

Recombinant Innovation in the Technological Startup Ecosystem: A Case Study on High Tech XXI

**Master of Engineering Management
2022 – 2024**

Submitted in partial fulfillment of the requirements for the degree of
Master of Engineering Management



**NAZARBAYEV
UNIVERSITY**

School of Engineering and Digital Sciences

In partnership with

Graduate School of Business

Aida Ualiyeva

Aizhan Umerbayeva

Gaini Khassenova

Sayazhan Assainova

Yevgeniy Lukhmanov

2024

Declaration

We, Aida Ualiyeva, Aizhan Umerbayeva, Sayazhan Assainova, Gaini Khassenova and Yevgeniy Likhmanov, declare that the research contained in this thesis, unless otherwise formally indicated within the text, is the author's original work. The thesis has not been previously submitted to this or any other university for a degree and does not incorporate any material already submitted for a degree.

Name: Aida Ualiyeva

Date: 24.04.2024

Name: Aizhan Umerbayeva

Date: 24.04.2024

Name: Gaini Khassenova

Date: 24.04.2024

Name: Sayazhan Assainova

Date: 24.04.2024

Name: Yevgeniy Likhmanov

Date: 24.04.2024

Acknowledgements

We express gratitude to our supervisor Professor Mariza Tsakalerou for constant support, motivation and guidance throughout the project.

We are grateful to Timur Tursynbayev of Ministry of Energy of RoK, Serzhan Berdengorov and Elina Akhmetzhan of Astana-Technopark, Aidos Charizat and his team of High Tech XXI company who provided us with valuable insights, facilitated the interviews and meetings, and supported our team during this project.

Special thanks to Espresso Day staff for delicious invigorating flat white.

Abstract

Introduction: The capstone project explores how startups in Kazakhstan approach innovations on the example of High Tech XXI.

Objectives: Analysis of High Tech XXI company ecosystem; Assessment of the company innovation system based on the maturity model; Development of a causal loop diagram (CLD) of the company's innovation system; Evaluation of factors driving employee motivation; White paper: executive summary of findings, root cause analysis, recommendations. This final objective involves summarizing the research findings.

Methods: Arranged several in-depth interviews with field experts. Through workshops plotted a map that shows relationships between 36 different processes that affect innovations, whether in a positive or negative way. Collected survey responses from 2 executive directors, 4 senior engineers and 2 technical workers and created a motivational factor analysis. Finally, assessed the company's maturity using interview and survey results conducted with executives.

Results: CLD confirms that talent development is a key driver of innovation strategy, while knowledge management plays a role of enabler. The results of surveys showed that executives are motivated primarily by career development, engineers and technicians value increased salaries, bonuses and incentives. Besides, as per maturity assessment results, the company excels in strategic alignment, formal processes, collaborative teams, training, and market research, while lagging in project performance evaluation.

Conclusion: High Tech XXI is able to foster innovation capabilities within a company through continuous talent development. The white paper and recommendations were proposed to help the company in this regard.

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List of Abbreviations

AHP	Analytic Hierarchy Process
AMS	Automated Monitoring System
CLD	Causal Loop Diagram
NU	Nazarbayev University
MEM	Master of Engineering Management
MICMAC	Impact Matrix Cross-Reference Multiplication Applied to a Classification
RCA	Root Cause Analysis
SEDS	School of Engineering and Digital Sciences
SME	Small and medium enterprises

Chapter 1. Introduction

1.1 Background

1.1.1 Research question

How does the recombinant innovation ecosystem of technological startups, exemplified by High Tech XXI, operate within the context of Kazakhstan, and what factors influence its effectiveness (considering internal organizational dynamics, external environmental factors, and the assessment of innovation system maturity)?

1.1.2 Research aim and objectives

The primary aim of this work is to analyze the innovation dynamics of High Tech XXI company within the technological startup ecosystem. This capstone project aims to research how this innovative company is sustained within a dynamic environment.

Research objectives:

1. Analysis of the High Tech XXI company ecosystem:
 - 1.1. Thorough examination of the internal and external factors that shape the ecosystem within High Tech XXI operates.
 - 1.2. Assessment of the company innovation system based on the maturity model: to evaluate the High Tech XXI's innovation practices the objective involves the application of an innovation maturity model. It includes deep analysis of the company's innovation processes, capabilities, resources, culture and management.
2. Development of a causal loop diagram (CLD) of the company's innovation system: the objective is to construct a causal loop diagram that illustrates the interconnection of different factors influencing innovation within High Tech XXI. It involves identifying key feedback loops and leverage points within the company's innovation ecosystem.
3. Evaluation of factors driving employee motivation: focusing on understanding the factors that drive employee motivation and engagement within High Tech XXI. It involves conducting surveys, interviews, and data analysis to identify the key motivators and organizational practices that contribute to a culture of innovation and high performance.
4. White paper: executive summary of findings, root cause analysis, recommendations. This final objective involves summarizing the research findings. It highlights key insights, challenges, and opportunities identified through the

study. Also, obstacles identification and providing recommendations for enhancing High Tech XXI's innovation capabilities and sustaining its competitive advantage in the technological startup ecosystem.

1.1.3 Purpose

The purpose of this capstone project is to explore and enhance the understanding of the structure and dynamics of the innovation ecosystem of technological startups in Kazakhstan. This investigation centers on High Tech XXI, a startup company specializing in the development of Automated Monitoring Systems for buildings based on software complex and innovative geotechnical sensors. The company works in collaboration with foreign organizations, adopting and innovatively modifying monitoring technological solutions to better suit demands of the Kazakhstani market. Consequently, by playing a representative role in the context of recombinant technology and innovations, this project aims to analyze how High Tech XXI interacts with different layers to create an effective value proposition across the innovation ecosystem.

1.1.4 Scope of work

Organizational dynamics of the innovation ecosystem will be analyzed in terms of both internal and external effects. Furthermore, the effectiveness of several aspects, which define whether the innovation system is successful, will be investigated. Internal organizational factors such as leadership, organizational culture, and employee motivation, as well as external environmental factors including government regulations and market conditions will be examined in this study. All of these factors will be studied in the context of the High Tech XXI company (a local Kazakhstani startup), and data will be collected through close collaboration with the company manager, employees, and government representatives, including semi-structured interviews and surveys, the results of which will be analyzed through several qualitative and quantitative methods. The study will span for four months during which interviews and surveys will be conducted.

The thesis's comprehensive study intends to provide significant insights into the operation of Kazakhstan's innovation ecosystem as well as shed light on the elements that influence its efficacy.

1.1.5 Significance

The study is important because it aims to provide managers with essential insights into the factors driving innovations across a company along with the

primary drivers of employee's motivation. Managers will understand the interconnections of different factors in the technological startup ecosystem and which factors to consider to strengthen within the organization to progress effectively.

1.2 Company overview

High Tech XXI is a technologically innovative local startup company which was established in 2014. The company specializes in manufacturing automated monitoring systems for buildings, as well as encompassing installation, servicing, and geotechnical sensor components based on European technologies.

In early stages as a startup High Tech XXI struggled with the strategic decision on which technology to prototype and design. After, the startup forms a strategic alliance with Earth System, an Italian innovative company, which is engaged in the production of 1,500 types of geotechnical sensors and data loggers. High Tech XXI successfully adapted and localized Italian products by integrating incremental modifications into its technologies and accompanying documentation. Further, these joint products were certified and registered in the State Register of Measuring Instruments of the Republic of Kazakhstan. Today, the key services and products of the company are:

- Geotechnical products based on European technologies.
- Development of the “AMS HT” hardware and software complex, a comprehensive solution for monitoring buildings and structures.
- In-House calibration and verification laboratory that ensures the accuracy and reliability of their equipment.
- Engineering service related to AMS implementation, including supply, installation and maintenance. Furthermore, the company offers solutions for both manual and automated monitoring to meet the needs of construction projects and operational facilities.
- Integration AMS with IT system to create digital business model for monitoring the technical condition of dynamic equipment. This “Automated Diagnostics” approach allows High Tech XXI for efficient data analysis and informed decision making.

During the last 7 years High Tech XXI had more than 275 projects. They provide monitoring solutions for various industries such as:

Construction industry: Monitoring buildings and structures during and after construction, ensuring safety and structural integrity. For instance, in 2017, High

Tech XXI implemented geotechnical sensors for partial load relief during the EXPO-2017 construction project.

Oil & Gas industry: Monitoring pipelines for leaks, deformation. In 2019, the company worked on projects related to monitoring pressurized vessels for leaks and implementing automated systems for pipelines and wells.

Transport industry: Monitoring railway infrastructure for temperature and stress, ensuring safe and efficient operation. During 2017-2018, the startup, in collaboration with JSC “”NC KTZ”, conducted trials of the “AMS HT” system for monitoring the temperature and stress state of railway tracks.

Energy industry: Monitoring power plants and other energy facilities for potential risks and optimizing performance.

In addition, High Tech XXI is strategically located in Astana city within the territory of Nazarbayev University Technopark. The company benefits from a Special Economic Zone “Astana - Technopolis”, having the opportunity to use intellectual capital and infrastructural resources of Technopark. Astana - Technopolis gives an opportunity to the startup to accelerate development of new technologies and assists in their commercialization. Leveraging this proximity, the startup also collaborates with the esteemed faculty of the university on research and development initiatives.

To compare the Kazakhstani startup with an external established tech hub for startups, Technopark startups can rely on government support such as financial incentives, grants, subsidies, or tax breaks. According to the fact that High Tech XXI is the company that operates in the construction industry in Kazakhstan, the main difference of the company from other technologically innovative startups is that the company works through the tender. Which means that the company receives an invitation to bid on a project, where the main objective of the participant in the tender is to offer the lowest price. To compare with innovative Kazakhstani startups, for example with “Smart house” smart home solutions provider and “Kwaaka” IT service company, the uniqueness of the High Tech XXI is collaboration with innovative geotechnical sensors providers and common IP protection. Thus, this allows the company to be a solo provider of specific innovative products for the construction industry of Kazakhstan.

Chapter 2. Literature review

The literature review process consisted of several stages, including both individual and group review of research papers. In order to find potentially relevant articles we have selected Scholar and Proquest databases and used the following combination of keywords: “innovation ecosystem”, “innovation capa*”, “innovation driver”, “technological startups”, “SMEs”. The first review included theses, peer-reviewed articles and conference papers that were publicly available or accessible through the NU Library. Studies were also included depending on the year of publication, the language of writing and excluded due to incompleteness of documents and duplications. The second stage was related to the detailed revision of titles and abstracts, as a result of which papers were selected to identify research gaps.

2.1 Innovation

2.1.1 Definition

In the realities of today's ever-changing world, innovation is critical to any company's market competitiveness. Many businesses and individuals mistakenly believe that innovation is always about introducing an entirely new product, method, or service (Kahn, 2018). However, the definition of innovation has evolved throughout the years. More recent standpoints suggest that innovation is more than the production of completely new items. Rather, innovation includes enhancing and improving current goods and processes (Fagerberg et al., 2010). Innovation is, in fact, a time-consuming process with unpredictable outcomes. One effective strategy to achieve innovation is the combination of existing knowledge. Cecere and Ozman (2014) define recombination as the process of tying existing elements of the product that were not previously connected. Recombinant innovation is the development of new goods, services, and processes by combining existing technology and concepts in unique ways (Bessant and Trifilova, 2017). There are many examples of recombinant innovation. One example is Kodak's choice to combine technology initially designed for quick film coating into high-speed printing (Tidd and Bessant, 2020).

Recombinant innovation provides various benefits to firms looking to bring innovation. First, it is cost-effective since it saves research and development expenditures by using existing resources inside the firm. Second, because corporations depend on previously established technology, recombinant innovation presents less risks than introducing completely new concepts.

Furthermore, it promotes a creative culture in firms by requiring employees to think outside the box and experiment with previously untested combinations (Rush et al., 2012).

2.1.2 Innovation Ecosystem

The development of an innovation depends on the people and resources of a company. Small firms and startups need help to innovate independently. Collaboration with other organizations interested in exploring new opportunities is crucial for developing a successful value proposition (Williamson & De Meyer, 2012). This collaboration results in what is called an innovation ecosystem. In other words, an innovation ecosystem is a network of several companies and institutions that work together to develop and promote innovation (Adner, 2017). It is a group of people who contribute to the innovation process by exchanging information, data, and experience. The ecosystem's members might include government agencies, suppliers, customers, research institutes, and rivals. Williamson and De Meyer (2012) underline how important it is to understand the value of each resource inside the innovation ecosystem because the resources of other ecosystem members might enhance an organization's resources. This insight emphasizes the importance of ecosystem collaboration and resource sharing in driving forward innovation and competitiveness. Visscher et al. (2021) agree that building an ecosystem is crucial for firms' operational execution and strategic planning. Organizations may increase operational efficiency and strategic alignment by building strong networks of partners, suppliers, consumers, and other stakeholders.

The existing literature provides data on innovation ecosystem analysis. However, there is a need to study the structure of an ecosystem and its interconnected layers in the context of Kazakhstan.

2.1.3 Innovation Capabilities

The organization must produce new ideas and effectively apply them to support innovation inside a corporation (Bai et al., 2016). Innovation capability is the ability to generate new products and valuable knowledge. It is essential for every company to remain competitive and adapt to the continuing technological changes (Saunila, 2020). Companies demonstrate their ability to develop new ideas and innovations by launching new products, processes, organizational structures, and marketing strategies (Rajapathirana, 2018). According to Gault (2018):

Product innovation involves creating or improving products and services with new features and functionality. This form of innovation allows organizations to grow into new markets.

Process innovation involves implementing new techniques and approaches to increase efficiency in production and operations. Such company operations adjustments might result in cheaper costs, shorter production cycles, higher productivity, and more customer satisfaction.

Organizational innovations are innovative structures, managerial concepts, and administrative processes used inside a corporation. According to Shanker et al. (2017), this innovation is related to optimizing internal procedures and systems to encourage a collaborative and idea-sharing environment.

Marketing innovation is using novel ways and tactics to sell products and services. The primary purpose of marketing innovations is to meet market requirements, attract new consumers, and boost the company's profitability.

2.1.4 Innovation Drivers

Innovation significantly contributes to economic growth, company performance, and societal progress. Thus, understanding what drives innovation is important.

Comprehension of the reason people innovate is the direct determinant of innovation drivers, which is valuable for further achievements and success - these are so called motivators for people to go beyond their responsibilities and comfort zone. (Baporikar, 2014) According to the author, organizations strive to innovate while they go through the crisis, when they are out of success or are on the way and the activities leading to innovations become a response to the external dangers. In this case, the definition of innovation drivers is straightforward: customer dissatisfaction, high costs, threats from new entrants to the market etc.

Another case, when organizations are successful and to some extent have an ongoing process of innovation, even if it might be not formal. They themselves understand the importance of innovation efforts, but the drivers are not evident.

Neeta Baporikar proposes a list of 10 most common innovation drivers, some of which are also mentioned in the other studies. They are the following: the individual, the team, the enterprise, processes, offerings, psychological climate, psychological environment, organizational culture, economic climate/ market conditions, geopolitical culture.

A study by Kim and Park (2019) supports N. Baporikar's proposition on ten most common drivers. Authors conducted research to find out the links and compare company's culture and innovation in South Korea, while their focus is laid on small and medium-sized enterprises. They suggest that a supportive organizational culture fosters innovation capabilities.

Also, individual activity internally, work climate and access to technology play an important role in enabling and promoting innovation. (Rahman et al.; Lo, 2021; Lam et al., 2021)

Furthermore, studies by Hansen and Pihl-Thingvad (2019) and Frishammar et al. (2012) are confirming that the management and leadership style as well as a corporate strategy directly influence innovation capability thus either fostering or weakening innovativeness within companies.

Last but not least, research by Zeng et al. (2010) and Talmar et al. (2020) define that external factors like collaborations with other organizations, institutional support, customers and external knowledge contribute to the company's innovation capability.

Finally, innovation drivers are essential not only for companies to succeed but also to survive and thus defining the drivers and strengthening them is vital.

2.2 Entrepreneurial Landscape of Kazakhstan

2.2.1 Technological startups

Technological startups are the integral part of the entrepreneurial landscape driving innovation, bringing societal advancement and enforcing economic growth.

As per Malkin P. who is a researcher and developer, Ph.D., professor and a serial technological entrepreneur, a CEO of international startup incubator "StartUpLab" technological entrepreneurship is the concept of transformation of research and the potential of research institutions into new products and services, which significantly expand and bring value to consumers and provide a fast economic growth in future, ensuring effective and synergistic relationship between science and business (Ivanov, 2019)

2.2.2 Small and Medium Enterprises (SMEs)

Small and medium enterprises are the basis of any country's economy. It's a leading sector, which defines the dynamics and agility of economic growth. Without the development of small and medium businesses, discussing the country's macroeconomic situation becomes complex. Due to that, SMEs in Kazakhstan were defined as the key sector (Bektembayeva et al., 2013).

According to the research article SMEs have three major characteristics:

1. SMEs play a significant role in the country's economic growth. SMEs must account for the main part of the economic sector, because they generate more revenue. These businesses are characterized by high dynamics and strong entrepreneurial activities.
2. SMEs are the major source of innovation. Such organizations are more and more innovative, attractive for research and development in innovations in developing existing technologies, creating products or agile services.

Chapter 3. Methodology

Figure 1 represents the flowchart of our research, starting with the identification of aim and scope and setting research questions, literature review and designing research approach.

The research design chosen for this study is a mixed-methods approach, it offers several advantages when evaluating effectiveness of innovations considering its complexity and multifaceted nature (Creswell & Creswell, 2017). Data will be collected through surveys, interviews, observations, and literature review. As defined by Johnson et al. (2007), a mixed-methods approach is “... the type of research in which a researcher or team of researchers combine elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.”

There are two stages of the research process: collection and analysis of qualitative data, which is then used as a basis on which to build and collect quantitative data.

The research question considers the complex interaction between internal and external factors influencing the effectiveness of a recombinant innovation ecosystem within the context specific to Kazakhstan.

First advantage of the mixed-method approach is a deep insight enabled by integrating qualitative insights with quantitative data, thus, providing a deeper understanding of the startup’s effectiveness. Qualitative methods, such as surveys and interviews, focus on subjective experiences, attitudes, behaviors, and perceptions. Quantitative evaluation helps to identify relationships and trends; in this study, the innovativeness of High Tech XXI is evaluated based on the number of ideas and the quality of these ideas, results of implementation and economic benefits. Also, motivational factors will be evaluated using an analytic hierarchy process.

Second, qualitative analysis is utilized to explore the contextual factors that shape innovation adoption, regulatory challenges, and market dynamics. These factors include socio-economic, organizational and other environmental factors specific to Kazakhstan. Organizational context will be evaluated based on the interviews, surveys, and company documents that show the internal structure, business processes, and culture of the High Tech XXI through evaluation of

company maturity and building of causal loop diagram. Environmental conditions and geographical location of the company are other important aspects to consider.

Third, flexibility of mixed-methods approach is one of the key advantages; the process of data collection can be iterative, depending on the emerging findings, unexpected challenges, or changes in the context of the study.

Overall, the mixed-methods approach is a versatile methodology for addressing complexity and multiple aspects of the topic.

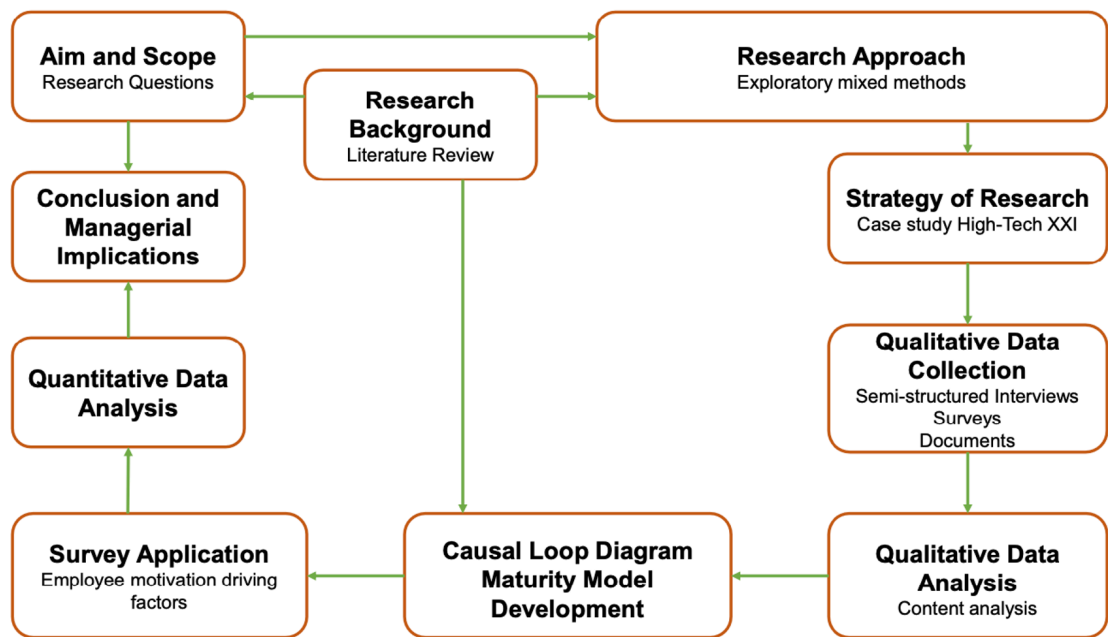


Figure 1. Methodology flowchart

3.1 Data collection method

A combination of semi-structured interviews and surveys is utilized to explore the effectiveness of innovations within High Tech XXI. The selection of these tools is guided by several considerations, outlined below.

Semi-structured interviews enable flexibility and understanding of personal perspectives and experiences, perceptions and insights. This type of interview implies open-ended questioning, having a certain list of questions but allowing additional questions based on the unfolding perspectives and unexpected insights, providing vast data for analysis (Smith, 2018). Comprehensive understanding of innovation processes, organizational dynamics, and contextual factors can be identified through a dialogue with participants (Creswell & Poth, 2018). Also, interviews help to engage with key stakeholders within High Tech XXI, including its employees, managers, and executives. This thorough examination of subjective experiences and perceptions allows us to understand

the “how” behind the innovation processes. On the other hand, semi-structured interviews with government representative and the head of Technopark allow us to explore the socio-economic, organizational, and regulatory environment specific to Kazakhstan that shapes High Tech XXI's innovation ecosystem. These factors include technology and process standardization practices in the government, tax benefits and other benefits from Technopark. This contextual understanding is crucial for addressing the "within the context of Kazakhstan" aspect of the research question.

Surveys enhance the qualitative insights obtained from the semi-structured interviews by yielding quantitative data on key variables and constructs of interest. The selection of surveys was guided by the following reasons: first, surveys allow to generalize findings to a broader population of employees within the company (Fowler, 2013); second, surveys enable comparative analysis across different organizational units within the company (Dillman et al., 2014). Factors, which influence innovation outcomes and performance, can be identified by disaggregating survey data and examining various patterns. By comparing and integrating quantitative survey data and qualitative interview data, the findings can be validated and triangulated, and reliability of the research findings can be enhanced (Creswell & Creswell, 2017).

To sum up, the selection of these methods as research tools is based on their complementary strengths in gathering and analyzing rich qualitative insights and quantitative data. By combining these methods, the understanding of innovation effectiveness within High Tech XXI can be provided.

Table 1 shows the list of individuals that were interviewed and/or surveyed. Government representative from the Ministry of Energy was invited to participate in the interview to gain insights into external factors that affect startup companies in Kazakhstan and to provide inputs to the causal loop diagram.

Technical director of High Tech XXI was the focal point and main source of information for the project. We have conducted two interviews to understand how the company operates, their internal processes, and organizational structure, while two surveys were aimed at understanding motivation factors and developing the company maturity model. Similarly, the executive director was invited to interview to gather his insights and vision.

The main challenge during data collection was the difficulty in scheduling the interviews with stakeholders due to the limited amount of time, careful

planning and flexibility helped overcome the challenge, but the interviews were delayed or canceled several times. Another challenge was setting realistic timelines for the interviews and surveys, but we have defined a clear roadmap for the project with all required deadlines, thus ensuring timely completion of the research.

Table 1. Summary of interview and surveys participants

Participant	Company	Job Title	Role	Interview	Survey
1	Ministry of Energy, RoK	IT Architect	Government representative with experience in the construction industry, standardization, startups	1	N/A
2	Astana-Technopark	Head of Technopark	Support of innovative companies, development of cooperation between Technopark residents and NU community	1	N/A
3	High Tech XXI	Technical Director	Decision making, customer relations, sales, marketing, supplier relations	2	2
4		Executive Director	Final decision making, customer relations	1	2
5		Senior Engineer 1		N/A	1
6		Senior Engineer 2	Development of technical solutions, project delivery and supervision	N/A	1
7		Senior Engineer 3		N/A	1
8		Senior Engineer 4		N/A	1
9		Technician 1		N/A	1
10	Technician 2	Installation, calibration and maintenance of AMS	N/A	1	
11	Technician 3		N/A	1	

Motivation survey was conducted among top managers (technical and executive director), senior engineers and technicians of the company to shed light on the motivational factors of employees at different levels of organization. Survey questions will be discussed in detail in the following sections.

3.2.1 Interviews

To collect information about the current status and specific factors that drive innovation within technological startup interviews with the technical director of a High Tech XXI company were conducted. To achieve the objective in our study we used a semi-structured open ended interview approach. This approach allowed us to identify less apparent and commonplace factors. The interview questions were structured based on research form questions from the Research Methodology of Bryman and Bell (2011).

According to Bryman and Bell (2011) it is essential to inform participants of interviews about an aim of the study in order to ensure alignment between the interviewer and them. Thus, before conducting the interview the invitation with the detailed information about the purpose of the interview and research was sent to the respondent. Moreover, the respondent also received a non-disclosure agreement which protects shared information of the company. All of the interviews were conducted face-to-face.

The main objective of this study is identifying and comprehending how technologically innovative startup High Tech XXI sustains in their ecosystem. Consequently, to facilitate the interview effectively, we established a structured set of topics for the questioning. Following the guidelines of Bryman and Bell (2011) the interview was designed to be relevant to the research subject. Our interviews consisted of overarching themes. And each of them had a series of open ended questions in order to capture necessary information from the respondent about the company, experience and opinion.

Introductory questions: These queries are aimed to gather background information about the startup, and about the interviewee to facilitate a better understanding of his role within the company.

Organizational structure and business processes: These questions formed to understand how the company works and how they are structured, what departments contribute to the project. The primary objective was to gain insights into project dynamics, organizational structure, internal and external interactions, collaborations and potential challenges.

Innovation process: These questions focused on exploring the organization's and employees' perceptions of innovation. These themes of questions aimed to understand how innovation is defined within the organization, the motivations driving innovation, what initiatives undertaken to promote innovation, how many ideas were generated and how. And additionally, identify if the company has any innovation strategy.

3.2.2 Survey

To collect qualitative data for our study, questionnaire surveys were conducted. Survey's questions were designed in order to gather useful and relevant information from participants. The survey questions design was planned according to the Roopa S., (2012). The steps of our planning questionnaires were

initial review, then question content and format check, the layout and sequence of the questions, revision and the last step was approving final questions (Figure 2).

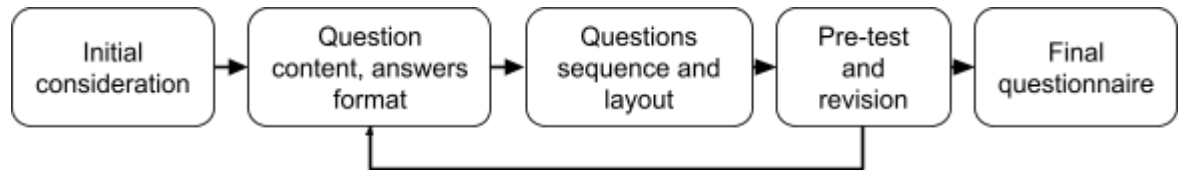


Figure 2. Questionnaire planning steps (adopted from Roopa 2012).

The questions were formed to be easily understood, simple and concrete. To receive the information about staff background and their experience the questionnaire was formed with multiple choice. Questions contained several answers, where participants of the survey should select options. To identify and measure the employee work motivation the answers were in a format of Likert scale. This approach aims to measure participant's attitude towards issues by offering different alternatives from strongly agree to strongly disagree (Schumacher et al., 2016). Likert scale in our survey has a one-dimensional scale with 7 variance of the answers.

For the maturity model of High Tech XXI development quantitative approach questionnaires were chosen. The survey questions are supported by research papers from the literature review and addressed to the executives of the company. The answer options for these questions were formed by selecting the level of the company. This survey was filled out by the technical director of High Tech XXI during the workshops; a full list of questions with responses can be found in Appendix C.

3.2 Data analysis

3.3.1 Causal Loop Diagram

Causal loop diagrams outline causal relationships between different variables, it is a powerful tool in systems thinking helping to understand complex systems, where the hidden connections between seemingly independent events can be identified.

CLDs consist of two main elements: variables and arrows. Variables represent the key elements or factors within the system, for this project they were identified through literature review and interviews with experts and stakeholders. Arrows show the causal relationship between the variables and how a change in one variable affects the other, where positive (+) arrow means reinforcing influence and negative (-) is balancing influence of one variable on the other.

There are two stages involved in developing the CLDs: problem identification and development of a dynamic hypothesis (Sterman, 2001). As stated in the research question and objectives of the current project, we are considering the innovation ecosystem of technological startups in Kazakhstan, in the case of High Tech XXI. Our main goal was to analyze the High Tech XXI company ecosystem through thorough examination of the internal and external factors that shape the ecosystem.

When analyzing complex systems, CLDs offer a structured framework that ensures every relevant factor and their interactions are taken into account. This systematic approach encourages in-depth comprehension. Moreover, CLDs are useful in the formulation of hypotheses regarding the possible outcomes of system changes by identifying important feedback loops.

3.3.2 Maturity Evaluation

The maturity model was selected to analyze the company innovation system. This tool can help business leaders assess their degree of innovation maturity and identify key areas for improvement in development of new products. The assessment of the maturity stage of High Tech XXI was carried out on the basis of following research papers: Nicholas & Ledwith, 2006; Kahn et al., 2006. These studies are aimed to analyze key success factors across six main dimensions: strategy, process, performance evaluation, people, portfolio management and market research. Each factor is evaluated on five levels of sophistication, ranging from poor practice to best practice.

In the scope of our capstone project, the company manager was asked to answer the questions across six main process areas. The answers to the questions were evaluated by the manager on a scale represented by the levels of development of each area, from the absence of a formal process to full integration with the mission of the organization. The questionnaire was developed based on the concept presented in the study (Florijn, 2017) and addressed to a representative of the company in printed form on paper.

- **Strategy.** The mentioned research works emphasize the importance of a strategic alliance with other activities of the company, as it defines a clear direction for the entire functionalities of the organization. The companies that achieve the best results are those who have a strategy that sets clear goals and strategically focuses on key product development stages. The manager of High Tech XXI answered questions about the clarity, consistency and flexibility of the company's strategy.
- **Process.** Product development largely consists of a well-established ideation process. The inability of employees to test their proposals due to poor implementation of ideas can negatively affect employee engagement. The companies that have a clear scheme from the proposal of an idea to its test / implementation is considered a company with the best practice.
- **Performance evaluation.** In order to evaluate the performance of each stage and overall product development process, organizations should have metrics for the evaluation. For example, research has shown that companies that determine the financial performance indicators for projects are better at product development.
- **People.** Research shows the importance of competent, coordinated teams responsible for various aspects of projects. The key success factors are high management support for their employees, as well as the effectiveness of internal communications and division of labor. The questions included team leadership assessment, employee engagement, and talent development aspects.
- **Portfolio management.** The company's capacity to prioritize project concepts and balance resource allocation identifies its ability to effectively perform portfolio management. The clear technique aimed at maximizing the strategic alignment of portfolio with company strategy is a key for the organization's success in this process area. The questions were selected to gain insight into the company's resource allocation balance and project prioritization process.

- **Market research.** Product development process considers the on-going process of evaluation of external factors of the company such as analysis of competitors and market studies. This process also is directed to the identifying customer need through continuous industry evaluation and product testes in the market. The best practice considers the strict alignment and established process of performing these activities.

3.3.3 Analytic Hierarchy Process

According to the research of Saaty (1987) the analytical hierarchy process (AHP) is a method for multicriteria decision making. This method helps to analyze complex decisions by structuring into a hierarchy of criteria or alternatives. By Saaty (1987) there are four phases in Analytical Hierarchy Process:

- 1) Problem modeling;
- 2) Hierarchy structuring;
- 3) Weights evaluation by importance according decision maker;
- 4) Prioritizing.

Firstly, it is essential to develop graphical representation for the problem. Secondly, is prioritizing criteria for decision alternatives, and development of pairwise comparison of the criteria. The pairwise comparison measures by numerical scale (Saaty, 1987). The next step is to create a pairwise comparison matrix for determining the priorities for the used criteria. Then it is needed to calculate the weights of the criteria and priorities.

The numerical scale proposed by Saaty is defined mathematically as function f , where A is a set of alternatives: $f: A \times A \rightarrow S$. To solve the problem by using AHP the following steps should be applied (Rawat,S. 2022) :

- 1) Pairwise comparison matrix formation: $A=[a_{ij}]$.

$A =$

$$\begin{bmatrix} 1 & a_{12} & a_{13} \\ \frac{1}{a_{12}} & 1 & a_{23} \\ \frac{1}{a_{13}} & \frac{1}{a_{23}} & 1 \end{bmatrix}$$

where , $a_{12}, a_{13}, a_{23} \in S$

- 2) Pairwise comparison matrix evaluation: $\bar{A}=[\bar{a}_{ij}]$

$A=$

$$\begin{bmatrix} \overline{a_{11}} & \overline{a_{12}} & \overline{a_{13}} \\ \overline{a_{21}} & \overline{a_{22}} & \overline{a_{23}} \\ \overline{a_{31}} & \overline{a_{32}} & \overline{a_{33}} \end{bmatrix}$$

Where, $\overline{a_{ij}} = \frac{a_{ij}}{\sum_{k=1}^3 a_{kj}}$

3) Normalized Eigen Vector evaluation:

$$w_i = \frac{\sum_{k=1}^3 \overline{a_{ik}}}{3}$$

4) Principal Eigen value evaluation:

$$\lambda_{max} = \sum_{j=1}^3 \left(\sum_{i=1}^3 \overline{a_{ik}} \right) w_j$$

5) Consistency ratio:

$$CR = \frac{CI}{RI}$$

Where, $CI = \frac{(\lambda_{max} - n)}{n-1}$ and RI is a random index.

This approach was used in a study of Lo, T. (2021) in order to incorporate the vagueness of human judgments in the topic of innovation performance. To be specific for developing an index of innovation performance in the construction industry.

Chapter 4. Results

4.1 Ecosystem Dynamics Analysis

To develop a comprehensive understanding of the innovation ecosystem of High Tech XXI, a CLD was constructed using the multi-methodology approach in two phases. Phase 1 involved aggregation of factors and processes. Phase 2 was about establishing causal relationships between processes. During Phase 3, the preliminary version of the CLD was constructed. The final version was presented in Phase 4.

4.1.1 Phase 1: Factor Aggregation

In this stage, the initial set of factors for the CLD was determined. It involved 23 factors identified through literature review and 15 factors identified through in-depth interviews with experienced stakeholders, who have shared their informed opinions: Technical Director of High Tech XXI, a Senior Manager of Technopark, and a representative from the Ministry with a background in standardization and the construction industry. The list below presented all 38 factors, their type in relation to the company (internal or external) and a source.

Factors proposed by authors based on literature review:

1. Entrepreneurial mindset of the founder (Internal) (Kuratko et al. 2023)
2. Technical expertise of the management team (Internal) (Tidd, 2021)
3. Clarity of corporate innovation strategy (Internal) (Prange & Schlegelmilch, 2020)
4. Efficiency of resource allocation for innovation (Internal) (Durana et al., 2020)
5. Supportive work climate for creativity (Internal) (Newman et al., 2020)
6. Effective ideation processes (Internal) (Campos-Blázquez et al., 2020)
7. Flexible organizational structure (Internal) (Afuah, 2020)
8. Continuous know-how development (Internal) (Pesch, 2021)
9. Encouragement of individual innovative activities (Internal) (van Essen et al., 2022)
10. Strength of informal networks within the company (Internal) (Horak et al., 2020)
11. Collaboration with universities and research institutions (External) (Tseng et al., 2020)
12. Partnerships with other companies in the industry (External) (Portna et al. 2020)

13. Engagement with customers and end-users (External) (Compagnucci et al., 2021)
14. Responsiveness to market trends and demands (External) (Ebersberger & Kuckertz, 2021)
15. Intensity of competition in the geotechnical sensor market (External) (Bouncken et al., 2020)
16. Availability of government grants and subsidies for innovation (External) (Wu et al. 2020)
17. Access to venture capital and angel investments (External) (Shuwaikh & Dubocage, 2022).
18. Presence of intellectual property protection mechanisms (External) (Neves et al. 2021)
19. Quality of technological infrastructure in the region (External) (Tang et al. 2021)
20. Availability of skilled workforce in relevant fields (External) (Horbach & Rammer, 2022)
21. Societal acceptance of entrepreneurship and risk-taking (External) (Ilevbare et al. 2022)
22. Bureaucratic hurdles in obtaining permits and certifications (External) (Courtade, 2020)
23. Resistance to change within the company (Internal) (Haesevoets et al., 2022)

Factors proposed by field experts based on interviews

24. Participation in government-funded smart city initiatives (External) (Senior Manager of Technopark, Representative from the Ministry)
25. Collaboration with international geotechnical sensor manufacturers (External) (Technical Director of High Tech XXI)
26. Availability of local suppliers for sensor components (External) (Technical Director of High Tech XXI, Senior Manager of Technopark)
27. Adoption of Industry 4.0 technologies in the construction sector (External) (Representative from the Ministry)
28. Participation in international trade fairs and exhibitions (External) (Technical Director of High Tech XXI, Senior Manager of Technopark)

29. Collaboration with local universities on sensor research and development (External) (Technical Director of High Tech XXI, Senior Manager of Technopark, Representative from the Ministry)
30. Availability of government-sponsored training programs for sensor technicians (External) (Senior Manager of Technopark, Representative from the Ministry)
31. Establishment of a dedicated sensor testing and calibration facility (Internal) (Technical Director of High Tech XXI)
32. Development of a comprehensive after-sales service network (Internal) (Technical Director of High Tech XXI)
33. Integration of geotechnical sensors with Building Information Modeling (BIM) systems (Internal) (Technical Director of High Tech XXI, Representative from the Ministry)
34. Customization of sensor solutions for specific client requirements (Internal) (Technical Director of High Tech XXI)
35. Dependence on imported sensor components (External) (Technical Director of High Tech XXI, Senior Manager of Technopark)
36. Size of dedicated R&D budget (Internal) (Technical Director of High Tech XXI, Senior Manager of Technopark)
37. Employee turnover rate (Internal) (Senior Manager of Technopark)
38. Protection against intellectual property infringement (External) (Technical Director of High Tech XXI, Representative from the Ministry)

The identified 38 factors happened to be about activities of key stakeholders: company management, employees, competitors, local and international partners, government, and customers.

4.1.2 Phase 2: MICMAC analysis

If Phase 1 was about identifying 38 important factors & processes, Phase 2 established the relationships between these factors & processes. Among the identified factors, some factors are closely related to each other. For some pairs of such factors, a direct strong causal-and-effect relationship could be established. This would facilitate the search for critical elements and leverage points in the system. Such analysis would be a foundation for the development of further actionable strategies.

relationships were marked as strong, while 26% were moderate and 68% were weak. Table 2 presents all 42 pairs of strong relationships. For better clarity, further analysis is focused on strong relationships between factors and processes.

Pairwise comparison revealed the strengths of relationships, but it did not show direction of relationship to indicate which of the factors is a predecessor and which is a successor. According to the methodology for creating the CLD by Dhirasasna & Sahin (2019), the direction of relationships can be determined by authors using the literature review.

After conducting an additional literature review, factors were marked as either cause or effect (Table 3). The exact status depends on the relationship, so that in pairs “factor 1 → factor 3”, factor 3 is the effect. On the other hand, in the pair “factor 3 → factor 14”, factor 3 is the cause. This feature enables building a complex network of relationships, including self-closed loops.

Table 3 also indicates direction of movement, marked as either “same” or “opposite”. In causal loop diagrams, "same" means that an increase (decrease) in the cause leads to an increase (decrease) in the effect, while "opposite" indicates that an increase (decrease) in the cause results in a decrease (increase) in the effect. For instance, a more supportive work climate (factor 5) leads to reduced employee turnover rate (factor 37). This is an example of the opposite direction of movement.

Table 3. Preliminary List of Key Causes and Effects based on MICMAC analysis

Cause	Effect	Movement Direction (S - Same; O - Opposite)
1. Entrepreneurial mindset of the founder	3. Clarity of corporate innovation strategy	S
1. Entrepreneurial mindset of the founder	9. Encouragement of individual innovative activities	S
2. Technical expertise of the management team	8. Continuous know-how development	S
3. Clarity of corporate innovation strategy	4. Efficiency of resource allocation for innovation	S
3. Clarity of corporate innovation strategy	6. Effective ideation processes	S

3. Clarity of corporate innovation strategy	7. Flexible organizational structure	S
3. Clarity of corporate innovation strategy	8. Continuous know-how development	S
3. Clarity of corporate innovation strategy	14. Responsiveness to market trends and demands	S
3. Clarity of corporate innovation strategy	36. Size of dedicated R&D budget	S
4. Efficiency of resource allocation for innovation	6. Effective ideation processes	S
4. Efficiency of resource allocation for innovation	8. Continuous know-how development	S
4. Efficiency of resource allocation for innovation	17. Access to venture capital and angel investments	S
4. Efficiency of resource allocation for innovation	31. Establishment of a dedicated sensor testing and calibration facility	S
4. Efficiency of resource allocation for innovation	36. Size of dedicated R&D budget	S
5. Supportive work climate for creativity	8. Continuous know-how development	S
5. Supportive work climate for creativity	9. Encouragement of individual innovative activities	S
5. Supportive work climate for creativity	23. Resistance to change within the company	O
5. Supportive work climate for creativity	37. Employee turnover rate	O
6. Effective ideation processes	9. Encouragement of individual innovative activities	S
6. Effective ideation processes	34. Customization of sensor solutions for specific client requirements	S
7. Flexible organizational structure	23. Resistance to change within the company	O
9. Encouragement of individual innovative activities	8. Continuous know-how development	S
8. Continuous know-how development	20. Availability of skilled workforce in relevant fields	S
8. Continuous know-how development	29. Collaboration with local universities on sensor research and development	S
36. Size of dedicated R&D budget	8. Continuous know-how development	S

9. Encouragement of individual innovative activities	23. Resistance to change within the company	O
9. Encouragement of individual innovative activities	37. Employee turnover rate	O
11. Collaboration with universities and research institutions	20. Availability of skilled workforce in relevant fields	S
11. Collaboration with universities and research institutions	29. Collaboration with local universities on sensor research and development	S
25. Collaboration with international geotechnical sensor manufacturers	12. Partnerships with other companies in the industry	S
13. Engagement with customers and end-users	14. Responsiveness to market trends and demands	S
13. Engagement with customers and end-users	34. Customization of sensor solutions for specific client requirements	S
27. Adoption of Industry 4.0 technologies in the construction sector	14. Responsiveness to market trends and demands	S
14. Responsiveness to market trends and demands	34. Customization of sensor solutions for specific client requirements	S
16. Availability of government grants and subsidies for innovation	36. Size of dedicated R&D budget	S
17. Access to venture capital and angel investments	36. Size of dedicated R&D budget	S
18. Presence of intellectual property protection mechanisms	38. Protection against intellectual property infringement	S
20. Availability of skilled workforce in relevant fields	37. Employee turnover rate	O
23. Resistance to change within the company	37. Employee turnover rate	S
26. Availability of local suppliers for sensor components	33. Integration of geotechnical sensors with BIM systems	S
26. Availability of local suppliers for sensor components	35. Dependence on imported sensor components	O
33. Integration of geotechnical sensors with BIM systems	34. Customization of sensor solutions for specific client requirements	S

4.1.3 Phase 3: Preliminary Causal Map

Based on the list of identified factors and data from Table 3, a preliminary causal map was constructed to visualize the strong relationships between the factors (Figure 4). Multiple causal chains can be traced using this diagram. For example, the entrepreneurial mindset of the founder (factor 1) leads to clarity of corporate innovation strategy (factor 3), which further leads to an increased size of R&D budget (factor 36), which enables continuous know-how development (factor 8).

Figure 4 shows three emerged networks, with the largest one consisting of 25 factors, and two smaller networks consisting of only 2 factors each. The remaining 9 factors were “orphans”, with no strong relationship connections to the larger networks of factors.

Figure 4 has unconnected concepts, does not have any loops and also does not consider financial performance of the company. To address this incompleteness, additional phase 4 was conducted.

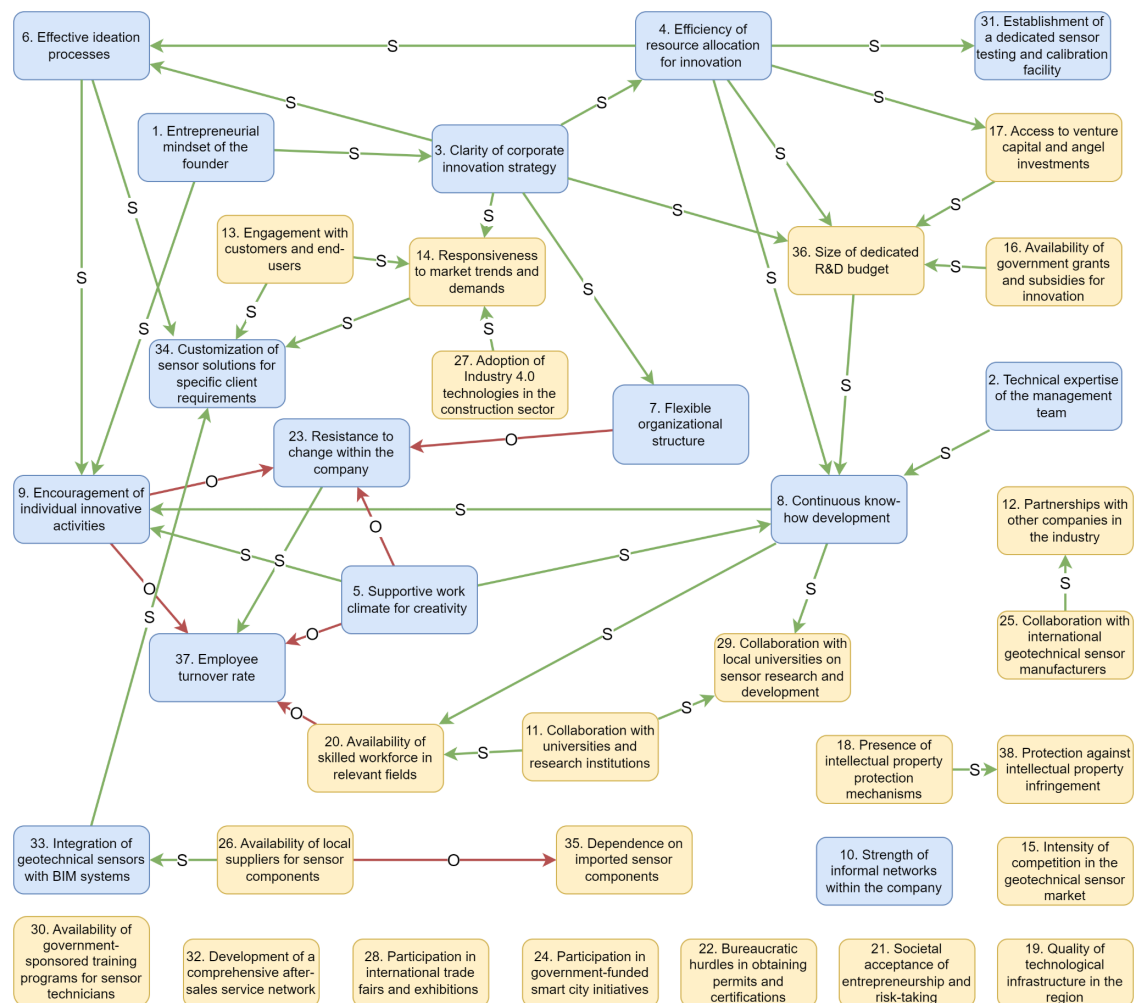


Figure 3. First draft of a causal map showing only strong relationships.

In Figure 3, “S” represents movements in the same direction (i.e. an increment in factor A leads to an increment in factor B), “O” - opposite (i.e. an increment in factor A leads to a decrease in factor B). Blue colored factors are internal, yellow colored - external.

4.1.4 Phase 4: Final Causal Loop Diagram

Additional rounds of workshops with the technical director of High Tech XXI were conducted to carefully scrutinize the preliminary causal loop diagram. During these workshops, concepts were removed, changed and added. The complete list of changes is presented below, with a revised version of the CLD presented in Figure 5.

Removed factors:

- Technical expertise of the management team
- Bureaucratic hurdles in obtaining permits and certifications
- Participation in government-funded smart city initiatives
- Availability of local suppliers for sensor components
- Adoption of Industry 4.0 technologies in the construction sector
- Participation in international trade fairs and exhibitions
- Availability of government-sponsored training programs for sensor technicians
- Establishment of a dedicated sensor testing and calibration facility
- Development of a comprehensive after-sales service network
- Integration of geotechnical sensors with Building Information Modeling (BIM) systems
- Dependence on imported sensor components
- Societal acceptance of entrepreneurship and risk-taking
- Presence of intellectual property protection mechanisms
- Partnerships with other companies in the industry

Changed factors:

- "Efficiency of resource allocation for innovation" changed to "Efficiency of resource allocation"
- "Effective ideation processes" changed to "Effectiveness of ideation processes"
- "Collaboration with local universities on sensor research and development" changed to "Collaboration with universities and research institutions"

Newly added factors:

- Market Share
- Market attractiveness
- Customer Satisfaction
- Employee satisfaction
- Product and Service Innovations
- Economies of Scale
- Profitability
- Investment in Talent Development
- R&D performance evaluation quality
- Product/Service Quality
- Quantity of Customer Feedback
- Continuous Learning

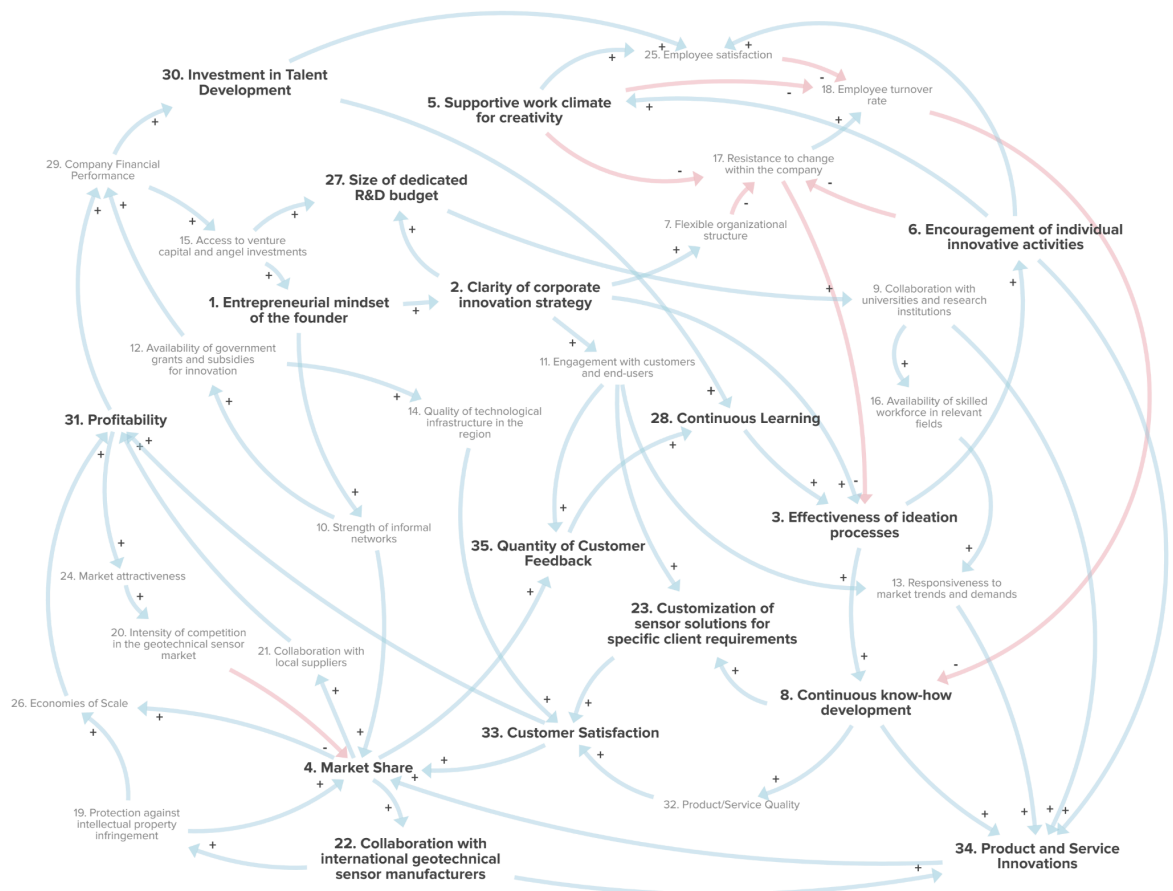


Figure 4. Final version of the causal loop diagram

Figure 5 depicts 36 processes and their relationships with the other factors. Figure 5 has 413 causal loops and several can be highlighted for exemplary purposes. The list below describes few notable loops and causal chains:

- The first loop shows the role of talent development: (30. Investment in talent development) → (28. Continuous learning) → (3. Effectiveness of ideation processes) → (8. Continuous know-how development) → (34. Product and service innovations) → (4. Market share) → (26. Economies of scale) → (31. Profitability) → (29. Company financial performance) → (30. Investment in talent development). This is a reinforcing loop, demonstrating how talent development has a positive impact on financial performance, which in turn enables talent development. This chain also illustrates the moderating effect of ideation processes and the ability of the company to develop know-how. If these processes are ill-developed, investments in talents are likely to be ineffective.
- Another important role of talent development is that it directly increases employee satisfaction. High employee satisfaction is needed to reduce turnover rate. Turnover rate is detrimental to the company, as “brain-drain” negates the continuous know-how development. Employee satisfaction can also be achieved through a supportive work climate. Such a climate often reduces employee’s resistance to change within the company, which in turn means that turnover rate will be lower.
- Another important causal chain shows the role of innovation strategy: (2. Clarity of corporate innovation strategy) → (11. Engagement with customer and end-users) → (23. Customization of sensor solutions for specific client requirements) → (33. Customer satisfaction) → (4. Market share). This chain demonstrates why efforts shall be made into shaping and clarifying the innovation strategy. If present and set up correctly, it will lead to more goal-oriented interaction with customers with an aim of extraction of valuable information for further specialization of solutions. If a company is successful in adapting its sensors, it is likely to achieve customer satisfaction, which in turn may directly increase company profitability.
- Another loop shows how customer satisfaction depends on the amount of feedback received from them: (4. Market share) → (34. Quantity of customer feedback) → (28. Continuous learning) → (3. Effectiveness of ideation processes) → (8. Continuous know-how development) → (32.

Product/service quality) → (33. Customer satisfaction) → (4. Market share). This causal loop demonstrates that winning market share is crucial for the company, as it will be able to gain more feedback to reflect on, and so it will be able to improve the quality faster.

- CLD analysis also reveals that market share is not only a goal in and of itself, but also a tool to achieve other goals. For example, higher market share means that local partners and, even more importantly, foreign partners are more willing to collaborate. This generates a short reinforcing loop, when intellectual property protection is considered: (4. Market share) → (22. Collaboration with international geotechnical sensors providers) → (19. Protection against intellectual property infringement). If High Tech is able to secure the partnership with an international partner, they get the protection of IP, and can leverage this to win even more market share.
- Size of the R&D budget is also important for the company, as it is used to stimulate collaboration with universities and research institutes, which sometimes leads to product and service innovations. Three sources of R&D budget are a company's financial gains, venture capital and government grants.
- Figure 5 also has a balancing loop that closely portrays implications of Porter's analysis. High market share of a company increases its profitability. Profitability of one company makes the whole industry more attractive for new entrants. However, these new entrants generate competitive intensity, which in turn reduces the company's market share. Simply speaking, this loop means that a company's financial gains lead to higher competition, which leads to company's financial losses. However, if a company has financial losses, it gives a signal to entrants that the industry is not good and so they stop entering the market. This enables High Tech XXI to slowly regain its financial performance.

4.2 Maturity Evaluation

High Tech XXI company was assessed by its technical director using the maturity model. The director filled up the survey and provided commentaries via a thinking-aloud method. The evaluation provided insights into the company's current state of innovation management practices. Based on the results, strength and potential improvement opportunities were identified. Six dimensions were

analyzed: strategy, processes, performance evaluation, people, portfolio management, and market research (Figure 6).

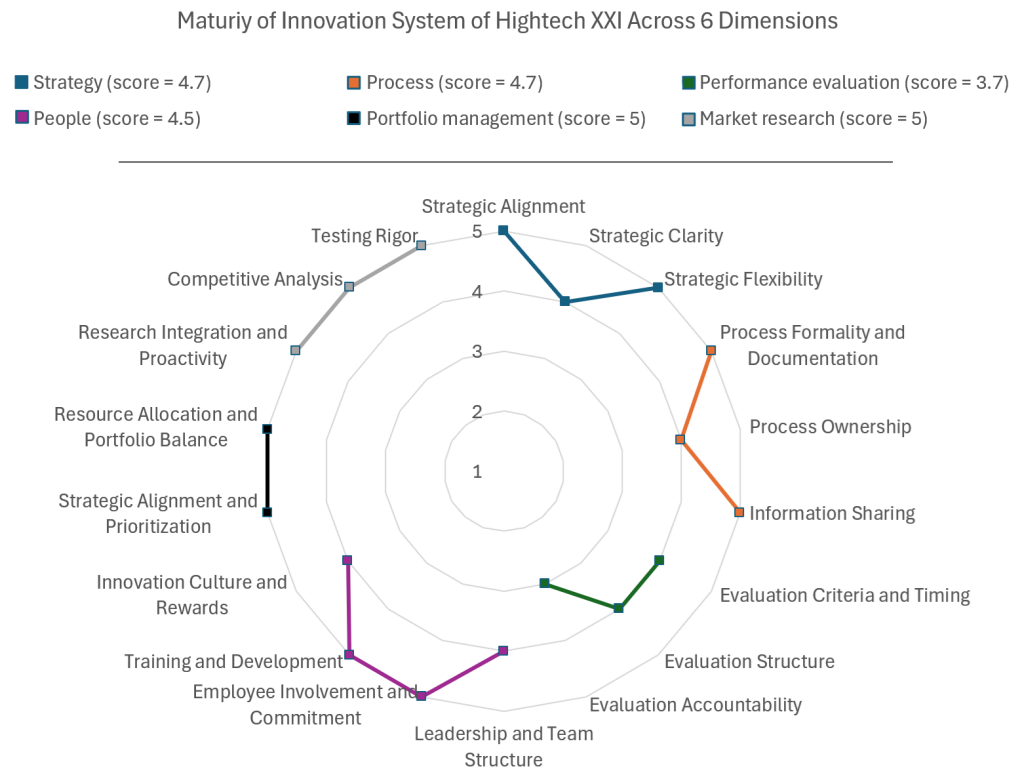


Figure 5. Maturity level of innovation system of High Tech XXI

4.2.1 Strategy

- High tech has a strong and well defined strategy for its innovation activities. Their innovations even set up the quality standards for the industry and also legal standards in Kazakhstan. This helps them capture substantial market share. (level 5 of 5, “optimized”)
- High Tech XXI’s innovation strategy is based on market needs and focuses on adaptation of internationally successful products of their partners for the local needs. (level 5 of 5, “optimized”)
- Innovation strategy is proactive in the sense that they anticipate general market trends, however they struggle to predict technological changes in the sensors industry. (level 4 of 5, “managed”)

4.2.2 Processes

- Processes are also well defined in the company, as the vast majority of processes have clear control points and quality check-in procedure. (level 5 of 5, “optimized”)

- The data about ongoing processes is available for all departments via a unified digital channel. However, process ownership can be further improved. (level 4 of 5, “managed”)
- Currently, many innovation and business processes require collaborative action from multiple departments. An improvement could be made in clearer separation of responsibilities. (level 5 of 5, “optimized”)

4.2.3 Performance Evaluation

- Quality of products is evaluated by end-users upon receiving them. However, this could be further improved if the feedback about quality could be delivered on a continuous basis in real time. (level 4 of 5, “managed”)
- Quality evaluation has its performance metrics and is supervised by the company leadership team, however it can benefit from further robustness checks from external agents. (level 4 of 5, “managed”)
- The quality score is measured by the project leader, who might have bias. Hence, an improvement can be made in either creating a separate department for quality control or by inviting external audit companies. (level 3 of 5, “defined”)

4.2.4 People

- Projects are executed through cross-functional teams with each member having a clear role. An improvement would be creating a separate project team where members focus on one project for the full-time, but also with a rotation of employees. (level 4 of 5, “managed”)
- Employees have high motivation and morale, as they are proud of their work. (level 5 of 5, “optimized”)
- Employees continually do professional training and receive certificates from courses. (level 5 of 5, “optimized”)
- Company has a reward system for innovative suggestions by employees, however the culture of innovation is only in an emergent stage. (level 4 of 5)

4.2.4 Portfolio Management

- Each project of High Tech XXI is carefully selected to maximize long-term value generation. (level 5 of 5, “optimized”)

- Resources are dynamically allocated to optimize risks and rewards in the working projects. (level 5 of 5, “optimized”)

4.2.5 Market Research

- Market research is performed on a continuous basis, looking for proactive research findings and customer needs. (level 5 of 5, “optimized”)
- Company performs in-depth analysis of competitors and strategic planning. (level 5 of 5, “optimized”)
- Innovative products are well tested before mass-scaled implementation. The testing is complex, involving pilot tests, feedback and improvement. (level 5 of 5, “optimized”)

4.2.6 Scoring

Average maturity levels in Portfolio Management and Market Research are 5.0 and 5.0, respectively. Henceforth, these two factors are the most developed and drive the company forward.

The moderately developed dimensions are Strategy (score = 4.7), Processes (score = 4.7) and People (score = 4.5)

On the other hand, the average level in Performance Evaluation is just 3.7. This may imply that performance measurement is a bottleneck for a company and needs to be improved first.

4.2.3 Comparison against Innovation Management Assessment Framework

The obtained results could be further re-used to see how well the company performs according to other innovation readiness assessment tools. Such models provide a diverse set of lenses to interpret the company's current stance.

A vastly different approach was explored by Lobo & Samaranayake in their innovation management assessment framework (2020). Authors suggested evaluating innovation systems by dividing them into six consecutive stages: Idea Discovery, Scoping, Business Case and Plan, Development, Testing and Validation, and Product Launch.

According to this model, High Tech XXI has a strong Generation and Preliminary Evaluation phases. This is achieved by good alignment between its strategy and market needs. Moreover, the company does lots of competitor analysis and this empowers their Concept Development.

The Product Definition phase could benefit from having more full-time, continuously focused employees. However, the most limited stage of the company is Scale-up & Verification, as product quality data, and customer feedback are not collected continuously.

4.3 Analysis of Employee Motivation

External factors that influence motivation of employees were examined using AHP survey, consisting of 5 motivation factors identified through literature review:

- Financial (salary and bonuses)
- Career (promotion at work and professional development)
- Recognition (assessment of achievements and efforts, awards, certificates, praise from colleagues and superiors)
- Avoidance (desire to avoid disciplinary action, punishment or dismissal)
- Social pressure (desire to meet the expectations of management, colleagues and society)

10 comparison pairs were constructed to match each factor against all others. The comparison was made using five option Likert scale: Equal Importance (corresponds to 1 point), moderate importance (3 points), strong importance (5 points), very strong importance (7 points), and extreme importance (9 points). In total, 9 surveys were collected. An exemplary calculation is prestende in the following subsection.

4.3.1. An Exemplary AHP Analysis of an Executive

A linguistic representation of responses of one of the executives is presented below:

- Financial motivation has equal importance with career motivation
- Financial motivation is moderately more important than recognition
- Financial motivation is moderately more important than avoidance
- Financial motivation is strongly more important than social pressure
- Career is moderately more important than recognition
- Career is strongly more important than avoidance

- Career is very strongly more important than social pressure
- Recognition is moderately more important than avoidance
- Recognition is moderately more important than social pressure
- Avoidance is strongly more important than social pressure

Table 4 shows transformation of survey inputs into AHP pairwise comparison matrix. Furthermore, each matrix element (M_{ij}) was divided by the sum of values in respective column j . This has produced a normalized pairwise comparison matrix (Table 5).

Table 4. An exemplary AHP pairwise comparison matrix

Factor	A	B	C	D	E
A. Financial	1	1	3	3	5
B. Career	1.00	1	3	5	7
C. Recognition	0.33	0.33	1	3	3
D. Avoidance	0.33	0.20	0.33	1	5
E. Social Pressure	0.20	0.14	0.33	0.20	1
sum	2.87	2.68	7.67	12.20	21.00

Table 5. An exemplary normalized comparison matrix

Factor	A	B	C	D	E	avg (weight)	rank
A. Financial	0.35	0.37	0.39	0.25	0.24	0.32	2
B. Career	0.35	0.37	0.39	0.41	0.33	0.37	1
C. Recognition	0.12	0.12	0.13	0.25	0.14	0.15	3
D. Avoidance	0.12	0.07	0.04	0.08	0.24	0.11	4
E. Social Pressure	0.07	0.05	0.04	0.02	0.05	0.05	5

In Table 5 an arithmetic mean of each row was computed to determine weight of respective weight and its relative importance rank. Additionally, a sensitivity test was performed using standard AHP sensitivity analysis procedure. For Table 5, $\lambda = 5.33$, $CI = 0.084$, $RI = 1.12$ (as $n=5$), and hence $CR = 0.075$. Since CR is below 0.10, this means that AHP matrix and thus judgements of respondent are consistent.

Results from Table 5 imply that for this particular executive, the most important factor is career (rank 1, weight = 0.37), the second is financial motivation (rank 2, weight 0.32). Recognition, avoidance and social pressure are third, fourth and fifth respectively, with weights of 0.15, 0.11, and 0.05.

4.3.2. AHP Survey Response Summaries

Factor weights for 2 executives, 4 engineers and 3 technicians were aggregated and summarized in Figure 6. The results revealed that there are

different motivation factors for different groups of employees. Executive directors are primarily motivated by career development and opportunities for growth, while engineers and technicians find financial rewards, such as salaries, bonuses, and other monetary incentives, to be their strongest motivation factor.

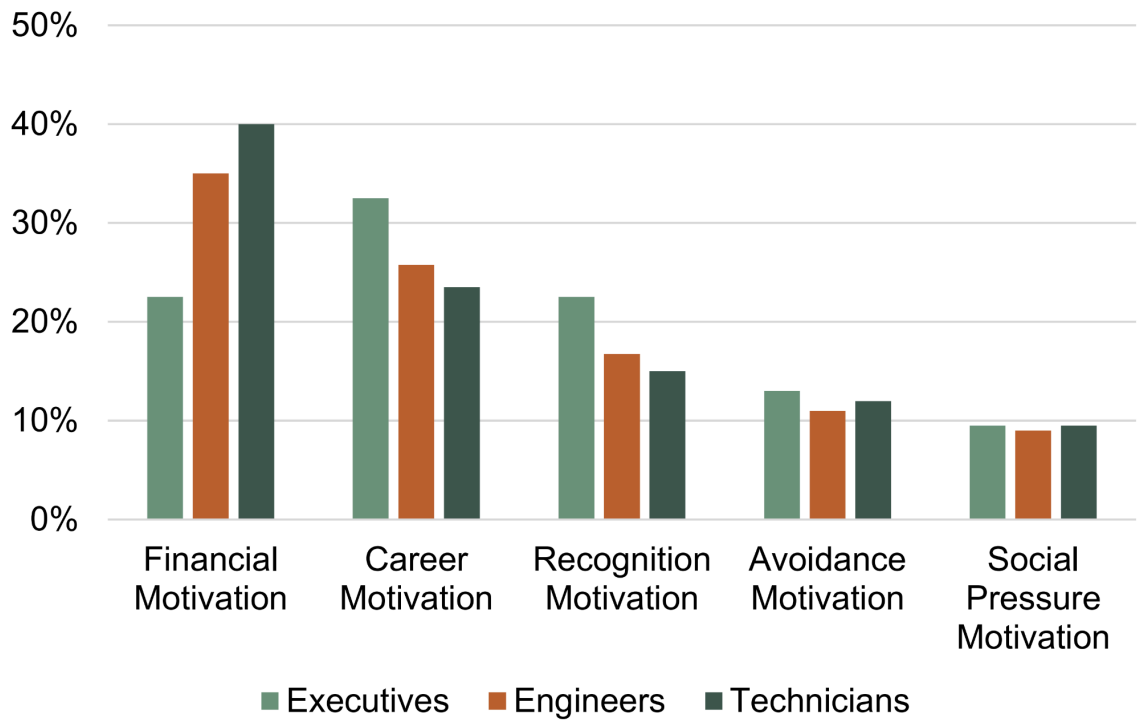


Figure 6. AHP analysis of motivations of employees

Chapter 5. Discussion

This section discusses how the major findings of this capstone project relate to the broader literature.

The first major result that arose from the dynamics analysis, is the foundational role of talent development. The analysis demonstrates how talent development increases organizational learning, effectiveness of ideation processes, and employee satisfaction. Empirical research confirms that talent development improves employees' sense of fulfillment and reduces turnover rate (Fang et al., 2020).

Talent development teaches employees to express their ideas and further develop them (Kaliannan et al., 2023). The literature proposes a concept of "inclusive talent development", which builds upon the benefits of looking at the problem from multiple perspectives. This approach highlights the importance of employee skill development across the organization, covering a diverse set of employees, not just a few top-performers or a small "innovations" department of the company. The effectiveness of such broad talent development programs is more evident in companies with younger employees, like High Tech XXI, as millennials are demanding and welcoming for any opportunities to grow (Kenney & Newcombe, 2011).

This study showed that talent development and supportive work climates are important factors leading to an increased innovative output of employees. A corporate social responsibility (CSR) is a term highly related to these concepts. Through CSR, companies show that they care about more than just profits, but also employee happiness, including their mental well-being and self-esteem (Alshebami, 2021). Empirical studies suggest that CSR is positively associated with enhanced firm-level innovation and performance (Palacios-Manzano et al. 2021). The exact mechanism remains unclear, but it involves aspects related to increased emotional resources to produce ideas, and positive emotional association to the company.

AHP analysis indicates that to make employees even more engaged and motivated, managers shall focus on providing financial reward (salary, bonuses) and career promotion for their employees. While Kuswati's research (2020) confirmed that higher motivation leads to substantially higher performance,

Soleas's (2020), in their systematic review, concluded that interest and fulfillment are generally more important drivers than external incentives. Cultivating a work culture, where employees have strong internal motivation shall be the focus of a long term strategy. However, for now, management of High Tech finds financial incentives as a more useful tool to manage employees.

The ecosystem dynamics analysis also showed that innovations are a collaborative process that involves not only company employees, but also partners and customers. CLD also demonstrated that customer satisfaction is higher when stakeholders participate in making customized products together. Loureiro et al.'s (2020) further suggest that such co-creation practices are stronger when goals are aligned and when socio-economic proximity is present. Since High Tech XXI serves construction companies of Astana, and is interested in their growth, the strategy of co-creation is well suited for this market.

However, maturity model evaluation showed that High Tech XXI collects customer feedback in only low volumes. Moreover, the data collection is not a continuous process, but happens only during sales. Nudurupati et al. (2021) highlighted that data collection through IoT sensors has transformed from a control tool, to more of an interaction tool. Continuous data collection could benefit both customers, through online access and advanced analytics, and High Tech XXI, by providing insights about their product performance over time and in different conditions. For now, High Tech misses the opportunity to leverage modern tools like big data and cloud computing, which were demonstrated to be useful even for SMEs (Liu et al., 2020). Hence, High Tech XXI can start collecting historical data from their sensors to use it in future.

Chapter 6. White Paper

6.1 Recommendation 1: Career Path and Mentorship Program

The objective of this part of the paper is to increase employee retention and to foster their skill development, while the very specific objectives are to achieve a 10% increase in employee retention rates and a 15% enhancement in employee skill proficiency within the next 12 months.

The consideration of a adoption of a mentorship program for achieving the goals listed above at High Tech XXI has arised due to the statistics represented by Harvard Business Review's article showing an evidence of 75% of executives who are giving credit of their achievements to their mentors and a recent research that demonstrate 90% of employees are happy at work who have a career mentor. (Gross, 2023)

Moreover, the Society for Human Resource Management and TalentLMS have conducted surveys with US-based HR managers and employees taking place in 2022 to understand the current trends in learning and development in America's workplaces. (2022) This report persuades that more than 8 of 10 HR managers are of the opinion that education and development initiatives are advantageous in both attracting (83%) and retaining (86%) skilled workforce, with nearly half (48%) of employees confirming that presence of training played a significant role in their decision to either join or not the organization. Furthermore, the majority (76%) of employees expressed that they would stay in the organization which proposes a continuous improvement opportunity.

As High Tech XXI has never experienced such a significant change in organizational structure and employee development plans have never existed before the frameworks below should be first implemented as a pilot program focusing on a narrow group of people ensuring it works effectively and efficiently. The pilot program might take place for 3 months, involving evaluation of outcomes, gathering feedback, and adjusting a program before implementation to the company-wide.

These frameworks should be implemented within the next 3 months and then the organization's management would monitor further progress on the quarter basis and adjust strategies accordingly.

6.1.1.Career path

Proposed career paths within High Tech XXI represent three categories of positions depending on the employee's individual set of skills, technical knowledge, experience and overall background, which are entry-level, mid-level and leadership roles. As employees come to the entry positions they are expected to grow to the mid-level positions and after mid-level to the leadership roles encouraging continuous improvement of their skills and knowledge.

For the entry-level specifically positions of Trainees students and recent graduates are eligible. Starting working as Trainees or Interns they will gain hands-on experience in different aspects of AMS and geotechnical sensors. For the positions of Junior Engineers or Technicians recent graduates with a little working experience are eligible, who will go through on-the-job training and mentorship programs developing and strengthening their technical skills.

For the positions of Senior Technicians or Senior Engineers employees with sufficient experience and expertise are acceptable, who will be taken on more complex projects and enriched responsibilities. Within the level they also have an opportunity of transition to the position of Project Manager, who executes projects and manages a team and other involved stakeholders.

Exceptional performers from mid-level positions can progress to the Heads of Departments, who will be leading their teams and driving innovations in the areas of hardware, software development, in product design and internal organizational processes. Positions of Executive Directors represent a final destination for career development within the organization. These individuals demonstrate strong leadership skills and have a strategic vision, shaping High Tech XXI's overall direction and future growth strategy.

6.1.2 Mentorship program

A mentorship program is developed for entry-level positions only enabling fast adaptation in a company and gradual and pain-free enhancement of their competences.

Mentees and mentors who have an extended working experience will be paired and continuously work together further. Mentors will guide their mentees, supporting throughout the way and provide career advice when required. They will have regular check-ins on the mentee's overall progress, on challenges faced and setting career development goals.

Mentees will enroll in technical training on High Tech XXI's hardware, software, diving into data analysis and project management basics to better understand internal processes and procedures. In this journey they will be able to improve communication skills through regular engagement with the team and collaborative work, upgrading problem-solving and demonstrating leadership skills.

Career planning section as part of a mentorship program will create a vision for newcomers of their future in a company. They together with mentors will generate a personalized development plan to make more informed decisions about their professional growth.

Mentees will build networks both internally and externally. Mentees will be responsible for introducing their ward to the key personnel in a company and invite mentees to industrial events, conferences and workshops to get to know the people from the industry and form strong connections.

6.2. Recommendation 2: Performance-based incentive program

Deloitte which is a leading global consulting firm that provides services in audit and assurance, financial advisory, risk advisory etc. claims that the practical incentive plan goes even further than the financial compensation as it helps organizations to attract and retain talents while moving forward to meet organizational business goals. (Equity & Incentives, 2024)

Thus, the primary objective of this part of the recommendation is to enhance the employee's motivation, their engagement and overall performance through the performance incentive program, which is assumed to increase employee's satisfaction by 20%. This program might be launched in the next 2 months while performance metrics could be measured every quarter and incentive structures adjusted as necessary. Again, this recommendation might be focused on the specific group of people who prioritize financial rewards as engineers and technicians as per results gathered through Motivational Factor Analysis and if successful, then implemented the framework company-wide.

For employee's motivation there are 7 types of incentive to encourage.

There are individual performance bonuses which consist of achievement-based bonuses and sales commission. For achievement-based

bonuses employees need to exceed their performance targets or show exceptional individual contributions in areas like project delivery, innovation, or problem-solving. For sales commission staff involved in securing new projects or contracts will receive commissions based on the value of the deals closed.

Another type is team performance rewards of two types which are project completion bonuses and quality and efficiency awards. For the first type of the reward teams have to successfully complete the projects within specified timelines and budget constraints collectively. While to be eligible for quality and efficiency rewards teams have to consistently deliver high-quality work and demonstrate efficiency in project execution.

The third is long-time incentives. These are stock options or equity grants and performance-based stock grants which aim to encourage those who show long-term commitment significantly contributing to the company's growth and success. The revenue growth, profitability targets, or successful product launches can stand for the performance-based stock grants as major performance metrics.

The fourth type of incentive provides career advancement opportunities. Those employees who show outstanding performance and demonstrate potential for growth will be further considered for promotions to higher-level roles with enriched responsibilities and salaries. Besides, those high-performing employees will gather access to specialized training programs, conferences, workshops enhancing even more of their skills and competencies.

Recognition programs as part of performance-based incentive programs are also proposed. High Tech XXI's management can decide to recognize outstanding individual contributions of the month or quarter by monetary rewards, certificates or any other forms of recognition. They also might want to celebrate team achievements or milestones through reward ceremonies or company-wide recognition events, thus reinforcing a culture of shared success and collaboration.

Furthermore, they might consider customer satisfaction incentives. As customer referral bonuses for those who bring new customers and this lead to successful projects and as per customer satisfaction surveys rewarding those teams or individuals who achieve high scores, encouraging employee commitment to delivering exceptional services and value to clients.

Last but not least, there are incentives for continuous improvement. As High Tech XXI is an innovative technological startup they have to encourage their employees to continuously propose and implement innovative ideas or improve

processes. For those who do so, through this type of incentive the management is capable of recognizing their hard work, creativity and ingenuity.

By deployment of a comprehensive performance-based incentive program, the company can effectively motivate and reward their employees for the commitment to the company's growth and success, driving performance excellence and employee engagement.

6.3 Recommendation 3: Project specific bonus structure

This program is aimed at employees to encourage outstanding performance on specific projects.

Table 6. Proposed project specific bonus structure

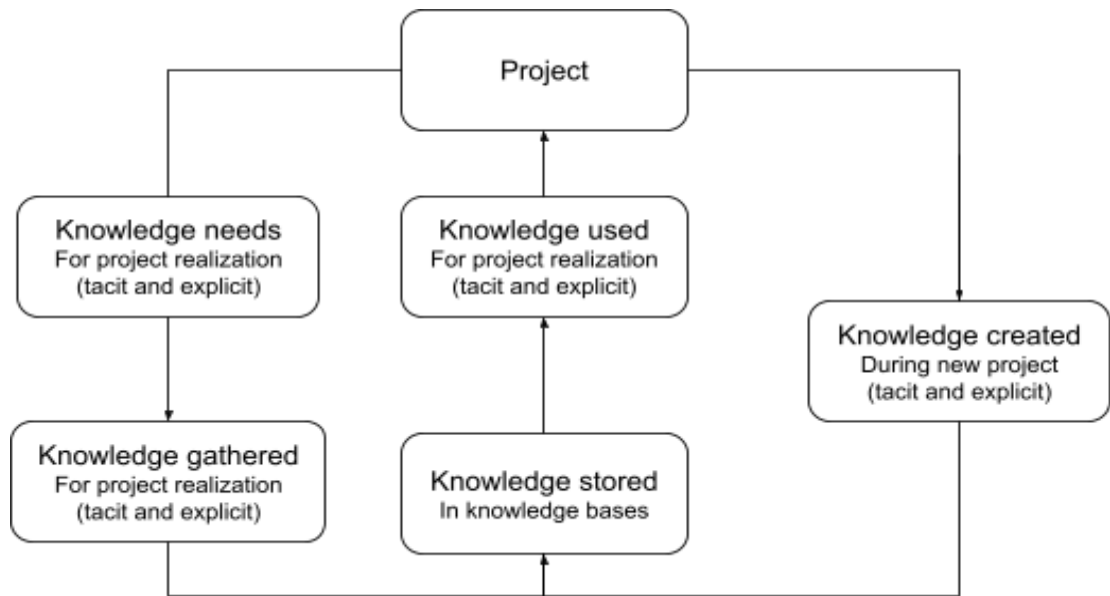
Who qualifies?	<ol style="list-style-type: none"> 1. Engineering team that is involved in the design of the AMS. 2. Technicians that are involved in the implementation, installation, and maintenance of the AMS.
Performance metrics	<ol style="list-style-type: none"> 1. Upselling (securing additional or upgraded features/sensors in the deal). 2. Completing project on time and within budget. 3. Implementing innovative solutions that save costs, improve productivity and performance. 4. Achieving high customer satisfaction and retention rates.
Bonus structure	<ol style="list-style-type: none"> 1. Will be established for each project based on a percentage of the project's total profit margin.
Bonus payout	<ol style="list-style-type: none"> 1. Each team member's contribution will be evaluated based on saved time, costs, or additional revenue. 2. Individual bonuses will be calculated based on the contribution.
Additional factors	<ol style="list-style-type: none"> 1. Program details and performance metrics should be clearly communicated to all employees involved in the project.
Benefits of the program	<ol style="list-style-type: none"> 1. Motivates employees to exceed expectations on project delivery. 2. Encourages teamwork and collaboration. 3. Rewards individual contributions and outstanding performance. 4. Improves overall project performance and increases customer satisfaction.

6.4 Recommendation 4: Structure for the database of completed projects

The process of knowledge treatment is a valuable strategic asset for organizations (Brown J.S., 1991). In order to be competitive companies should implement efficient and effective knowledge creation, data location and knowledge capturing. Moreover, it is essential for an organization to share their expertise and knowledge within the company, and to be able to use their knowledge to solve issues and overcome challenges (Zack, M.H. 1999).

Based on results from maturity model assessment of High Tech XXI the project performance evaluation is the weakest part of the company. According to the results from CLD (Causal Loop Diagram) one of the important factors that has an impact on organization performance is investments in talent development. Talent is a valuable resource for an organization. And to sustain in a competitive environment it is essential to maintain talent development within the organization through continuous learning, knowledge capturing and sharing (Maycock, E. 2015). Thus, our recommendation for High Tech XXI is to develop the database design of completed projects in order to have an opportunity to efficiently evaluate their performance and have effective knowledge management among employees. According to the Gourova E., (2014) people are the core of the knowledge management process. And to build the company's memory it is essential not only to have a repository of explicit knowledge, but also storing tacit knowledge and expertise in the organization. According to the interview with the technical director of the High Tech XXI the company has only codified data storage related to the projects, and no tacit knowledge repository. And it might be beneficial for the company to construct a data storage of explicit knowledge from executed projects with the employees' tacit knowledge (Figure 7.).

Figure 7. Project process and knowledge flow (adopted from Gourova, E. 2014).



To develop information systems and the database design for completed projects the High Tech XXI can create knowledge profiles of their staff, list of their tasks related to a specific activity, and job descriptions. Also, they can list the needed knowledge for each task, and document the knowledge which was created after the realization of the project. To capture implicit knowledge and implement knowledge sharing the High Tech XXI can use individual and team knowledge acquisition techniques. For example, they can use interviews, questionnaires, protocol analysis and brainstorming. The documentation of new problem-solutions and past experience (case studies) can be standardized by using templates. This can help to keep consistency and make the information easy to find. Furthermore, in order to have easy navigation the company can use tags or keywords.

Based on research findings by Gourova E. for developing knowledge management it is necessary to break down the data management into several layers (Figure 8). The first layer is data sources. On this layer located different sources of information that are needed for knowledge management:

- Information from external resources such as market research, competitor analysis, reports from partners, feedback from customer;
- Web repository, information from the internet, websites, articles;
- E-mail repository, information stored in emails;
- Text repository, digitized documents;
- Documented cases, documented creative problem-solutions, experiences;
- Business database, information storage in organizational database;

- Domain repository, specialized information relevant to a particular field or expertise within the organization.

The second layer is the knowledge processing. It is a set of activities that transform raw data into usable knowledge. For instance:

- Knowledge capture, the process of collecting knowledge from different sources;
- Knowledge codification, the process of converting tacit knowledge (informal, experience-based knowledge) into explicit knowledge (documented, transferable knowledge);
- Knowledge storage, storing the codified knowledge with an easy access;
- Knowledge retrieval, methods for finding and accessing the codified knowledge.

And the top layer is knowledge presentation. This layer focuses on how knowledge is presented to the end user. It includes:

- Knowledge portal, web-based platform with a central access point for all organization's knowledge assets;
- Reports and dashboards, visual representations of data and information that can be used for knowledge sharing;
- Search functionality, which allows users to easily find the information they need;
- Collaboration digital tools that allow groups of people to work together online.

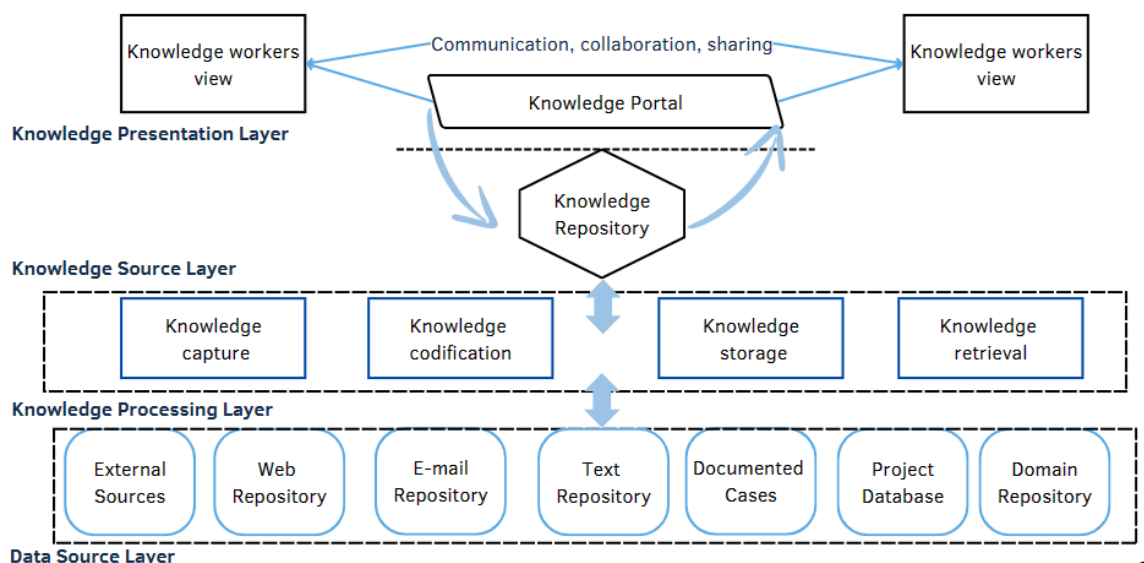


Figure 8. Knowledge management design (adopted from Gourova, 2014)

Overall, by developing the robust database design for completed projects High Tech XXI can facilitate project evaluation more efficiently and enhance the knowledge management among employees. These can help the company to develop risk mitigation strategies based on previous projects and experience, reduce time related to the future projects and focus more on innovations.

Chapter 7. Limitations

Due to the complexity and specificity of an innovation ecosystem of technological startups in Kazakhstan there are several limitations in the research.

First, there is no one and only unique existing tool to cover all the aspects of the ecosystem and to get valuable insights on that. To approach a problem in a more holistic way more than one tool is implemented.

Second, the qualitative method implemented as part of data collection consists of semi-structured interviews which focus on respondent's experiences and opinions, which are subjective by their nature. This could lead to biases.

Third, financial indicators are restricted by the organization by default. Besides that, there are also gaps in data tracking; some data was never collected and stored before.

Chapter 8. Conclusion

The main objective of this capstone project was to analyze the innovation ecosystem of technological startups and identify both internal and external factors affecting its sustainable effectiveness. The project focused on the case of High Tech XXI as a startup company that specializes in providing innovative solutions in the field of geotechnical monitoring systems. This chapter aims to provide key findings of the analysis and specify possible areas for further research.

According to the results of CLD, there are several key factors in the company that affect the performance of High Tech XXI. The main factors were identified by conducting literature review and semi-structured interviews with different stakeholders of the ecosystem. As per results, the diagram showed that talent development is a key driver of innovation strategy of High Tech XXI. By investing in talent, the organization stimulates various important activities, which leads to an increase in the profitability of the company. High profits, in turn, allow the company to invest more in talent and initiate the loop again. It is vital for startups to understand what are the factors that drive innovation in the company. The diagram shows that one factor alone is less effective, emphasizing the role of each activity in the chain. Thus, the company can use the developed CLD as a source for understanding the innovation ecosystem and making appropriate decisions in accordance with it.

The company's maturity assessment was the next step in this capstone project. High Tech XXI was assessed based on the main 6 dimensions, including strategy, performance evaluation, process, people, portfolio management, and

market research. The maturity assessment showed that performance evaluation and people are the weakest indicators among the rest. According to the manager's interview, the company collects customer feedback once when they install the sensors, omitting collecting feedback during the lifecycle of technologies. However, collecting feedback on a continuous basis provides companies with more insights, contributing continuous learning. The maturity assessment analysis can help organizations identify less optimized processes in the company, showing exactly what needs to be improved. This project incorporates an example of a maturity assessment survey, as well as research papers that can be used by companies to independently evaluate their processes. Maturity assessment can stand as a roadmap for improvement, identifying the areas that need most attention.

According to the literature review and CLD, employees are one of the main contributors to the company's innovation capability. In order to better understand the motivation of employees, the survey was designed and analyzed using the AHP method.

The main insight of this survey is that managers have different motivation factors compared to engineers and technicians. Motivation is a driver for employees to acquire new knowledge and achievements (Ali, 2021). Therefore, through the identification of employee motivation factors, companies can create a win-win situation for both themselves and their workers.

Recommendations for the company were developed based on the analysis performed. First, in order to develop talents more efficiently, management of the organization should cultivate skills through suggesting a clear career path and a mentorship program for entry-level engineers. They also must motivate employees to innovate through a developed performance-based incentive program and project-specific bonus structure. The second, for enabling better evaluation they first should document past projects and collect information in a structured database including best practices, lessons learned, and expert insights which will also facilitate knowledge sharing, allowing employees to quickly find information on geotechnical sensor configurations, data analysis techniques, and risk mitigation strategies.

To summarize, this capstone project used three main methodologies to understand the innovation ecosystem of High Tech XX and identify the factors that influence its effectiveness. Based on the analysis, four main recommendations

were proposed to help High Tech XXI improve its overall performance and sustain in the innovative ecosystem.

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Appendix A - Survey #1 questions (for employees)

Section 1: General information

1. Please indicate your first and last name.
2. What is your position within the company?

Section 2: Certificates

In the last 5 years, how many certificates confirming the improvement of your qualifications or development of personal skills have you obtained?

**Do not consider: First aid certificates; Safety technique certificates.*

1. Certificates for training/sessions lasting more than 1 year:
2. Certificates for training/sessions lasting 1 to 12 months:
3. Certificates for training/sessions lasting less than 1 month:

Education and Experience

1. Select your highest level of education:
 - Secondary (9-11 grades)
 - Vocational (college)
 - Bachelor's degree
 - Master's degree
 - PhD
2. Please indicate the total years of work experience? (For example, 3 years)

Section 3: Any Ideas for Improving Processes and/or Products

Have you proposed any ideas to management for improving the product or optimizing the work process?

If yes: Describe the most important ideas, in your opinion.

If no: Proceed to the next question.

- 1) Please specify the total number of ideas you have proposed:
 - 0
 - 1
 - 2
 - 3
 - 4
 - Other:

Appendix B - Survey #2 questions (for employees)

Section 1: General information

1. Please indicate your first and last name.

Section 2: Likert Scale Questions

In this section, you need to select how much you agree or disagree with each statement, using a scale from 1 to 7, where 1 - strongly disagree, and 7 - strongly agree.

1. I am comfortable taking risks for the sake of trying something new in my work.
 - Strongly disagree
 - Disagree
 - Somewhat disagree
 - Neither agree nor disagree
 - Somewhat agree
 - Agree
 - Strongly agree
2. I have all the necessary resources to try out new ideas in my work.
3. I regularly communicate and collaborate with colleagues, and often participate in teamwork.
4. My new ideas and suggestions are supported and encouraged.
5. I have the opportunity to attend various trainings and courses to improve my skills.
6. I find my work interesting; it challenges me to adapt quickly and find the best ways to complete tasks.
7. I receive constructive feedback on my proposed ideas.
8. My workspace (office and provided amenities) promotes teamwork and idea exchange.
9. New ideas are freely discussed and tested in my workplace.
10. I independently determine the sequence of completing my tasks, which contributes to my work efficiency.
11. I regularly take on a leadership role in the team and have the opportunity to delegate tasks among its members.

12. I have the freedom to independently solve production and operational problems in my work.

Section 3: "Yes" or "No"

In this section, you need to choose whether you agree or disagree with the statements provided.

1. I have a clear way to suggest new ideas and ensure they are considered at work.
 - Yes
 - No
2. I regularly spend time reflecting on how to improve my work.
3. In the past year, I have worked on a task or tasks that required a new solution.
4. I feel that my ability to generate new ideas is taken into account when evaluating my work.
5. I am frequently asked for feedback on how to improve work or processes within the company.
6. I actively participate in teamwork within my organization.
7. I regularly perform various functions within the company (For example, an engineer may temporarily work in the marketing department to better understand how the company's products are promoted).

Section 4: Motivation Factors and Their Importance

In this section, you will need to choose which factors influence your motivation and assess their importance compared to others.

1. What motivates you more?
 - Finances (salary, bonuses, and incentives)
 - Career (job promotion and professional development)
2. How much more important is the chosen factor compared to the other?
 - Both factors are equally important
 - One is slightly more important than the other
 - One is clearly more important than the other
 - One is significantly more important than the other

- One is extremely more important than the other
3. What motivates you more?
 - Finances (salary, bonuses, and incentives)
 - Recognition (acknowledgment of achievements and efforts, rewards, certificates, praise from colleagues and superiors)
 4. How much more important is the chosen factor compared to the other?
 5. What motivates you more?
 - Finances (salary, bonuses, and incentives)
 - Avoidance of negative consequences (desire to avoid disciplinary actions, penalties, or dismissal)
 6. How much more important is the chosen factor compared to the other?
 7. What motivates you more?
 - Finances (salary, bonuses, and incentives)
 - Social pressure (desire to meet the expectations of management, colleagues, and society)
 8. How much more important is the chosen factor compared to the other?
 9. What motivates you more?
 - Career (job promotion and professional development)
 - Recognition (acknowledgment of achievements and efforts, rewards, certificates, praise from colleagues and superiors)
 10. How much more important is the chosen factor compared to the other?
 11. What motivates you more?
 - Career (job promotion and professional development)
 - Avoidance of negative consequences (desire to avoid disciplinary actions, penalties, or dismissal)
 12. How much more important is the chosen factor compared to the other?
 13. What motivates you more?
 - Career (job promotion and professional development)
 - Social pressure (desire to meet the expectations of management, colleagues, and society)
 14. How much more important is the chosen factor compared to the other?
 15. What motivates you more?
 - Recognition (acknowledgment of achievements and efforts, rewards, certificates, praise from colleagues and superiors)

- Avoidance of negative consequences (desire to avoid disciplinary actions, penalties, or dismissal)

16. How much more important is the chosen factor compared to the other?

17. What motivates you more?

- Recognition (acknowledgment of achievements and efforts, rewards, certificates, praise from colleagues and superiors)
- Social pressure (desire to meet the expectations of management, colleagues, and society)

18. How much more important is the chosen factor compared to the other?

19. What motivates you more?

- Avoidance of negative consequences (desire to avoid disciplinary actions, penalties, or dismissal)
- Social pressure (desire to meet the expectations of management, colleagues, and society)

20. How much more important is the chosen factor compared to the other?

Appendix C - Maturity model questions (for manager)

Strategy (3 questions)

1. How well does your current R&D strategy support the installation and maintenance of automated monitoring systems in residential buildings?
 - No formal strategy. Installation and maintenance are done on demand without a clear plan.
 - Basic strategy is being developed. Some buildings are equipped with systems as needed.
 - Clear strategy. Most new buildings are equipped with systems, regular maintenance is conducted.
 - Strategy closely aligns with the mission. All new buildings have systems, innovative solutions are implemented.
 - Proactive strategy. The company sets industry standards and actively promotes its systems. (V)
2. How clearly does your R&D strategy define the types of monitoring systems and sensors to be developed for residential buildings?
 - No clear guidance. Development is carried out without a plan.
 - The strategy provides general direction, details are unclear.
 - The strategy identifies key areas for system development.
 - Clear guidance on systems and adaptation to market needs. (V)
 - The strategy proactively anticipates future system needs.
3. How well does your R&D strategy account for changing market needs in residential buildings and new technologies?
 - The strategy is static, does not account for market changes.
 - Limited ability to adapt the strategy.
 - Some flexibility in the strategy to accommodate market dynamics.
 - The strategy is regularly adapted to market trends.
 - High flexibility of the strategy, proactive consideration of future market trends. (V)

Processes (3 questions)

4. How formalized and documented is your process for installing and maintaining monitoring systems in residential buildings?
 - No formal process. Each installation is unique.
 - Basic documentation. The process varies slightly between projects.

- Formalized process, generally adhered to.
 - Strict process with checkpoints, minor deviations.
 - Fully standardized process with clear stages and quality control. (V)
5. Who bears the primary responsibility for the process of installing and maintaining monitoring systems?
- No clear owner. Responsibility is blurred between departments.
 - Project managers manage the process individually.
 - A dedicated department is responsible for the process.
 - The process requires close collaboration between multiple departments. (V)
 - A single process owner with clear accountability at all levels.
6. How is information exchanged between departments in the process of installing and maintaining monitoring systems?
- Information exchange is irregular and informal.
 - Periodic updates on status between some departments.
 - Regular meetings for information exchange at key stages.
 - Standardized reports and centralized data repository.
 - Unified information system for all departments with real-time access.
- (V)

Performance Evaluation (3 questions)

7. How do you assess the quality and success of installed monitoring systems in residential buildings?
- No formal quality assessment criteria.
 - Basic assessment of system functionality after installation.
 - Assessment based on several parameters at key project stages.
 - Detailed technical and user testing for each system. (V)
 - Continuous monitoring and real-time evaluation of system performance.
8. How structured and formalized is your process for evaluating installed monitoring systems?
- Evaluation is not conducted or entirely informal.
 - Periodic informal evaluation of some systems.
 - Basic evaluation parameters and procedures are defined.
 - Detailed evaluation procedures with documentation and management oversight. (V)

- Strictly defined evaluation protocols with independent audits.
9. Who is responsible for evaluating the quality of installed monitoring systems?
- No specific responsibility for quality evaluation.
 - Installation engineers provide a general assessment of their work.
 - Project manager and their team evaluate the system. (V)
 - A dedicated quality control department evaluates all systems.
 - External auditors provide an independent assessment of each system.

People (4 questions)

10. How are your project teams organized for the installation and maintenance of monitoring systems in residential buildings?

- No permanent teams. Specialists are assembled for each project.
 - Project manager forms teams, but the composition often changes.
 - Key roles are defined, and the team is partially permanent.
 - Cross-functional teams with permanent members and clear roles.
- (V)
- Dedicated project teams with full-time commitment and personnel rotation.

11. How involved and motivated are employees involved in monitoring systems?

- Low involvement. Monitoring systems are not considered important.
- Some employees are involved but do not feel connected to the outcome.
- Most employees understand the importance of their work.
- High involvement and motivation to achieve quality results.
- Monitoring systems are a top priority. Employees take pride in their work. (V)

12. What training and development opportunities are available to employees involved in monitoring systems?

- No specialized training is provided.
- Rare informal training sessions with no clear plan.
- Periodic training for some employees.
- Systematic training for most roles.

- Continuous specialized training and certification for all employees.
- (V)

13. How much are innovations in monitoring systems for residential buildings encouraged in your company?

- Innovations are not encouraged; the main focus is on standard solutions.
- Innovative ideas are rarely discussed, with no reward system.
- There are some initiatives for innovation, occasionally rewarded.
- Regular innovative projects, formalized reward system. (V)
- Innovation is part of the culture, significant rewards are given for them.

Portfolio Management (2 questions)

14. How does your company select and prioritize projects for the installation of monitoring systems in residential buildings?

- No clear project selection criteria.
 - Projects are selected as they come, prioritized by date.
 - Projects are evaluated based on basic criteria: size, deadlines, budget.
 - The project portfolio is formed in accordance with the company's strategy.
 - Projects are carefully selected to ensure maximum long-term value.
- (V)

15. How does your company allocate resources among various monitoring system projects?

- No formal resource allocation process.
- Resources are allocated on request based on the budget.
- Resources are partially allocated according to project priorities.
- The company's strategy determines the allocation of key resources.
- Resources are dynamically reallocated to ensure an optimal project portfolio. (V)

Market Research (3 questions)

16. How do market research on the residential sector influence the development of your monitoring systems?

- No market research is conducted.
- Research is conducted sporadically, with little influence on development.
- Research determines initial requirements for the systems.
- Regular research is conducted at all stages of system development.
- Continuous proactive research and system adaptation to market needs. (V)

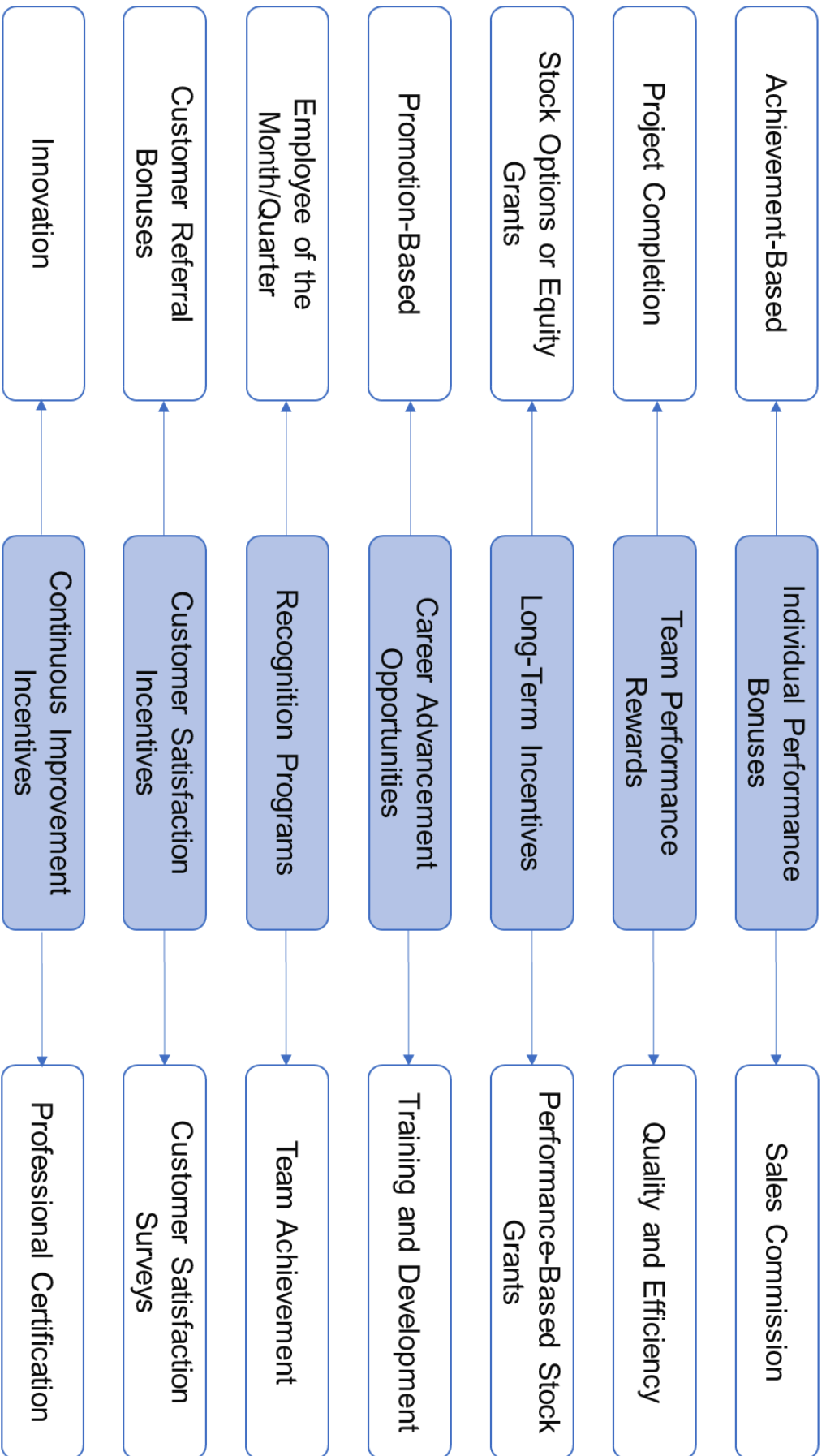
17. How thoroughly do you analyze competitors' offerings in the market for monitoring systems in residential buildings?

- Competitor analysis is not conducted.
- Non-systematic surface analysis of key competitors.
- Periodic competitor analysis as needed.
- Regular analysis and monitoring of competitors' actions.
- Deep proactive competitor analysis, strategic planning. (V)

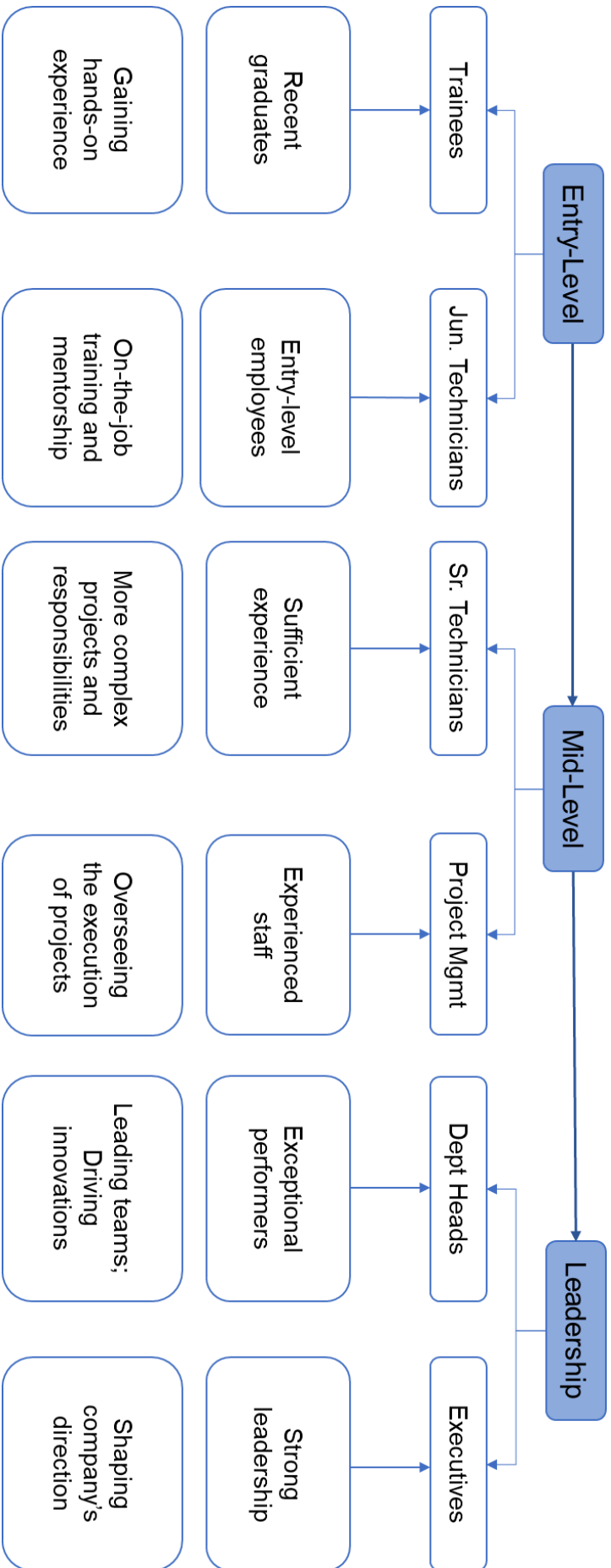
18. How thoroughly do you test new monitoring systems before their full-scale implementation in residential buildings?

- No testing is conducted or only basic functional testing is performed.
- Limited testing of some systems in laboratory conditions.
- Structured testing of key systems involving some users.
- Detailed multistage testing of all systems in real conditions.
- Comprehensive testing, including pilot deployment, feedback collection, and refinement. (V)

Appendix D - Performance-Based Incentive Program



Appendix E - Proposed Career Path



Appendix F - Proposed Mentorship Program

