was very important for us and our startup.  
 I know what you are talking about, but it is a very big problem and it is not a success.
7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.  
 Good question. Some critical success factors as I have mentioned before CSF, IP it is important in an early stage of the startup, but in the later stages, I think, there are other factors. For example, even colleagues or team is very important in early stages and I think in some cases as in our case, even the board is quite important factor for early stage. But not it became not as important, because the company is growing and most of the people there are working are much more important than the board.  
 - So would you say that CSFs are different in early stage and later stages of the startup?  
 Yes, exactly.



8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

I think that each company is unique and even the startups are the companies, yes? I can't say that the same factors could be applied for each company. Of course, it is very important to understand each startups, what critical factors are important, and it is impossible to find it or implement our CSFs to another companies. It is impossible, because companies are dedicated to find their ways or to find and collect team, board team to find the right factors for their growing. So it is absolutely impossible to apply the same ones.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Good question. I can't say that, yes. No, I don't.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

Yes, I will say that financial part for each startup is very critical. And from my point of view now in Lithuania there are no good, let's say, good climate to get or to find the right financial partners.

- So with what type of financial constraints your startup face with?

Mainly, ok, most of our financials came from ourselves, one part from bank loans and that's all.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

For R&D we are mainly trying to find projects, local projects, even international projects and it is one of the possibilities to reduce the costs of R&Ds. Of course, most of our IPs was as a result working with a institute of biotechnology. So it is another possibilities to reduce the costs of R&D.

- Would you say it is a CSF?

Yes, of course, absolutely.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes, HR is always a problem, I think everywhere it is the same, but in our case let's say the climate for the HR as it was in our startup, it was not a big problem. I don't know why, but maybe let's say to collect a great team is not a big problem. Of course, the main problem is the manager.

- Would you say it is a CSF?

Yes, it is a critical factor, too.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

You are talking about which question?

- Question number 13.

I don't understand the question.

- In other words, would you say that the team is motivated by the projects and work they do or the management holds the instruments to motivate the team?

I think that the most motivation for them is the salary.

- So it is the instrument of the management.

Yes, exactly, not much more. Okay, maybe sometimes as I mentioned in our company are working few phd students, so it is not only working half of the working our for the projects and another part working for the phD, so I can not say that the salary is the main rule for their work. But in most cases I would say that salary is the most important.

- Would you say it is a CSF or not?

I can't say that it is absolutely critical factors. It is a factor, but it is not critical. Let's say from my point of view, most employees are young people and let's say most of them, they like to make some science. It's important, but not very critical.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.

*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

I can't say that, you know, KM is very, hard to say. Generally, yes. You know, there is no such let's say, we don't say that it is KM. We are collecting and trying to find new ideas, but it is not that we would say "now we are talking about KM".

- But in a way, you would say that you are managing KM?

Yes.

- Would you say it is a CSF?

Yes. It is quite critical.

15. Does the infrastructure (or the environment) has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?

*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

Yes, it is quite important. And it is sometimes, as it was in our company, it is a critical factor. Because we rise as a startup from the biotechnology institute. Environment was very important. And as I mentioned before talking about IPs, most of our IP was working together with the institute, so it is critical and very important factor.

### Start-up no. 9

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

I am an investor and CEO and a partner.

- Could you please briefly tell what your startup does?

We are (company description) which already introduced companies in the US and UK. We are launching our products in the US on 8<sup>th</sup> of January.

- And what are the products itself?

Nutrient supplements and creams.

2. How long is the start-up already operating legally?

From 1<sup>st</sup> of October, 2014. So for a year and a month.

3. How many employees work at the start-up?

At the moment 4 permanent. Each year we attracted more than 80 employees for the outsource.

4. Does your start-up generate revenue?

Yes, already.

5. Does your start-up currently experience any financial difficulties?

Not yet.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

I will elaborate more on the table at the end.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

Yes, I would say due to this issue that I am already in this business from 1989.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

Yes, I already have experience in (company name) (another startup), 3 years the member of the board. We met the same challenged as we are meeting in (company name) to some extent. With some differences of course which I will elaborate more later.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?  
*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

I have no right answer to this question. This question is from a lot of ingredients. Let me propose to walk through another questions and talk about this alter on.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

Frankly speaking, no. But I would say yes to some extent. Maybe, maybe basing my experience from the previous one. Now we are trying to cover the equity investments, we have in the environment problems or maybe challenged to attract financing, to attract equity funds due to this issue. Not enough funds are available in Lithuania. Yes, it is a CSF.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

Yes, at the moment we are using our internal resources and we are waiting messages from the government about announcement of financing or funding from EU funds.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes and no. Due to this issue that here internally from permanent staff we are not meeting any problems. But with outsourcing in the environment it is already a different culture and different approaches to the business and from this outsource sometimes it creates some problems.

- In the human resources field?

Yes.

- Could you please state those problems?

Again, recruitment of short term employees. We are meeting problems with the regulation.

- Here, in Lithuania?

Yes.

- So would you say that it is a critical success factor to manage start-ups' human resources?

Yes.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Yes. Always we are meeting challenges if human resources are not motivated. We are always trying to apply models which are acceptable for human resources individually.

- Would you say it is a CSF?

Yes.

14. Do you or anyone at your start-up manage “knowledge management”? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Yes. Due to this issue that I am licensed human for knowledge management routine.

- So is it a critical success factor?

Yes.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it?  
Would you say that infrastructure as an external factor is one of the critical success factors?  
*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

Yes, we are meeting now problems with regulation. Our activities are strictly regulated and we should apply a lot of time to cover requirements of the regulators.

- So would you say it is a critical success factor?

Yes.

### Start-up no. 10

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

My name is (name) and I am currently running a startup called (company name), the idea is about life sciences and it is designed to control (product description). And I am working on making it the best product ever.

2. How long is the start-up already operating legally?

As a company? It is a tricky question, because we are using currently our existing company's status for all the legal issues. We have an outsourcing company which we are using for any kind of legalities to do. All the IP is there, all the legal stuff is there. But it pre-exists the startup.

- So when did you legally start using that company for your start-up?

About 7-8 months ago. Basically we started using it when we have to cover some of the travel costs, rents, basically to conduct design. It started when we had to order something from the designers and we needed a legal entity to buy some services. The company is basically owned by me.

3. How many employees work at the start-up?

Currently we have 4-5 members, who work on it all the time, also there are 7 people who contributes irregularly.

- So you would say that you have around 10 people who works on the startup and its related matters?

Yes.

4. Does your start-up generate revenue?

Currently, no.

- Has it ever? Did you have any previous sales?

We can't legally, we still have not yet created a device which can legally be sold as a thing that do development. We can only as being classified in this specific category where we have this diagnostic medical device, we can only give it out for free or let people test it out during conventions. So we can do, create revenue from adding applications, but we can not use our own product yet as it has not undergo all the legal aspects to be able to appear on the shelves for customers.

- Did you give any giveaways on those conferences or exhibitions?

Last one we didn't. Basically, what we did we met people first and then communicated with them later on and decided who are these best people to give away for them to test it. Who basically needs it the most.

5. Does your start-up currently experience any financial difficulties?

Yes, as any startup. To make a short summary about that, the EU financing supposed to happen two or three months ago and it was supposed to be quite significant, so we were relying on that to work for certain amount on the product in order to present the investors what we have created pre-seed. And now we are in this position, that we are still able to get the money, but it will be later, so we are in this position that we can't get the seed round without that money, so it is a mess. So I have a plan how to fix it, but in short, yes, we have a problem.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

Medical recognition, so we are not targeting to be first in the medical devices, but we have realized through testing, communicating with doctors and all that, realized that selling to the patients it's much easier as in explaining what it is, why you need it in the sense of that you have easier access to them, it's easier to access the market through patients. But it is harder to access doctors, because of the restrictions and you have to have, expect from the device that it is going to be very well scientifically proven and have a strong medical claim. We have proven information of research that this methodology is working, but we do not have particular methodology for that. Since we are looking to doctors as one of our critical people to sell it, so that would be one of our critical things.

Another one is probably... Strangely enough, we are recently communicating with people who are in the sector basically, who have created a lead sensor that monitors breathing and other matters as well as other hardware companies. And common denominator of these companies is design that we found it strange at first. Because usually in the beginning you just talk about the technical things. But that is the thing that will be with the person, thing that will be interacting with the person all of the time. So first of all purchases basing their decision on the design and one of our critical competitive advantages is from existing medical companies that they do not include design in their products. They usually overlook it for value of functions. And actually a good product design is creating the uniqueness in the look and feel and it could be very important and valued for a lot of things. And what I was able to gather from people who are working in the sector and it is true especially in the hardware section as it is very personal. And also, one of the things that we have discovered, particularly in our case, that we have a clunky mechanical device that looks really ugly and we had a lot of social problems and felt uncomfortable. So creating this design was very critical for us.

Another thing is also legal aspects. I learned from medical stand point and CE certifications and a lot from those things about the legal part. And I was consulting with people who are very good in that sector and actually could carry this device through this entire (legal) process. The process itself is very finicky and it almost feel archaic. So going through this process is quite tricky and basically without it you will end up wasting your resources or in jail for complying to the legal things. So these are quite two extreme problems.

So those are three critical factors that are worth mentioning and probably I could find more, but these are the ones that are most important for us.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

I think a lot of them transcend the stages. Just I think that in early stage of startup what is most needed is the clear understanding. For example, all of the things that I have mentioned: legal, design and medical recognition need to appear at the very beginning, at the first stage. You don't need to pursue those things, but you have to understand how these things work. So for example taking it from the design point of view you have to understand what kind of design is needed. At early stage you have to specify that clear understanding of what you need and how to proceed is the best thing. I've been learning from lean startups and ideologies how to build startups, but it came to me when I have researched it myself and started seeing that some of the processes are not working. And it becomes very painful when you waste time, waste resources, so it's a problem. Basically, having this basic education or basic understanding and grasping how startups work in general is the most critical thing for any startup, not even in life sciences. Especially in life sciences as it has many nuances. I remember discussing this problem with somebody else and in academic field in Germany they have a clear process how you treat your projects: you create your project, you apply for the patent and there is a clear path how to do this. For startups it does not apply for pretty much any type of ecosystem, but there are milestones that are clear that you have to work on and how to get there.

So in short, CSFs are different in early stage and later stages of the startup?

Yes, they are different. In later stage you have to acquire those competences in certain fields and in early stage you have to acquire that understanding what competences you will need and how you will achieve them. So what will you need and how will you get there is the early stage and then getting there is the later stage.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

Critical factors are pretty broad determination as such as it is. But I think that to some extent, most of them do, but they some factors to other startups are not critical. For example, if you are making a non invasive, non electronic, non diagnostic some kind of device (noble app that connects you to other doctors), there is an interesting trend that is growing in this field (people are connected to psychiatrists, “uber for doctors”). So the idea is that those guys are not so restricted by the legality of those things or the design of things. Those are important for them, but for them communication is critical thing. And it is very important for me, but it is not as critical, because technical challenges and legal challenged precede that. So most of them apply to certain degree, some of them maybe are not critical, but I think due to heavily science based or that are trying to disrupt the market by entering the medical devices field or more connected to the person, if you want to create a significant value in this field, so you will be faced with the same factors. In early or later stage you will probably face with the same challenges. You have to know what things you can and you can not do.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Yes, at first, when I was trying to manage this startup at the beginning, I was trying to manage these unforeseeable risks and I felt them very much and I was paying attention that a lot. But at certain point I have realized that as a startup you do not have enough resources to research most of these paths, second of all prepare an actually effective risk management plant to make it work all of those factors. So instead of creating those plans for possible risks or preparing internal risks, external risks tables and all that, but prepare instead guidelines or rules that will prevent you to do certain mistakes that will end up creating you those risks. So for example, if you don't know if some certain information is protected by some certain certifications, you have to assume by default that it is. Because you don't know and researching that will take you a lot of time and actually spend a lot of time with lawyers to find out all these details. But I am not a lawyer, it is not my job, I should not be doing this. My job is to make a product, to make it the best for a client and create the best experience. And preparing such rules will prevent me as a startup wasting time. That's my take on these unforeseeable risks. By definition, they are unforeseeable, so when they will happen, I will deal with them.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

I can't tell you that now, because I am working on the startup. So this question should be better addressed to those who have created a startup and they would have the retrospect whether it worked or not. But yes, we are facing it all the time. With any startup in Lithuania, the problem is that in other countries they have this kind of “bar” that you spend on your living costs. I mean those, who are creating a startup, they work before for a company for couple of years and saves up some money and they have the ability to work on their startup for certain amount of time, they give themselves like 6 or 12 months for a lead and they can survive on what they have saved. The problem in Lithuania is that it is very difficult to save money. So when you create a startup you have to work on projects which gives you financing and build the startup, so it results in under-performing both tasks, because you are trying to do two things that are very important at the same time. And maybe you are still developing software or platforms, but at the same time you have to be focusing on some specific metrics of the commercial project. So this is where the finances come in. Another thing, I think there is a lack of well structured incubators in Lithuania. They give you some lead time to work at the incubator. I currently work at the incubator which has the capability to give you that. The idea it has the resources, next to the incubator there are dorms and you could basically take a team, fit it in the dorm, give an office and say here you go guys, this is the time you have these resources (you can live here)

and now you can work on it full time. And in early stage they don't need money, they just need to figure out a lot of things. Consultation is good, but sometime you just need to have some time. That's where the financial problems come in. Another thing is that we are working on a hardware product, which is capital intensive, each alteration on the product costs you a lot of time. And with hardware every time you buy something to test it whether it fits with your software, methodology etc. it costs not only time and money if it doesn't and you have to look for another parts. And it is very hard for a startup to compensate that.

- From your startups experience would you say that financial constraints are CSF or it's not at the moment?

I think, it counts as one. There are always alternatives how you can do this. I value critical success factor as if it is critical, you can not do anything without it. So having these financial constraints, you can still do this, but it is much harder. And it requires much, much more time so it gives you fatigue and you feel like worn out and that might affect the quality of the startups activities. Also, you might be late to enter the market if there are some startup which are not experiencing these financial constraints.

So I don't think it is completely critical.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

Basically, what we do is we work on different projects, for example we have worked on a project with a Bluetooth company and we have some informational resources and we do not need to spend money on that or we have a connection to company which can give us some lead time for production. We find things that we can get cheap or we have an access to some companies that we can use it. And the costs, for no we are just figuring out how to manage it. You can use tools or now we have this open access policy, where you can go to university and say what we need and how could they help. And they would do that, but again it will cost you. So you will not need to buy the actual equipment or machines, but you will need to spend some money and time developing the relationship. Or we agree with universities to do pro-bono for one another. That would benefit both of us, and these are the things that reduce our costs. But managing them? Let's just say we use the trial-and-error method. There are things that you have to fix and there are no ways around, so you just spend your own money. Is it your company's money, is it your money, is it additional resources you got from grants, you just pull that from there.

- So would you say it is a CSF?

Oh, yes. If you don't manage it, you will run out of money and you will not be able to advance your project. If you discover some kind of problem that needs to be addressed from the legal stand point, you will not be able to change it, because you will not have the R&D and costs to do it. So yes, it is a CSF.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes, I think it is. Actually, I am pretty certain it is. First of all, the idea is that HR at early stage you need people who are not really skilled in one particular thing, but are skilled more or less in many things, be universal and help in a lot of things. But later you need to switch in some certain areas for experts, or people who have worked in that area. Who are recognized to perform on professional level. I have high standard for professionalism. As for managing that is really important to understand what people can do what. Because at certain point I had my medical person sitting on marketing and it did not turn out very good. She did her function, but she did not get the right information. And in order to educate her would take a lot of time, so basically we are trying to find now a marketing person or at least someone who would be able to work in that sphere. Another thing in HR management is when you come to VCs or accelerators another question is that is not vocally asked, but is up there in the air: "ok, when we will give you the money and you will need to hire some people, will you know who to hire?". So now in our slides we implemented a slide which lists people who works or advise us on this project, they are that "unofficial hire list" that would be working for us legally if we would raise the money. The HR management is very important and you can't overlook it, because it will cause you problems and let you to step into traps. And from my experience, when a person comes from a specific industry, they are very good on working one specific thing, so getting from an early stage to a later stage startup, it is very difficult to find these people and another thing is recognizing those people in the field where you may not be the expert in that field. As difficult as it is, it is a critical thing.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Basically, the style in which you approach management or anything will impact your business very much. The concept of lean management is that you have to have clear management goals and those are the success factors. There are many vanity factors that you measure. You have to be aware of the metrics in order to know how to manage them.

- So getting back on the topic, you would agree that management as an impact of the overall motivation of startup's human resources?

Yes, definitely. Because management styles as in such some of them are motivational, some of them are based on intimidation styles, you know putting it in very general terms. But the idea is that motivation comes from how much do you feel you have advanced on something and how much are you recognized by other people. Some people want to get ahead of the goal and that what motivates me, because I am running it. But for example my engineers are motivated by technical challenges, so if you are pushing them towards the goal without giving them a technical challenge, they will not be motivated and the product will suffer because of that.

- Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factor?

Yes, it is.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Well, I think it fall into whatever the management of the startup does. First of all we have a problem with that. Second of all, yes we are doing that, but this is basically not how the management communicates with the people, but how you communicate with each other. So it comes into a part of teams management. I think of KM not as the management of the information itself, but how you communicate with the team members so everybody stays on the same page. So, that comes into the basic management of human resources. Ok, if somebody prefers communicating on skype, sms or emails, you as a manager you will be in trouble, because you are the single communicating point and if anything, single point of failure. So you have to create a system where everybody can see the same information and have a clear understanding for whom it is meant to. There are some information that is more meant for others, so some info is seen by the persons that are required to see and others don't. But general direction everyone should see of who is doing what in order to have an understanding where everybody is moving. KM goes to the tools and what tools you are using to carry them team. So yes, at certain point it works. KM is crucial, but it is crucial to any kind of company, any kind of process and team.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?  
*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

Yes, definitely. Infrastructure is a major problem. For startups in general I think this kind of legal system is screwed up. Before we had companies statuses like MBs and UABs, which were another form of company that you should use if you are making revenue. But now the problem is that you can't just use another company to develop your startup because you do not have shares of it and investor will not be interested. If you want to work in Lithuania as a company, you should start a legal entity. Lithuania sometimes is very strange, especially in company naming. Every product that is released in Lithuania has to have a Lithuanian instruction by law. So if you are not releasing this product globally not in Lithuania? So you have to have all these instructions in Lithuanian. Legal system is a problem. Community as such is lacking communication. You have to follow trails of others, but there is no one clear path that you could follow and consult with multiple people. There are people who work on that, but it is very hard to access them. The problem is also that at early stage of the startup, you don't know what you ask and if you do not have a specific questions, you should not be contacting people who are smarter than you. You will be wasting their time and you will not be getting any valuable information. Having them just explaining in broad terms what it is what is happening would be very helpful.



The problem with universities is that it takes much more time to do for them than for ourselves. Like technology transfer – university might do it for tens of years, while you can do it yourself in 10 months. But the idea if you want to bring it to the market, you have to do it yourself. So we can talk about it for hours.

### Start-up no. 11

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

So the startup is established in 2014 and it is a spin off of Vilnius University, of institute of Biotechnology. And I am like the chief scientists of the startup. Main scientists and there are only two shareholders, me and an American businessman. He is responsible for business development and I am responsible for scientific issues related. And we are in the drug discovery field. Startup provides services and some molecules for bigger, larger drug discovery companies

- Are those big molecules or small molecules?

Small molecules, but we make big human molecules as well.

2. How long is the start-up already operating legally?

Since summer, 2014.

3. How many employees work at the start-up?

Employed full time zero. Because we do not have funds, it's only a startup. And we are only performing research, so essentially it is in the application stage.

- How many people work at the startup overall? Without legally employed? You are your American partner?

Yes, two people. But realistically, since it is a startup, many people are involved at the laboratory in Vilnius University.

- How many people contributes like this?

30. Twenty five who are doing help that helps the startup.

4. Does your start-up generate revenue?

Yes, we do. But it's very little.

5. Does your start-up currently experience any financial difficulties?

I should say, essentially we do not have any funds, so we are at zero situation. So either we are experiencing major difficulties or no difficulties at all.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

So, I would not say we are successful so far, I don't know that yet. So I don't know what success could be called.

- Why has your startup has been successful until now, why is it still operating?

It's our enthusiasm essentially, that it keeps it alive. And maybe our belief that we could get some fund for the startups' activities. But the beginning is very difficult, because we do not have anything to sell, we do not have drugs. If we would have discovered a drug, we would be billionaires by now. We would not be a startup anymore.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

I would say yes, and it depends on the stage, but yes, it's the same.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

I would think of course, that it would be very important that the startup owners are enthusiastic, but I think what was meant here, little bit more than enthusiasm. For example, state support. If we get some grants from MITA, we could be much better off, but so far we did not obtain any grant. We have only one opportunity to apply, so that could be a big success factor for the startup situation.

- So do you think all CSF apply for all startups operating within the same field?

I would think so, yes. More or less.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Yeah, but we have not yet faced with all these things. But we are in complete uncertain situation now.

- So do you take any actions to manage it?

No. Maybe I do not understand the question.

- If you have so many mentioned uncertainties are you trying to identify them and then think what would happen if that uncertainty would come true.

Oh, yes, for example we had one source of funding and then that source of funding kinda seized. And it was unforeseeable, we kind of got some money and then we got a response that "BOOM, we are not going to buy anymore your services". And I was thinking, it was like a success, seemed it is going to be a good path for us in the beginning but then it just stopped. So these things it was uncertain if it is going to work one day. It's ok, but we have other sources, other ways to go.

- So you are not really planning your future?

No, no, we have a plan for drug development, we know what we will do next month or march next year, so until May we have an exact plan how we are proceeding.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

Yes, but of course it is one of the CSF. Our constraints are so large, that we are not even managing it. Two of us are discussing the most important things that we will use our money for. It's essentially our own money that we put in.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

Our uncertainty, imagine, we are Vilnius University and we were funded 1 million litas a year and then we decided to create a startup. So people put their effort into the startup, but it is completely uncertain. R&D plan is going within the university, and we will be using the startup only when we will see that it is more attractive to work as a company, but not a university.

- So if I understand correctly, services that you want to provide and small molecules are being developed by Vilnius University.

Exactly.

- So it's university's money?

Correct, that's how it all gets started. And there is a big conflict of interest, public money is being used for private profit, but there is no way around it. It's the policy of state to support the startups, that those startups one day would support the state.

- What happens when the big breakthrough will come? Who will hold the IP rights?

Now Vilnius University, but when it will license the IP rights, then all the money will go to the company. The goal is that the company would make the money.

- So is managing R&D activities and its costs a CSF?

Yes. R&D managing is that's what I do, but I do it at university.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

- Having in mind all these 30 people who contributes to the startup activities?

Yes, absolutely, managing HR. Actually, people and my students are my biggest achievement, those who I taught how to do this research.

- What type of challenges do you face with while managing those 30 people?

Oh, personalities. Everybody is different, you have to have both feeling and be whole-hearted toward everybody. Use their strengths and make sure that they do not compete too much with each other and don't conflict with each other.

- Do you think it is hard to find good people to join your team?

Yes and no. There are nice students, but to find a really good one and to grow that person is very difficult and takes many years. Because the new ones don't know anything. But after 00 years, since I have returned, in those 10 years I have grown quite nice people that now have a pretty strong team.

- Do you think it is the problem of the state, of the universities? Or is it the problem of the students themselves that they come not knowing anything?

Both, I wouldn't say they know nothing, they know chemistry, they know biology, they know the basic things, but then they learn more things about it in the labs, that they wouldn't normally. How to write scientific manuscripts, how to prepare a presentation at a conference, these things are poorly taught at university or not entirely. I teach myself those things at uni.

- Is that being taught at let's say Scandinavian universities?

Oh, yes. And both in Scandinavian and here too, I have copied the model from the university of Minnesota, it's pretty much the same.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Oh, yes, it is one of the most critical ones. Probably personnel is the most important. If you have the people, then you can find the money later.

- But do you think the owner is able to motivate people? Or there is something else that they are motivated by?

Yes, the management has an impact. It's my opinion.

14. Do you or anyone at your start-up manage "knowledge management"? If yes, please explain.  
*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

It is very important and I think we do it quite well, because we share the knowledge. We have weekly and monthly meetings when everybody has to do progress report to everybody, who is involved.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it? Would you say that infrastructure as an external factor is one of the critical success factors?  
*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

I think it also very important. Being at Vilnius University, renting the place for the company, even though it is very small.

- Is it critical?

Yes. What would be critical and what would be not, if we would have to rent a room at incubator we would not be successful. We need all those university's rooms and the equipment, so you are right.

- Do you think regulatory affairs are important?

Those are not critical, as soon as they do not get in a way.

### Start-up no. 12

1. Could you please briefly introduce yourself, how are you affiliated to the start-up, what is your current role and briefly introduce the activity of the start-up?

So my name is (cname) and I am the CEO of a (company name) corporation, based in Boston and it has a full subsidiary in Kaunas, Lithuania. And I am a CEO responsible for all aspects of (company name) corporation including financing, fund raising which is very important, managing commercialization activities, pre-commercialization activities, clinical registration, clinical installation and we are looking at manufacturing and product development.

- Could you please briefly introduce the startup and the activity of the startup?

(company description)

2. How long is the start-up already operating legally?

So when I become a CEO, one of the requirements was a to flip or to register Lithuanian company in the US and it was done two years ago. In Lithuania, as a research spinoff it has existed for already ten years.

3. How many employees work at the start-up?

Currently we have 3 employees in Boston and around ten in Lithuania. And we rely heavily on consultants in particular areas, like clinical registration, FDA, market installation, reimbursement and consultants are a very important part of (company name) resources.

4. Does your start-up generate revenue?

Currently, we generate revenue from leasing to NASA and small side companies. But it is not sales revenue, it's lease for research.

5. Does your start-up currently experience any financial difficulties?

Well, the cash is the bloodflow you know. And if you do not have cash, you are dead. My role as a CEO is the conceptual raising money, which I have recently closed a 10 million investment in round A. We closed everything in 6 months, before the seed for two years we were raising money for earlier rounds. It is not a difficulty, it is a focus, it is very important to be focused for CEO and to raise money.

6. What are the most important critical success factors for your start-up in your opinion? Why the mentioned factors are critical in your opinion?

Well, if you measure your success by raising money, as raising money is very important, the critical success factors are basically team you have or you are able to assemble, to have a world class research, to have world class clinic and world class CEO which was credibility to attract funding. Second critical factor is you technology, you need to have pilot data to show that your technology, your device is working. And you have a credible team of engineers who will develop this from technology into product, you know, majority of the companies will die at that death valley. And the third critical factor is the course you have chosen basically. You need to look at the market, what are the competing products, let's say in neuro diagnostics, how hot is the market, how important is the market. And what will be the reimbursement from hospitals in the US and Europe. Lithuania is not a market at all, we do not consider Lithuania as a market, we focus on export markets. And what are the critical opinion leaders are thinking, how important is their clinical practice. Whether they will adopt that for therapeutic and decision making. So to raise money, to give you a good image. You bet as investor on a jockey, you have a jockey, you have a horse and you have the environment or course. So you bet not on a jockey which is the CEO, you bet on the horse, so the horse needs to be already tested, otherwise you will not know what you are betting on. You also bet that his horse is suitable for this CEO, and the course which has to be navigated to (let's say it is FDA approvals). So the jockey, horse and a course.

7. Are the same critical success factors are important both in early stage and later stages of the start-up? If no, please explain.

No, they shift obviously, but you need to have a pathway. On early stages your pathway is to have empirical data to support your claims in life sciences, your technology, how crude it is, your pre-clinical studies and clinical data if you could have that. And you move toward your product, what would be your approval, how investors will make money. And the way they make money is by selling the company to big, as we call, strategic partners, like GE healthcare, siemens, but they need to understand before investing money, how it will fit in 5, 6 years down the run to the business that they have now. Critical success factors changes, but to be blunt they are measured by data and money attracted. Data and money attraction. And really people who have foreign credibility that they have already done that, professors from MIT are nice, from Stockholm. But KTU? Nobody has heard about KTU, unless the CEO tells them that it is a great technology. It is a crude. Venture capital and private angels invest to names.

8. In your opinion, do same critical factors apply for all start-ups operating within the same field as your start-up? If no, please explain.

No, they are very different. Talking about medical devices and life sciences, even in biotech it is very different CSFs.

- But in medical devices itself?

I think there is a pattern. You have a clear pattern which you have to follow. But there is a variation. I think yes, there is a pattern, but it is different for IT. IT is not about revenue, it's not even about the key opinion leaders, it's how quickly you can get eyeballs, now it is penetration. It is very different, they do not have to worry about FDA or any approval. As you have heard from 1-2-3 diagnostics, google's wife was not able to approve very quickly their diagnostic to us, no matter how much millions and millions they put into that. And biotech it will be the strength of your compound, patent protection which is extremely important. There is nothing to invest if they have not patented it. No matter how strong is the team, how strong is the technology. Because there will be nothing to sell.

9. Did you or you still do take into consideration unforeseeable uncertainty as a factor which has influence on your start-up? If so, what steps are taken to manage it?

*UU could be described as an inability to foresee all variables that might affect the startup, its management and performance in the future. Preparing a risk management plan is a good example of managing unforeseeable uncertainty.*

Well, a startup is a journey, really. And it is quite intense, because you are undergoing rapidly of all corporate development cycle and you are undergoing not necessary with the team you have chosen. There is a lot of turn arounds in the startup and unfortunately it is true. You need to have people are at the right place at the right moment. For example, a study made by Harvard business school which looked at the success of startups led by founders vs CEO brought from outside (and it could be a mix) and they found that startup which brought a CEO (and founders allowed to bring a CEO) performed much better. And this is the natural conflict, because the founders always think that they know everything better, but it is not true, maybe only on the technology, but not on finances, marketing etc. So that changes. Cash as a CEO you need constantly raising and be ready that in 6 months your plan and development might be very different. A good example could be the Lithuanian Ministry of Economy, the structural funds. I have talked with you minister about a possibility to invest 18 months ago and they still talking about it. And they promised that they will definitely have the structural funds before Christmas and it became the famous "Christmas", because he did not specify which Christmas. It's a miracle, right?

- So would you say in general that you are trying to manage unforeseeable uncertainty or you would say that you are just going with the flow more or less with your startup?

Well, we are not trying to go with the flow. But it is very hard and you need to make very tough decisions, look at the budgets, people and have all that contingency. And money! You have to have that blood flow, even if you have a little blood flow, you are alive, you could revive. If you don't have blood flow, actually our device measures blood flow, you die. It is very important how much cash you have.

10. What type of financial constraints did your start-up face with? Would you say that managing financial constraints is one of the critical success factors?

That's correct, as I have said. You always have constraints, it is interesting constraints. You have constraints when you raise money. You have cash constraints. Once you raise, your constraints are tied. That's why you need experienced people, that's why startup try to hire people who are from industry, who already have experience. In startups, at least in Boston area, and we do that as well in Lithuania, we pay top salary in order to get these resources. Because you don't have time for failure or learning, it is not acceptable.

11. How do you manage R&D activities and its costs? Would you say that managing R&D activities and its costs is one of the critical success factors?

Yes, it is, but you know there are really, at big companies who are managing different processes and aspects of it, portfolio management and it is still not easy for them. At a small company, you have a very short term objectives and you manage that by firing light in people and managing budget. R&D of revolutionary invention will always take 2-3 years to might be successful or not. You can not allow to product improvements which are on the fence. You have to go to the market and get feedback from the customers and patients. And R&D is in the lab. Our guys have never seen a patient, an alive patient and creating a monitor for them. And it is very important.

- So, in general would you say it is a critical success factor?

It is. But there are many dimensions for those critical factors. May I encourage you not to think in linear, like one-two-three, but think more like dimensions. And these dimensions become important or less important in life. Think about, since we are in life sciences, like a human body – what is a critical factor? That you fingers are intact? Is it a critical factor or not? Sometimes when you have an accident a critical factor is a brain function. What is really important is a blood flow, if you cut blood flow and nutrients.. You wanna guess what is a blood flow? Money. It is crude. But it is interesting, it is important to have, but it is absolutely not guaranteed that if you have a normal blood circulation, you will be healthy or better. So if you wanna have my quote: “critical success factors for life sciences startups are like vital signs of the body – it's a system”.

12. With what challenges do you face with while managing start-ups' human resources? Would you say that managing human resources is one of the critical success factors?

Yes, people is. If you want to come back talking about that. You don't have time and there are pre-determined conflict situations that founders and management of the startup will have. There will always be conflicts between investors and the management. Because the management will always want to do some improvements. If you fail to measure anything, it is always your fault. And is your device a good device if it is not used? It takes too much time for anything.

13. Do you think management has an impact on overall motivation of startup's human resources? If yes, please explain. Would you say that impact of management team on overall motivation of startup's human resources is one of the critical success factors?

Yes, it does. And it has both. You need to have a vision, to believe in it. You need to help them to focus and work on what you really feel that is important for hospital or patients. You need to give them some freedom, because you don't want to take away their drive. But it is also very important that they would feel appreciated and focused. It is a big, big difference, cultural difference being in R&D especially, between USA and Lithuania. It is the same name, but two different Worlds.

- What are the main differences?

Well, R&D in US, they have timelines, budgets, clear marketing and clinical leading what they need for core product requirements. And they are focused on profit at the end of the day. Look at R&D, from my experience, Lithuanian universities are looking at innovation, looking at solving a technical problem and really basically making sure that you manage your budget on research dollars or grants that you are allocated with. And make it sure that you manage it, you don't have any over-budgets. And you have your research forever, for life. They made one project, maybe they failed, no one really cares, they move to another one. They are still there.

- So if getting back to the impact on overall motivation of startup's human resources by management, would you say it is a critical success factor?

I will be kinda puzzled to you. It is a very important critical success factor and it is not important at all. The question will be why am I saying this? As mentioned, your vital signs depends on the state you are at, if you are at a normal state, it is very important marketing, introduction stage. You want to use your vital signs to support you on that specific startup functions. And sometimes, if you have too much oxygen what happens to your brain? It has hallucinations. It is called R&D overhead. Non critical, brain and a person becomes non critical, it does not realize the reality and has hallucinations. That's a clinical fact, you can tell that.

14. Do you or anyone at your start-up manage “knowledge management”? If yes, please explain.

*Knowledge management is the process of capturing, effectively using and distributing knowledge among team members.*

Usually at startup what you have is very important to make sure that all IP is assigned to the company. When you hire anybody, they have to sign the IP part, non disclosure and non competing agreements. Including founders, CEO, everyone. Second, there is always inventors as they are entitled to more, more salary, more bonuses and they know that. And if you will not give them that they will walk away. So KM is a big mistake not have it. It is a fatal mistake if the company starts without IP, non disclosure agreements. And it is not easy to make the founders to sign those agreements.

15. Does the infrastructure has an impact on your start-up? What are the most important aspects of it?

Would you say that infrastructure as an external factor is one of the critical success factors?

*Conditions, that are independent and company has no influence on it i.e. political background, geographic location.*

Absolutely, I don't think I would be able to attract millions of investments in Lithuania. They tried to attract it for ten years. It is very important the cluster environment to get the support, investors, R&D, institutions, hospitals. You need to be in a cluster. And to be in clusters that are relatively well known, like Boston, New York, San Diego. They have very hard time to raise money in Chicago, for example one company moved their entire company from France, because they did not have any support. And many Israelis do some similar things as they have R&D and manufacturing in Israel, but marketing and fund raising happens in the US. The advice I will have for majority life sciences startups – you repeat the success factors, you find the CEO and management from the cluster, it might be Berlin, it might be London, Cambridge. The names that are important in Europe are Berlin, London, Zurich area, maybe Scandinavian corridor. And in the US you have Boston, San Francisco, New York and San Diego. Try to find a flip flop company as investors are not comfortable to invest into non-US companies. Malaysian investors invest into US companies. Why? Because it will be developed in Boston, built in Boston and sold in Boston. Hopefully.