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KNOWLEDGE MODELING FOR INNOVATIVE COMPANIES: CASE OF BUSINESS INCUBATOR

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The paper presents a study which is aimed at building a knowledge model for a case company – business incubator “Ingria” (St. Petersburg, Russia). The business incubator is one of its kind organization in St. Petersburg, and one of the few in Russia, providing services for innovative entrepreneurial companies at an international level.

Business incubation impact is deeply researched from the point of view of knowledge engineering.

The paper also provides a broad analysis of various knowledge engineering tools used for visualization of knowledge, as well as knowledge modeling techniques.
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Аннотация:
Целью данной работы является построение модели знаний исследуемой компании – бизнес-инкубатора «Ингрия» (Россия, Санкт-Петербург). Данный бизнес-инкубатор является единственной организацией подобного рода в Санкт-Петербурге и одной из немногих в России, предоставляющей поддержку в развитии малым инновационным компаниям на международном уровне.
Влияние бизнес-инкубирования на компанию глубоко изучено в данной работе с точки зрения инженерии знаний.
Работа также предоставляет широкий анализ разнообразных инструментов инженерии знаний, используемых для визуального представления знаний, а также различные методики моделирования знаний.
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Introduction

Background of research

A business incubator, or an organization whose primary mission is to develop economics in the region through development of small and medium enterprises, mainly entrepreneurial startups, is a recently appeared concept in Russia, specifically in St. Petersburg. The internal processes which take place inside business incubators have not received much attention in studies up to the current moment.

High technology entrepreneurial firms join university-based business incubators to enhance their organizational structures and gain access to research and development opportunities (Mian, 1997; Rice, 2002). It is supposed that an entrepreneurial firm which is associated with a business incubator is more likely to be successful, although the research dealing with entrepreneurial success associated with a business incubator has been primarily in the form of case studies (Mian, 1997; Rice, 2002; Sherman, 1999) without theoretical foundation. Nevertheless, the study of high technology entrepreneurial firms’ social interactions with a business incubator to acquire business knowledge has received limited attention (Studdard, 2006).

Figure 1. A Concept Map explaining the relationship between a business incubator and an entrepreneurial firm (in this case high-technology startup)
This diagram represents a visual overview of the structure described above. It shows how two concepts ("Business incubator" and "High-technology startup") interact and exert influence upon each other. From the image we can conclude that the main point of intersection of the both concepts is Knowledge and Success rate. In this work we take a look at knowledge as at one of the three main resources needed by entrepreneurial companies during the stage of early development.

During a firm’s developmental stage one of the main activities of the firm is acquisition of resources, required for the company formation and growth. These resources might be structured into three main categories: financial capital, human capital, and knowledge. They exist mainly outside the firm’s limits, thus, in most cases they are difficult to acquire. Consequently, high technology entrepreneurial firms often seek such resources from various social structure actors during the first stage of business development and formation (Kirchoff, 1994). This implies that knowledge acquisition processes are crucial for acquiring one of the basic resources needed for the firm’s development.

Given that business incubators provide extensive knowledge acquisition opportunities, it is especially useful to analyze the knowledge acquisition processes which appear between entrepreneurial firms and the business incubator managers.

**Research questions and sub questions**

Which knowledge processes exist in entrepreneurial companies?

Before analyzing the acquisition of knowledge from the business incubator, it is important to collect information on which knowledge processes in general exist in entrepreneurial companies. Which of them are of higher priority for the company’s development, and which are the most crucial ones.

Which types of knowledge do entrepreneurial firms acquire from a business incubator?
Depending on company characteristics, such as age, phase of development, management, type of business, number of employees, the knowledge needed from a business incubator might differ. Although it may be assumed which are the major types of knowledge it is important to find out what is exactly of greater importance for the companies’ business performance and prioritize them.

What are the main sources of knowledge in the business incubator?

Particularly there are several parties involved into knowledge sharing and acquisition process:

(1) business incubator management,

(2) other incubatees,

(3) outside experts.

Depending on which types of knowledge are more crucial for entrepreneurial firms, the sources might differ as well.

How does high technology entrepreneurial firms’ social interaction with business incubator management impact the acquisition of business process knowledge?

How is the acquired knowledge managed? How is it codified, stored, accessed?

Which business processes exist in the business incubator and how can they be described from the knowledge viewpoint?

As an answer to this question knowledge-based model of business processes will be constructed.
Literature review

Introduction

There are two large blocks of literature resources which need to be analyzed in the current work. The first one is literature on business incubators, particularly which covers the topic of business incubator management interaction with the entrepreneurial firms. Second block of resources is the one covering the issues of knowledge engineering, especially overviews of existing and available for use approaches of tools. Proper classification of knowledge engineering methods and tools is crucial in this paper for understanding which ones could be applied to the description of the right processes. It is also important for these approaches to be classified properly according to the principles of business and cognition.

Business incubation

Business incubator (BI) is an organization that provides novice small enterprises of premises, communication facilities, office equipment, necessary equipment on preferential conditions. In addition, the business-incubator provides the enterprises a wide spectrum of services, secretarial, accounting, legal, helps obtain financial means on development of business and entering the local market.

As defined in the National commonwealth of business-incubators, business-incubator is an organization, which creates the most favorable conditions for the start of the development of small enterprises by providing a complex of services and resources, including: maintenance of the enterprises of area on preferential terms, means of communication, office equipment, necessary equipment, personnel training, consulting, etc (Hamdani, 2006). Complex of services - secretarial, accounting, legal, educational, consulting - this is one of the most important conditions, because the complexity of the matter for starting development of small enterprises.
Business-incubator in some cases helps obtaining the equipment in leasing, credit for the development of business and the company (the owner) on the local market (Mian, 1996). Thus, the entrepreneur is focused on one task - to produce products (services) and to leave on the market; whereas all other problems are covered by the business-incubator staff (administration, experts, consultants). It helps to represent its interests in the external environment, creates a positive image.

Active development of business-incubators started 20 years ago. For all this time thousands of business-incubators have been emerging all over the world, and their further growth is ongoing: in the 1990s, SMEs provided about 80% of new jobs in Europe and the USA. In Russia, according to the company "RosInvest", small businesses create only about 10% of GDP, and their potential is far from being exhausted: by calculations of the Ministry of economic development of Russia, they should be 3.5-4 million against today's 876000. Meanwhile, there are not so many business-incubators in the country: around 80.

Business-incubator estimates of how real it is to realize the idea. One of its functions is to determine, how saturated one or another sector of the market, how soon will the firm be able to get to the break-even point (Hamdani, 2006). On average it should be able to do it within a year of its existence. Not less important is the fact that entrepreneurs can start a business with their own resources or, at least, clearly represent real sources of financing. Personal characteristics of the entrepreneur also add to the evaluation of the company’s business potential.

As a result, according to the National commonwealth of business-incubators in Russia, thus, from 1/5 up to 1/3 of ideas are selected. Rigid selection, primarily due to the specifics of the BI, for which the main objective is the rapid creation of profitable, strong small enterprise, a company should not be in the business-incubator for longer than three, rarely - five years (Soshnikova, 2003).

In the technology business incubation partnerships between large and small companies can develop.
A significant share of large enterprises and production associations regardless of the form of property faces difficulties related to the ineffectiveness of the production and sale of industrial products. There are many reasons for this situation, however, it is almost always lagging technology, the lack of effective demand for their products, inefficient use of production capacity, redundancy of staff, and at the same time, the unpreparedness of the greater part of the staff to the activities in conditions of market economy.

In order to increase efficiency of activity of the industrial enterprises (large and medium), as a rule, deep restructuring, involving the identification of new kinds of production and technology is required, as well as radical changes in the management structures, retraining of personnel, creation of more effective commercial structures, that is accompanied by the release of a large number of workers of the enterprise. In turn, small companies do not have those shortcomings, which are faced widely by large enterprises, but at the same time they are having difficulties with the lack of premises, equipment and production facilities, working capital, are in need of consulting, information and infrastructure support.

According to the National commonwealth of business-incubators creation of business incubators on the basis and with the support of large enterprises (industrial-technological centers), on the premises of which small enterprises will be incubating, solves the following tasks: development of new technologies for the large enterprises; performance of subcontract works; rendering of marketing and consulting services; creation of new productions with the purpose of creating new jobs.

Small enterprises are selected on a competitive basis on the basis of the criteria approved by the founders of BI. Selection criteria depend on the needs of a large enterprise. However, enterprises that have proved their viability (or viability of business ideas) should be selected in all cases, offering services or goods, needed by the basic enterprise, or consuming produced raw materials or components, or providing services.
Business incubation impact

The value of business-incubation, as well as the influence of the business-incubator services on the incubatees was studied by many scientists. The existing literature on business-incubation shows the studies that evaluate the impact of business incubation in the number of jobs created (Udell, 1990), incubatee development (Smilor, 1987), or incubatee graduation rates (Peters et al., 2004).

Different types of incubators were studied such as the university with incubators, non-profit incubators, and for-profit incubators (Peters et al., 2004). In addition, the methodological approaches used in the research evaluation of business incubation vary from case studies (Mian, 1997) for surveys (Allen and McCluskey, 1990). This, of course, led to the dispersal of the conclusions and the leaves of the value of business-incubation of a topic of debate.

In an early attempt to determine the potential of business incubators for the development of the enterprise, Allen and Rahman (1985) came to the conclusion that the incubatees do not indicate of the overall services of a business-incubator highly, as well as business and technical assistance provided. In addition, 87% of the entrepreneurs could have started their business without the incubator services. Allen and McCluskey (1990) came to the conclusion that the number of jobs created among the incubatees and the number of firms, graduated from the incubator practically do not fall under the influence the incubator structure, policy, or services. It was found out, that, instead of this, the age of the incubator and the number of incubatees explained more than half of the deviations in jobs created and graduation firms. This suggests that the impact on its incubates is higher, when learned from the experience (Allen and McCluskey, 1990; Peters et al., 2004).

The fact of business incubation services being lowly appreciated can be explained by the general notion that entrepreneurs reduce the importance of external assistance, or by the fact that these services business incubators transfer are not relevant to the support of business incubator
residents. The last reason may be especially true for growth-oriented and technology-based firms, because they require complex set of supportive measures, such as mentoring, or business and technical support (Udell, 1990). The mere provision of physical services and capital will not allow these types of business incubator residents to develop into a successful company.

Other studies have found that business incubation generally have a positive influence on the development of incubatees. Based on a sample of 50 U.S. business incubators Smilor (1987) collected data through surveys, on-site reviews, case studies, and in-depth interviews with incubator managers. This led to the identification of ten factors important for the success of tenant companies and business incubators of which the most notable factors are:

Other studies have found that business incubation as a rule, have a positive impact on the development of the residents of the business incubator. On the basis of a sample of 50 American business incubators Smilor (1987) gathered information through surveys, on-site reviews, in-depth interviews, as well as case studies with the incubator managers. This has led to the outlining of the ten factors essential for the success of the incubating firms and business-incubators, among which the most important ones are:

- On-site business expertise
- Access to financing and capitalization
- In-kind financial support
- Community support
- Entrepreneurial network
- Entrepreneurial education
- Selection process for tenants

These proposals partially coincide with the conclusions and proposals of the Udell (1990), mentioned earlier; providing expert knowledge is essential for the development of the business incubator residents. This
experience can be provided through training, mentoring, or through the network of external experts and professionals. This is supported by another study (Mian, 1996), that came to the conclusion that the university technological business-incubators are particularly suitable for the development of new high-tech companies. More specifically, the "soft" services, such as psychological support, training, provision of learning, or seminars are considered of value added in the incubator for the residents of business-incubator (Mian, 1996). Both the provision of mentoring and business expertise, go along with what has been proposed and suggested by Udell (1990).

The findings of Smilor (1987) and Udell (1990) clearly converge in that Smilor (1987) considers financial support and the selection process of incubatees to be a key factor in the success of an incubatee. Although these factors can be beneficial in the context of business incubation, this study will not cover their impact because it is believed that they do not allow an incubatee to substantially distinguish itself from its competitors. The role of the selection process in the success of incubatees has been addressed by Bearse (1998). It remains unclear however, whether incubatees perform well because of the efforts of the business incubator, or because the business incubator only selects incubatees that will perform well regardless of business incubation efforts (Bearse, 1998). For similar reasons as mentioned before - and in accordance to Allen and McCluskey (1990) – this study will also refrain from considering the impact of passive environmental interventions (Rice, 2002) such as photocopiers, computers, meeting rooms, or a receptionist.

The results of Udell (1990) and Smilor (1987), obviously agree on that Smilor (1987) considers financial support and the selection process for business incubator residents to be a key success factor for an incubating company. Although these factors may be useful in the context of business-incubation, this study does not cover their influence, because it is believed that they do not allow the incubatee significantly differentiate themselves from their competitors. The role of selection in the success of incubatees was discussed by Bearse (1998). It is unclear, however, if the business-
incubator resident is to perform well due to the efforts of the business-incubator, or because of the business-incubator only selects incubatees that will perform well regardless of the business incubation efforts (Bearse, 1998). For much the same reasons, as mentioned earlier - and in accordance with Allen and McCluskey (1990) - this research will also refrain from reviewing the impact of passive environmental activities (Rice, 2002), for example, copying machines, computers, conference-halls, or a porter.

Based on the above stated literature review and considering the findings of the existing literature (Udell, 1990; Smilor, 1987; Mian, 1996), the provision of expertise and the linkages to a support network appear to be important in the development of incubatees. Therefore, this study will examine the impact of business incubation on incubatees in terms of the provision of expertise by coaching and the linkage of incubatees to other actors by network mediation.

**Knowledge engineering tools**

One of the purposes of the work is to explore the potential of knowledge engineering methods in description of knowledge acquisition processes for entrepreneurial firms which are being involved into interaction with business incubator. Processes of knowledge elicitation and visualization are at the core of the descriptive representation of knowledge and information. Several publications have been discovered during the overview of literature which provides more or less solid structure of these approaches. Based on the reviewed sources, the following is derived.

Visualization is commonly used in data analysis to help the user in getting an initial idea about the raw data as well as a visual representation of the regularities obtained in the analysis (Fortuna, Mladenic and Grobelnik 2009). Making knowledge visible so that it can be better accessed, discussed, valued or generally managed is a long-standing objective in knowledge management (Sparrow 1998). Therefore, by augmenting
human intellect it is possible to increase the capability to visualize a complex information situation.

A range of mapping techniques and support tools has evolved, shared by the problems being tackled, the skills of mappers, and the sophistication of software available. Okada (2008) characterizes below the main genres of map.

- Mind Mapping was developed by Tony Buzan in the early 1970s when he published his popular book “Use You Head”. Mind Mapping requires the user to map keywords, sentences and pictures radiating from a central idea. The relatively low constraints on how elements can be labeled or linked makes it well suited for visual notetaking and brainstorming.

- Concept Mapping was developed by Joseph Novak around 1972, based on Ausubel’s theory that meaningful learning only takes place when new concepts are connected to what is already known. Concept maps are hierarchical trees, in which concepts are connected with labeled, graphical links, most general at the top. Novak and many others have reported empirical evidence of the effectiveness of his technique, with an international conference dedicated to his approach.

- Arguments and Evidence Mapping was first proposed by J.H. Wigmore in the early 1900s to help in the teaching and analysis of court cases. The objective is to expose the structure of an argument, in particular how evidence is being used, in order to clarify the status of the debate. Still used in legal education today, the idea has been extended, formalized (and reinvested) in many ways, but all focused on elements such as Claims, Evidence, Premises and supporting/challenging relations.

- Issue Mapping derives from the “Issue-Based Information System” (IBIS) developed by Horst Rittel in the 1970s to scaffold groups tackling “wicked” socio-technical problems. IBIS structures deliberation by connecting Issues, Positions, and Arguments in consistent ways, which can be rendered as textual outlines and
graphical maps. “Dialogue Mapping” was developed by Conklin for using IBIS in mapping, extended as “Conversational Modelling” by Sierhuis an Selvin to integrate formal modeling and interoperability with other tools.

- Web Mapping appeared relatively recently as a result of the rapid growth of the Internet. Software tools provide a way for users to capture, position, iconify, link, and annotate hyperlinks in a visual space as they navigate, creating a richer trail which come to have more personal meaning than a simple bookmark list.

- Thinking Maps as defined by Hyerle contrasts all of the above with a set of abstract visual conventions designed to support core cognitive skills. Hyerle’s eight graphic primitives (expressing basic reasoning about, e.g. causality, sequence, whole-part) are designed to be combined to express higher order reasoning (e.g. metaphor, induction, systems dynamics).

The visualization format perspective structures the visualization formats into eight main groups:

- structured text/tables
- heuristic sketches
- conceptual diagrams/concept maps
- image/visual metaphors
- knowledge maps
- objects
- interactive graphic environments
- mental (non-material) visualization and visual story telling

1. Text and tables

Visualization can further help understand the context and relationships of objects (named entities), which are described in a text corpus. For example, given a stream of news articles, one can apply visualization on the named-entities that appear in the corpus to show their topical context (e.g. the topical context of Bill Cinton on a visit in China could be Asia,
Trade, etc.) and topical relations between different named-entities (e.g. the topical relation between Chicago and Bill Clinton for a given time period could be Democratic convention that took place there and which Bill Clinton attended) (Fortuna, Mladenic and Grobelnik 2009). There the authors described a set of methods that represent a text document:

First of all, there is the bag-of-words representation, where a document is vectored in a high-dimensional vector space and each dimension corresponds to one word from the vocabulary. Also non-related words (e.g. “the”, “and”, etc.) are eliminated and more account is put onto the topically significant words by weighting.

The second approach is called Latent Semantic Indexing, where a term-document matrix from a given corpus of text documents is constructed. This is the matrix with vectors of documents from a given corpus as columns.

Another one method is multidimensional scaling that enables dimensionality reduction by mapping original multidimensional vectors onto two dimensions.

So, visually structured texts or numbers are a first visualization type:

- highlighting words,
- formatting paragraphs,
- using different colors, fonts and sizes.

Tables are grid-like arrangements of textual information that can be used for matching, listing, comparison, or rating purposes (Epplerand and Burkhard 2007).

2. Sketches

Heuristic sketches are drawings that are used to assist the personal or group reflection and communication process by making knowledge-in-progress explicit and debatable.
Generally a sketch notes down his preliminary ideas for a work that will eventually be realized with greater precision and detail (Alavi and Leidner 2001). In the context of knowledge management, these drawings can be called heuristic sketches to highlight their problem solving potential. can be defined as “a rough drawing or painting”.

Sketches represent the main idea, are atmospheric, and help to quickly visualize an idea. They present the key features, support reasoning and arguing, and allow room for own interpretations (Sparrow 1998).

3. Diagrams

Diagrams are abstract, schematic representations used to explore structural relationships among parts by denoting functional relationship. Diagrams explain causal relationships, reduce the complexity to the key issues, structure and display relationships (Cañas 2000).

![Diagrams](image)

Figure 2. Taxonomy of diagrams as one of the instrument of visual knowledge representation (developed together with Prof. Tatiana A. Gavriloa and Kirill Shikhanov)
Diagrams are used to structure information and illustrate relationships. For the transfer and creation of knowledge conceptual diagrams help to make abstract concepts accessible, to amplify cognition and to discuss relationships.

4. Images and metaphors

Images are impressive, expressive, or represent reality. They catch the attention, inspire, address emotions, improve recall, and initiate discussions. Images are instant and rapid, instructive, and facilitate learning. Visual metaphors support recall, lead to a-ha effects, support reasoning and communication (Chen 2000).

Metaphor provides the path from the understanding of something familiar to something new by carrying elements of understanding from the mastered subject to a new domain. This is why Aristotle calls the metaphor a tool of cognition. A metaphor provides rapid information, is highly instructive, and facilitates the process of learning (Chen 2003).

5. Maps

The maps are represented both in individual elements (e.g., roads) and in the global context (e.g., city) and illustrate both the overview and detail, the relationship between articles, information about the structure of the territorial alignment and allow zoom-in and easy access to information (Burkhard 2004).

Maps of knowledge are graphic formats, which are followed by mapping of the convention reference to the relevant knowledge. A knowledge map, as a rule, consists of two parts: a layer of soil, which is the context for the display (e.g. cities), and the individual elements that appear in this context (for example, street). The ground layer, as a rule, consists of mutual respect that all subjects of interaction can understand and relate to, such as the business model, product, tasks, or geographical map.

The elements which are mapped onto such a shared context range from experts and communities of practice to more explicit and codified forms of
knowledge such as articles, patents, lessons learned bases, or expert systems. Knowledge maps are thus graphic directories of knowledge-sources, assets, structures, applications, or development stages (Burkhard and Meier 2005).

6. Objects

Objects exploit the third dimension and tactile. They help to attract the recipients of support learning through a permanent presence, and allow for the integration of digital interfaces (Eppler and Burkhard 2007). Objects in space are useful, for example, for the items of information, knowledge, trade fair or exhibition.

7. Interactive visualizations

Interactive Visualizations allow to access, explore, and make sense of different types of digital information. Interactive visualizations help to fascinate people, enable interactive collaborations across time and space and allow to represent and explore complex data, or to create new insights (Tergan 2005).

Interactive visualizations are computer-supported interactive visualizations that allow users to control, interact, and manipulate different types of information in a way that fosters the transfer and creation of knowledge (Alavi and Leidner 2001).

By interacting with the information, new insights are created or shared. Interactive visualizations help to fascinate and focus people, to enable interactive collaboration and persistent conversations, and to illustrate, explore, and discuss complex issues in various contexts.

8. Storytelling

Stories are imaginary visualizations that are efficient in disseminating knowledge across time and space. The use of stories allows transporting an illustrative mental image by using spoken or written language. They help to establish a shared vision, a mutual story, which motivates and activates individuals (Loebbert 2003). Storytelling is a closely related
knowledge management tool, as it strives for rich, mental imagery (Epplerand and Burkhard 2007).

Analyzing the second block of literature referred to above it can be concluded that among some fundamental studies on the subject of entrepreneurial firms development – such as (Kazanjian, 1998) and (Kirchoff, 1994) – there are several recent studies, some of which are rather precise and targeting concrete issues and effects of business incubator development and interaction with new ventures.

Studdard (2006) examines how high-technology entrepreneurial firms' social interactions with business incubator management impact the acquisition of business process knowledge. Although the primary hypotheses and initial research settings are close to what is presented in the current paper, the outcomes are not in the scope of our research. According to Studdard the findings of the research are described as “the sole knowledge benefits gained by the firm, from the incubator relationship, is a perception of enhanced reputation”.

Another work, by Vanderstraeten J. and Matthyssens P. critically examines performance measurement literature in the domain of business incubators. They have examined the performance at both individual and system levels and evaluated it with a use of Tangen’s output prerequisites. Upon the finding of their work they proceed with the contributions for managers, future researches, and those related to the business incubator domain.
Knowledge and knowledge acquisition

As mentioned before, business incubation aims to support the development of successful new ventures. Developing successful new ventures represents a great challenge considering their high mortality rates. New ventures often lack vital resources, a loyal customer base, a reputation to which it can refer (Brush et al., 2001) and have to overcome the liability of newness (Stinchcombe, 1970).

A key determinant in the successful development of new ventures that is identified by many scholars is knowledge. The eventual success or failure of a new venture may be attributed to various factors – Chrisman et al. (1998) suggest that a new venture's performance depends on the entrepreneur(s), industry, strategy, tangible and intangible resources, and organizational structure – but Wiklund and Shepherd (2003) explain that superior knowledge enables firms to assess their dynamic competitive environment, which in turn allows them to develop an appropriate strategy to deal with these changes. A new venture, similarly, is less capable to identify and benefit from new opportunities if it lacks this knowledge.

Knowledge is also important because it forms the basis of other (tangible) resources such as financial or physical capital, which are essential to a developing firm (West and Noel, 2009).

Knowledge-based view of the firm

The theoretical foundation for the knowledge aspects that are used in this study is provided by the knowledge-based view (KBV) of the firm. The KBV is essentially an extension of the resource-based view (RBV) of the firm in that they both apply a perspective that relates a firm's internal characteristics to its performance. More specifically, the RBV posits that performance differences between firms are largely determined by their ability to control resources that are valuable, rare, imperfectly imitable, and for which no direct substitute exist (Barney, 1991; Grant, 1996). KBV distinguishes itself from RBV by emphasizing the importance of knowledge-based resources. Spender (1996) explains this by arguing that, because a firm's tangible resources all find their origin outside the firm,
intangible resources such as firm-specific knowledge are its most important strategic resources. KBV has evolved into several variations varying in terms of level of analysis but the underlying idea remains the same; knowledge is a firm's most important source of organizational advantage over other firms (Grant, 1996; Spender, 1996; Kogut and Zander, 1996).

**Types of knowledge**

To understand the importance of knowledge in firms, it is necessary to conceptualize knowledge. Conceptualizations of knowledge have been the basis of debates ever since the time of classical Greek philosophers (Alavi and Leidner, 2001; Grant, 1996) without resulting in consensus. This study will not take part in the discussion, rather a concise overview is provided that covers the findings that are most relevant to the purpose of this research. A view that is widely adopted among academics makes the distinction between tacit and explicit knowledge. Tacit knowledge can be thought of as an experiential type of knowledge as it is mainly acquired by experience, or learning by doing (Hitt et al., 2000). Because of these characteristics, tacit knowledge is not easily codified, duplicated, or transferred (Chrisman and McMullan, 2004). The dimension of tacit knowledge can be associated with 'knowing how' (Grant, 1996). The ability to speak a language is an example of tacit knowledge, while its grammatical conventions stated in textbooks are a form of explicit knowledge. In contrast, explicit knowledge is an articulated type of knowledge (Hitt et al., 2000). Explicit knowledge is based on theory and facts (Chrisman and McMullan, 2004) and can be transferred through language or symbols (Alavi and Leidner, 2001). Therefore, explicit knowledge is more easily transferred and communicated and can be associated with 'knowing about' (Grant, 1996). Since the introduction of the two concepts, tacit knowledge has received more academic attention than explicit knowledge, but - as Alavi and Leidner (2001) explain - both types are beneficial to a firm. Tacit and explicit knowledge are not two mutually exclusive types of knowledge. Instead they have to be thought of as complementing and influencing each other. Furthermore, these two
types of knowledge can reside at both an individual level and firm level (Spender, 1996). In this study knowledge is examined at the firm level, rather than the individual level.

A more practical way in which knowledge can be viewed deals with the types of knowledge that are useful to firms. These types can consist of both tacit and explicit elements. Examples include knowledge about customers, stakeholders, products, or a firm's competitive environment (Alavi and Leidner, 2001). Other knowledge types, such as technical knowledge (Hitt et al., 2000), market knowledge (Wiklund and Shepherd, 2003), or general business knowledge (Studdard, 2006) are also deemed important in the context of a firm.

Knowledge acquisition

Firms operate in a dynamic competitive environment in which they rely on knowledge to survive. Knowledge is important as it enables a firm to identify opportunities and create value. Because the firm's competitive environment is dynamic, it needs to increase and adapt its knowledge base to sustain its competitive position (Hitt et al., 2000). Therefore, the creation, accumulation, and transfer of knowledge is an important factor in the development and growth of new ventures (Yli-Renko et al., 2001). Firms can acquire knowledge through organizational learning and, as such, a firm's performance is influenced by its ability to learn. Organizational learning refers to the firm's ability to acquire and combine new knowledge with the knowledge it possesses (Hitt et al., 2000). This knowledge can be acquired externally (i.e. acquisitive learning) or internally (i.e. experimental learning). This study focuses on the acquisition of knowledge from sources external to incubatees the business incubator.

A firm's ability to acquire and exploit external knowledge (absorptive capacity) is determined by its prior related knowledge (Cohen and Levinthal, 1990). Lane and Lubatkin (1998) take this notion a step further by asserting that the knowledge acquisition process is determined by the similarity between two actors involved. The actors would be the 'teacher' firm and 'student' firm, or, in the context of this study, the incubator and
incubatee. These notions give important insights in the knowledge acquisition process. This study recognizes that differences may exist in the ability of forms to acquire knowledge from external parties. To take these characteristics into account however, would require in-depth insights in the internal characteristics of both the incubatee and incubator. Because this study focuses on the business incubation process, it chooses to place these subtleties outside the scope of this research. Although this may be interpreted as a crude measure, it is believed it is appropriate given the underdeveloped state of the type of research this study aims to conduct.
Theoretical background of the study

Introduction

This chapter describes the conceptual model (theoretical framework) that formulates the core of this research. The following sections are concerned with describing different types and approaches to knowledge modeling techniques. The bodies of knowledge reviewed in previous chapter are used as a base for the providing of the theoretical framework.

Knowledge modeling

According to the Merriam-Webster Online Dictionary, Knowledge is “the sum of what is known: the body of truth, information, and principles acquired by mankind.” Or as A.C. Foskett puts it: "Knowledge is what I know, Information is what we know."

There are many other definitions such as:

- Knowledge is “information combined with experience, context, interpretation, and reflection. It is a high-value form of information that is ready to apply to decisions and actions." (T. Davenport et al., 1998)
- Knowledge is “human expertise stored in a person’s mind, gained through experience, and interaction with the person’s environment.” (Sunasee and Sewery, 2002)
- Knowledge is “information evaluated and organized by the human mind so that it can be used purposefully, e.g., conclusions or explanations.” (Rousa, 2002)

Research literature classifies knowledge as follows:

<table>
<thead>
<tr>
<th>Classification-based Knowledge</th>
<th>Ability to classify information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision-oriented Knowledge</td>
<td>Choosing the best option</td>
</tr>
<tr>
<td>Descriptive knowledge</td>
<td>State of some world</td>
</tr>
<tr>
<td>Procedural knowledge</td>
<td>How to do something</td>
</tr>
<tr>
<td>Reasoning knowledge</td>
<td>What conclusion is valid in what situation</td>
</tr>
<tr>
<td>Assimilative knowledge</td>
<td>What its impact is</td>
</tr>
</tbody>
</table>
For more than two millennia, intellectuals, philosophers and scientists have tried to conceptualize awareness, information, knowledge and intelligence in various shapes, forms and situations. Unquestionably, many efforts have been made and many applications have been developed that resemble the capture and use of Knowledge in various forms by using different methods.

However, with the rapid increase in the amount of available information combined with the flexibility in accessing this information put forward the need for a concentrated effort to accelerate our utilization of information under a common framework.

As available technology advances our expectations and level of complexity embedded with knowledge, this situation increases the need for effective synthesization and efficient distribution. In time, Knowledge will gradually move into the sphere of the public domain – where it becomes “information”, while at the same time new knowledge gets created.

**Knowledge Capture and Modeling (KCM)**

KCM – or in short Knowledge Modeling – is a cross disciplinary approach to capturing and modeling knowledge. Knowledge Modeling packages combinations of data or information into a reusable format for the purpose of preserving, improving, sharing, aggregating and processing Knowledge to simulate intelligence.

Innovation, progress and prosperity, all depends heavily on making “right decisions”.

The good news is that making right decisions is not hard. For a rational agent there is no way of making wrong decisions, given “all” the facts and a “clear” objective. The only reason for making wrong decisions is by neglecting the facts or misinterpreting the goal.

That is why Knowledge Modeling is such a critical element of cognitive discipline and a prerequisite for reaching true Artificial Intelligence.
Expanding beyond Knowledge-based Reasoning (KBS) and Case-based Reasoning (CBR) systems, Knowledge Modeling offers a shift from local proprietary solutions to produce and disseminate embedded Knowledge Models into larger computational solutions in effort to generate “applied knowledge.”

“Applied knowledge” is so very important to the immerging “Knowledge Age.” “Applied knowledge” contributes to scores of intellectual activities, from continuous improvement to automated decision-making or problem-solving, and hence increases “Intellectual Capital” for generations of humankind to come.

The fundamental goal of KCM is to bring methodologies and technologies together in an implementation neutral framework as a practical solution for maximizing the leverage of knowledge. The core difference between working with information and knowledge is that – in addition to facts – a Knowledge Model includes enactment and has the ability to support intuition as well as the subjectivity of experts and/or users.

In everyday situations, people make a variety of decisions to act upon. In turn, these decisions vary based on one’s preferences, objectives and habits. The following example, Figure 3 – Situational Effects, highlights how gender and age play a role in the decision-making process.
As such, many models, like the example of Alice and Bob, can only be executed after having a profile assigned. A profile is defined as the personnel interpretation of inputs to a model.

KCM incorporate the quantitative and qualitative use of information, and processes tangible and intangible attributes that contribute to end result, such as Bob’s decision of watching an action movie. The bridging together of quantitative and qualitative methods enables KCM to incorporate subjectivity, which is the main differentiator between information and knowledge.

Each model can have data, information or outputs from other models as input. As such, models can be chained, nested or aggregated. For consistency in this paper all inputs to a model are considered as “information”. As such the output of a model would be referred to as information, when used as input to another model.

Among its benefits, a Knowledge Model has the ability to be constantly monitored and improved. Furthermore, Knowledge Models help us to learn from past decisions, to assess present activities and, just as important, to
preserve domain expertise. KCM saves time and overhead costs, and reduces the mistakes from overlooks.

Knowledge Models are very valuable and often outlive a particular implementation and/or project. Accordingly, the challenge of KCM is that this process must be designed not only as an abstract idea, but as an implementable process with the ability to aggregate and disseminate applied knowledge for the purpose of creating intellectual capital for generations of humankind to come.

There are countless possible applications for KCM just as there are countless intellectual activities performed by humankind around the world.

The most common groups of KCM’s applications are as follows:

- Problem Diagnostics
- Decision Support and Analysis
- Detection and Alerting
- Task and Process Automation
- Forecasting and Projection

Imaginably, various applications within each of the categories above can be constructed.

For example, a KCM model may be used for investment activities, such as valuation, risk assessment or imposing a best practice methodology to the due diligence workflow. The importance of such a model can be measured by its contribution to the “expected value” of the investment transaction.

There are already many applications available that directly or indirectly operating a KCM model. Among them are authoring tools such as Analytica and Protégé, knowledge bases such as Xaraya and KnowledgeStorm, and reasoning or analytical models such as MetaStock or Apoptosis, as well as many strategic games. Noteworthy, an important aspect of Knowledge Modeling is the incorporation of users’ subjectivity that is missing from many current solutions.
Knowledge Modeling is not the perfect solution for every situation. But there are many applications that could benefit from KCM, such as the following situations:

- The number or complexity of parameters involved in an activity makes it hard to proceed without risk of overlooks or without computational aids.
- The decision-making process is so important and stakes are so high that one cannot afford making any mistakes. In other words, when the Cost of Mistake or Value of Certainty is so high that it justifies the effort.
- Streamlining and/or continuous improvement of repetitive activities.
- Preserve and build upon domain expert efforts in house.
- Capture and package domain knowledge for transfer, share or sale.
- Facilitate decision-making by less skilled workers.
- To automate tasks and/or business processes.

The below example, Figure 4 – Simplified Decision Mode, shows a simplified decision model for "buying a used car." In this example, both quantitative and qualitative elements are used in the decision-making process.

![Simplified decision model for purchasing a used car.](image)

**Model Types**

At its highest-level, Knowledge Models can be categorized into following seven groups:
Diagnostic models

This type of model is used for diagnosing problems by categorizing and framing problems in order to determine the root or possible cause.

Semantic: Complaint – Possible Cause(s)

Example: I have these symptoms. What is the problem?

Explorative models

This type of model is designed to produce possible options for a specific case. The options may be generated using techniques such as Genetic Algorithms or Monte Carlo simulation, or retrieved from a knowledge and/or case-base system.

Semantic: Problem Description – Possible Alternatives

Example: I now realize the problem. What are my options?

Selective models

This type of model is used mainly for the decision-making process in order to assess or select different options. Of course, there would be always at least two alternatives; otherwise there is no need for making any decision.

A Selective Model distinguishes between cardinal and ordinal results. On one hand, when a cardinal model is used, the magnitude of the result's differences is a meaningful quantity. On the other hand, ordinal models only capture ranking and not the strength of result. Selective Models can be used for rational Choice under Uncertainty or Evaluating and Selecting Alternatives. Such a selection process usually has to consider and deal with “conflicting objectives.”

Semantic: Alternatives – Best Option

Example: Now I know the options. Which one is the best for me?

Analytical models

Analytical Models are mainly used for analyzing pre-selected options. This type of model has the ability to assess suitability, risk or any other desire
fitness attributes. In many applications, the Analytic Model is a sub-component of the Selective Model.

Semantic: Option – Fitness

Example: I picked my option. How good and suitable is it for my objective?

Instructive models

This type of model provides guidance in a bidirectional or interactive process. Among the examples are many support solutions available in the market.

Semantic: Problem Statement – Solution Instruction

Example: How can I achieve that?

Constructive models

A Constructive Model is able to design or construct the solution, rather than instructing it. Some of the recently popularized Constructive Models are used for generating software codes for various purposes, from computer viruses to interactive multimedia on websites like MySpace.com.

Semantic: Problem Statement – Design Solution

Example: I need a <…> with these specifications <…>.

Hybrid models

In many cases more advanced models are constructed by nesting or chaining several models together. While not always possible, but – ideally – each model should be designed and implemented as an independent component. This will allow for easier maintenance and future expansion. A sophisticated, full-cycle application may incorporate and utilize all the above models:

Diagnostic Model – Explorative Model – Selective Model – Analytic Model – Constructive Model
Theoretical framework

The theoretical framework might be represented as a model, shown in Figure 5. The model shows relationship between business incubator, performance of entrepreneurial firms, and knowledge acquisition.

The rationale behind this theoretical framework can be described as following. An outside assistance which entrepreneurial firms find in business incubators can be categorized into three types: business incubator management, internal network consisting of other incubatee, and external experts, which are brought in by business incubator. These three parties provide knowledge (mostly of two types: business knowledge and technical expertise) or, in other words, initiate knowledge processes. This knowledge processes accompany and influence business processes, which in turn determine the whole essence of the businesses inside the business incubator. Knowledge sharing processes also have four different types: administrative, social, domain knowledge, and network knowledge. The knowledge model will be built around the description of these processes and will present the knowledge processes along with the objects and the subjects of them.

![Knowledge Model](image)

Figure 5. Theoretical framework.
Empirical study

Description of the case organization – business incubator

The company chosen for the current study was business incubator “Ingria”. Business incubator “Ingria” is a city-owned business incubator established in St. Petersburg in the year 2008. The business incubator is a project of Technopark “Ingira”, or otherwise called structural department. It is a platform for providing support for highly technological projects and startup entrepreneurs. “Ingria” aims at pre-seed and seed stage companies and its main goal is to provide them with support while developing of business until the stage of getting investor financing and market entrance.

Business incubator started its activities in the end of 2008 in St. Petersburg, established by the city government, by the Committee for Economic Development, Industrial Policy and Trade as a part of a bigger project of Technopark. It offers innovative startup companies a range of services of promoting business, attracting financing, consulting and service support. Business incubator residents are offered two main course progemas: pre-incubation and incubation. Pre-incubation is aimed at forming a business model for a startup, whereas incubation program is targeted at development and launch of a product and market entry. Program choice depends on the stage of development of Your project and is determined after the team of the business-incubator will analyze startup. The project will be proposed schedule with a list of specific actions that need to be taken for the development of business, and formulated on the basis of a wide range of services offered by Business-incubator "Ingria".

Pre-incubation. The first stage of the assistance in the development of the project, the purpose of which is the formulation and detail of the business-ideas. The result of this stage is a compilation of the preliminary business-plan of the project, a plan for the protection of intellectual property, creation of a prototype product, preparation of the calendar plan of the project development and preparation of presentation of the project. The
pre-incubation program ends preparation of presentation of the project. The program takes up to 6 months.

Incubation. The second and the main stage of assistance in development of the project, the purpose of which is to create a functioning business. The result of this stage is formed by the project team, the project's business plan, the marketing plan of the project, implemented the plan of protection of the intellectual property or output at the level of self-sustainability of the project and the beginning of sales. Residents are considered to have successfully passed the incubation when received external funding. The program of incubation takes from 11 to 33 months.

Along with the two described above programs, the business incubator also offers educational and investment activities which give access to the knowledge and experience of widely known entrepreneurs, coordinators and consultants of the business incubator, as well as a possibility to network with the representatives of other innovational business projects.

The mission of the business incubator is stated as promoting the birth and growth of innovative businesses of the world level in Saint-Petersburg.

Among the goals of the incubator are: to help startups to raise funds and clients, and to enter the market with a finished product; to develop a platform for open interaction of beginning businessmen, experts and potential investors; to promote implementation of the strategy of the city, in particular, on the creation of high-paying jobs in innovative sectors.

The main task of the business incubator "Ingria" is to help the companies to leave the "valley of death". This is the period of the first steps of a young enterprise, when revenues are absent or minimal.

The business incubator offers companies participating in the pre-incubation programs and incubation, rooms for the successful implementation of the set tasks and comfortable work of the project team. The two existing sites of the business incubator possess offices, cubicles and co-working centers. In addition, the infrastructure includes a cozy
kitchen, equipped with necessary equipment, conference-halls and meeting rooms.

**Case study design**

Empirical study was designed according to analogical studies conducted by previous researches, based on a literature reviewed in the first part of this paper. It gathered both experience of the business incubator studies and knowledge engineering projects. It consisted of several stages.

First stage consisted of a series of interviews conducted with a purpose to obtain information about the knowledge processes in the organization. The main goal of this stage is to collect enough information for the next ones. At the same time the information collected needed to be sufficient and add providing enough value for the research. Thus, the interviews were divided into several parts. This is described more precisely in the next section.

After that information was being collected, a preliminary knowledge model of the business incubator was created. This model was further modified during the second iteration and a series of interviews with correspondent knowledge processes participants.

Then knowledge mapping was applied to the preliminary model of the business incubator. In other words, the consecutive interrelated elements of the model were thoroughly reviewed and described in detail, with the analyses of functions, and importance of them and the role in the knowledge model. This analysis provided further understanding of the principles which the final model should be built around.

Some strategic and practical managerial application for the obtained knowledge model were presented and discussed. This was not planned at the beginning of work, but it naturally occurred so that the participant of the interviewing process expressed interest in the results and volunteered to discuss the model and provide valuable feedback and insights on how the model could be applied for the processes of their organization. This once more emphasized the managerial value, usefulness and importance of the created model.
In last stage the solution itself was applied to the organization and the results were specifically discussed, basing on the various aspects of the application.

**Interviews and interviewees**

Before the interviews were being conducted, the interviewees were divided into groups: consultants, top management, and entrepreneurial companies. The difference between these groups is in the relation to the knowledge processes in the organization. It was crucial that this division was being done, because the participants played different roles in the organization, and it was important for the course of my research to conduct interviews with them at different time periods, one following another. For instance, after the second set of interviews, and having the model constructed, it was important to interview representatives of the entrepreneurial companies, shows them the model and receive feedback upon the correctness of it, and upon how they fit in it, considering the everyday knowledge processes they are being involved into. Thus it was crucial to structure the process of interviews consequently, so that they logically follow one another according to the chosen timeframe.

![Figure 6. Visual representation of the research design](image)

Due to different groups were to be questioned, different sets of questioned were formulated into questioners, one for each group.
According to the questioner for group one, which included business incubator consultants consisted of questions aimed at the preliminary description of the existing knowledge processes in the incubator. The main purpose at this stage was to identify the main participant of the model, the main types of knowledge being used, and the existing processes, which are being applied to the knowledge distinguished.

Due to the nature of the interview, it was semi-structured, thus there were no exact set of questions, although the main points to be covered and issues to be discussed were nevertheless formulated. The reason to conduct this kind of interviews is that this kind of questions is not a matter of an often discussion, and people are not used to speak about intangible assets and their exchange. This leads to a wide range of methods of describing this or that business process, or part of a model. Thus, the questions had to be shaped according to each person’s way of sharing knowledge and communication.

The research methodology is based around the following items:

- Qualitative interviews with business incubator consultants.
- Qualitative interviews with business incubator management
- Qualitative interviews with the entrepreneurial companies to collect information on the processes of interaction with business incubator management and consultants.

**Data collection**

The primary data collection for this study was conducted during March and April 2011. The author interviewed all three parties of the interviewees as described in previous part of the paper.

During the period of March 1-15 the first set of interviews was conducted – that is interviews with consultants of the business incubator. Five out of six consultants of the business incubator were interviewed, which makes it an 83% sample. Later on, by the beginning of April, the second set of interviews was finished, during which 3 people from the business incubator management were interviewed. This represents the full sample of the
management of the company, except for only general manager, who is responsible for the whole Technopark division. It was chosen not to conduct interviews with him since he is neither in any way involved into everyday activities of the incubator, nor takes part in company business incubator residents selection process. Thus, it was decided that he would not add value to the research, rather increasing the time of the data collection process due to the scheduling issues.

After the first two stages of data collection process were finished, the process was paused while the information obtained was processed and the preliminary results were discussed and interpreted in a form of visual representations and parts of a knowledge model. Only upon the completion of the preliminary data analysis the author continued the data collection and conducted interviews with entrepreneurial companies-residents of the business incubator.

During this last set of the data collection representatives of 6 entrepreneurial companies were interviewed, which makes it 11% of the total number of business incubator residents to the moment of interviews were being conducted.

The interviewed respondents are:

Dmitry Stepkin, Oleg Rozhdestvenskiy, Evgeniya Barchenko - all project consultants of business incubator “Ingria” to the moment of the research being conducted; and Evgeny Barulin and Sergey Poduzov – project consultants of the business incubator.

From the management side the following people were chosen for an interview: Irina Petrova, marketing director of “St.Petersburg Technopark”, Igor Rozhdestvenskiy, director of business incubator “Ingria”, Maxim Shabrov, director for investments and promotion of projects.

During the third set of interviews, when the companies-residents of the business incubator were being interviewed the following 6 companies were chosen:
• 2Nova is a new media agency, developing a project which is aimed at creation of a convenient and simple CRM-tool using SMS as the main communication channel. Mr. Danis Suleymanov - CEO of the company - was interviewed in this company.

• Altirix is a company that produces solutions for information security systems. It seeks to improve overall performance of commercial organisations and state establishments and minimise information risks for business by introduction of innovative approaches and usage of up-to-date information technologies. Mr. Aleksandr Kuzmin – the CEO of the company – was interviewed in this firm.

• GC Promo. Group of Companies Promo LLC was founded in 2009 in St. Petersburg. The founders of the company specialize in information technologies, development of applications and marketing. The corporate business consists of two complementary parts: publication, development, promotion of applications in social networks and advertising in social networks. The company has partnership relations with major players in the market of Internet advertising and a wide experience of development and promotion of applications for social networks under the brand of Social Vision. Mr. Evgeny Marchenkov – the executive director of the company – was interviewed in this firm.

• IT-Mozg LLC. The company is engaged in organisation and development of a new Internet service on search and supply of work for IT and telecommunication specialists from all over the world. The new service is equally useful to both employees and employers. The specialists can place their CV free of charge, look through vacancies, expanding the geography of job search. The major consumers of the company are the employers looking for IT specialists and job seekers looking for a job in this sphere. Mr. Artyom Kumpel – the director of the project – was interviewed in this company.

• Chuck Norris LLC representing The Ministry of Life project. It is aimed to help the social network users to find new ideas for leisure
and expand the functionality of social networks. The company develops applications and games appealing to such aspects of motivation of users as desire to socialise, find new vectors for personal development and compete with the "neighbours" in the social network. In its development, the company is focused on non-game applications, where the content is generated by users. Mr. Andrey Shostka – the director of the project – was interviewed in this company.

- LLC Dlya Dushi representing the Double Defense project which is a detection system for unauthorized cargo opening (sensor detecting opening of the package during transportation) consisting of the sensor with unique optical characteristics sticking to the package and sensor reading sticker data. Ms. Svetlana Spivak – the director of the project - was interviewed in this company.

**Data analysis**

Due to the character of the work and the peculiarities of the research design, which was organized into three stages of in-depth interviews, the process of the analysis of the data was also not linear, but rather had an iterative structure.

The first data analysis was carried out in the beginning of April 2011, shortly after the first and the second sets of interviews were finished. First of all, every record of each interview was revised again. The purpose was to design a comprehensive picture with the respect to the research questions, stated at the beginning of the paper. Thus, after analysis of the first set of data the preliminary knowledge model of the business processes of the business incubator was created, along with the classification of types of knowledge involved in the processes. Moreover, preliminary schemes of the knowledge processes were created to be further revised by the entrepreneurial companies, as it is stated in the research setting.

The second data analysis was conducted after the information had been acquired from the third set of interviews. There is always a risk of getting a
biased opinions on the subjects discussed in a research, that is why the
decision of splitting the data analysis into two stages was made. However,
the author believes that final result of the knowledge gathered from the
interviewees is truthful and models built upon it reflect the true state of
things in the company. This was double checked and proved by the
revision interviews with the representatives of the entrepreneurial
companies, who reviewed the models and described their relevance to
each of the processes, as well as how closely the model describes their
experience throughout the whole incubation.

Figure 7. The qualitative data analysis process (Seidel, 1998).

Overall the data analysis process was not linear, and was in accordance
with the principles described by Seidel (1998), suggesting that when one
makes a qualitative data analysis, he should keep in mind that the process
has following characteristics:

- Iterative and progressive: The process is a cycle that keeps
  repeating. For example, when you are thinking about things you
  also start noticing new things in the data. You then collect and think
  about these new things. In principle the process is an infinite spiral.
• Recursive: In the process one part can call you back to a previous one. For example, while you are busy collecting things you might simultaneously start noticing new things to collect.

• Holographic: The process is holographic in that each in the process contains the entire process. For example, when researcher first notices things he/she is already mentally collecting and thinking about those things.

The Figure 7 shows the process of qualitative data analysis, suggested by Seidel (1998) and used by the author in the current work.
Analysis of the results

Introduction

In this chapter the focus is on the results of the research which was described in previous chapters. As mentioned earlier in the paper, three different research streams were chosen for this research: description and classification of the types of knowledge mostly important for the innovative entrepreneurial firms inside the business incubator, description of knowledge processes inside the business incubator, and, most importantly, modeling the business incubator knowledge processes from the point of view of knowledge. These results will be followed by a summary and a proposal for deeper discussion and some possible further research in the conclusion chapter.

Types of knowledge

During the first two sets of interviews the consultants and managers of the business incubator were asked to describe the main types of knowledge entrepreneurial companies have to deal with. It was rather challenging to pick up the importance of each of the type, since different interviewees prioritized it differently. Nevertheless, the major trends had been outlined and thus, the derived types of knowledge mostly used inside the business incubator a condensed to the following list:

- Strategic planning
- Project management
- Financial modeling
- Product design
- Usability
- Product strategy
- IP rights
- Business planning
- Investment proposal
- Client targeting
- Networking: business and technical experts
• Value proposition
• Promotion channels
• Sales
• Customer discovery
• Pricing
• Product development
• Market assessment
• Marketing strategy
• Prototyping
• IP strategy
• Financials
• Networking: investors, startup events, business seminars
• People management
• Financial management

According to the interviewed respondents, some of these types of knowledge gather importance in dependence with the stage of the firm’s development. A brief overview of the enumeration of these knowledge types might leave a reader wondering, and seem rather obvious at first place, but the purpose of the work is to present a descriptive model of the business incubator knowledge processes, thus, the description of knowledge types is at the basis of it.

Moreover, during the third set of interviews, when the representatives of the business incubator residents were being interviewed, 4 out of 6 of them pointed out that it was not obvious for them at all, which types of knowledge are most useful at certain stages of their development.

The presented above list has been modified into a mind map – shown in Figure 8 – which depicts the classification, as it was planned during the research statement. Among the higher levels of abstraction the author has chosen three main clusters:

• Business knowledge
• Technical knowledge
• Networking
Each of the three clusters breaks down further into sub-categories, which, in turn, mostly have further branches.

Figure 8. Classification of the types of knowledge required by incubatees

Analyzing the mind map it is quite obvious that business knowledge is the most widely presented among the alternatives. Another cogent knowledge sub-category is networking, whereas technical knowledge is being only provided in three forms: prototyping, product design, and product testing knowledge. These findings exactly prove the assumptions about the nature of business incubators and their usefulness in the knowledge transfer towards the incubatees.

As a quite unexpected outcome of this analysis can be pointed out the lesser importance of technical knowledge transfer to the residents of the business incubator. According to the interviews results, technical knowledge is provided to the residents to some extent, only in a form of consultations with the technical expert, who a part of the business incubator’s staff. Residents receive the most support from the outside experts and networks, access to which is much more broadly provided by the business incubator consultants. Thus, this type of knowledge is related to the “Networking” rather than to “Technical knowledge” branch of the mind map.
Knowledge flow processes

This section is devoted to the description and analysis of the knowledge processes inside of the business incubator.

The process of describing knowledge processes is important for understanding the knowledge structure of the business incubator. All of the flows of knowledge should be described in a visual structure, based on the empirical research results. Upon completing this step, we will receive a full set consisting of different types of knowledge operations arising inside the incubator. It is important to understand the recipients and transmitters of knowledge in each case, since it could even be the same party in various situations.

Based on the analysis of interview results, the author came up with the following five types of knowledge processes, or otherwise, knowledge flows. Knowledge flow can represent different knowledge processes at once: sharing, acquiring, transmitting, and receiving (Chen, 2003).

![Diagram of Knowledge Flows](image)

**Figure 9. Knowledge flows “consultant-to-residents”**

The discovered knowledge flows have been presented in a visual form with the use of visual diagrams of a mixed type: they represent a mix of both dynamic and static diagram types, showing process flow as well as quantitative details, and relationships between subsets.
Author has provided names for each of the five discovered knowledge flows for easier recalling and description of the core of the found relationship.

Thereby, Figure 9 represents the “consultant-to-resident” knowledge flow. This diagram represents the process which occurs during direct knowledge acquisition by the business incubator residents from a business incubator consultant. One of the distinctive features of such knowledge process is that it is “one-to-many” relation, which makes the consultant a so-called “hub” though which the knowledge is transmitted in different forms. As it is seen from the diagram, the forms of knowledge are both tangible and intangible. They are, on one hand, learning materials, such as books, journals, documents, manuals, drafts of financial models, marketing plans, and business summaries. On the other side it is intangible knowledge sharing, such as contacts of potential customers and suppliers, and even contracts. Thus, the diagram represents not only business knowledge transfer, but also networking, and, in some cases, technical knowledge. This is the basic diagram, related to the most used types of knowledge acquisition by business incubator residents.

The next knowledge flow is described on a diagram in Figure 10. It has been categorized as a “resident-to-resident” knowledge flow, representing the second most popular knowledge relationship discovered in the business incubator.

To some extent this relationship was quite unpredictable. Nevertheless, it turned out to be among the most intensively discussed and mentioned during the interviews with both consultants, and the residents of the business incubator. The “internal” knowledge sharing, between business incubator residents does not involve any intermediaries, thus providing
value on a basis of self-generated content. Among the most used types of knowledge in this case are best practices, contacts, such as suppliers and potential customers, as well as mentioned above tangible knowledge assets: books, documents, and other informational materials. Residents often help spread knowledge among each other creating a pool of common knowledge, which in turn increases the overall value of a business incubator and attracts new residents.

Another distinguished knowledge flow is a so-called “resident-to-marketing” flow, described in a form of a diagram in Figure 11.

![Figure 11. Knowledge flow “resident-to-marketing”](image)

The main value of this type of knowledge transferring results in benefits for the business incubator residents in terms of outside advertisement, or, in knowledge management terms, spreading the knowledge to an outside network. Business incubator consultant plays role of an intermediary in this process. His main activities are to collect knowledge from a business incubator resident and transmit it to the Marketing department of the business incubator. Marketing department is in charge of spreading the word about the resident’s activity, services, needs, and networking. It is also responsible for the attracting customers and finding possible partners for the residents.

![Figure 12. Knowledge flow “expert-to-resident”](image)
Figure 12 describes the knowledge flow, which is mostly used for the knowledge from a technical cluster. As mentioned above, most of the knowledge that business incubator residents receive from consultants falls into the boundaries of two clusters – business knowledge and network knowledge. Thus, technical knowledge has to be derived from outside experts. “Expert-to-resident” knowledge flow represents exactly the described above case. An outside expert is being attracted by the business incubator consultant and provides technical expertise, trainings and seminars to the resident of business incubator.

“Resident-to-external network” knowledge process is described in Figure 13. The main difference of this type of knowledge flow is that it is iterative and intermediary is needed only once, for initiating purposes.

Business incubator residents send a request to a consultant, who transmits it further to the external network, which is in a way, his personal asset and one of the key value creating factors. After the resident is “connected” to the network, the process of mutual knowledge sharing starts. This is an iterative process and it repeats as long as the parties are interested in knowledge transmitting and acquisition.
Since the main types of knowledge have been shown and the knowledge processes have been distinguished and described in detail, the next step of the work is to build the knowledge model of the business incubator, connecting the above mentioned points together.

**Knowledge model**

Figure 14 demonstrates the knowledge model of the researched business incubator. This is the procedural knowledge model, which is a combination of knowledge cells, described earlier.

This model consists of several layers, both logically and visually. The discussed above notions of types of knowledge and the different knowledge flow processes are represented on this diagram in accordance with timeline, which structurally describes the lifespan of a project inside of a business incubator.
Moreover, the coordinate axes have been added to the model to represent the overall average income flow of the organization in accordance with the current stage of the development of the company. The lower extreme point of the curve is representing the “Valley of death” period of the startup (Blank, 2006).

The composition is designed in a way that all elements are aligned according to the timeline, lifespan of a project, and a current stage of a project. The knowledge types are explicitly added to the transition lines between different stages, showing the most demanded knowledge during passing different stages by the firm. Moreover, certain knowledge processes are interconnected with the knowledge types, representing, once again, the most crucial knowledge flow processes in the organization along the lifespan of the entrepreneurial company.

Visually, this diagram exploits several types of knowledge engineering visualization tools: they represent a mix of both dynamic and static diagram types, showing process flow as well as quantitative details, and relationships between subsets.

As a result of classification a taxonomy of the knowledge types is presented in a conceptualized form with a use of one of the knowledge visualization tools described above.
Conclusions and recommendations

Managerial recommendations

Based on the results and the information derived during the course of this work, the author had gotten closely acquainted with the field of study and the processes involved in business incubation and the entrepreneurial high-technology companies’ knowledge acquisition from the business incubator. This knowledge helped the author to develop a list of recommendations for the management of business incubator, which might help increase the effectiveness of knowledge transferring processes inside the organization, thus providing more effective development process for entrepreneurial firms.

As it turned out during the study, one of the main issues faced by the firms is a necessity to switch often between different consultants, while searching for the right type of knowledge during at different stages of the firm lifespan. Most of the interviewed business incubator consultants were pointing out this characteristic of their knowledge being “deeply-spread” whereas an entrepreneurial company requests wider range of knowledge flows, covering more extensive amount of knowledge areas. Thus, the recommendation would be to define a specific set of knowledge areas covered by each of the consultants, according to one’s preferences, as well as objective tendencies towards knowledge area due to previous working experience, undergone training, or other objective factors.

The author assumes this would lead to a lesser extent of fluctuations of companies inside of the business incubator in a search of proper knowledge agents, resources, and networking possibilities. More precise business incubator residents’ dispersion among the consultants could lead to an overall higher survival rates among the firms due to savings of time, money, and human resources.

Another recommendation is that incubatees could be integrated into some kind of knowledge clusters, in accordance to their age, maturity, business needs, and the development stage. Each of the clusters can be
undergoing similar educational activities, in accordance with the most urgent needs of the companies forming it. One, or a very limited number of consultants, should be assigned to this type of a cluster, in order to reduce the total amount of man-hours spent per by each of the consultants per each resident. This will again, allow for more targeted knowledge transfer to the entrepreneurial companies, and, as a possible side effect, will increase network effect inside a cluster. This is effect is being found inside the business incubator as a whole, which is discussed in the study above. There is a possibility of it appearing inside the clusters as well, which would accelerate all the knowledge processes, both sharing and learning.

The next recommendation is based on the ideas of the business incubator management, which were announced during the interviews conducted. The ideas were later on supported also by the companies’ representatives. The core of it is to develop a more standardized program of an entrepreneurial company development, throughout the course of incubation period. According to the this program newcomers would be thoroughly assessed at the very first stage of incubation, with different criteria proposed, which would provide an overview of the condition of the company. This proposition is based on an assumption of that each of the business incubator residents could be comprehensively assessed and categorized rather accurately in order to fall under certain project boundaries. This might help to develop specialized programs for different categories of the business incubator residents, which would decrease the amount of time spent by consultant on average, and thus, create capability for a business incubator to scale and be able to provide services for larger numbers of residents with less costs.

**Limitations and recommendations for future research**

The boundaries of the study and the research were rather clearly defined, in the research setting part, with all the reasoning provided. Nevertheless, the author of the paper sees some limitations which he believes are important to point out.
First of all, every knowledge engineering project has some level of uncertainty, as it involves much interpretation of different people’s opinions and ways of representing thought. Moreover, even trying to stay an independent analyst, author imposes his own interpretation of the received results. Thus, the outcomes could be somewhat biased and representing one person’s point of view on issues. For the future research the author suggests trying to involve more people in the research process, especially during the stage of interviewing and opinion interpreting.

Secondly, the case company itself (business incubator “Ingria”) to the moment of the study being conducted is rather a young company, with less than 3 years operating experience. On one hand, this partially made the research itself possible, but on the other hand, there is definitely a need for a further research conducted for the same company when it steps into the next stage of development.

All of the interviews from the third set were conducted with the companies who succeeded, and have gained at least a six month operating experience inside the business incubator. Some information about the failed projects might be collected during further research, which might lead to adjustments of the knowledge model.

As the last direction of the possible further research the author proposes revising his managerial recommendations, given in the previous section. Researching the usefulness of the suggested recommendations would definitely be an essential outcome of the current research.
References


